Understanding the Biological Pathways in the Associations between Social Position and Mental Health: An Examination of Allostatic Load

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Declarations

I declare that this thesis represents my work, and no part of it has been submitted in a previous application for a degree.

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Abstract

Introduction

Individuals from disadvantaged social positions experience poorer mental health than their peers from advantaged social positions. One biological mechanism by which these associations occur is theorised to be through psychosocial or ‘stress’ mediated processes. Allostatic load is hypothesised as a biological consequence of chronic stress composed of ‘primary’ biomarkers of stress and ‘secondary’ outcomes.

Aims

This thesis examines the social and biological factors underpinning inequality in mental health.

Methods

This study uses logistic and linear regression models and data from the English Longitudinal Study of Ageing (ELSA), the Understanding Society, the UK Household Longitudinal Study (UKHLS), the 1958 National Child Development Study (NCDS) and the 1970 British Cohort Study (BCS70) to examine the association between 1) social position indicators education and occupation and mental health; 2) allostatic load and mental health and 3) social position indicators and allostatic load. Given the inconsistencies in operationalising allostatic load identified in the literature review, the thesis used data from the above datasets and the MRC National Survey of Health and Development (NSHD), the Hertfordshire Cohort Study (HCS) and Avon Longitudinal Study of Parents and Children (ALSPAC) to understand the composition of allostatic load using factor analysis. The thesis investigated first whether variables representing each biological system affect the allostatic load factor structure; second, if including primary mediators will change how biomarker variables load onto factors; and finally, if the factor structures were similar across the seven datasets.

Results

Results suggest that 1) higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health; however, only the link with occupational class persists when both variables are investigated concurrently.

2) Overall, five components of allostatic load, including metabolic, inflammatory, glucose metabolism, cardiovascular and neuroendocrine factors, were associated with mental health, although the direction of association varied in some studies. For example, in NCDS, each additional metabolic factor score decreased the odds of having poor mental health. However, some components of allostatic load, such as lipid and iron factors, were not associated with mental health.

3) Different variables representing specific biological systems did not affect the allostatic load factor structure. Including primary mediators did not change how biomarkers load onto factors; factor structures were similar across the seven datasets. Disadvantaged social position was associated with greater allostatic load, for example, neuroendocrine and inflammatory factors, but not all components were consistently patterned across all studies examined.

Study contributions

These findings support the literature on social position and mental health and provide better insights into how education is linked with mental health. The study suggests that lipid and iron factors were not associated with mental health and are unlikely to underpin any social differences in health.

Conclusions

In conclusion, higher occupational class and educational attainment are linked to better mental health. However, the association of educational attainment and mental health is working via occupational class. Individuals from disadvantaged social positions experience poor allostatic load, in particular neuroendocrine and inflammatory components. They are at higher risk of having poor mental health than their peers from advantaged social positions. This study suggests that the lipid and iron biomarker components of allostatic load do not contribute to inequalities in mental health.

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List of abbreviations

ALSPAC = Avon Longitudinal Study of Parents and Children

APOE = Apolipoprotein E

APOA1 = Apolipoprotein A1

APR = Acute Phase Response

BCS70 = British Cohort Study

BMI = Body mass index

CAR = Cortisol Awakening Response

CES-D = Center for Epidemiologic Studies Depression Scale

CFA = Confirmatory Factor Analysis

CFI = Comparative fit index

CINAHL = Cumulative index to nursing and allied health literature

CMV = Cytomegalovirus

CRP = C-reactive protein

DBP = Diastolic blood pressure

DHEA-S = Dehydroepiandrosterone

EFA = Exploratory Factor Analysis

ELSA = English Longitudinal Study of Ageing

ESR = Erythrocyte sedimentation rate

FIB = Fibrinogen

GHQ = General Health Questionnaire

HbA1c = Glycosylated haemoglobin

HCS = Hertfordshire Cohort Study

HDL = High-density lipoprotein

HGB = Haemoglobin

HPA = hypothalamic-pituitary-adrenal (HPA) axis

IGE = Immunoglobulin E

IGF-1 = Insulin-like growth factor 1

IGF-2 = Insulin-like growth factor 2

IGF-3 = Insulin-like growth factor 3

IL-4 = Interleukin 4

IL-6 = Interleukin 6

IgM = Immunoglobulin M

LDL = Low-density lipoprotein

MAP = Mean arterial pressure

MCH = Mean corpuscular haemoglobin

MLR = Robust Likelihood Estimation

NCDS = National Child Development Study

NSHD = National Survey of Health of Development

NS-SEC = National Statistics Socio-economic Classification

RMSEA = Root mean square error of approximation

SBP = Systolic blood pressure

SNI = Social Network Index

SRMR = Standardised root mean square residual

TLI = Tucker-Lewis index

TPA = Tissue plasminogen activator antigen

TRIG = Triglyceride

U.K = United Kingdom

UKHLS = The UK Household Longitudinal Study

U.S = United States of America

VWF = Von Willebrand factor antigen

WBC = White blood cell count

WHO = World Health Organisation

WHR = Waist-to-hip ratio

Chapter One

Introduction

A disadvantaged social position is said to have a damaging influence on biological and mental health outcomes (Comes et al., 2018; Darin-Mattsson et al., 2017). Evidence suggests that the dysregulation of biological systems, which leads to allostatic load, could explain how social factors get under the skin to impact health (Krieger, 2005; McEwen & Stellar, 1993; Prior et al., 2018). Chronic stress has been implicated in the dysregulation of biological systems (Krieger, 2005). Over time, extensive literature has developed linking higher allostatic load to poorer health outcomes (Guidi et al., 2020; Johnson et al., 2017; Krieger, 2005; Prior et al., 2018). Nonetheless, there is no consensus on how to operationalise allostatic load.

There are considerable differences in the number of biomarkers used to calculate the allostatic load index (Piotrowski et al., 2019; Savransky et al., 2018; Savransky et al., 2017). There are also considerable differences in calculating the allostatic load score (Piotrowski et al., 2019; Savransky et al., 2018). Some literature combines all the biomarkers, assuming that each biomarker contributes equally to the allostatic load (Rodriquez et al., 2019). At the same time, others calculated the allostatic load in two stages. First, individual biomarkers are recoded using clinical risk cut-off points, high-risk quartiles, or the use of medication (Dargél et al., 2020; Rodriquez et al., 2018). Lastly, varying scores are calculated for individual organ systems, such as inflammatory and cardiovascular systems (Prior et al., 2018).

The summative count method is the most common technique in determining the allostatic load score (Prior et al., 2018). The summative count technique infers that individual biomarkers have an equal influence on the allostatic load score, but this has not been established (Rodriquez et al., 2019). Other methods include averaging continuous z-scores of biomarker variables (Hawkley et al., 2011). This approach could nullify the impact of individual biomarker systems (Rodriquez et al., 2019). Another method is calculating the allostatic load score using clinical risk cut-offs (Dargél et al., 2020). Nonetheless, the main problem with this method is that not all biomarkers have clinical risk cut-offs (King et al., 2019).

On the other hand, evidence suggests that factor analysis, a data reduction method that allows researchers to examine notions that cannot easily be measured (Finch, 2020), could be a robust approach to measuring allostatic load (King et al., 2019). However, a few studies have used factor analysis to calculate the allostatic load scores (King et al., 2019; Wiley et al., 2016), creating a gap in the literature on allostatic load. Therefore, this study operationalises allostatic load using factor analysis to fill this gap.

Also, evidence suggests that biomarkers load onto factors representing different biological systems, which have been shown to have varying connections with social position (Hawkley et al., 2011). For example, Robinson et al. (2020) report that disadvantaged social position was associated with higher metabolic biomarkers. Contrarily, the evidence on the link between lipid biomarkers and social positions is mixed. Espírito Santo et al. (2019) suggest that individuals from advantaged social positions had higher lipid levels than those from disadvantaged social positions. In contrast, Kohler et al. (2013) and Trias-Llimós et al. (2022) found that advantaged social position was linked to lower lipid biomarkers. Consequently, more research is needed examining the associations between social position and allostatic load components. To this end, therefore, this study examines the association between social position and the subsystems of allostatic load in Chapter Four.

As highlighted earlier, a disadvantaged social position damages mental health outcomes (Comes et al., 2018; Darin-Mattsson et al., 2017). Poor mental health, including depression, psychological distress and schizophrenia, is among the ten top causes of disability and death, significantly affecting an individual's quality of life and individual and societal cost (Ahnquist & Wamala, 2011; Baughman et al., 2016). Untreated poor mental health is responsible for thirteen per cent of the overall worldwide illness problem (World Health Organization, 2012). Poor mental health is responsible for twenty-eight per cent of the United Kingdom's (UK's) disease liability, making it a key reason for sickness absence (Davies, 2014). It costs the UK economy between seventy to a hundred billion pounds yearly (Davies, 2014).

Generally, individuals with poor mental health have shorter life expectancies than those without poor mental health; on average, they die fifteen to twenty years earlier than those without poor mental health (Baughman et al., 2016; Davies, 2014; Piatt et al., 2010). Evidence suggests that over fifty per cent of persons in middle- and high-income countries will experience one form of poor mental health during their lifetime (Trautmann et al., 2016). The Covid-19 pandemic magnified these numbers. For example, Banks & Xu (2020) suggest that the recent Covid-19 pandemic has worsened the incidence of poor mental health with an approximate increase of eight per cent, and the most vulnerable groups, namely women and young adults, are worse hit than the general population. Thus, poor mental health is a crucial public health issue that demands urgent and ongoing attention.

What is mental health?

Mental health, a crucial part of general well-being, has become a growing concern and attention topic. However, having a single definition for mental health continues to be challenging (Bhugra et al., 2013; Marques et al., 2023; Weinstein & Spandler, 2014). Nonetheless, there is a common consensus that mental health is not just a lack of mental disorder, but it involves thoughts, feelings and behaviour (Bhugra et al., 2013; Weinstein & Spandler, 2014). This study proposes that mental health is a state of equilibrium in thoughts and feelings which enables a person to function well and live an everyday life using previously described definitions (Bhugra et al., 2013; Marques et al., 2023; Weinstein & Spandler, 2014).

Prevalence of poor mental health

Generally, advances in tackling poor mental health have been made through policies and initiatives (World Health Organization, 2022). However, despite these advances, the prevalence of poor mental health continues to rise (World Health Organization, 2022) and the World Health Organization states that the incidence of poor mental health increased by about twenty-five per cent between 2000 and 2019, and this estimate is growing due to Covid-19 (Banks & Xu, 2020; World Health Organization, 2022).

The literature reports that the rise in poor mental health is driven mainly by the increase in poor mental health amongst the younger population, but the rises were also higher in women; young adults experienced around a 71 per cent increase in psychological distress and a 63 per cent increase in major depression (Twenge et al., 2019). Cultural trends point to new drivers of poor mental health, including social media usage

(Twenge et al., 2019), suggesting age and period differences in the promoters of poor mental health.

How has mental health been measured?

Population health surveys have measured mental health using standardised instruments (Baxter et al., 2013; Coffey et al., 2021). These instruments are intended to capture information about symptoms a person reports, for example, persistently lowered mood and reduced capacity for enjoyment or loss of sleep due to worry. Some standard tools used in population health surveys to measure mental health are listed in Table 1.1 below.

Table 1. 1: Instruments used to measure mental health in population health surveys

Name of the instrument	Summary	Strengths and limitations
Center for Epidemiologic Studies Depression Scale	The Center for Epidemiologic Studies Depression Scale is a self-report tool used to measure depression in the general population (Catalogue of Mental Health Measures, 2023). However, it has proven reliable for patient samples (Catalogue of Mental Health Measures, 2023).	The Center for Epidemiologic Studies Depression Scale has high internal consistency and is established as a valid instrument (Radloff, 1977). However, the interviewer and type of interview can impact the mean scores (Radloff, 1977).
General Health Questionnaire (GHQ)	The GHQ is a self-report tool for measuring minor mental health conditions in the general population (Catalogue of Mental Health Measures, 2023).	The GHQ is easy to use (Jackson, 2007) and is a widely validated and reliable tool (Goldberg et al., 1997). However, it does not capture subtle changes in mental health (Anjara et al., 2020).
Malaise Inventory	The Malaise Inventory is a self-report instrument used for measuring psychological distress, including anxiety and depression (Catalogue of Mental Health Measures, 2023).	Many studies have shown that the Malaise Inventory has high internal reliability and is a valid and trustworthy tool (Rodgers et al., 1999b). Nevertheless, some studies suggest that results may not be consistent across different groups (Grant et al., 1990).
Clinical Interview Schedule – Revised	The Clinical Interview Schedule – revised is a structured interview to measure symptoms of common mental health conditions (Catalogue of Mental Health Measures, 2023). It can be used as a computer-assisted self-administered or by an interviewer (Catalogue of Mental Health Measures, 2023).	The revised Clinical Interview Schedule has been proven to be a valid and reliable tool (Lewis et al., 1992). Nonetheless, sample-based alteration is possible (Lewis et al., 1992).

Patient Health Questionnaire Depression Scale	The Patient Health Questionnaire Depression Scale is a self-report instrument used for measuring depression symptoms (Catalogue of Mental Health Measures, 2023). It can be used in both patient and population samples (Catalogue of Mental Health Measures, 2023).	The Patient Health Questionnaire Depression Scale is a validated and reliable tool for measuring depressive symptoms and anxiety (Kroenke et al., 2016). However, some studies have highlighted inconsistencies between the Patient Health Questionnaire Depression Scale scores and similar tools, including the Global Rating of Change (Robinson et al., 2017).
Warwick-Edinburgh Mental Well-being Scale	The Warwick-Edinburgh Mental Well-being Scale is an instrument used to measure mental well-being in the population (Catalogue of Mental Health Measures, 2023).	The Warwick-Edinburgh Mental Well-being Scale is a reliable and validated tool (Maheswaran et al., 2012; Tennant et al., 2007). However, (Marmara et al., 2022) have called for caution in gender comparisons.
Kessler Psychological Distress Scale	The Kessler Psychological Distress Scale is an instrument for assessing psychological distress in the population (Catalogue of Mental Health Measures, 2023).	The Kessler Psychological Distress Scale is a widely validated and reliable tool (Easton et al., 2017). Nevertheless, some studies have reported variable evidence for its cultural suitability (Stolk et al., 2014).

Table 1.1 shows that despite some limitations, the different instruments used in measuring mental health in population health surveys are broadly reliable and valid. The choice of the tool to use depends on the aims of the study, the attributes of mental health that are the focus of the investigation and available resources (Baxter et al., 2013; Coffey et al., 2021).

In the UK, McElroy et al. (2020) carried out a project in which they examined the measurement properties of the indicators of mental health used in six British birth cohort studies, including the NCDS, BCS70, NSHD, ALSPAC, Millennium Cohort Study and Next

Steps. The indicators of mental health used in the six cohort studies include the GHQ, Malaise Inventory, Short Form Health Survey, Kessler Psychological Distress Scale, Mood and Feelings Questionnaire, Psychiatric Symptom Frequency Scale, and Present State Examination (McElroy et al., 2020). McElroy et al. (2020) aimed to harmonise the mental health indicators used in the six British birth cohort studies to make them more comparable because the mental health indicators used differ across the various studies and cohorts within identical studies. Additionally, most instruments are self-administered and highly subjective, which could impact how participants understand and interpret questions (McElroy et al., 2020). These reasons could bias responses, which may impact the comparability of these instruments across the datasets (McElroy et al., 2020).

McElroy et al. (2020) used a content validation technique to find theoretically comparable elements from the various indicators of mental health used in the six cohort studies. Generally, McElroy et al. (2020) found that the indicators had eighty-eight per cent content agreement. This means that although differences in age, cohorts, time point and survey design had an impact, the indicators are reasonably comparable (McElroy et al., 2020).

Current literature on the aetiology and pathophysiology of poor mental health remains limited (Comes et al., 2018). However, the evidence is consistent across the literature that poor mental health results from the complicated interaction between social, biology, and behaviours (Taurines et al., 2011). The effect of this interaction is the alteration of a person's biological processes, a notion defined as biological embodiment (Krieger, 2005), which, put differently, can be referred to as a concept describing how the social gets under the skin to impact health.

Social determinants of mental health

We are exposed to social factors that could place us at an advantage or disadvantage (Public Health England, 2018a). These social factors, such as educational attainment, occupation and wealth, create inequalities in health and society and are examples of the social determinants of health (Public Health England, 2018a). There is a long history of research to assert that mental health problems are significantly greater among persons with disadvantaged social positions than among those from more advantaged social positions (Adler & Stewart, 2010; Dahlgren & Whitehead, 2006; Darin-Mattsson et al., 2017; Tiikkaja et al., 2013; World Health Organization, 2005). Identifying and understanding how and why individuals from disadvantaged social positions have poorer health outcomes than those from advantaged social positions will help tackle health inequalities (Kelly-Irving, 2019; Public Health England, 2017). Social inequalities in health result from the unfair distribution of opportunities and resources and are discriminatory and alterable (Dahlgren & Whitehead, 2006; Public Health England, 2017).

Understanding the social patterning of mental health offers a better understanding of the inequalities in mental health. It hence helps policymakers to develop better-targeted policies and strategies in addressing the social determinants of poor mental health (Public Health England, 2018b) and to formulate better ways of assigning limited resources according to health needs (Darin-Mattsson et al., 2017; Klanscek et al., 2014).

Various terms, including social position, socioeconomic status and social class, have been used in the literature to represent disadvantaged social positions (Galobardes et al., 2006; Lynch & Kaplan, 2000). In this study, social position refers to the social factors that determine an individual's rank within society (Farkas, 2022; Lynch & Kaplan, 2000), and it has been operationalised in different ways but mostly as occupation and educational attainment (Adler & Stewart, 2010; Dahlgren & Whitehead, 2006; Darin-Mattsson et al., 2017).

Occupation reflects an individual's position within society and is conceptually explicit and empirically validated (Darin-Mattsson et al., 2017; Galobardes et al., 2006). However, occupation cannot be used for individuals without official occupations, such as homemakers and the unemployed, and it is not easy to classify certain groups, including the self-employed (Galobardes et al., 2006; Krieger et al., 1997; Martikainen & Valkonen, 1999). Also, occupation may not capture differences in working conditions by gender or race (Krieger et al., 1997). In addition, occupation may mean different things in different societies (Galobardes et al., 2006).

Persistent occupational differences exist between men and women (Blau & Kahn, 2017). As women became more empowered, particularly in Western societies, human capital factors such as educational attainment are comparatively insignificant in explaining gender differences in occupation, but discrimination remains a factor (Blau & Kahn, 2017). Despite the occupational differences between men and women, the literature suggests a substantial increase in women in work, which implies that occupation has changed over the years (Blau & Kahn, 2017).

Education empowers people with health-associated knowledge, which helps people to engage in better health behaviour, improving health (Darin-Mattsson et al., 2017; Galobardes et al., 2007; Smith et al., 1998). Also, education is intrinsically connected to occupation as it increases employment opportunities (Bruna et al., 2006; Galobardes et al., 2007). Additionally, education, compared to other measures of social position, is relatively easy to measure, and the response rate seems to be high, and education applies to adults irrespective of their age or where they work (Darin-Mattsson et al., 2017; Galobardes et al., 2006). However, education does not have a general meaning in all groups as it is impacted by factors such as gender (Krieger et al., 1997).

Historical gender gaps in educational attainment are well documented. Prior studies on gender differences in educational attainment indicated that women had lower educational attainment than men (Aisenberg & Harrington, 1988; Finn, 1979). The gender gap in education could be attributed to labour market discrimination against females, as females have fewer educational rewards compared to men (Hadjar et al., 2014; Kingdon, 2002). Also, parents treat male and female children differently because they value sons more than daughters and, as a result, give greater importance to the well-being of their sons (Saha, 2013).

Nevertheless, women's educational attainment has improved significantly (van Hek et al., 2016), with some studies suggesting that females have equalled males (Snyder et al., 2016) and others (Buchmann et al., 2008; Morgan & Volante, 2016) implying that females now outperform males in several Western countries. These results indicate that education has changed over the years. Furthermore, high educational attainment does not necessarily mean better jobs and higher income, as factors such as chronic illness may force persons with high educational attainment to take up low-earning jobs below their educational level (Krieger et al., 1997).

There is a vast literature on the association between social position and health. Studies on inequalities in health have continually found a social gradient in health (Amin et al., 2023; Back & Lee, 2011; Darin-Mattsson et al., 2017; Thomson et al.,

2018) such that individuals from disadvantaged social positions have poorer health outcomes than those from advantaged social positions (Darin-Mattsson et al., 2017). Results from earlier studies on inequalities in health have sparked debates about the indicator of social position to use (Darin-Mattsson et al., 2017; Geyer et al., 2006). Some studies have used the different measures of social position interchangeably (Smith et al., 1998; Nilsson et al., 2004). However, some studies have argued that these measures should not be interchanged because, though related, they measure different aspects of social disadvantage (Geyer et al., 2006; Khang & Kim, 2005).

On the other hand, other studies (Darin-Mattsson et al., 2017; Galobardes et al., 2006) suggest that seeking a specific best measure of social position is not beneficial. These studies maintain that although different measures of social position capture distinct aspects of social disadvantage, most of the measures are related and capture inherent aspects of social disadvantage (Darin-Mattsson et al., 2017; Galobardes et al., 2006). Instead, some (Darin-Mattsson et al., 2017; Galobardes et al., 2006) propose that researchers should base their choice of the indicator of social position on their research question and the anticipated processes connecting social position to the health outcome.

Measures of social position used in this study

Changes in gender and population differences in education and other factors have meant that educational attainment has changed over time (Paterson, 2022; van Hek et al., 2016). For instance, in the UK, a smaller proportion of people attained graduate or postgraduate levels of education in older age groups, which is much more prevalent in younger age groups (Paterson, 2022). Also, policy changes are partly responsible for the shift in educational attainment as policymakers considered education a basic right of citizens in a democratic country (Paterson, 2015).

Furthermore, there has been a big difference in people's jobs, from more manual and lifelong occupations in older age groups to more service-based, sedentary, and less secure occupations for younger people (Paterson, 2022). Given the changes in educational attainment, occupational type and mental health, it is not clear that the relationships between these factors are still apparent the same way they have been. Consequently, a thorough examination of the inequalities in mental health using occupation and education as indicators of social position in different datasets may provide essential insights into the processes generating social gradients in mental health. In addition, the most used indicators of social position are embedded in educational and occupational classifications (Darin-Mattsson et al., 2017).

Therefore, the first aim of this study is to examine the association between social position measured using occupation and educational attainment, respectively and mental health. In addition to the above reasons, this study operationalises social position using occupation and educational attainment for three reasons. First, occupation and educational attainment give a more longstanding outlook of a person's social position, and they allow a discussion of the life course as educational attainment reflects the early life course while occupation reflects conditions in mid-life (Galobardes et al., 2006; Piha et al., 2009). On the contrary, although income, for example, is an important measure of social position, it can change quickly for different reasons, including economic and job changes, and it depicts present financial health (Duncan et al., 2002). Second, occupation and education hold more social and cultural importance than income (Haupt & Ebner, 2020; Watt & Eccles, 2008). Finally, occupation and education are more commonly used for policy interventions addressing the root causes of societal inequalities (Antoniou et al., 2012; Haupt & Ebner, 2020; Raghupathi & Raghupathi, 2020; Williams, 2012).

The biological underpinning of mental health

Literature indicates differences in the biological profiles of individuals with poor mental health compared to those without poor mental health (Comes et al., 2018). Several studies suggest that our social exposures, life experiences and health behaviour impact our biological processes, and together, they impact our health outcomes (Blane et al., 2013). Yet, most research has focused on social and behavioural or biological processes (Harris & Schorpp, 2018). However, there has recently been a push for research integrating social and biological factors to understand better how social factors get under the skin to impact health (Preece et al., 2018). This highlights the importance of understanding the pathways from social to biological, as it is essential in tackling inequalities in mental health (McDowell, 2023).

The Pathways Creating Health Inequalities

Over the years, different frameworks have emerged explaining how social and biological factors interact to impact health (Gruenewald et al., 2012; Haslam et al., 2019). One such framework is the biopsychosocial model of health introduced by Engel (1977), which considers biological, psychological, and social factors that impact health outcomes (Engel, 1977). Engel's model provides a more holistic approach to health than alternative models, such as the biomedical model (Haslam et al., 2019). However, the biopsychosocial model has been critiqued for being vague and not detailing how the biological, psychological, and social factors interact to impact health (Haslam et al., 2019; Karunamuni et al., 2021).

On the other hand, the biosocial framework is key for improving our understanding of how social, biological, and behavioural factors interact to impact health (Mullan & Harris, 2018). There are different biosocial frameworks, but some, such as the one illustrated by (Harris & Schorpp, 2018) (the modified stress process), integrates social, biological, and behavioural factors (Harris & Schorpp, 2018).

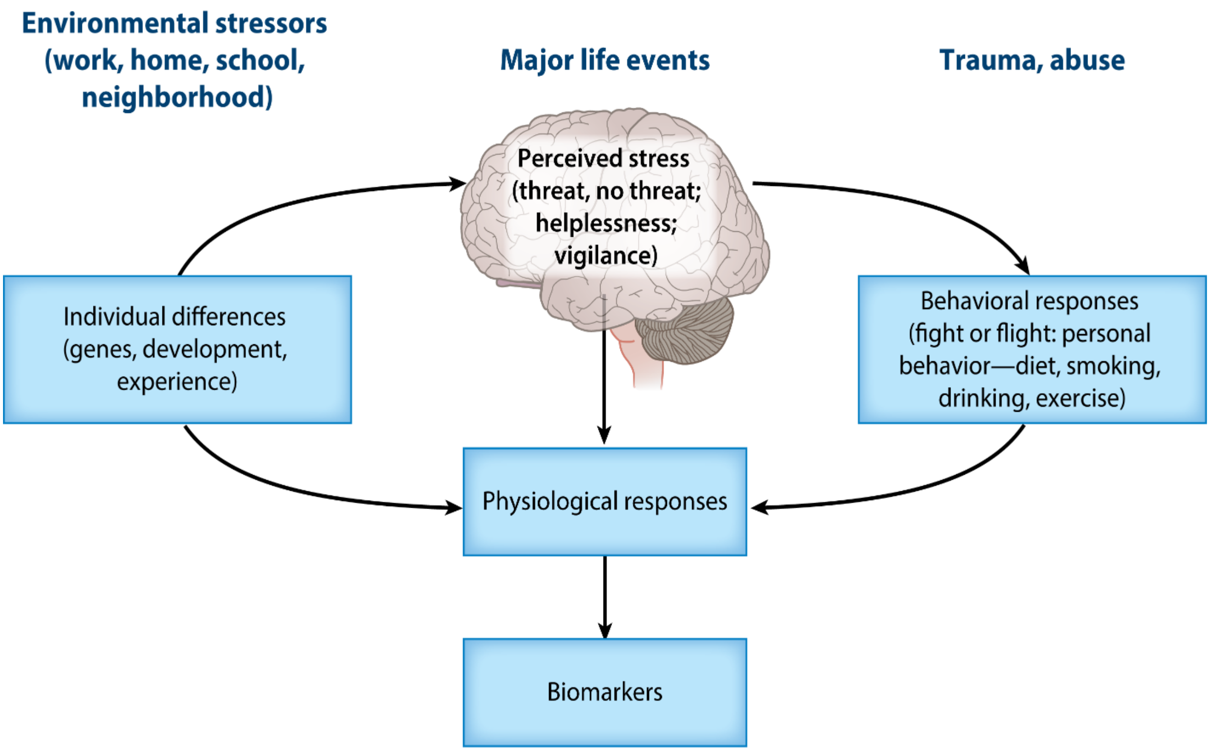


Figure 1. 1: The modified stress process framework

Harris & Schorpp 2018

Perceived stress or stressors caused by social factors cause biological responses, which biomarkers can capture (Harris & Schorpp, 2018). Perceived stress or stressors also cause behavioural responses, impacting biological responses (Harris & Schorpp, 2018). Individual differences partly resulting from social factors affect how we understand biological stress and behavioural responses, and the interactions of these factors ultimately impact health (Harris & Schorpp, 2018). A biomarker is a feature through which a specific biological, pharmacological or disease process can be detected (Biomarkers Definitiions Working Group, 2001).

The complicated association between social factors and biological processes operates via numerous pathways that eventually impact health (McDowell, 2023). One important pathway connecting social factors to biological processes is the differential exposure to stress pathway (Adler & Stewart, 2010). There is no single universal definition of stress. Nonetheless, a widely accepted definition by Koolhaas et al. (2011) refers to stress as a failure to function effectively to an unpredictable or controllable stressor that results in biological or behavioural stress. Differential exposure to stress refers to the notion that people experience differing types and levels of stressors due to their rank within society (Adler & Stewart, 2010; Farkas, 2022). Our rank within society also impacts our stress response as disadvantaged social positions expose individuals to chronic stress (Harris & Schorpp, 2018; Prior et al., 2018). Allostatic load is the collective consequence of prolonged stress and adverse life occurrences in the body (McEwen & Stellar, 1993).

The allostatic load theory offers insight into the processes that impact health (Guidi et al., 2020). To operationalise allostatic load, earlier studies of allostatic load used ten biomarkers, namely epinephrine, norepinephrine, cortisol, dehydroepiandrosterone (DHEA-S), systolic blood pressure (SBP), diastolic blood pressure (DBP), cholesterol, body mass index (BMI) glycosylated haemoglobin (HbA1c) and waist-hip ratio (Seeman et al., 2001; Seeman et al., 1997). The initial four biomarkers are neuroendocrine, regarded as primary mediators because they are released as a direct response to a stressor during allostasis (Seeman et al., 2001; Seeman et al., 1997).

The other six biomarkers are considered secondary outcomes because they occur as impacts of the primary mediators (Seeman et al., 2001; Seeman et al., 1997).

Earlier allostatic load studies adhered more to the initial allostatic load index, but with time, researchers excluded primary biomarkers and began to add more biomarkers to their allostatic load index (Duong et al., 2017; Whelan et al., 2021). This contributes to the current debate on allostatic load (Whelan et al., 2021), as some researchers (Johnson et al., 2017; Piazza et al., 2010) call for including primary biomarkers in the allostatic load index. These researchers maintain that primary biomarkers should be included because the neuroendocrine system is vital to the stress pathway, and chronic stress underpins the allostatic load theory (Johnson et al., 2017; Piazza et al., 2010). Other researchers (Gersten et al., 2010; Whelan et al., 2021) do not think including primary biomarkers is necessary as they argue that the initial allostatic load index was not considered the gold standard; instead, it was regarded as the initial effort to operationalise allostatic load (Whelan et al., 2021).

The pathways creating health inequalities used in this study

As highlighted above, different frameworks have conceptualised the social determinants of health and how the social gets under the skin to impact health. The modified stress process framework by Harris & Schorpp (2018) integrates social, biological, and behavioural factors and provides an understanding of how inequalities in health are generated. To this end, this study draws on the Harris and Schorpp framework to create a simplified conceptual model that forms the basis of the study structure.

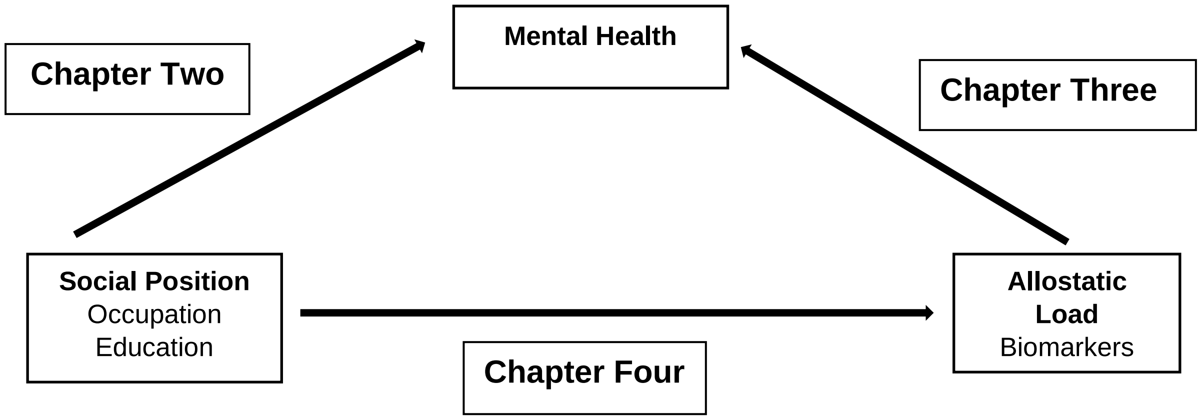


Figure 1. 2: Conceptual Model of this study

The conceptual model of this study (Figure 1.2) shows two pathways- one direct (1: social position -mental health) and one indirect (3-2: social position-allostatic load-mental health) between social position and mental health. A disadvantaged social position exposes people to situations that increase their risk of poor mental health (Public Health England, 2017). A disadvantaged social position also exposes people to more acute and chronic stress, leading to increased allostatic load, which leads to ill health, including poor mental health (Darin-Mattsson et al., 2017; Prior et al., 2021; Tiikkaja et al., 2013).

Potential confounders

The pathways linking social and biological factors to health could be impacted by potential confounders (Creswell & Creswell, 2023). This thesis judges gender and age as important demographic factors because they are critical in influencing results across varied circumstances (Creswell & Creswell, 2023). There is a consensus in the literature that health behaviours are patterned by social position and associated mental health (Kraft & Kraft, 2021; Walsh et al., 2013). Thus, smoking (Kurtze et al., 2012; Velten et al., 2014), physical activity (Velten et al., 2014) and alcohol intake

(Kurtze et al., 2012; Velten et al., 2014) are all associated with a variety of measures of mental health. This study adjusted for potential confounders as it is necessary to understand whether associations are robust and not due to these confounding factors (Creswell & Creswell, 2023; Skelly et al., 2012; Tabachnick & Fidell, 2013).

Study aims, research questions and hypotheses

Overall study aim

The overall aim of this thesis is to examine the social and biological factors that underpin inequalities in mental health. The thesis conducted three substantive analyses in chapters Two, Three and Four using data from the ELSA, UKHLS, NCDS and BCS70 to achieve its overall aim.

Chapter aims

The aims of the three substantive analyses are:

Aim 1: Examine the association between social position and mental health.

The literature suggests that individuals from disadvantaged social positions have poorer mental health than those from advantaged social positions. However, educational attainment rates, conditions of occupational type and levels of mental health have changed. It is unclear whether the relationships between these factors are still apparent the same way they have been.

Aim 2: Examine the association between allostatic load and mental health.

Over time, extensive literature has developed linking higher allostatic load to poorer health outcomes (Guidi et al., 2020; Johnson et al., 2017; Krieger, 2005; Prior et al., 2018). Nonetheless, there is no consensus on operationalising allostatic load, but evidence suggests that factor analysis could be a robust approach to measuring allostatic load (King et al., 2019). However, a few studies have used factor analysis to calculate the allostatic load scores and their association with mental health (King et al., 2019; Wiley et al., 2016).

Aim 3: Examine the association between social position and allostatic load.

A disadvantaged social position is said to have a damaging influence on biological outcomes (Darin-Mattsson et al., 2017). Evidence suggests that a higher allostatic load is linked to poor mental health (Kobrosly et al., 2013). Nevertheless, the indicators of social position, educational attainment and occupational type have changed over time, and it is not clear that the relationships between these indicators and allostatic load remain the same.

Study questions

This study will answer three main research questions to address its aims**.**

1. What is the association between social position and mental health?
   a. Is the association consistent across different populations?
   b. Does the association between social position and mental health vary depending on the social position or mental health measure used?
   c. Is the association independent of covariates?

2. What is the association between allostatic load and mental health?
   a. Do variables representing each biological system affect the allostatic load factor structure?

b. Does including primary mediators change how biomarker variables load onto factors?
c. Are the factor structures similar across different populations?
d. Is the association independent of covariates?

3. What is the association between social position and allostatic load?
a. Does factor scores vary by social class within each study and across studies?
b. Does including primary mediators change the factor scores by social class?
c. Is the association independent of covariates?

Hypotheses

This study has three hypotheses.

1. A disadvantaged social position is associated with poor mental health.
2. Higher allostatic load is associated with poor mental health.
3. A disadvantaged social position is associated with a poorer allostatic load.

Overview of the study structure

As mentioned, Figure 1.2 shows the conceptual model underpinning this thesis. This study is split into five chapters: the reference list and appendices. Chapter One provided an overall introduction to the thesis. It discusses mental health and how it is measured in population health surveys. Chapter One also provides an overview of the social and biological factors that underpin inequalities in mental health. It looks at the frameworks and pathways that link social and biological factors to health. Chapter One highlights the study aims, objectives, research questions and hypotheses.

Chapter Two addresses the first study objective, question, and hypothesis by determining the association between social position and mental health using occupation and educational attainment as measures of social position. It seeks to establish if the findings from both indicators are comparable. Chapter Two begins with a literature review on social position and mental health. The chapter uses data from ELSA, UKHLS, NCDS and BCS70 and logistic regression analyses to achieve its aims. ELSA, UKHLS, NCDS and BCS70 were chosen for Chapter Two of the study because the datasets capture people of all ages aged 16 years and above, representing the UK population.

Chapter Three addresses the second objective, question, and hypothesis by identifying the association between allostatic load and mental health. The chapter begins with a literature review on allostatic load and mental health. Given the inconsistencies in operationalising allostatic load, this chapter addressed three sub-aims. First, the chapter identified whether variables representing each biological system affect the allostatic load factor structure. Second, the chapter determined if including primary mediators will change how biomarker variables load onto factors. Finally, the chapter investigated if the factor structures were similar across seven datasets. This section of the study used data from seven datasets from the UK, including ELSA, UKHLS, NCDS, BCS70, NSHD, HCS and ALSPAC and factor analysis to address its sub-aims. Chapter Three used regression analysis with data from four UK datasets, ELSA, UKHLS, NCDS, and BCS70, to examine the association between allostatic load and mental health.

Chapter Four addresses the third objective, question, and hypothesis by examining the association between social position and allostatic load. This chapter begins with a literature review on social position and allostatic load. Then, the study examines the association between social position and allostatic load using four datasets, including ELSA, UKHLS, NCDS and BCS70 and regression analyses to achieve its aims. However, to answer question three, Chapter Four uses results from earlier chapters and investigates whether factor scores vary by social position across the studies, given the different individual components. To achieve this, Chapter Four will answer two sub-research questions.

Question 1: Do factor scores vary by social class within each study and across studies?

Question 2: Does including neuroendocrine biomarkers change the factor scores by social class?

Chapter Five, the last chapter, provides an overall discussion, conclusion, and recommendations.

Datasets used in this study

This study chose seven datasets, including ELSA, UKHLS, NCDS, BCS70, NSHD, HCS and ALSPAC, to address the three sub-aims in Chapter Three because the datasets included a number of biomarkers representing a variety of biological systems, including neuroendocrine function. The study used four datasets, including ELSA, UKHLS, NCDS and BCS70, to answer its three main research questions. Using different datasets to investigate the same phenomenon aids in verifying the consistency of findings across varied measurement processes. Other instruments are often used to collect information on similar topics in various datasets (Taylor & Marchi, 2018). In addition, it enhances the generalisability of results as similar conclusions from different datasets broaden the population covered (Taylor & Marchi, 2018).

Furthermore, it allows for cross-validation and credibility of findings (Lipton, 2020). Moreover, using different datasets to examine the same phenomenon could offer diverse perspectives, enhancing a deeper understanding of the phenomenon under investigation (Lipton, 2020). This study now provides an overview of the datasets used.

Table 1. 2: The summary of the seven datasets used in this thesis

Characteristics of the seven datasets used in this thesis	The datasets used in this thesis						
	ELSA	**UKHLS**	**NCDS**	**BCS70**	**NSHD**	**HCS**	**ALSPAC**
Wave used	Waves 2, 4 and 6	Wave 2	Age 44 Sweep	Age 46 Sweep	1999 and 2009 waves	1998 and 2002 waves	2011-2013 waves
Year of data collection	2004/2005, 2008/2009, 2012/2013	2010/2011	2002/2004	2016/2018	1999 and 2009	1998 and 2002	2011-2013
Age range	45-84 years	16-84 years	44-46 years	45-48 years	53 and 63 years	60 and 64 years	25-55 years
Sample size	9324	24052	6284	6369	2228	1013	1453
Gender	9324	24052	6284	6369	2228	1013	1453

ELSA waves 2, 4, and 6, UKHLS, NCDS, BCS70, NSHD, HCS, and ALSPAC were used in Chapter Three of the thesis to address its sub-aims because of the inconsistencies in operationalising allostatic load identified in the literature review conducted in this study. First, the chapter identified whether variables representing each biological system affect the allostatic load factor structure. Second, the chapter determined if including primary mediators will change how biomarker variables load onto factors. Finally, the chapter investigated if the factor structures were similar across the seven datasets. However, this thesis used ELSA wave 4, UKHLS, NCDS and BCS70 to address its main aims and research questions.

ELSA

ELSA, which started in 2002, is a longitudinal study representative of persons in England aged fifty or above living in private households (Banks et al., 2021). The initial participants were taken from those participating in the Health Survey for England (HSE) from 1998 to 2001 (Banks et al., 2021). Afterwards, the study sample was reinvigorated at intervals (wave 3, 4, 6, 7 and 9), and this means new participants have been added with time to ensure that the study remains representative of persons in England aged fifty or above living in private households (Banks et al., 2021). Ageing is a normal process of human life; at an older age, people experience considerable changes in their well-being, physical and mental health and social networks (English Longitudinal Study of Ageing, 2023). ELSA collects information about physical and mental health and social and economic circumstances, and nurses take biological samples and physical measurements (Banks et al., 2021). This study used data from ELSA waves 2 (2004/2005), 4 (2008/2009) and 6 (2012/2013) in Chapter Three to answer the questions, but ELSA wave 4 in Chapters Two and Four. The respondents aged 85 and older in ELSA were excluded from the analysis.

Biomarkers

Physical measures, which include blood pressure, height, weight, waist, and hip circumference, were taken by nurses (Banks et al., 2021). All participants except pregnant women had their blood pressure taken (Banks et al., 2021). Systolic blood pressure, diastolic blood pressure and pulse rate were measured three times with an Omron machine on the right arm of those eligible while sitting (Banks et al., 2021). The mean values were used in the analyses in this study. Nurses measured height while participants were sitting and standing in waves 2 and 4 but only while standing in wave

6 using standardised protocols (Banks et al., 2021). All participants were eligible for height and weight measurements, and BMI was calculated using height and weight (Banks et al., 2021). Nurses used estimates where possible if it was impossible to take these measurements because the participants could not stand or were unsteady (Banks et al., 2021). If the weight exceeded 130kg, estimates were used if possible (Banks et al., 2021). All participants except those who used wheelchairs and had ileostomy or colostomy were eligible to have their hip and waist measured (Banks et al., 2021). The hip and waist were measured twice, but a third measurement was taken if the difference between the first and second was 3cm and above (Banks et al., 2021). The mean values were used in this study.

Participants who consented were eligible to have blood taken from them except those with bleeding or clotting conditions, participants with fits or convulsions and those taking anticoagulation medication (Banks et al., 2021). Fasting blood samples were taken from participants below 80 years, except those who had diabetes and received treatment, those malnourished or those unfit to fast (Banks et al., 2021). All blood biomarkers except glucose were measured from fasting and non-fasting blood samples (Banks et al., 2021).

UKHLS

The UKHLS is a UK longitudinal survey of over 40,000 households that started in 2009 and is conducted annually; this stratified clustered random sample of households is representative of the UK population (University of Essex-Institute for Social and Economic Research, 2022). The UKHLS collects information on family, education, work, income, health, and social life; nurses took biological samples and physical measurements, making it an important source of longitudinal data on the whole population (University of Essex-Institute for Social and Economic Research, 2022). Adult participants who completed the full face-to-face interview in the corresponding wave in English and women who were not pregnant were eligible for a nurse visit at home (University of Essex-Institute for Social and Economic Research, 2022). This study took samples from adult participants from wave 2 (2010/2011) who took part in a nurse health assessment and had blood samples taken from them (University of Essex-Institute for Social and Economic Research, 2022).

Biomarkers

Systolic and diastolic blood pressure, height and weight were measured using the same standardised protocols as ELSA and NCDS (see below). BMI was calculated using height and weight, and waist circumference was measured using tape (Institute for Social and Economic Research, 2022).

Biomarkers were measured from non-fasting blood, which were taken from consenting participants who did not have the human immunodeficiency virus, hepatitis-B, hepatitis-C, bleeding condition, clotting disorder, who never had a fit and who were not on anti-clotting medicine (Institute for Social and Economic Research, 2022).

NCDS

NCDS, which started as the Perinatal Mortality Study, is a longitudinal study that follows the lives of over 17000 individuals living in England, Scotland and Wales born in a specific week in 1958 (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). NCDS collects information on family conditions, educational attainment, behaviour from children and parents, physical and mental health and social and economic conditions; nurses took biological samples and physical measurements (University of London-Institute of Education-Centre for Longitudinal Studies, 2021).

Post the 1958 birth sweep, the Centre for Longitudinal Studies did subsequent sweeps in 1965, 1969, 1974, 1981, 1991, 2000, 2002, 2004, 2008 and 2013 (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). The 2002 sweep is the first biomedical sweep (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). This study uses data from the age 44 sweep, which occurred between September 2002 and March 2004 when participants were aged 44-46 (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). The survey was a face-to-face nurse visit and a self-completed questionnaire (University of London-Institute of Education-Centre for Longitudinal Studies, 2021).

Biomarkers

During face-to-face visits to participants, nurses took three measurements of systolic blood and diastolic blood pressure and pulse rate (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). The mean values were used in this study. Nurses also measured height when participants were sitting and standing and measured weight using standardised protocols (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). BMI was calculated with height and weight collected using tape; nurses measured participants' hip and waist circumferences (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). Biomarkers were measured from non-fasting blood, which nurses took from cohort members who qualified and consented (University of London-Institute of Education-Centre for Longitudinal Studies, 2021).

BCS70

The BCS70 is a national longitudinal birth cohort study of over 17000 individuals born in a particular week in 1970 in England, Scotland and Wales (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). Participants were surveyed at intervals after 1970 (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The BCS70 has collected data on social and economic circumstances, education, and physical and mental health; nurses took biological samples and physical measurements (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). This study used data from the age 46 sweep (2016/2018), which included a nurse visit, taking biological samples and physical measurements (University of London-Institute of Education-Centre for Longitudinal Studies, 2023).

Biomarkers

Systolic blood pressure, diastolic blood pressure and pulse rate were measured three times with an Omron HEM 907 on the right arm of those eligible while sitting (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The mean values were used in the analyses in this study. Weight, height, and waist circumference were measured using standard instruments, and BMI was calculated using height and weight measurements (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). Biomarkers were measured from blood samples (University of London-Institute of Education-Centre for Longitudinal Studies, 2023).

NSHD

NSHD is the first British birth cohort study with an initial sample of 5362 singleton males and females born in March 1946 to married parents in England, Scotland, and Wales (Wadsworth et al., 2005). Nurses conducted home visits when participants became adults and took physical measurements and biological samples (Wadsworth et al., 2005). The participants in this study were taken from the 1999 and 2009 waves.

Biomarkers

Systolic and diastolic blood pressures, height and weight were measured using standardised protocols (Wadsworth et al., 2005). BMI was calculated using height and weight measurements, and waist circumference was measured using standard instruments (Wadsworth et al., 2005). Biomarkers were measured from non-fasting blood samples (Wadsworth et al., 2005).

HCS

The initial HCS consisted of 3000 males and females born between 1931 and 1939 and living in Hertfordshire in the 1990s (Syddall et al., 2019). Participants were selected from records kept by midwives and health visitors about individuals born in Hertfordshire between 1931 and 1939 (Syddall et al., 2019). Cohort members participated in face-to-face interviews and clinics, and some participants also gave blood samples (Syddall et al., 2019). This study was started and is preserved by the Life Course Epidemiology Centre at the University of Southampton (Syddall et al., 2019). The participants for this study were taken from the HCS study conducted between 1998 and 2002.

Biomarkers

Physical measures, including blood pressure, height, weight, and waist circumference, were taken from participants in HCS using standardised protocols; BMI was calculated using height and weight (Syddall et al., 2019). Some biological measurements were obtained from blood samples (Syddall et al., 2019).

ALSPAC

ALSPAC started in 1991 via the recruitment of over 14500 pregnant women from April 1991 to December 1992 in the previous County of Avon, and the children born by these women and parents have been followed since then (Boyd et al., 2013). Participants answered questionnaires, attended clinical assessments and provided biological samples (Boyd et al., 2013). The UK Medical Research Council (MRC), University of Bristol and the Wellcome Trust fund ALSPAC (Boyd et al., 2013). The participants in this study were aged between 25 and 55 years.

Biomarkers

Physical measures, including blood pressure, height, weight, and waist circumference, were taken from participants in ALSPAC using standardised protocols; BMI was calculated using height and weight (Boyd et al., 2013). Some biological measurements were obtained from blood samples (Boyd et al., 2013).

Chapter Two

Introduction

The literature suggests that mental health problems are socially patterned, with persons from disadvantaged social positions having higher rates of poor mental health compared to persons from advantaged social positions. Given the changes in educational attainment, occupational type, and mental health, it is not clear that the relationships between these factors are still apparent the same way they have been.

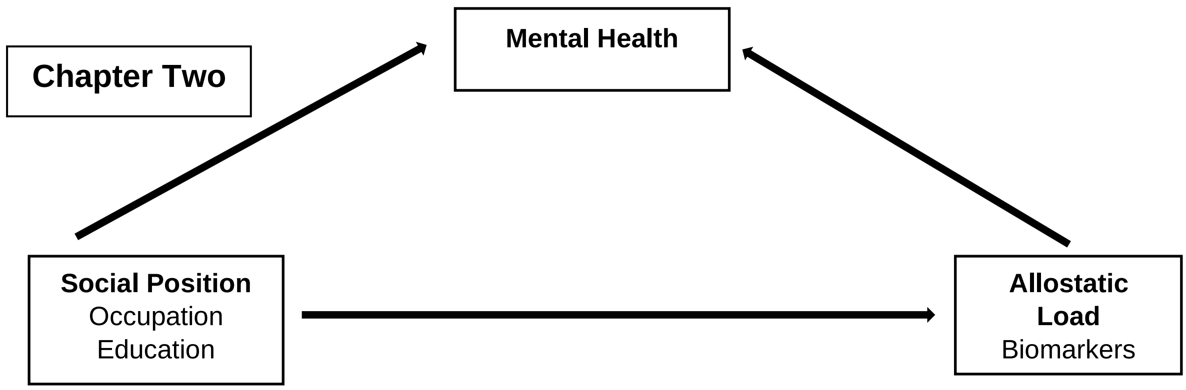


Figure 2. 1: Conceptual Model of this study (Chapter Two)

Therefore, this chapter examines the association between social position and mental health using occupation and educational attainment as indicators of social position.

Literature review on social position and mental health

Chapter Two begins with a literature review on social position and mental health to identify gaps in the literature (Booth et al., 2016). It then examines the association between social position and mental health. The findings of this chapter provide further support for the link between disadvantaged social positions and poor mental health. Nonetheless, it also highlights that the indicator of social position impacts this link. Also, the association between indicators of social position and mental health may vary depending on the type of poor mental health. Gender, age and health behaviour are contributory factors to poor mental health.

Search strategy and study selection

This study searched Medline with full text, Pubmed, Web of Science, APA PsycInfo, APA PsycArticles, ProQuest, CINAHL Complete, Ovid, Scopus, SAGE Journals and the Cochrane Library. The study located peer-reviewed publications on human population studies investigating the relationship between social position and mental health between 2011 and 2023. Search terms included "Social position", “Socioeconomic status”, “Social status”, "Mental health", "Depression", and "Psychological distress". Boolean operators such as "AND" were used. The study also searched the literature using Google, and articles were scrutinised for studies not already recognised. Initially, this study focused the search of the literature on social position and mental health articles and 8753 articles were obtained. However, only seventeen publications were related to the research interest in this paper. As a result, the search focus was expanded to include studies that looked at socioeconomic status, social status and mental health and 23789 articles were obtained. This study initially screened titles and abstracts, and then studies with full text were further scrutinised to select the relevant publications.

Search results

This study reviewed forty-six studies investigating the relationship between social position and mental health. Thirty-five studies (Amin et al., 2023; Amroussia et al., 2017; Anand et al., 2018; Arias-de la Torre et al., 2016; Azizabadi et al., 2022; Back & Lee, 2011; Domènech-Abella et al., 2018; Hailemichael et al., 2019; Hashmi et al., 2021; Hoebel et al., 2017; Honjo et al., 2014; Hudson et al., 2012; Ibrahim et al., 2013; Jiang et al., 2020; Kurtze et al., 2012; Lacey et al., 2016; Lam et al., 2019; Lindström et al., 2014; Lopes et al., 2019; Mezuk et al., 2013; Morasae et al., 2012; Murcia et al., 2015; Mutyambizi et al., 2019; Najafi et al., 2020; Niemeyer et al., 2019; Paskov & Richards, 2021; Richards & Paskov, 2016a; Sasaki et al., 2021; Scott & Jeremy, 2014;

Shi et al., 2014; Sironi, 2012; Srivastava et al., 2021; Thomson et al., 2018; Tiikkaja et al., 2013; Yi & Hong, 2020) from the literature reviewed are cross-sectional analyses. Nine studies (Bracke et al., 2020; Green & Benzeval, 2013; Hoven et al., 2015; Joinson et al., 2017; Kong et al., 2014; Kosciuszko et al., 2023; Nagasu & Yamamoto, 2020; Ojagbemi et al., 2018; Parra-Mujica et al., 2023) are longitudinal and two studies (Madigan & Daly, 2023; Schlax et al., 2019) used both cross-sectional and longitudinal designs. Twenty-three of the studies were conducted in Europe, and nine of them were from the UK. Twelve studies were conducted in Asia, two in Australia, four in North America, four in Africa, and one worldwide. On average, the quality of the literature reviewed was moderate to high.

Table 2. 1: Literature on social position and mental health

Table 2.1: Literature on social position and mental health						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**The measure of social position**	**Measure of mental health**	**Main findings**
Amin et al. (2023)	The UK Biobank	367327 (168970/198357)	Cross-sectional study	Education	Depressive symptoms were measured using a recently validated scale for recent depressive symptoms.	Higher educational attainment is linked with lower depressive symptoms.
Kosciuszko et al. (2023)	English Longitudinal Study of Ageing (ELSA)	6202 (2964/3238)	Longitudinal study	Educational attainment and wealth	Depressive symptoms were measured using the eight-item Centre for Epidemiologic Studies Depression Scale and Polygenic score.	Participants with lower educational qualifications had higher depressive symptoms.
Madigan & Daly (2023)	The United States National Longitudinal Study of Adolescent to Adult Health	Baseline-4949, follow up-3509	Cross-sectional and longitudinal study	The MacArthur scale was used to measure subjective social status. Household income, personal income, combined income, assets, education, and job prestige were used to construct a socioeconomic status composite variable.	The Centre for Epidemiological Studies Depression Scale was used to measure depressive symptoms.	Low socioeconomic status and subjective social status were linked with elevated depressive symptoms.

Table 2.1: Literature on social position and mental health						
Parra-Mujica et al. (2023)	The UK Household Longitudinal Study (UKLHS)	9581 (4295/5286)	Longitudinal study	Net equivalised household income	Anxiety and depression were measured using the Mental Component Summary of the Short-Form Health Survey.	Higher-income is linked to a decreased likelihood of anxiety and depressive symptoms.
Azizabadi et al. (2022)	The Neyshabour longitudinal study on ageing	7462	Cross-sectional study	Several variables indicating asset were used to compute the socioeconomic score, education, and occupational status.	Anxiety and depressive symptoms were measured using the "Hospital Anxiety and Depression Scale Questionnaire", and the short-term form of the Epidemiological Center Questionnaire, respectively.	Disadvantaged socioeconomic was linked to anxiety and depressive symptoms.
Paskov & Richards (2021)	Round 6 of the European Social Survey	52672	Cross-sectional study	Subjective social status was used to indicate social position. Subjective social status was measured using answers to a single survey item	Depressive symptoms were measured using the Center for Epidemiologic Depression Scale.	Higher Subjective social status was associated with lower depressive symptoms at the individual and country levels.
Sasaki et al. (2021)	Data was obtained during the project titled 'Healthy ageing in Myanmar.'	1186 (480/706)	Cross-sectional study	wealth index was used as an indicator of objective socioeconomic status, and answers to multiple-choice questions about	Depressive symptoms were assessed using the Geriatric Depression Scale.	Bivariate analysis suggests that both subjective socioeconomic status and objective socioeconomic status have a link with

Table 2.1: Literature on social position and mental health

				current financial situation were used as an indicator of subjective socioeconomic status		depressive symptoms in urban and rural areas. However, subjective socioeconomic status has a stronger link to depressive symptoms than objective socioeconomic status, and this link is more evident in rural areas. However, after accounting for covariates, only subjective socioeconomic status was associated with depressive symptoms.
Srivastava et al. (2021)	Building a Knowledge Base on Population Ageing in India	9181	Cross-sectional study	Wealth, employment, caste and education	The General Health Questionnaire (GHQ) was used to measure psychological distress.	Low socioeconomic status was linked to psychological distress.
Bracke et al. (2020)	The third, sixth, and seventh waves from the European Social Survey	116783 (53680/63103)	Longitudinal study	Education, employment, and household income	The Center for Epidemiologic Studies Depression Scale was used to measure depression.	The prevalence and severity of depressive symptoms were higher in participants from disadvantaged social positions than those from advantaged ones.
Hashmi et al. (2021)	The National Health Survey	21315 (10086/11229)	Cross-sectional study	Household income, education, socioeconomic index	Answers to questions about health conditions were used to measure	All measures of social position were negatively

Table 2.1: Literature on social position and mental health

				for areas scores and labour force status	mental health conditions.	linked to mental disorders.
Jiang et al. (2020)	The China Family Panel Studies 2010	12303	Cross-sectional study	Educational attainment	The mental health index was measured using the 10-question Kessler psychological distress scale.	Increased educational attainment is associated with better mental health.
Nagasu & Yamamoto (2020)	The Japan Household Panel Survey	14717 (7215/7502)	Longitudinal population study	Employment status and household income	Mental health was measured using the General Health Questionnaire (GHQ)	Lower socioeconomic status was associated with poor mental health.
Najafi et al. (2020)	The baseline data of Prospective Epidemiological Research in IRAN	130078 (58251/71827)	Cross-sectional study	Ownership of household assets and educational attainment were used to construct the socioeconomic status index, which was categorised into five quintiles.	Mental health classed as 'Poor mental health' and 'Good mental health' using a self-report of mental health treatments for a minimum of 3 months during the past year, which a general physician recorded.	Poor mental health was higher among individuals with lower socioeconomic status than those with higher socioeconomic status, which was more evident in females.
Yi & Hong (2020)	The 2018 Korea Welfare Panel Study	7257 (2938/4319)	Cross-sectional study	Childhood socioeconomic status was measured using answers to a question on family economic circumstances. Adult socioeconomic status was measured	The Center for Epidemiologic Studies Depression Scale was used to measure probable depression.	There was no link between childhood socioeconomic status and probable depression, but a connection with low adult socioeconomic status was associated with probable depression.

Table 2.1: Literature on social position and mental health						
				using current income, education and employment status.		
Hailemichael et al. (2019)	A population-based, comparative household survey	836	Cross-sectional study	Income, asset possession and consumption	Mental health problems	Participants with mental health problems came from disadvantaged households.
Lam et al. (2019)	Twins Research Australia's Health and Lifestyle Questionnaire	3636 (827/2809)	Cross-sectional study	Income (the Index of Relative Socioeconomic Disadvantage) and occupation (the Australian Socioeconomic Index 2006)	Psychological distress was operationalised using the Kessler 6 Psychological Distress Scale.	There is a link between lower occupation (measured using Australian Socioeconomic Index 2006 score or income) and higher psychological distress, even after accounting for confounders. However, there was no significant connection between Index of Relative Socioeconomic Disadvantage decile and psychological distress.
Lopes et al. (2019)	The Psychiatric Morbidity among Adults in Private Households Survey	4596	Cross-sectional study	Occupation, household income, personal income and job rank	Psychotic disorders were measured using the Psychosis Screening Questionnaire, and mood disorders were measured using the	Low socioeconomic status was linked with poor mental health but not paranoia. Paranoia was instead linked to job rank and occupational health.

Table 2.1: Literature on social position and mental health

					Revised Clinical Interview Schedule.	
Mutyambizi et al. (2019)	The 2014 South African Social Attitudes Survey	3027	Cross-sectional study	Subjective social status was measured using answers to questions about social hierarchy.	The Centre for Epidemiologic Studies was used to measure depressive symptoms.	Disadvantaged subjective social status was associated with depressive symptoms.
Niemeyer et al. (2019)	The Bochum Optimism and Mental Health Studies	7937 (3777/4160)	Cross-sectional study	Educational level	The Depression Anxiety Stress Scales was used to assess depressive symptoms.	Lower educational levels were linked to higher odds of having depressive symptoms.
Schlax et al. (2019)	The Gutenberg Health Study	12484 (6430/6054)	Cross-sectional and longitudinal study	Education, occupation and household net income	Elevated depressive symptoms were measured using the 2-item version of the Patient Health Questionnaire depression module.	At baseline, the absence of elevated depressive symptoms was associated with better educational attainment, higher occupational class and higher household net income. However, at follow-up two years later, the occupational class was no longer associated with elevated depressive symptoms. None of the three measures of socioeconomic status at the follow-up after two years were linked to participants to had

Table 2.1: Literature on social position and mental health

						elevated depressive symptoms at baseline.
Anand et al. (2018)	The 2012 wave of the Mexican National Health and Nutrition Survey	44618 (19036/25582)	Cross-sectional study	Household wealth	The Centre for Epidemiologic Studies Depression Scale was used to measure depression.	Lower wealth was associated with depressive symptoms.
Domènech-Abella et al. (2018)	The COURAGE in Europe data, which was conducted in Finland, Poland, and Spain	7966 (3401/4565)	Cross-sectional study	Education, household income and occupation	Major depressive disorder	Education was significantly linked to depression in that lower educational attainment was associated with higher depressive symptoms.
Ojagbemi et al. (2018)	The Ibadan Study of Ageing	1349	Longitudinal study	Number of household possessions, living conditions and occupational attainment	Major depressive disorder was measured using the World Mental Health Survey version of the World Health Organisation Composite International Diagnostic Interview, and dementia was measured using the 10-Word Delay Recall Test	Participants from disadvantaged social and economic backgrounds were more likely to develop major depressive disorder via gender-specific pathways later.

Table 2.1: Literature on social position and mental health						
Thomson et al. (2018)	The Health Survey for England (1991–2014)	56343 (24930/31413)	Cross-sectional study	Education and area-level deprivation	The General Health Questionnaire (GHQ) was used to assess mental health.	Overall, a disadvantaged socioeconomic position is associated with the risk of poor mental health, which is higher in women than men.
Amroussia et al. (2017)	The 2014 Health on Equal Terms survey of the four northernmost counties in Sweden: Västernorrland, Jämtland/Härjedalen, Västerbotten, and Norrbotten	25646 (11848/13798)	Cross-sectional study	Annual disposable income	Mental health symptoms were assessed using the General Health Questionnaire (GHQ)	The less affluent individuals have poorer mental health than the more affluent individuals.
Hoebel et al. (2017)	The German Health Update study	4952 (2183/2769)	Cross-sectional study	Objective social status was measured using education, occupation, and income. Subjective social status was measured using the German version of the MacArthur Scale.	Current depressive symptoms were measured using the eight-item Patient Health Questionnaire depression scale.	Lower objective socioeconomic status and lower subjective social status were separately linked to current depressive symptoms in both men and women.
Joinson et al. (2017)	The Avon Longitudinal Study of Parents and Children (ALSPAC)	9193 (4425/4768)	Longitudinal study	Occupation, education, and standard of living	The Short Mood and Feelings Questionnaire and the Clinical Interview Schedule were used to assess depressive symptoms.	Low socioeconomic position was linked with increased depressive symptoms in late childhood, adolescence, and adulthood.

Table 2.1: Literature on social position and mental health

Arias-de la Torre et al. (2016)	The 2011 Spanish National Health Survey	7396 (3748/3648)	Cross-sectional study	Social position was operationalised using socioeconomic variables (age, education, occupation, and marital status) and work-related variables (type of work contract, job stress and job satisfaction)	Mental Health was assessed using the General Health Questionnaire (GHQ).	The incidence of poor mental health in 2011 among the working population of Spain was higher in individuals with disadvantaged socioeconomic variables, and the incidence was higher among women.
Lacey et al. (2016)	The Family Across Generations and Nations (FAGN)	Jamaicans (1218) and Guyanese (2068)	Cross-sectional study	Education, employment status and household income	A modified version of the World Health Organization Composite International Diagnostic Interview was used to measure lifetime mental health disorders	A disadvantaged social position was associated with a higher prevalence of mental health disorders in Guyanese than Jamaican participants.
Richards & Paskov (2016b)	The Health Survey for England and the British Household Panel Survey	Health Survey for England (120921) and British Household Panel Survey (10977)	Cross-sectional study	The Registrar General's schema, Goldthorpe's class schema and NS-SEC	The 'GHQ' was used to measure psychological well-being	The association between social class and psychological well-being faded after controlling for employment status.
Hoven et al. (2015)	The Survey of Health, Ageing and Retirement in Europe	2798 (1658/1140)	Longitudinal study	Occupation and work stress	The EURO-D depression scale was used to measure depressive symptoms.	Lower occupational class and work stress were independently associated with depressive symptoms.

Table 2.1: Literature on social position and mental health

Murcia et al. (2015)	The Santé et Itinéraire Professionnel (SIP) survey	8072 (3916/4156)	Cross-sectional study	Educational level	The Mini International Neuropsychiatric Interview was used to measure major depressive disorder and general anxiety disorder.	Lower educational attainment was associated with a higher incidence of major depressive disorder and general anxiety disorder.
Honjo et al. (2014)	The World Mental Health Japan (WMH-J) Survey	1502 (708/795)	Cross-sectional study	Education and household income were used as measures of objective socioeconomic status, and responses to a question about social position were used as an indicator of subjective social status	Subjective mental health and any mental disorders diagnosed in the past 12 months using the World Health Organization Composite International Diagnostic Interview version 3.0	There is a link between objective socioeconomic status and subjective social status and subjective mental health, but after controlling for cofounders, the objective socioeconomic status link became insignificant. They also found an association between subjective social status and the 12-month incidence of any mental conditions.
Kong et al. (2014)	A longitudinal survey in Tama City, Japan	7366 (3563/3803)	Longitudinal study	Education and annual income	Mental health was assessed using the Three Health Factors Scale	Low socioeconomic status was linked to poor mental health in people aged 65 and above in Japan, with a stronger link observed among older women.

Table 2.1: Literature on social position and mental health						
Lindström et al. (2014)	The 2008 public health survey in Skåne, Sweden	28198 (12726/15472)	Cross-sectional study	Occupation and employment status	Psychological health was assessed using the General Health Questionnaire (GHQ)	Lower socioeconomic position was linked with poor psychological health.
Scott & Jeremy (2014)	The data from 20 surveys in 18 countries	56 085	Cross-sectional study	The MacArthur subjective social status scale was used to measure subjective social status. Education, income, and occupation were used to measure objective social status	Mental Disorders were measured using the World Mental Health survey version of the World Health Organization Composite International Diagnostic Interview	Even after controlling for objective social status, low subjective social status was associated with all mental disorders.
Shi et al. (2014)	The China, Oxford and VCU Experimental Research on Genetic Epidemiology study of Major Depressive Disorder	All participants are female. 3,639 with Major Depressive Disorder and 3,800 controls	Cross-sectional study	Education, occupation, and employment status were used to measure socioeconomic position.	Major Depressive Disorder was diagnosed using the Composite International Diagnostic Interview.	Higher educational attainment, higher occupational status and higher employment status are linked with lower rates of Major Depressive Disorder.
Green & Benzeval (2013)	The West of Scotland Twenty-07 Study	Baseline 1515 (737/778), 2nd visit 1343 (638/705), 3rd visit 691 (325/366), 4th visit 843 (384/459) and 5th visit 942 (424/518)	Longitudinal study	Education and occupation were used as indicators of socioeconomic status	Anxiety and depression symptoms were assessed using the Hospital Anxiety and Depression Scale.	Disadvantaged socioeconomic status was connected to higher rates of both anxiety and depression symptoms.

Table 2.1: Literature on social position and mental health						
Ibrahim et al. (2013)	Convenience samples of undergraduate recruited students from six UK universities	923 (676/247)	Cross-sectional study	Index of multiple deprivation, parental education, parental occupation and family affluence scale	The modified version of the Zagazig Depression Scale was used to measure depressive symptoms.	Disadvantaged backgrounds were associated with a higher risk of depression.
Kurtze et al. (2012)	The Norwegian Survey of Level of Living from 2005	5764 (2887/2877)	Cross-sectional study	Education and household income	Mental health was assessed using the 25-item Hopkin's Symptom Check List	Lower socioeconomic position was associated with poorer mental health.
Mezuk et al. (2013)	The Virginia Adult Twin Study of Psychiatric and Substance Use Disorders Study	Females (2153)	Cross-sectional study	Childhood socioeconomic status was measured using education of main support and occupation of head of household. Adult socioeconomic status was measured using education, income, and occupation.	The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders was used to assess major depression.	There was no link between childhood socioeconomic factors and major depression, but lower socioeconomic status. was linked with major depression in adulthood.
Tiikkaja et al. (2013)	Several Swedish population-based, nation-wide registries	1 016 276	Cross-sectional study	Occupation	Psychiatric disorders are measured using the World Health Organisation's International Classification of Diseases.	Disadvantaged social class was linked to a higher incidence of psychiatric disorders.

Table 2.1: Literature on social position and mental health						
Hudson et al. (2012)	The National Survey of American Life	12-month- 1629 (579/1050) and lifetime-1869 (602/1,267)	Cross-sectional study	Household income, education, employment status, net worth and home value	Major Depressive Episodes for 12 months and lifetime were measured using the World Mental Health version of the Composite International Diagnostic Interview	Higher household income and employment status were linked to increased odds of having major depressive episodes, which was evident in men than women. There is no link between net worth, home value and major depressive episode.
Morasae et al. (2012)	The Urban Health Equity Assessment and Response Tool survey, carried out in Tehran in 2007	22135 (8955/13180)	Cross-sectional study	An index of household economic status	Mental health disorders were assessed using the General Health Questionnaire (GHQ).	Mental disorders are higher in persons with lower socioeconomic status compared to those with higher socioeconomic status.
Sironi (2012)	The third edition of the European Social Survey	29500 (13549/15951)	Cross-sectional study	Education	Mental health problems were measured using a set of 18 questions on participants' mental and psychological situation.	Higher education is associated with better mental health outcomes.
Back & Lee (2011)	The Korean Longitudinal Study of Aging	4123 (1726/2397)	Cross-sectional study	Education, household income, and wealth	Depressive symptoms were measured using the 10-item Center for Epidemiologic Studies Depression scale.	There was a significant link between disadvantaged socioeconomic status and symptoms of depression.

Discussion

Social position and mental health

Overall, the review results indicate that mental health is socially patterned, with individuals from disadvantaged social positions more likely to have poor mental health than those from advantaged social positions. Several measures of social position were associated with mental health. For example, Shi et al. (2014) found that higher educational attainment, higher occupational status and higher employment status were linked with lower rates of major depressive disorder. Similarly, (Hashmi et al., 2021) reported that household income, education, socioeconomic index for the area scores and labour force status were negatively linked to mental disorders.

Nonetheless, these review results suggest that the link between social position and mental health is complex. The findings showed that even though mental health is socially patterned, different indicators of social position may define distinct concepts and have variable links with mental health, as demonstrated in the study of the association between socioeconomic position and major depressive episode (Hudson et al., 2012). Hudson et al. (2012) found that higher household income and employment status were linked to increased odds of having a major depressive episode in men. However, they found the opposite for educational attainment. Lam et al. (2019) agree that associations with mental health might vary by the measure of social position examined when they demonstrated that lower socioeconomic status measured using the Australian Socioeconomic Index 2006 was linked to higher psychological distress even after accounting for confounders. However, there was no significant connection between the Index of Relative Socioeconomic Disadvantage and psychological distress (Lam et al., 2019).

Additionally, Schlax et al. (2019) reported that at baseline, participants with no elevated depressive symptoms had better educational attainment, higher occupational class, and higher household net income. However, at a follow-up two years later, the occupational class was no longer associated with elevated depressive symptoms (Schlax et al., 2019). It is plausible that the above findings are because different indicators of social position are likely to have different effects on an individual's health since they are achieved at diverse phases of an individual's life (Karp et al., 2004; Kosciuszko et al., 2023).

Another observation in the literature reviewed is that the association between indicators of social position and mental health may vary depending on context and type of mental disorder. This is illustrated by Lacey et al. (2016), who suggest that disadvantaged social position was associated with mental health disorders with higher prevalence in Guyanese participants compared to Jamaican participants, and there were differences in the type and pattern of mental illness in both countries. Similarly, Lopes et al. (2019) found that low socioeconomic status was linked with poor mental health, such as depression, panic and personality disorders but not paranoia. Paranoia was instead linked to job rank and occupational health (Lopes et al., 2019).

Gender differences

Gender differences in mental health have been established in the literature (Sironi, 2012). Most studies indicate that the risk of poor mental health is higher in females than in males (Kong et al., 2014; Sasaki et al., 2021; Sironi, 2012). However, a few studies have highlighted gender-driven associations between indicators of social position and poor mental health (Mutyambizi et al., 2019), as demonstrated in the study by (Back & Lee, 2011). Back & Lee (2011) found that household income was significantly linked with depressive symptoms in both males and females. Nevertheless, in males, wealth was linked considerably with more significant depressive symptoms, while in females, education was more strongly linked with higher levels of depressive symptoms.

In line with these results, Ojagbemi et al. (2018) found different associations between social and economic factors and incidents of major depressive disorder over five years in men and women. In women, residency in rural areas and minimal contact with family members were linked with later major depressive disorder (Ojagbemi et al., 2018). At the same time, unskilled men were more likely to develop later major depressive disorders (Ojagbemi et al., 2018).

Health behaviour

Health behaviour is acknowledged to be associated with mental health (Velten et al., 2014). A study by Kurtze et al. (2012), who observed that a lower socioeconomic position was associated with poorer mental health, also claimed that unhealthy behaviours such as a lack of physical activity and smoking were linked to low socioeconomic position and poor mental health except for alcohol intake. They stated that the incidence and increased rate of alcohol consumption was higher in participants from advantaged socioeconomic backgrounds compared to those from disadvantaged socioeconomic backgrounds. Similarly, a study by Nagasu & Yamamoto (2020) partially confirms Kurtze et al. (2012)'s results. Nevertheless, contrary to Kurtze et al. (2012), Nagasu & Yamamoto (2020) did not find a higher incidence and increased rate of alcohol consumption in individuals from advantaged socioeconomic backgrounds. These results imply a complex mechanism underlying how alcohol consumption is connected to the link between social position and mental health.

A possible explanation could be that there has been a significant change in behaviours with time (Livingston et al., 2023). The increase in social media use among the younger generation is a competing activity to alcohol consumption (Lyons et al., 2015; Törrönen et al., 2019). Online practices, including gaming and networking, are inherently part of the younger generation's day-to-day life and limit the time left for drinking alcohol (Lyons et al., 2015; Törrönen et al., 2019). In addition, there is a shift in attitude towards alcohol consumption; a lot of young persons disapprove of alcohol intoxication as it harms academic achievement (Livingston et al., 2023).

Conclusion

Overall, the literature reviewed here suggests that mental health is socially patterned, with individuals from disadvantaged social positions more likely to have poor mental health than those from advantaged social positions. However, the link between social position and mental health is complex. Most studies have established gender differences in mental health, but a few have highlighted gender-driven associations between indicators of social position and poor mental health. Health behaviour is acknowledged to be associated with mental health, but a complex mechanism underlines how alcohol consumption is connected to the link between social position and mental health.

The current study

The first aim of Chapter Two is twofold. First, this study will use four UK datasets to examine the association between social position and mental health using occupation and educational attainment as measures of social position. Second, to investigate if the findings from both indicators are comparable. It is evident in the literature that no one measure of social position is the best, as each measure captures different but related aspects of the socioeconomic stratum. Consequently, its appropriateness depends on how social position impacts health (Bruna et al., 2006; Joinson et al., 2017).

Nonetheless, social position is measured most generally through the education, occupation, and income pathways (Adler & Stewart, 2010; Darin-Mattsson et al., 2017). The literature suggests that studies use a range of indicators of social position because social position is a multifaceted social theory (Joinson et al., 2017). Besides, replication is important as it validates prior findings (Taylor & Marchi, 2018).

Methods

This study uses data from ELSA, UKHLS, NCDS, and BCS70 to examine the association between social position and mental health. This study hypothesised that a disadvantaged social position is associated with poor mental health.

Datasets

This chapter uses ELSA, UKHLS, NCDS and BCS70 to examine the association between social position and mental health because the datasets included a number of biomarkers representing a variety of biological systems, including neuroendocrine function.

Measures

Dependent variable: mental health

ELSA: in ELSA wave 4, mental health was measured using the Center for Epidemiologic Studies Depression Scale (CES-D) (Banks et al., 2021). The CES-D is a validated and commonly used measure of depressive symptoms (Blodgett et al., 2023). Participants were asked eight questions about their feelings, and the values from their answers were added to get a range between 0 and 8 (Banks et al., 2021). This study operationalised the CES-D as a binary variable with values four and above indicating poor mental health, aligning with the literature (Blodgett et al., 2023).

UKHLS: in UKHLS wave 2, mental health was operationalised using the GHQ-12: Likert measure. The GHQ-12 is a validated and commonly used instrument for assessing minor mental health conditions, including psychological distress in the general population (Goldberg et al., 1997). Researchers have scored the GHQ-12 using various scoring techniques, and one of the most common and validated methods is the Likert scoring technique (Ruiz et al., 2017). The GHQ: Likert scoring technique scores answers to the GHQ-12 questions using a 0-3 scale, and the scores are then added to obtain scores from 0 to 36, with 0 being the least distressed and 36 being the most distressed (Goldberg et al., 1997; Ruiz et al., 2017). This study operationalised the GHQ-12 as a binary variable with values above eleven, indicating poor mental health, which aligns with previous studies (Lundin et al., 2016).

NCDS: mental health was measured using the Malaise Inventory (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). The Malaise Inventory is a widely used and validated self-completion instrument for assessing depression or psychological distress (Rodgers et al., 1999a). The sums of the answers to the Malaise Inventory were classed into two categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). The first category is scored three or below, indicating good mental health; the second category scored four and above, indicating poor mental health (University of London-Institute of Education-Centre for Longitudinal Studies, 2021).

BCS70: mental health was measured using the Malaise Inventory (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The sums of the answers to the Malaise Inventory were classed into two categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The first category is scored three or below, which indicates good mental health, and the second is scored four and above, which indicates poor mental health (University of London-Institute of Education-Centre for Longitudinal Studies, 2023).

The four datasets in this chapter used different instruments to measure mental health. The literature reviewed suggests that the association between indicators of social position and mental health may vary depending on the type of mental disorder (Lacey et al., 2016). However, this thesis aims to examine the social and biological factors that underpin inequalities in mental health generally and not specific mental health disorders. Also, according to evidence in the literature, the intersecting pathophysiological indicators of mental illness suggest that some biomarkers may be shared in diverse psychiatric conditions (Caldiroli et al., 2023). Furthermore, as discussed earlier, (McElroy et al., 2020) carried out a project in which they examined the measurement properties of the indicators of mental health used in six British birth cohort studies, including NCDS, BCS70, NSHD, ALSPAC, MCS and Next Steps. The indicators of mental health used in the six cohort studies include the GHQ, Malaise Inventory, Short Form Health Survey, Kessler Psychological Distress Scale, Mood and Feelings Questionnaire, Psychiatric Symptom Frequency Scale, and Present State

Examination (McElroy et al., 2020). McElroy et al. (2020) used a content validation technique to find theoretically comparable elements from the various indicators of mental health used in the six cohort studies.

Generally, they found that the indicators had eighty-eight per cent content agreement (McElroy et al., 2020). This means that although differences in age, cohorts, time point and survey design had an impact, the indicators are reasonably comparable (McElroy et al., 2020). Also, the findings from the study conducted by McElroy et al. (2020) suggest that the measurement equivalence of the Malaise Inventory was maintained in both NCDS and BCS70. These findings signify that differences in age, cohorts, time point and survey design did not affect how participants understood and interpreted the questions of the Malaise Inventory and the obtained scores; as such, the results of the Malaise Inventory can be compared across both datasets (McElroy et al., 2020). Therefore, considering the above reasons, the measure of mental health should not be an issue.

Independent variable: social position

In the four datasets (ELSA, UKHLS, NCDS, BCS70) used in this chapter, this study operationalised social position using the five class categories of the National Statistics Socioeconomic Classification (NS-SEC) and educational attainment to investigate whether the findings from both indicators are comparable. The NS-SEC indicates an individual’s socioeconomic position using occupation and other job attributes (Office for National Statistics, 2023). In the four datasets, the NS-SEC 5 categories were classed into Semi-routine and routine occupations, Lower supervisory & technical occupations, Small employers and own account workers, Intermediate occupations, and Management and professional occupations (Office for National Statistics, 2023). The Semi-routine and routine occupations class is the reference category.

In the four datasets, participants were asked about their educational qualifications. In ELSA and UKHLS, participants' responses were classed into No qualification, Other Qualification, O Level/equivalent, A Level/equivalent, Higher qualification below degree, and Degree/Above (Banks et al., 2021; Institute for Social and Economic Research, 2022). In NCDS and BCS70, participants' responses were classed into eight categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2021; University of London-Institute of Education-Centre for Longitudinal Studies, 2023), which this study grouped into six categories to align responses to the classification in ELSA and UKHLS to aid analysis, interpretation and comparison across the studies.

In ELSA, the education variable was taken from wave 4 (2008–2009) (Banks et al., 2021). In UKHLS, the education variable was taken from wave 2 (2010-2011) (Institute for Social and Economic Research, 2022). In NCDS, the education variable was taken from the age 46 sweep (2004-2005) to fill in the gap in educational attainment (Reid & Allum, 2019) because the age 44 sweep (2002-2004), which is the first biomedical sweep did not have the education variable (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). In BCS70, the education variable was taken from the age 46 sweep (2016-2018) (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The No qualification is the reference category.

How the independent and dependent variables were collected

ELSA

Occupational class and educational attainment were collected using computer-aided personal interview (CAPI) and CES-D by a self-completion questionnaire (Cheshire et al., 2012).

UKHLS

Occupational class and educational attainment were collected using CAPI and GHQ-12 by a self-completion questionnaire (Institute for Social and Economic Research, 2022).

NCDS

Occupational class, educational attainment and Malaise Inventory were collected using self-completion questionnaires (University of London-Institute of Education-Centre for Longitudinal Studies, 2021).

BCS70

Occupational class and educational attainment were collected using CAPI and Malaise Inventory by a self-completion questionnaire (University of London-Institute of Education-Centre for Longitudinal Studies, 2023).

Covariates

In all datasets used to examine the association between social position and mental health, this study adjusted for gender and age groups but not in NCDS and BCS70, as participants are of similar age groups, marital status, smoking status, alcohol consumption and physical activity. The study also adjusted for educational attainment in the analyses where social position was measured using the NS-SEC.

The categories of some of the covariates were renamed to be the same where they are fundamentally the same thing. For instance, the reference category in the physical activity variable in NCDS was labelled ‘Not done in the last year’, but for ease of use, this is referred to as 'No activity' in this thesis.

Gender: in all datasets, gender was measured using a dichotomous variable classed as male and female, and male is the reference category.

ELSA Wave 4

Age: in this study, ages in ELSA wave 4 ranged from 45 to 84 years, and these were classed into four age groups, namely 1. 45-54 years, 2. 55-64 years, 3. 65-74 years and 4. 75-84 years. The reference category is age group 45-54 years. The age of participants was restricted to 84 years because this thesis is keeping to populations with full data in all variables. Also, there are not many participants above 84 years, which will unlikely significantly affect the overall results.

Marital status: participants were asked about their "current legal marital status" (Banks et al., 2021), and responses were classified into five categories including 1. Single, that is never married, 2. Married/Partnership, 3. Remarried/In Partnership before, 4. Divorced/legally separated, and 5. Widowed. Single, that is never married is the reference category.

Smoking status: the smoking status variable was classed into three categories: 1. Never Smoked, 2. Ex-Smoker and 3. Current Smoker. The reference category is Never Smoked.

Alcohol intake: participants were asked, "How often respondent has had an alcoholic drink during the last 12 months?” and responses were classified into nine categories

(Banks et al., 2021). The categories are: 1. No alcohol, 2. Not at all in the last 12 months, 3. Once or twice a year, 4. Once every couple of months, 5. Once or twice a month, 6. Once or twice a week, 7. Three or four days a week, 8. Five or six days a week and 9. Almost every day. The reference category is No alcohol.

Physical Activity: participants were asked about vigorous, moderate, and mild physical activity, and their answers were summarised into four. Categories: 1. No activity, 2. Low, 3. Moderate, and 4. High (Banks et al., 2021). The reference category is No activity.

UKHLS

Age: in this study, ages in UKHLS wave 2 ranged from 16 to 84 years, and these were classed into seven age groups (Institute for Social and Economic Research, 2022). The age groups are 1. 16-24 years, 2. 25-34 years, 3. 35-44 years, 4. 45-54 years, 5. 55-64 years, 6. 65-74 years and 7. 75-84 years. The reference category is the age group 16-24 years. The age of participants was restricted to 84 years because this thesis is limited to populations with full data in all variables, and there are not many participants above 84 years.

Marital status: participants were asked about their "legal marital status", and responses were classed into four categories (Institute for Social and Economic Research, 2022). The categories are 1. single, never married/civil partnership, 2. Married/Partnership/Couple, 3. Divorced/legally separated, and 4. Widowed. The reference category is single, never married/civil partnership. The UKHLS does not have the Remarried/In Partnership before category.

Smoking status: smoking status was operationalised using two variables. Answers to the two questions "have you ever smoked cigarettes?" and "do you smoke cigarettes now?" were classed into three categories (Institute for Social and Economic Research, 2022). The categories are: 1. Never Smoked, 2. Ex-Smoker and 3. Current Smoker. The reference category is Never Smoked.

Alcohol intake: alcohol intake was measured using two variables. Participants were asked, ‘have you ever had an alcoholic drink?’ and ‘how often have you had an alcoholic drink during the last 12 months?’ with responses categorised into nine categories (Institute for Social and Economic Research, 2022). The categories are: 1. No alcohol, 2. Not at all in the last 12 months, 3. Once or twice a year, 4. Once every couple of months, 5. Once or twice a month, 6. Once or twice a week, 7. Three or four days a week, 8. Five or six days a week and 9. Almost every day. The reference category is No alcohol.

Physical activity: physical activity was measured using two variables. Participants were asked if they had ‘done walking at least 10 minutes’ and ‘number of days walked at least 10 minutes’, with responses classed into four categories (Institute for Social and Economic Research, 2022). The categories are: 1. No Activity, 2. Low Activity, 3. Moderate Activity, and 4. High Activity. The reference category is No Activity.

NCDS

Age: this study did not create an age group for this dataset as all participants are aged 44-46.

Marital status: participants were asked, ‘What is your current legal marital status?’ and responses were categorised into four (University of London-Institute of Education-

Centre for Longitudinal Studies, 2021). The categories are: 1. Single, that is never married, 2. Married, 3. Remarried and 4. Divorced/legally separated/Widowed. Single, that is never married is the reference category.

Smoking status: the smoking status variable was classed into three categories. The categories are: 1. Never Smoked, 2. Ex-Smoker and 3. Current Smoker. The reference category is Never Smoked.

Alcohol intake: participants were asked, ‘How often do you have a drink containing alcohol?’ and responses were categorised into five categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). These categories include: 1. No alcohol, 2. Once a month or less, 3. Two to four times a month, 4. Two or three times a week, and 5. Four or more times a week. The reference category is No alcohol.

Physical Activity: participants were asked, ‘How often on average did you do swimming, leisurely not laps last year?’ and responses were classed into six categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2021). These categories include: 1. No activity, 2. Less than once a month, 3. Once a month, 4. 2 to 3 times a month, 5. Once a week and 6. More than once a week. The reference category is No activity.

BCS70

Age: this study did not create an age group for this dataset as all participants are aged 45-48.

Marital status: participants were asked about their ‘legal marital status’, and their responses were categorised into three categories (University of London-Institute of

Education-Centre for Longitudinal Studies, 2023). The categories are: 1. Single, that is never married/Partnership, 2. Married/Partnership and 3. Divorced/legally separated/Widowed. The reference category is Single, that is never married/Partnership.

Smoking status: participants were asked ‘Whether smoke (or used to smoke)’ with responses classed into three categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The categories are: 1. Never Smoked, 2. Ex-Smoker and 3. Current Smoker. The reference category is Never Smoked.

Alcohol intake: participants were asked about the ‘Frequency of having an alcoholic drink’ with responses classed into five categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The categories include: 1. No alcohol, 2. Monthly or less, 3. 2-4 times a month, 4. 2-3 times a week and 5. 4 or more times a week. The reference category is No alcohol.

Physical Activity: participants were asked, ‘Number of days in a typical week does 30 mins or more of exercise’, and responses were classed into four categories (University of London-Institute of Education-Centre for Longitudinal Studies, 2023). The categories are: 1. No activity, 2. Low, 3. Moderate, and 4. High. The reference category is No activity.

Descriptive Statistics

This study carried out descriptive statistics in StataMP 17(64-bit) (StataCorp., 2021). Table 2.2 results show the characteristics of the variables used in this study by dataset.

Table 2. 2: Characteristics of variables by datasets

Variables		**Datasets**							
		ELSA		**UKHLS**		**NCDS**		**BCS70**	
		Number	%	Number	%	Number	%	Number	%
All Participants		9324	100	24052	100	6284	100	6369	100
Mental Health (Dependent variable)									
	Good Mental Health	7989	85.68	15905	66.13	5562	88.51	5366	84.25
	Poor Mental Health	1335	14.32	8147	33.87	722	11.49	1003	15.75
Social Position (Independent variable)	**NS-SEC 5 category classification**								
	Semi-routine and routine occupations	2813	30.17	6658	27.68	1144	18.20	1010	15.86
	Lower supervisory & technical occupations	901	9.66	1840	7.65	669	10.65	576	9.04
	Small employers and own account workers	1107	11.87	2208	9.18	681	10.84	590	9.26
	Intermediate occupations	1285	13.78	3413	14.19	719	11.44	861	13.52
	Management and professional occupations	3218	34.51	9933	41.30	3071	48.87	3332	52.32
Gender									

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	Male	4195	44.99	11369	47.27	3211	51.10	3237	50.82
	Female	5129	55.01	12683	52.73	3073	48.90	3132	49.18
Age Group									
	16-24 years			2689	11.18				
	25-34 years			4769	19.83				
	35-44 years			6147	25.56	6037	96.07		
	45-54 years	1390	14.91	5957	24.77	247	3.93	6369	100
	55-64 years	3695	39.63	3654	15.19				
	65-74	2804	30.07	726	3.02				
	75-84	1435	15.39	110	0.46				
Level of Education (Independent variable)									
	No qualifications	2394	25.68	1335	5.55	852	13.56	1639	25.73
	Other Qualification	1052	11.28	1943	8.08	914	14.54	419	6.58
	O Level/equivalent	1829	19.62	5194	21.59	2324	36.98	1606	25.22
	A Level/equivalent	807	8.66	5628	23.40	600	9.55	382	6.00
	Higher qualification below degree	1439	15.43	3181	13.23	305	4.85	563	8.84
	Degree/Above	1803	19.34	6771	28.15	1289	20.51	1760	27.63
Marital Status									
	Single, that is never married	560	6.01	4779	19.87	599	9.53	1161	18.23
	Married/Partnership	5273	56.55	17113	71.15	3896	62.00	4216	66.20
	Remarried/Partnership before	1202	12.89			870	13.84		

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	Divorced/legally separated	1117	11.98	1884	7.83				
	Divorced/legally separated/widowed					919	14.62	992	15.58
	Widowed	1172	12.57	276	1.15				
Smoking Status									
	Never Smoked	3707	39.76	10539	43.82	3062	48.73	3158	49.58
	Ex-Smoker	4256	45.65	8381	34.85	1934	30.78	2076	32.60
	Current Smoker	1361	14.60	5132	21.34	1288	20.50	1135	17.82
Frequency of Alcoholic Drinks									
	No alcohol	1063	11.40	855	3.55	308	4.90	571	8.97
	Not at all in the last 12 months	894	9.59	951	3.95				
	Once or twice a year	698	7.49	1610	6.69				
	Once every couple of months	574	6.16	2179	9.06				
	Once a month or less					857	13.64	1139	17.88
	Once or twice a month	948	10.17	4048	16.83				
	Two to four times a month					1400	22.28	1524	23.93
	Once or twice a week	2091	22.43	7648	31.80				
	Two or three days a week					2040	32.46	2130	33.44
	Three or four days a week	1151	12.34	3799	15.79				
	Four or more times a week					1679	26.72	1005	15.78
	Five or six days a week	569	6.10	1360	5.65				
	Almost everyday	1336	14.33	1602	6.66				
Physical Activity									

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	No activity	507	5.44	2705	11.25	2275	36.20	1393	21.87
	Low activity	2070	22.20	5427	22.56			2996	47.04
	Moderate activity	4755	51.00	7211	29.98			966	15.17
	High activity	1992	21.36	8709	36.21			1014	15.92
	Less than once a month					2512	39.97		
	Once a month					514	8.18		
	2 to 3 times a month					380	6.05		
	Once a week					383	6.09		
	More than once a week					220	3.50		

Females comprise roughly 52% (24017) of the overall participants (46029) included in this study. The proportion of participants with poor mental health ranged from 14.32% in ELSA, 33.87% in UKHLS, 11.49% in NCDS, to 15.75% in BCS70. BCS70 has the highest percentage (25.73%) of participants with no qualifications, while UKHLS has the highest percentage (28.15%) of participants with a degree or above. Over half of the participants were married in the four datasets (ELSA 56.55%, UKHLS 71.15%, NCDS 62.00% and BCS70 66.20%). In all datasets, the highest percentage of participants never smoked (UKHLS 43.82%, NCDS 48.73%, BCS70 49.58%) except in ELSA, where the highest percentage were ex-smokers (45.65%). In all datasets, most of the participants consumed alcohol moderately. Most of the participants engaged in low to moderate physical activity levels. The respondents aged 85 and older in ELSA were not included in the analysis.

Figure 2. 2: The procedure for selecting the samples in Chapter Two

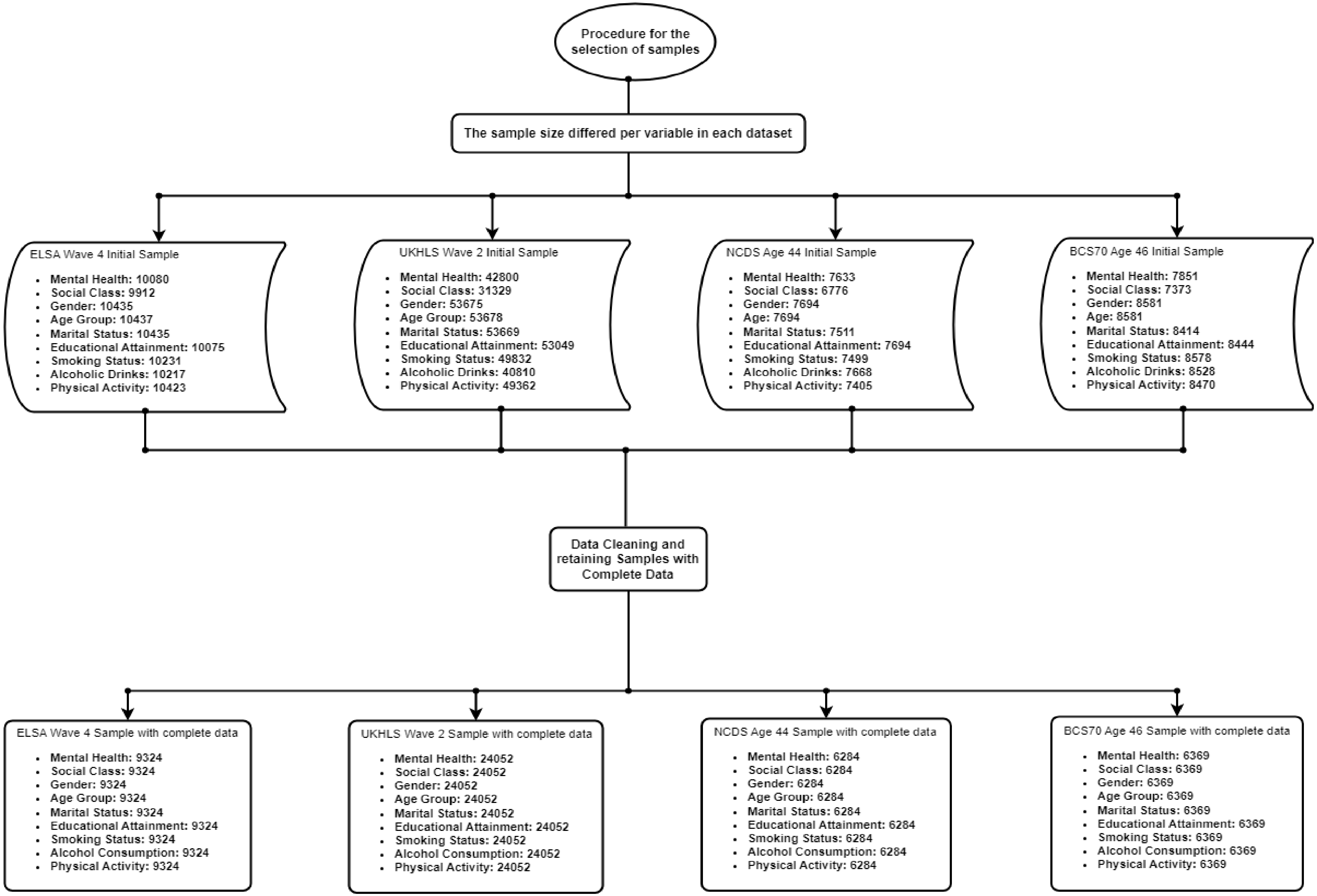

Procedure for the selection of samples
The sample size differed per variable in each dataset
ELSA Wave 4 Initial Sample
Mental Health: 10080
Social Class: 9912
Gender: 10435
Age Group: 10437
Marital Status: 10435
Educational Attainment: 10075
Smoking Status: 10231
Alcoholic Drinks: 10217
Physical Activity: 10423
UKHLS Wave 2 Initial Sample
Mental Health: 42800
Social Class: 31329
Gender: 53675
Age Group: 53678
Marital Status: 53669
Educational Attainment: 53049
Smoking Status: 49832
Alcoholic Drinks: 40810
Physical Activity: 49362
NCDS Age 44 Initial Sample
Mental Health: 7633
Social Class: 6776
Gender: 7694
Age: 7694
Marital Status: 7511
Educational Attainment: 7694
Smoking Status: 7499
Alcoholic Drinks: 7668
Physical Activity: 7405
BCS70 Age 46 Initial Sample
Mental Health: 7851
Social Class: 7373
Gender: 8581
Age: 8581
Marital Status: 8414
Educational Attainment: 8444
Smoking Status: 8578
Alcoholic Drinks: 8528
Physical Activity: 8470
Data Cleaning and retaining Samples with Complete Data
ELSA Wave 4 Sample with complete data
Mental Health: 9324
Social Class: 9324
Gender: 9324
Age Group: 9324
Marital Status: 9324
Educational Attainment: 9324
Smoking Status: 9324
Alcohol Consumption: 9324
Physical Activity: 9324
UKHLS Wave 2 Sample with complete data
Mental Health: 24052
Social Class: 24052
Gender: 24052
Age Group: 24052
Marital Status: 24052
Educational Attainment: 24052
Smoking Status: 24052
Alcohol Consumption: 24052
Physical Activity: 24052
NCDS Age 44 Sample with complete data
Mental Health: 6284
Social Class: 6284
Gender: 6284
Age Group: 6284
Marital Status: 6284
Educational Attainment: 6284
Smoking Status: 6284
Alcohol Consumption: 6284
Physical Activity: 6284
BCS70 Age 46 Sample with complete data
Mental Health: 6369
Social Class: 6369
Gender: 6369
Age Group: 6369
Marital Status: 6369
Educational Attainment: 6369
Smoking Status: 6369
Alcohol Consumption: 6369
Physical Activity: 6369

Figure 2.2 shows the procedure for selecting the study sample in Chapter Two by variables and datasets. The sample size differed per variable in each dataset. The scrutiny of the sample not selected indicates that ELSA participants 85 years and above and UKHLS participants 74 years and above were more likely not to be selected as they had more missing data. In all the datasets, the participants not selected were more likely to have missing data on social class. Data cleaning involved retaining only participants with complete cases in all the datasets used in Chapter Two.

Analysis approach

The dependent variable is binary, and as such, this study fitted logistic regression models in StataMP 17(64-bit) (StataCorp., 2021) to examine the association between social position and mental health (Scott & Jeremy, 2014). Participants included in this study had complete data in all the variables. ELSA and UKHLS data were weighted to account for their sampling design and ensure that the study sample was representative of the population (Domènech-Abella et al., 2018). NCDS and BCS70 data were not weighted as these datasets had no weight variables. The results of the weighted analyses are similar to those of the unweighted analyses and are attached as an appendix to avoid duplication of the results presentation. Also, reporting the results of the unweighted analyses makes comparisons between the four datasets easier.

Results

Logistic regression

Occupation

ELSA

Table 2. 3: Logistics regression using ELSA data and occupation as a measure of social position

Variables	ELSA											
Mental Health	**Model 1[1]**			**Model 2[2]**			**Model 3[3]**			**Model 4[4]**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Social Position												
Lower supervisory & technical occupations	0.70***	0.57	0.85	0.84*	0.68	1.03	0.85	0.69	1.04	0.89	0.71	1.11
Small employers and own account workers	0.57***	0.47	0.69	0.71***	0.58	0.87	0.74**	0.61	0.91	0.79**	0.64	0.99
Intermediate occupations	0.65***	0.54	0.77	0.67***	0.56	0.81	0.69***	0.57	0.84	0.77**	0.63	0.94
Management and professional occupations	0.42***	0.37	0.49	0.55***	0.46	0.65	0.55***	0.46	0.66	0.60***	0.50	0.73
Gender												
Female				1.59***	1.40	1.81	1.46***	1.28	1.66	1.40***	1.22	1.61
Age Group												
55-64 years				0.84**	0.70	0.99	0.81**	0.68	0.97	0.79**	0.66	0.95
65-74 years				0.76***	0.63	0.91	0.69***	0.57	0.83	0.61***	0.50	0.75

[1] Model 1 examines the association between social position and mental health in all datasets used in chapter two
[2] Model 2 adjusts for gender and education in all datasets and age in ELSA and UKHLS
[3] Model 3 adjusts for gender, education and marital status in all datasets and age in ELSA and UKHLS
[4] Model 4 adjusts for gender, education, marital status and health behaviours in all datasets and age in ELSA and UKHLS

75-84 years				0.95	0.78	1.17	0.77**	0.61	0.96	0.53***	0.41	0.67
Education												
Other qualifications				0.79**	0.65	0.96	0.82*	0.67	1.01	0.94	0.76	1.16
0 Level/equivalent				0.67***	0.56	0.80	0.70***	0.59	0.83	0.87	0.72	1.05
A Level/equivalent				0.66***	0.51	0.84	0.66***	0.52	0.85	0.90	0.70	1.17
Higher qualification below degree				0.68***	0.56	0.84	0.72***	0.59	0.89	1.01	0.80	1.24
Degree/equivalent				0.66***	0.53	0.82	0.69***	0.55	0.86	1.04	0.82	1.31
Marital Status												
Married/Partnership							0.42***	0.34	0.53	0.50***	0.39	0.63
Remarried/In Partnership before							0.58***	0.45	0.76	0.69**	0.52	0.91
Divorced/legally separated							0.95	0.74	1.22	0.96	0.73	1.25
Widowed							1.07	0.83	1.38	1.19	0.91	1.56
Smoking Status												
Ex-smoker										1.16*	1.00	1.33
Current smoker										1.47***	1.23	1.75
Alcohol Intake												
Not at all in the last 12 months										1.11	0.89	1.39
Once or twice a year										1.12	0.88	1.42
Once every couple of months										0.72**	0.55	0.96
Once or twice a month										0.67***	0.52	0.86
Once or twice a week										0.58***	0.47	0.72
Three or four days a week										0.54***	0.41	0.70
Five or six days a week										0.62**	0.45	0.87
Almost every day										0.65***	0.51	0.83
Activity												
Low Activity										0.49***	0.39	0.61
Moderate Activity										0.23***	0.19	0.29
High Activity										0.17***	0.13	0.22
Constant	0.25***	0.23	0.28	0.26***	0.21	0.32	0.46***	0.35	0.61	1.37	0.94	2.01

*** p<.01, ** p<.05, * p<.1 [5]

Table 2.3 shows the results of the logistics regression examining the association between occupation as a measure of social position and mental health using ELSA data. Model 1 indicates that mental health is socially patterned. Individuals from higher social classes had statistically significantly decreased odds of having poor mental health compared with individuals in the Semi-routine & Routine occupations social class group. Model 2 shows results similar to those of Model 1 after controlling for gender, age group, and education, indicating that occupational class and educational attainment are associated with poor mental health. However, the educational attainment results were no longer statistically significant in Model 4. In adjusted models, being female compared to male, a current or ex-smoker was associated with increased odds of poor mental health. While being in the older age group compared to the younger age group, higher educational attainment, being married compared to single or never married, increased frequency of alcohol consumption and greater physical activity were associated with decreased odds of having poor mental health.

Educational attainment

Table 2. 4: Logistics regression using ELSA data and education as a measure of social position

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.71***	0.59	0.85	0.72***	0.60	0.88	0.76**	0.63	0.92	0.91	0.74	1.11
0 Level/equivalent	0.59***	0.50	0.70	0.58***	0.49	0.69	0.61***	0.51	0.72	0.80**	0.67	0.96
A Level/equivalent	0.52***	0.42	0.66	0.53***	0.42	0.66	0.54***	0.43	0.68	0.77**	0.60	0.99

[5] The respondents aged 85 and older in ELSA were not included in the analysis.

Higher qualification below degree	0.49***	0.40	0.59	0.52***	0.43	0.63	0.55***	0.45	0.67	0.81**	0.66	0.99
Degree/equivalent	0.43***	0.36	0.51	0.45***	0.37	0.54	0.48***	0.40	0.58	0.78**	0.64	0.96
Gender												
Female				1.61***	1.43	1.82	1.47***	1.30	1.66	1.40***	1.22	1.60
Age Group												
55-64 years				0.82**	0.69	0.98	0.80**	0.67	0.95	0.78**	0.65	0.94
65-74 years				0.73***	0.61	0.88	0.66***	0.55	0.80	0.59***	0.49	0.73
75-84 years				0.92	0.75	1.12	0.73**	0.59	0.91	0.52***	0.41	0.65
Marital Status												
Married/Partnership							0.43***	0.34	0.54	0.51***	0.41	0.65
Remarried/In Partnership before							0.59***	0.45	0.76	0.71**	0.54	0.93
Divorced/legally separated							0.98	0.76	1.25	0.98	0.75	1.27
Widowed							1.10	0.85	1.41	1.23	0.94	1.60
Smoking Status												
Ex-smoker										1.18***	1.02	1.35
Current smoker										1.58***	1.33	1.88
Alcohol Intake												
Not at all in the last 12 months										1.11	0.89	1.39
Once or twice a year										1.14	0.90	1.44
Once every couple of months										0.73**	0.55	0.96
Once or twice a month										0.66***	0.51	0.85
Once or twice a week										0.59***	0.48	0.73
Three or four days a week										0.52***	0.40	0.68
Five or six days a week										0.59***	0.42	0.82
Almost every day										0.63***	0.49	0.80
Activity												
Low Activity										0.50***	0.40	0.62
Moderate Activity										0.24***	0.19	0.30
High Activity										0.17***	0.13	0.22
Constant	0.26***	0.24	0.29	0.23***	0.19	0.28	0.41***	0.31	0.54	1.17	0.81	1.68

*** p<.01, ** p<.05, * p<.1

Table 2.4 shows the results of the logistics regression examining the association between education as a measure of social position and mental health using ELSA data. Model 1 indicates an association between education as a measure of social position and mental health. Individuals with higher educational qualifications have lower odds of having poor mental and results are statistically significant (0.71, *** p<.01; 0.59, *** p<.01; 0.52, *** p<.01; 0.49, *** p<.01; 0.43, *** p<.01). These results remain after controlling for covariates. Overall, the association between social position and mental health using occupational class and education as indicators of social position are comparable. However, in Table 2.3, in Model 4, educational attainment was not associated with mental health in a model containing occupational class.

UKHLS

Table 2. 5: Logistics regression using UKHLS data and occupation as a measure of social position

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Social Position												
Lower supervisory & technical occupations	0.75***	0.67	0.84	0.81***	0.73	0.91	0.82***	0.73	0.91	0.80***	0.72	0.90
Small employers and own account workers	0.84***	0.76	0.93	0.92*	0.83	1.01	0.93	0.84	1.03	0.93	0.83	1.03
Intermediate occupations	1.04	0.95	1.13	0.97	0.89	1.06	0.98	0.90	1.07	0.98	0.89	1.07
Management and professional occupations	0.92**	0.86	0.98	0.92**	0.85	0.99	0.93*	0.86	1.00	0.94	0.87	1.02
Gender												
Female				1.43***	1.35	1.51	1.40***	1.33	1.48	1.43***	1.35	1.51

Age Group								
25-34 years			1.14**	1.03 1.27	1.22***	1.10 1.37	1.22***	1.09 1.36
35-44 years			1.19***	1.08 1.31	1.28***	1.14 1.43	1.27***	1.13 1.43
45-54 years			1.32***	1.20 1.46	1.41***	1.26 1.58	1.42***	1.26 1.59
55-64 years			1.01	0.90 1.13	1.07	0.95 1.22	1.08	0.95 1.23
65-74 years			0.64***	0.52 0.77	0.68***	0.55 0.83	0.68***	0.55 0.84
75-84 years			0.99	0.67 1.47	1.06	0.71 1.59	0.84	0.53 1.31
Education								
Other qualifications			1.00	0.87 1.16	1.00	0.87 1.16	1.02	0.88 1.19
0 Level/equivalent			0.99	0.87 1.12	0.99	0.87 1.12	1.00	0.88 1.14
A Level/equivalent			1.02	0.90 1.16	1.02	0.89 1.16	1.06	0.92 1.21
Higher qualification below degree			1.00	0.87 1.15	1.01	0.87 1.14	1.04	0.90 1.20
Degree/equivalent			0.94	0.83 1.07	0.94	0.83 1.08	1.00	0.87 1.15
Marital Status								
Married/Partnership					0.86***	0.79 0.93	0.84***	0.78 0.92
Divorced/legally separated					1.15**	1.02 1.29	1.11	0.98 1.25
Widowed					0.99	0.76 1.28	0.99	0.76 1.29
Smoking Status								
Ex-smoker							1.11***	1.04 1.18
Current smoker							1.28***	1.19 1.38
Alcohol Intake								
Not at all in the last 12 months							1.30**	1.06 1.58
Once or twice a year							1.36***	1.14 1.63
Once every couple of months							1.17*	0.98 1.39
Once or twice a month							1.08	0.92 1.28
Once or twice a week							0.99	0.85 1.16
Three or four days a week							1.03	0.87 1.21
Five or six days a week							1.16	0.96 1.40
Almost every day							1.26**	1.04 1.51
Activity								
Low Activity							0.93	0.84 1.02
Moderate Activity							0.85***	0.77 0.93
High Activity							0.78***	0.71 0.86

Constant	0.55***	0.52	0.58	0.40***	0.35	0.46	0.42***	0.36	0.48	0.39***	0.32	0.49

*** p<.01, ** p<.05, * p<.1

Table 2.5 shows the results of the logistics regression using UKHLS data. Model 1 indicates that mental health is socially patterned, with individuals from higher social classes having decreased odds of having poor mental health. After controlling for covariates, only participants in the 'Lower supervisory & technical occupations' had a statistically significant decreased odds of having poor mental health compared to participants in the 'Semi-routine & Routine occupations' social class group in all Models. The direction of association is similar to ELSA but not statistically significant. Also, the odds of having poor mental health begin to drop from the age group 55-64 years, and the direction of the association is similar to ELSA from the age group 65-74 years but not statistically significant in the age group 75-84 years. There are also other similarities in the results of both ELSA and UKHLS. Females have higher odds of having poor mental health compared to males. Being married and in a legal partnership compared to being single or never married decreases the odds of having poor mental health. Smoking increases the odds of having poor mental health.

Unlike ELSA, educational attainment is not associated with mental health in all models; however, odds ratios look very similar in Model 4. Unlike in ELSA, in UKHLS, consuming alcohol increased the odds of having poor mental health, and the results of consuming alcohol almost every day are statistically significant (1.26, ** p<.05).

Educational attainment

Table 2. 6: Logistics regression using UKHLS data and education as a measure of social position

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.81***	0.75	0.88	0.76***	0.70	0.83	0.77***	0.71	0.84	0.83***	0.76	0.90
0 Level/equivalent	0.78***	0.73	0.83	0.69***	0.64	0.74	0.69***	0.65	0.75	0.77***	0.71	0.83
A Level/equivalent	0.75***	0.70	0.80	0.69***	0.65	0.75	0.70***	0.65	0.75	0.81***	0.75	0.87
Higher qualification below degree	0.72***	0.67	0.78	0.63***	0.58	0.68	0.64***	0.59	0.69	0.74***	0.68	0.81
Degree/equivalent	0.65***	0.60	0.69	0.56***	0.52	0.60	0.57***	0.53	0.62	0.71***	0.66	0.77
Gender												
Female				1.43***	1.37	1.49	1.40***	1.34	1.46	1.43***	1.37	1.49
Age Group												
25-34 years				1.20***	1.11	1.29	1.34***	1.23	1.46	1.27***	1.16	1.39
35-44 years				1.27***	1.18	1.37	1.44***	1.32	1.57	1.37***	1.25	1.50
45-54 years				1.41***	1.31	1.52	1.58***	1.45	1.73	1.53***	1.40	1.68
55-64 years				1.08*	1.01	1.17	1.21***	1.10	1.33	1.16***	1.05	1.28
65-74 years				0.78***	0.71	0.85	0.88**	0.80	0.97	0.83***	0.75	0.92
75-84 years				0.92	0.83	1.02	1.02	0.91	1.15	0.90	0.79	1.02
Marital Status												
Married/Partnership							0.79***	0.74	0.84	0.79***	0.74	0.85
Divorced/legally separated							1.21***	1.10	1.32	1.14**	1.03	1.25
Widowed							0.93	0.83	1.05	0.92	0.81	1.04
Smoking Status												
Ex-smoker										1.14***	1.09	1.20
Current smoker										1.47***	1.39	1.55
Alcohol Intake												
Not at all in the last 12 months										1.21***	1.07	1.37
Once or twice a year										1.16**	1.03	1.31
Once every couple of months										0.97	0.86	1.09
Once or twice a month										0.90*	0.81	1.01
Once or twice a week										0.80***	0.72	0.89

Three or four days a week							0.83***	0.74 0.92
Five or six days a week							0.90	0.79 1.03
Almost every day							0.98	0.87 1.11
Activity								
Low Activity							0.69***	0.64 0.74
Moderate Activity							0.63***	0.59 0.67
High Activity							0.57***	0.53 0.61
Constant	0.78***	0.74 0.82	0.62***	0.57 0.68	0.65***	0.59 0.71	0.85**	0.74 0.97

*** p<.01, ** p<.05, * p<.1

Table 2.6 shows the results of the logistics regression using UKHLS data and education as a measure of social position. Model 1 shows an association between education as a measure of social position and mental health. Individuals with higher educational qualifications have lower odds of having poor mental health, and results are statistically significant (0.81, *** p<.01; 0.78, *** p<.01; 0.75, *** p<.01; 0.72, *** p<.01; 0.65, *** p<.01). These results remain after controlling for covariates. Thus, as observed in ELSA, the association of educational attainment with mental health is apparent; however, these associations are not apparent in models that include occupational class. The estimates of educational attainment are almost the same as ELSA when not adjusted for occupational class. Like ELSA, in adjusted models, being female compared to male, a current or ex-smoker was associated with increased odds of poor mental health. Being in the older age group compared to the younger age group, having higher educational attainment, being married compared to single or never married, increased frequency of alcohol consumption and greater physical activity were associated with decreased odds of poor mental health.

NCDS

Table 2. 7: Logistics regression using NCDS data and occupation as a measure of social position

Variables	NCDS											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Social Position												
Lower supervisory & technical occupations	0.79*	0.60	1.04	0.97	0.73	1.28	0.92	0.69	1.22	0.95	0.71	1.27
Small employers and own account workers	0.60***	0.45	0.80	0.76*	0.56	1.02	0.76*	0.56	1.02	0.81	0.60	1.11
Intermediate occupations	1.08	0.85	1.39	1.01	0.78	1.30	1.01	0.77	1.29	1.02	0.78	1.34
Management and professional occupations	0.60***	0.50	0.73	0.73**	0.59	0.91	0.70***	0.56	0.87	0.76**	0.61	0.96
Gender												
Female				2.02***	1.72	2.38	2.01***	1.70	2.37	2.00***	1.68	2.38
Education												
Other qualifications				1.06	0.82	1.38	1.08	0.83	1.42	1.10	0.83	1.46
0 Level/equivalent				0.90	0.71	1.13	0.94	0.75	1.19	1.01	0.78	1.28
A Level/equivalent				0.68**	0.49	0.96	0.68**	0.48	0.98	0.76	0.53	1.10
Higher qualification below degree				1.10	0.75	1.61	1.17	0.80	1.72	1.22	0.81	1.82
Degree/equivalent				0.74**	0.55	0.99	0.78	0.58	1.05	0.83	0.60	1.14
Marital Status												
Married/Partnership							0.77*	0.60	1.01	0.84	0.64	1.09
Remarried							0.94	0.69	1.27	0.99	0.72	1.36
Divorced/legally separated Widowed							0.96	0.72	1.30	1.01	0.74	1.38
Smoking Status												
Ex-smoker										1.10	0.91	1.33
Current smoker										1.19	0.97	1.46
Alcohol Intake												
Once a month or less										0.73*	0.51	1.03
Two to four times a month										0.62**	0.44	0.88
Two or three times a week										0.61***	0.44	0.84
Four or more times a week										0.72*	0.52	1.01

Activity								
Less than once a month							0.86	0.71 1.03
Once a month							0.93	0.68 1.27
2 to 3 times a month							0.76	0.52 1.10
Once a week							0.77	0.54 1.10
More than once a week							0.72	0.45 1.15
Constant	0.18***	0.15 0.21	0.12***	0.09 0.15	0.14***	0.10 0.19	0.18***	0.11 0.28

*** p<.01, ** p<.05, * p<.1

Table 2.7 shows the results of the logistics regression using NCDS data. Model 1 indicates that mental health is socially patterned, with individuals from higher social classes having decreased odds of having poor mental health. After controlling for covariates, only participants in the ‘Management and professional occupations’ social class group had a statistically significant decreased odds of having poor mental health compared to participants in the ‘Semi-routine & Routine occupations’ social class group in all Models. The results of educational qualifications, marital status, smoking status and physical activity were not statistically significant after controlling for covariates. Although the results are not statistically significant, this pattern is similar to the pattern seen in ELSA and UKHLS results, as the direction of association is generally the same. Females have higher odds of having poor mental health compared to males in the three datasets.

Different from UKHLS but similar to ELSA, consuming alcohol is associated with decreased odds (0.73, 0.62. 0.61, 0.72) of having poor mental health, and the results are statistically significant (* p<.1, ** p<.05, *** p<.01, * p<.1) in final models.

Educational attainment

Table 2. 8: Logistics regression using NCDS data and education as a measure of social position

Variables	NCDS											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.78**	0.63	0.97	0.78**	0.63	0.97	0.82*	0.65	1.01	0.85	0.67	1.07
0 Level/equivalent	0.67***	0.56	0.80	0.63***	0.53	0.76	0.67***	0.56	0.81	0.76**	0.63	0.93
A Level/equivalent	0.48***	0.36	0.63	0.45***	0.34	0.60	0.47***	0.35	0.63	0.58***	0.43	0.78
Higher qualification below degree	0.78	0.57	1.07	0.70**	0.51	0.97	0.73*	0.53	1.02	0.85	0.60	1.20
Degree/equivalent	0.46***	0.37	0.57	0.45***	0.36	0.56	0.47***	0.37	0.59	0.58***	0.45	0.74
Gender												
Female				2.02***	1.76	2.32	2.04***	1.77	2.35	1.98***	1.71	2.29
Marital Status												
Married/Partnership							0.66***	0.53	0.82	0.76**	0.61	0.96
Remarried							0.83	0.64	1.08	0.92	0.70	1.21
Divorced/legally separated Widowed							0.92	0.72	1.18	1.01	0.77	1.29
Smoking Status												
Ex-smoker										1.16*	0.98	1.37
Current smoker										1.37***	1.15	1.64
Alcohol Intake												
Once a month or less										0.64***	0.48	0.84
Two to four times a month										0.49***	0.37	0.64
Two or three times a week										0.47***	0.36	0.61
Four or more times a week										0.59***	0.46	0.77
Activity												
Less than once a month										0.76**	0.65	0.90
Once a month										0.77*	0.58	1.02
2 to 3 times a month										0.61**	0.43	0.87
Once a week										0.76*	0.56	1.04
More than once a week										0.61**	0.40	0.93
Constant	0.24***	0.21	0.28	0.16***	0.14	0.19	0.21***	0.16	0.26	0.31***	0.22	0.43

*** p<.01, ** p<.05, * p<.1

Table 2.8 shows the results of the logistics regression using NCDS data and education as a measure of social position. These results are comparable to using education as an indicator of social position in both ELSA and UKHLS datasets.

BCS70

Table 2. 9: Logistics regression using BCS70 data and occupation as a measure of social position

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Social Position												
Lower supervisory & technical occupations	0.68***	0.52	0.89	0.75**	0.57	0.99	0.79*	0.60	1.04	0.79	0.59	1.05
Small employers and own account workers	0.78*	0.60	1.01	0.85	0.65	1.10	0.86	0.66	1.12	0.88	0.67	1.16
Intermediate occupations	0.83	0.66	1.04	0.81*	0.64	1.03	0.86	0.68	1.08	0.86	0.68	1.10
Management and professional occupations	0.61***	0.51	0.73	0.68***	0.56	0.82	0.71***	0.58	0.86	0.74***	0.61	0.91
Gender												
Female				1.37***	1.19	1.58	1.36***	1.18	1.56	1.27***	1.10	1.47
Education												
Other qualifications				1.05	0.80	1.38	1.03	0.78	1.37	0.98	0.73	1.30
0 Level/equivalent				0.93	0.78	1.12	0.94	0.78	1.13	0.94	0.78	1.14
A Level/equivalent				0.75*	0.54	1.03	0.77	0.55	1.07	0.78	0.56	1.10
Higher qualification below degree				1.10	0.86	1.42	1.13	0.87	1.45	1.18	0.91	1.52
Degree/equivalent				0.85	0.70	1.04	0.86	0.70	1.06	0.91	0.74	1.13
Marital Status												
Married/Partnership							0.71***	0.60	0.84	0.74***	0.63	0.89
Divorced/legally separated/ Widowed							0.85	0.68	1.06	0.83	0.67	1.04
Smoking Status												
Ex-smoker										1.14*	0.98	1.34

Current smoker										1.18*	0.97	1.43
Alcohol Intake												
Monthly or less										0.89	0.69	1.15
2 -4 times a month										0.64***	0.50	0.82
2-3 times a week										0.68***	0.53	0.86
4 or more times a week										0.74**	0.57	0.97
Activity												
Low										0.62***	0.52	0.73
Moderate										0.59***	0.47	0.74
High										0.52***	0.42	0.66
Constant	0.26***	0.23	0.30	0.23***	0.18	0.27	0.27***	0.22	0.34	0.48***	0.35	0.67

*** p<.01, ** p<.05, * p<.1

Table 2.9 shows the results of the logistics regression using BCS70 data. Model 1 indicates that mental health is socially patterned, with individuals from higher social classes having decreased odds of having poor mental health. After controlling for covariates, only participants in the ‘Management and professional occupations’ social class group had a statistically significant decreased odds of having poor mental health compared to participants in the ‘Semi-routine & Routine occupations’ social class group in all Models. The direction of association is similar in the four datasets. In adjusted models, being female compared to male, a current or ex-smoker was associated with increased odds of having poor mental health. While being married compared to single or never married, greater physical activity were associated with decreased odds of having poor mental health. This pattern is similar to the pattern in the other three datasets. Consuming alcohol decreases the odds (0.64, 0.68. 0.74) of having poor mental health. The results are statistically significant (*** p<.01, *** p<.01, * p<.1). These findings are similar to ELSA and NCDS but different to UKHLS, whose results indicate that consuming alcohol increases the odds of having poor mental health.

The results of the educational qualifications are not statistically significant after controlling for covariates, but in Model 4, the direction of association is comparable in the four datasets.

Educational attainment

Table 2. 10: Logistics regression using BCS70 data and education as a measure of social position

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.87	0.69	1.10	0.86	0.68	1.08	0.87	0.69	1.11	0.87	0.68	1.11
0 Level/equivalent	0.71***	0.61	0.82	0.69***	0.59	0.80	0.72***	0.61	0.84	0.78***	0.66	0.92
A Level/equivalent	0.51***	0.39	0.69	0.50***	0.37	0.67	0.54***	0.41	0.73	0.62***	0.46	0.84
Higher qualification below degree	0.77**	0.62	0.96	0.73**	0.59	0.91	0.78**	0.63	0.98	0.89	0.71	1.12
Degree/equivalent	0.51***	0.43	0.60	0.49***	0.42	0.58	0.53***	0.45	0.62	0.64***	0.54	0.77
Gender												
Female				1.48***	1.32	1.67	1.46***	1.30	1.65	1.34***	1.19	1.52
Marital Status												
Married/Partnership							0.57***	0.50	0.66	0.64***	0.55	0.74
Divorced/legally separated/ Widowed							0.78**	0.65	0.94	0.78**	0.64	0.94
Smoking Status												
Ex-smoker										1.13*	0.98	1.30
Current smoker										1.39***	1.19	1.63
Alcohol Intake												
Monthly or less										0.72***	0.59	0.88
2 -4 times a month										0.48***	0.39	0.59
2-3 times a week										0.51***	0.42	0.62
4 or more times a week										0.59***	0.48	0.74
Activity												

Low										0.55***	0.48	0.64
Moderate										0.49***	0.40	0.60
High										0.51***	0.42	0.61
Constant	0.32***	0.29	0.35	0.26***	0.23	0.29	0.37***	0.31	0.43	0.77**	0.61	0.98

*** p<.01, ** p<.05, * p<.1

Table 2.10 shows the results of the logistics regression using BCS70 data and education as a measure of social position. Results show that mental health is socially patterned, with individuals with higher educational qualifications having decreased odds of having poor mental health after controlling for covariates. These results are comparable to using education as an indicator of social position in ELSA, UKHLS and NCDS datasets.

Results after adjusting for covariates in the four datasets

To make it easier to compare the four datasets used in Chapter Two, Table 2.11 and Table 2.12 present the results of the four datasets after controlling for covariates using occupation and education as a measure of social position, respectively.

Table 2. 11: Results of the four datasets after adjusting for covariates and using occupation as a measure of social position

Variables	**ELSA**			**UKHLS**			**NCDS**			**BCS70**		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Social Position												
Lower supervisory & technical occupations	0.89	0.71	1.11	0.80***	0.72	0.90	0.95	0.71	1.27	0.79	0.59	1.05
Small employers and own account workers	0.79**	0.64	0.99	0.93	0.83	1.03	0.81	0.60	1.11	0.88	0.67	1.16
Intermediate occupations	0.77**	0.63	0.94	0.98	0.89	1.07	1.02	0.78	1.34	0.86	0.68	1.10
Management and professional occupations	0.60***	0.50	0.73	0.94	0.87	1.02	0.76**	0.61	0.96	0.74***	0.61	0.91

Gender												
Female	1.40***	1.22	1.61	1.43***	1.35	1.51	2.00***	1.68	2.38	1.27***	1.10	1.47
Age Group												
25-34 years				1.22***	1.09	1.36						
35-44 years				1.27***	1.13	1.43						
45-54 years				1.42***	1.26	1.59						
55-64 years	0.79**	0.66	0.95	1.08	0.95	1.23						
65-74 years	0.61***	0.50	0.75	0.68***	0.55	0.84						
75-84 years	0.53***	0.41	0.67	0.84	0.53	1.31						
Education												
Other qualifications	0.94	0.76	1.16	1.02	0.88	1.19	1.10	0.83	1.46	0.98	0.73	1.30
0 Level/equivalent	0.87	0.72	1.05	1.00	0.88	1.14	1.01	0.78	1.28	0.94	0.78	1.14
A Level/equivalent	0.90	0.70	1.17	1.06	0.92	1.21	0.76	0.53	1.10	0.78	0.56	1.10
Higher qualification below degree	1.01	0.80	1.24	1.04	0.90	1.20	1.22	0.81	1.82	1.18	0.91	1.52
Degree/equivalent	1.04	0.82	1.31	1.00	0.87	1.15	0.83	0.60	1.14	0.91	0.74	1.13
Marital Status												
Married/Partnership	0.50***	0.39	0.63	0.84***	0.78	0.92	0.84	0.64	1.09	0.74***	0.63	0.89
Remarried/In Partnership before	0.69**	0.52	0.91				0.99	0.72	1.36			
Divorced/legally separated	0.96	0.73	1.25	1.11	0.98	1.25	1.01	0.74	1.38	0.83	0.67	1.04
Widowed	1.19	0.91	1.56	0.99	0.76	1.29						
Smoking Status												
Ex-smoker	1.16*	1.00	1.33	1.11***	1.04	1.18	1.10	0.91	1.33	1.14*	0.98	1.34
Current smoker	1.47***	1.23	1.75	1.28***	1.19	1.38	1.19	0.97	1.46	1.18*	0.97	1.43
Alcohol Intake												
Not at all in the last 12 months	1.11	0.89	1.39	1.30**	1.06	1.58						
Once or twice a year	1.12	0.88	1.42	1.36***	1.14	1.63						
Once every couple of months	0.72**	0.55	0.96	1.17*	0.98	1.39						
Once or twice a month	0.67***	0.52	0.86	1.08	0.92	1.28						
Once or twice a week	0.58***	0.47	0.72	0.99	0.85	1.16						
Three or four days a week	0.54***	0.41	0.70	1.03	0.87	1.21						
Five or six days a week	0.62**	0.45	0.87	1.16	0.96	1.40						
Almost every day	0.65***	0.51	0.83	1.26**	1.04	1.51						

Once a month or less							0.73*	0.51	1.03			
Two to four times a month							0.62**	0.44	0.88			
Two or three times a week							0.61***	0.44	0.84			
Four or more times a week							0.72*	0.52	1.01			
Monthly or less										0.89	0.69	1.15
2 -4 times a month										0.64***	0.50	0.82
2-3 times a week										0.68***	0.53	0.86
4 or more times a week										0.74**	0.57	0.97
										0.89	0.69	1.15
Activity												
Low Activity	0.49***	0.39	0.61	0.93	0.84	1.02				0.62***	0.52	0.73
Moderate Activity	0.23***	0.19	0.29	0.85***	0.77	0.93				0.59***	0.47	0.74
High Activity	0.17***	0.13	0.22	0.78***	0.71	0.86				0.52***	0.42	0.66
Less than once a month							0.86	0.71	1.03			
Once a month							0.93	0.68	1.27			
2 to 3 times a month							0.76	0.52	1.10			
Once a week							0.77	0.54	1.10			
More than once a week							0.72	0.45	1.15			
Constant	1.37	0.94	2.01	0.39***	0.32	0.49	0.18***	0.11	0.28	0.48***	0.35	0.67

*** p<.01, ** p<.05, * p<.1

Table 2. 12: Results of the four datasets after adjusting for covariates and using education as a measure of social position

Variables	ELSA			UKHLS			NCDS			BCS70		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.91	0.74	1.11	0.83***	0.76	0.90	0.85	0.67	1.07	0.87	0.68	1.11
0 Level/equivalent	0.80**	0.67	0.96	0.77***	0.71	0.83	0.76**	0.63	0.93	0.78***	0.66	0.92
A Level/equivalent	0.77**	0.60	0.99	0.81***	0.75	0.87	0.58***	0.43	0.78	0.62***	0.46	0.84
Higher qualification below degree	0.81**	0.66	0.99	0.74***	0.68	0.81	0.85	0.60	1.20	0.89	0.71	1.12
Degree/equivalent	0.78**	0.64	0.96	0.71***	0.66	0.77	0.58***	0.45	0.74	0.64***	0.54	0.77
Gender												
Female	1.40***	1.22	1.60	1.43***	1.37	1.49	1.98***	1.71	2.29	1.34***	1.19	1.52

Age Group												
25-34 years				1.27***	1.16	1.39						
35-44 years				1.37***	1.25	1.50						
45-54 years				1.53***	1.40	1.68						
55-64 years	0.78**	0.65	0.94	1.16***	1.05	1.28						
65-74 years	0.59***	0.49	0.73	0.83***	0.75	0.92						
75-84 years	0.52***	0.41	0.65	0.90	0.79	1.02						
Marital Status												
Married/Partnership	0.51***	0.41	0.65	0.79***	0.74	0.85	0.76**	0.61	0.96	0.64***	0.55	0.74
Remarried/In Partnership before	0.71**	0.54	0.93				0.92	0.70	1.21			
Divorced/legally separated	0.98	0.75	1.27	1.14**	1.03	1.25	1.01	0.77	1.29	0.78**	0.64	0.94
Widowed	1.23	0.94	1.60	0.92	0.81	1.04						
Smoking Status												
Ex-smoker	1.18***	1.02	1.35	1.14***	1.09	1.20	1.16*	0.98	1.37	1.13*	0.98	1.30
Current smoker	1.58***	1.33	1.88	1.47***	1.39	1.55	1.37***	1.15	1.64	1.39***	1.19	1.63
Alcohol Intake												
Not at all in the last 12 months	1.11	0.89	1.39	1.21***	1.07	1.37						
Once or twice a year	1.14	0.90	1.44	1.16**	1.03	1.31						
Once every couple of months	0.73**	0.55	0.96	0.97	0.86	1.09						
Once or twice a month	0.66***	0.51	0.85	0.90*	0.81	1.01						
Once or twice a week	0.59***	0.48	0.73	0.80***	0.72	0.89						
Three or four days a week	0.52***	0.40	0.68	0.83***	0.74	0.92						
Five or six days a week	0.59***	0.42	0.82	0.90	0.79	1.03						
Almost every day	0.63***	0.49	0.80	0.98	0.87	1.11						
Once a month or less							0.64***	0.48	0.84			
Two to four times a month							0.49***	0.37	0.64			
Two or three times a week							0.47***	0.36	0.61			
Four or more times a week							0.59***	0.46	0.77			
Monthly or less										0.72***	0.59	0.88
2 -4 times a month										0.48***	0.39	0.59
2-3 times a week										0.51***	0.42	0.62
4 or more times a week										0.59***	0.48	0.74
Activity												
Low Activity	0.50***	0.40	0.62	0.69***	0.64	0.74				0.55***	0.48	0.64

Moderate Activity	0.24***	0.19	0.30	0.63***	0.59	0.67				0.49***	0.40	0.60
High Activity	0.17***	0.13	0.22	0.57***	0.53	0.61				0.51***	0.42	0.61
Less than once a month							0.76**	0.65	0.90			
Once a month							0.77*	0.58	1.02			
2 to 3 times a month							0.61**	0.43	0.87			
Once a week							0.76*	0.56	1.04			
More than once a week							0.61**	0.40	0.93			
Constant	1.17	0.81	1.68	0.85**	0.74	0.97	0.31***	0.22	0.43	0.77**	0.61	0.98

*** p<.01, ** p<.05, * p<.1

Discussion

The main results of this chapter are that higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health when examined separately; however, only the link with occupational class persists when both variables are investigated concurrently.

In all datasets used in this chapter, being female and smoking increased the odds of having poor mental health, irrespective of the indicator of social position used. In both ELSA and UKHLS, older age was associated with decreased odds of having poor mental health. In all datasets, being married and having higher levels of physical activity decreased the odds of having poor mental health. The results of the datasets on the connection between alcohol intake and poor mental health were varied. Weighting did not make any difference in the findings of ELSA and UKHLS. There was no significant interaction between covariates and occupation or education, so results were not included.

Trends of the associations between occupation and poor mental health in the four datasets

In all four datasets, higher occupational class was associated with lower odds of having poor mental health. In ELSA, this relationship remained statistically significant after adjusting for covariates, but in UKHLS, the link was no longer statistically significant and unweighted and weighted results are similar. In NCDS and BCS70, this association was only statistically significant in the highest occupational class. These results are identical to the evidence in the literature. For instance, Hoven et al. (2015) found a link between occupation and poor mental health, while others (Osler et al., 2007; Richards & Paskov, 2016b) found that this link became insignificant after controlling for covariates.

A possible explanation is that the link between occupation and poor mental health is complex (Stansfeld et al., 2011). Some studies (Lahelma et al., 2005; Stansfeld et al., 2011) found that occupational inequalities in mental health, rather than following specific classifications, trailed along work context-related risk. Elevated degrees of responsibility, absence of longstanding job security, and the demand to meet targets, among other things, are common working conditions of the jobs within higher occupational classes, and these working conditions together add up to substantial occupational stress (Belloni et al., 2022). Occupational stress, which may differ even within similar jobs, is linked to poor mental health (Moreno Fortes et al., 2020).

Trends of the associations between education and poor mental health in the four datasets

In all four datasets, higher educational qualification was associated with lower odds of having poor mental health, and this relationship remained statistically significant after adjusting for covariates. The results of unweighted and weighted data are comparable. These results are not surprising and may be due to numerous factors. One factor may be that higher educational attainment impacts people’s lives via several pathways, improving health together (Braveman et al., 2011). Another factor may be that higher levels of education could increase health knowledge, which helps individuals engage in healthy behaviours (Darin-Mattsson et al., 2017). Also, higher educational attainment has also been linked to better job and income opportunities, which enhance an individual’s social position (Amroussia et al., 2017). This study's findings align with (Amin et al., 2023; Jiang et al., 2020; Niemeyer et al., 2019).

Comparing associations of each indicator of social position with poor mental health

The second part of the aim of this chapter was to investigate if the findings from occupation and education as indicators of social position are comparable. Higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health; however, only the link with occupational class persists when both variables are investigated concurrently. The results in this chapter suggest that education is working through occupational class in its association with mental health. These findings were unexpected. Previous studies have reported causal links between education and health (Domènech-Abella et al., 2018; Halpern-Manners et al., 2016). Higher educational attainment is said to create added economic resources and better health behaviour, directly impacting health (Darin-Mattsson et al., 2017).

However, our results are not totally out of place as other studies (Geyer et al., 2006) have also demonstrated that the link between social position and health depends on the indicators of social position used. Also, Torssander & Erikson (2009) reported findings similar to those of Geyer et al. (2006) in their study of stratification and mortality using Swedish data. Torssander & Erikson (2009) argued that the four indicators of social position they used were linked to mortality but via varied processes. Findings on socioeconomic differences in physician-diagnosed illnesses by Volkers et al. (2007), who examined health inequalities in the working population in the Netherlands using occupational class and education as indicators of socioeconomic status, are comparable to our results of a social gradient in mental health.

In contrast, our findings were inconsistent with Domènech-Abella et al. (2018), who suggest that educational attainment was linked with depression but occupation was not after controlling for covariates in a study among older people in Finland, Poland

and Spain. A possible reason for these findings could be selection. Persons are selected into different occupational classes based on factors including educational attainment, and endowments (Ravesteijn et al., 2013). Ravesteijn et al. (2013) reported that individuals in higher occupational classes generally had higher educational attainments than those in lower occupational classes.

Another reason could be that educational attainment becomes less suggestive of recent social position as individuals age, and more recent factors, including occupation, become more important (Krieger et al., 1997). As an illustration, Green & Benzeval (2013) indicate that both education and occupation are connected with anxiety and depression. However, occupation was linked with some variations in the continuity of depressive symptoms in older people, which was lacking in educational attainment (Green & Benzeval, 2013). An alternative explanation for these results could be that impacts outside those of knowledge are implicated in these associations (Smith et al., 1998). Personal factors such as resilience, family dynamics and genes have been reported to influence the link between social position and health (Kawachi et al., 2013).

The literature reviewed in this chapter suggests that all the papers reviewed reported an association between social position and mental health. Analyses conducted in this chapter used four datasets with large samples representative of the UK population to show that educational attainment is associated with mental health but not if the occupational class is in the model. These findings support the literature on social position and mental health and provide better insights into how education is linked with mental health. Our results indicate that occupation is an important measure of social position. The findings in this study also highlight the necessity of using multiple measures of social position in examining health inequalities (Smith et al., 1998).

Covariates specific connections

Gender: in all datasets used in this study, being female compared to being male increased the odds of having poor mental health regardless of the indicator of social position used. The results of unweighted and weighted data are similar. Gender differences in mental health have been documented in the literature. Kong et al. (2014), in their study of the link between social position, mental health and the need for long-term care, assert that the risk of poor mental health was higher in women than men. This was collaborated by Sasaki et al. (2021), who claimed in their study of depressive symptoms in Myanmar that the risk of depressive symptoms was higher in women than in men.

Age group: in both ELSA and UKHLS, an increase in age was associated with decreased odds of having poor mental health. These results are in line with the literature. A study by Lam et al. (2019) suggests that the incidence of poor mental health tends to decrease with age. This study did not control for age in NCDS and BCS70 as the participants in both datasets are within the same age group.

Marital status: in all datasets, being married compared to being single decreased the odds of poor mental health. Similar findings have been documented elsewhere with improved mental health in married persons compared to single persons (Velten et al., 2014).

Smoking status: in all datasets used in this study, ex-smokers and current smokers had higher odds of having poor mental health than participants who never smoked.

Although the results were not statistically significant in NCDS, the direction of association was similar. The findings support reports in the literature. The results by Kurtze et al. (2012) indicate that smoking is related to poor mental health. Similar results were reported by Velten et al. (2018).

Alcohol intake: the findings in this study on the connection between alcohol intake and poor mental health are varied. In ELSA, NCDS and BCS70, higher alcohol consumption was linked with decreased odds of having poor mental health regardless of the indicator of social position. While in UKHLS, higher alcohol consumption was associated with increased odds of having poor mental health using occupation as the indicator of social position, the opposite was observed with education as the indicator of social position. This accords with the literature as results are mixed (Rodgers et al., 2000; Xu et al., 2010). A study by Velten et al. (2018) who examined the link between lifestyle choices and mental health using German and Chinese data, reported that higher levels of alcohol consumption were linked to better mental health in German participants but not in Chinese participants.

Previous studies reported that positive links between alcohol consumption and mental health are moderated by confounders (Massin & Kopp, 2014). Therefore, it appears improbable that the act of consuming alcohol is accountable for the lower risk of poor mental health. This study agrees with Velten et al. (2018) that an alternative explanation might be that individuals who often drink alcohol demonstrate other social attributes that are linked to better mental health. For instance, Kurtze et al. (2012), who observed that a lower socioeconomic position was associated with poorer mental health, argued that the incidence and increased rate of alcohol consumption was higher in participants from advantaged socioeconomic backgrounds compared to those from disadvantaged socioeconomic backgrounds. Another possible explanation for these results is that societal norms may mitigate the impact of alcohol on health. For example, results by Velten et al. (2018) could partly be because alcohol intake rates in Germany are one of the highest in the world, and as such, drinking may be seen as a form of socialising which could improve health (World Health Organization, 2019).

Physical activity: higher levels of physical activity were connected to lower odds of having poor mental health in all datasets regardless of the indicator of social position used except in NCDS, where results were only statistically significant with education as a measure of social position, but the direction of association was similar for occupation. These findings, in line with other studies (Kurtze et al., 2012), highlight the importance of regularly engaging in physical activity. A study by Velten et al. (2018) maintains that higher physical activity is associated with better mental health.

Causality and Temporality

This study supports the existing literature on the association between social position and mental health. Its findings suggest that higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health; however, only the link with occupational class persists when both variables are investigated concurrently. Nonetheless, due to its cross-sectional nature, this study cannot determine causality (Wang & Cheng, 2020). Also, because this study is cross-sectional, the observed associations between social position and mental health represent only a snapshot of a one-time point in each study; they cannot determine the temporal association between social position and mental health (West-Pavlov, 2013).

In ELSA, people are likely to have completed education decades ago, while they might have completed their occupation more recently. In UKHLS, the younger participants are more likely to have completed their education more recently and still actively engaged in their occupations. Participants in both NCDS and BCS70 are more likely to have completed their education more recently and are still actively engaged in their professions. Education is more likely to be completed in young adulthood, while occupation may start in young adulthood; these differences in life stages are likely to impact an individual's social position and mental health and underscore the importance of temporal viewpoint and causality.

Strengths and Limitations

Strengths

The main strength of this chapter was showing that educational attainment is associated with mental health but not if the occupational class is in the model. These findings move the literature on social position and mental health forward because it provides better insights into how education is linked with mental health. This study contributes to a deeper understanding of the association between social position and mental health. Another strength is that to the best of the author's knowledge, this study is the first to use data from ELSA, UKHLS, NCDS and BCS70 to examine the association between social position and mental health using occupation and educational attainment as measures of social position.

The four datasets have large sample sizes representative of the UK population. These datasets provide insights into response reliability across time and the life course (Burton-Jeangros et al., 2015). Using multiple datasets and different indicators to examine the same phenomenon aids the robustness, cross-validation, and generalisability of findings and increases the potential for reproducibility in other settings (Taylor & Marchi, 2018).

Limitations

The cross-sectional nature of this study is a limitation as it provides only a snapshot of a one-time point and cannot determine the temporal association between social position and mental health or causality (West-Pavlov, 2013). Also, participants were mostly White or European as such findings may not apply to ethnic minority groups (Smart & Harrison, 2017).

Conclusions

In conclusion, the findings of this study provide further support for the link between disadvantaged social positions and poor mental health and provide better insights into how education is linked with mental health. Higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health when examined separately; however, only the link with occupational class persists when both variables are investigated concurrently. These results suggest that education is working through occupational class in its association with mental health.

To the best of the author's knowledge, this study is the first to use data from ELSA, UKHLS, NCDS and BCS70 to examine the association between social position and mental health using occupation and education as measures of social position. This study conducted a cross-sectional analysis, but using these datasets helped uncover the patterns and trends between social position and mental health outcomes across the distinct phases of life (Burton-Jeangros et al., 2015). Using multiple datasets and different indicators to examine the same phenomenon aids the robustness, cross-validation, and generalisability of findings and increases the potential for reproducibility in other settings (Taylor & Marchi, 2018).

Chapter Three

Key findings in Chapter Two

Chapter Two examined the association between social position and mental health using occupation and educational attainment as measures of social position. Overall, analyses with both indicators of social position support the idea that a disadvantaged social position is associated with a higher risk of poor mental health. Nonetheless, only the link with occupational class persists when both variables are investigated concurrently. However, with occupation as an indicator of social position, after adjusting for covariates, the results in UKHLS were not statistically significant. Nevertheless, the direction of association is similar across the four datasets regardless of the indicator used, as illustrated in Table 3.1 below.

Table 3. 1: The direction of association of the results of Chapter Two

Variables	Datasets			
	ELSA	**UKHLS**	**NCDS**	**BCS70**
Social position and mental health using occupation as a measure of social position				
Occupation class				
Unadjusted	⬇	⬇	⬇	⬇
+gender, age, education	⬇	⬇	⬇	⬇
+marital status	⬇	⬇	⬇	⬇
+health behaviours	⬇	⇩	⬇	⬇
Social position and mental health using education as a measure of social position				
Educational attainment				
Unadjusted	⬇	⬇	⬇	⬇
+gender, age, education	⬇	⬇	⬇	⬇
+marital status	⬇	⬇	⬇	⬇
+health behaviours	⬇	⬇	⬇	⬇

⬇ Less odds of having poor mental health in more advantaged social positions, and results are statistically significant.

⇩ Less odds of having poor mental health in more advantaged social positions, but results are mostly not statistically significant.

Introduction

Having demonstrated in Chapter Two that mental health is socially patterned, with individuals from disadvantaged social positions having higher odds of having poor mental health compared to individuals from advantaged social positions, this study now investigates the biological processes underpinning mental health.

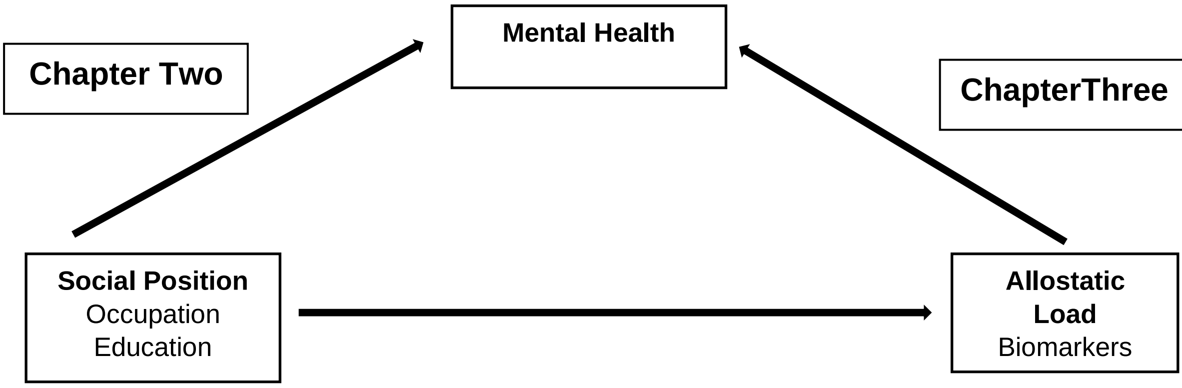


Figure 3. 1: Conceptual Model of this study (Chapter Three)

Chapter Three examines the association between allostatic load and mental health.

A disadvantaged social position may be associated with a number of pathways that elicit changes in biology (Guidi et al., 2020). These can include 'physical' or 'material' factors such as pollution (Thomson, 2019). In this thesis, I investigate an alternative biological pathway by examining the theoretical pathways associated with psychosocial stress.

Allostatic load theory

Humans are social and biological beings (Harris & Schorpp, 2018), and understanding poor mental health means understanding the social, behavioural and biological processes underpinning mental health (Preece et al., 2018). Several studies suggest that the diverse network of biology, experiences, behaviours, and their interactions influence how effectively the body functions (Gruenewald et al., 2012; Prior et al., 2018).

As noted earlier, the biological consequences of persistent stress can be captured using allostatic load. Over time, extensive literature has developed linking higher allostatic load to poorer health outcomes (Guidi et al., 2020; Prior et al., 2018). Whilst evidence in the domain of mental health remains inadequate, the literature has linked higher allostatic load to poor mental health (Savransky et al., 2018).

The allostatic load theory offers insight into the processes that impact health (Guidi et al., 2020). Bodily systems typically maintain relative stability in the internal environment to function well. This state is called homeostasis (Clancy & McVicar, 2010). However, the body continually experiences stressors from the external environment that can threaten or alter its internal stability (Hawkley et al., 2011). The body maintains its internal stability by activating a negative feedback loop, a compensatory mechanism to counter these threats or alterations to the body's internal environment (Clancy & McVicar, 2010). This homeostasis mechanism is called allostasis (Rodriquez et al., 2019). Exposure of the body to persistent stress makes it lose its ability to cope or correct the threats or alterations to its internal environment's stability, causing dysregulation (Guidi et al., 2020). Over time, this dysregulation results in allostatic load (Prior et al., 2018).

Earlier studies on the allostatic load used ten biomarkers, namely epinephrine, norepinephrine, cortisol, dehydroepiandrosterone (DHEA-S), systolic blood pressure (SBP), diastolic blood pressure (DBP), cholesterol, body mass index (BMI) glycosylated haemoglobin (HbA1c) and waist-hip ratio (Seeman et al., 2001). The initial four biomarkers are primary mediators, and the other six are secondary outcomes (Seeman et al., 2001). Earlier allostatic load studies adhered more to the initial allostatic load index, but with time, researchers excluded primary mediators and began to add more biomarkers to their allostatic load index (Whelan et al., 2021).

The literature suggests that allostatic load is a response to stressors (McEwen & Stellar, 1993). Stressors are also associated with poor mental health (Savransky et al., 2018). However, it is unclear whether allostatic load is associated with mental health. The main aim of Chapter Three is to examine the association between allostatic load and mental health. The chapter begins with a literature review of allostatic load and mental health.

Literature review on allostatic load and mental health

Search strategy and study selection

This study searched Medline with full text, Pubmed, Web of Science, APA PsycInfo, APA PsycArticles, ProQuest, CINAHL Complete, Ovid, Scopus, SAGE Journals and the Cochrane Library. Peer-reviewed publications on human population studies investigating the relationship between allostatic load and mental health between 2011 and 2021 were located. Search terms included "Allostatic load", "Mental health", "Depression", and "Schizophrenia". Boolean operators such as "AND" were used. Literature was also searched using Google, and articles were carefully scrutinised for studies not already recognised. Initially, the literature search focused on allostatic load and mental health articles and 3456 articles was obtained, but only sixteen publications were related to the research interest in this paper. As a result, the search focus was expanded to include studies that looked at allostatic load as a mediator variable between another variable and a variable representing poor mental health.

This study initially screened titles and abstracts, and then studies with full text were further scrutinised to select the relevant publications.

Search results

The current paper reviewed twenty-nine studies investigating the relationship between allostatic load and mental health. Thirteen studies from the literature are population studies, of which four (Carbone, 2020a; Gale et al., 2015; Juster et al., 2011; McClain et al., 2021) used longitudinal design. Eight studies (Berger et al., 2019; Bey et al., 2018; Carbone, 2020b; Gillespie et al., 2019; Kobrosly et al., 2013; Prior et al., 2018; Rodriquez et al., 2018; Thorpe et al., 2020) used a cross-sectional design, and one study (Kobrosly et al., 2014) used both cross-sectional and longitudinal designs. Fifteen (Berger et al., 2018b; Chiappelli et al., 2017; Dargél et al., 2020; Hare et al., 2020; Honkalampi et al., 2021; Juster et al., 2018; Misiak et al., 2018; Misiak et al., 2019; Nugent et al., 2015; Piotrowski et al., 2020; Piotrowski et al., 2019; Savransky et al., 2018; Savransky et al., 2017; Scheuer et al., 2018; Vaccarino et al., 2018) of the twenty-nine studies reviewed are case-control studies which used a cross-sectional design. One study (Berger et al., 2018a) is a double-blind, placebo-controlled randomised clinical trial.

Table 3. 2: Literature on allostatic load and mental health

Table 3.2: Literature on allostatic load and mental health						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**Number of biomarkers**	**Condition/measure of mental health**	**Instrument used for diagnoses/assessment**
Honkalampi et al. (2021)	Honkalampi et al 2021 enlisted participants with major depressive disorder from the outpatient Department of Psychiatry at the Kuopio University Hospital, Finland, and enrolled the non-depressed controls from the municipality of Lapinlahti	177 with major depressive disorder (40/137) and 228 control (112/116)	Case-control	Ten biomarkers. Honkalampi et al 2021 determined biomarker risk based on clinical cut-offs.	Major depressive disorder	A trained nurse confirmed the diagnoses of major depressive disorder using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth edition. The 21-item Beck Depression Inventory was used to evaluate the intensity of depression in patients with and major depressive disorder used to detect depressive symptoms in the healthy controls.
McClain, Tucker and Mattei (2021)	The Boston Puerto Rican Health Study	620 (175/445)	Longitudinal (baseline, two years, and five years)	11 biomarkers. The researchers based their biomarker risk on both clinical risk cut-off values and study sample distribution	Depressive symptoms	The Center for Epidemiology Studies Depression (CES-D) scale
Carbone (2020a)	The Midlife Development in the United States. Carbone	714 (312/402)	Population study (longitudinal study of non-	25 biomarkers. Each biomarker was assigned a	Depression	The Composite International Diagnostic Interview Short Form scales

Table 3.2: Literature on allostatic load and mental health						
	used data from three waves, namely wave one, wave two and wave three		institutionalised adults in the US)	risk score based on the sample distribution.		
Carbone (2020b)	The second wave of Midlife Development in the United States study	1757 (783/974)	Population study	22 biomarkers. Biomarkers risk cut off value were defined based on sample distributions	Major depressive disorder	major depressive disorder was measured using self-reported response, the Center for Epidemiological Studies Depression Inventory (CES-D), the Mood and Anxiety Symptom Questionnaire and the Anhedonia subscale.
Dargél et al. (2020)	The French Network of FondaMental Advanced Centers of Expertise in Bipolar Disorders	1072 (434/638)	Case-control 544 had emotional hyper-reactivity, and 528 did not have emotional hyper-reactivity.	At first, the authors used 12 biomarkers, but the biomarkers were reduced to six after the initial analysis. Biomarker risk was determined using clinical reference ranges.	Bipolar disorder	The diagnosis was confirmed using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth edition. The Montgomery–Åsberg Depression Rating Scale and the Young Mania Rating Scale were used to assess depressive symptoms. The Functioning Assessment Short Test was used to evaluate general functioning. Multidimensional Assessment of Thymic States was used to measure the level of emotional reactivity in participants.

Table 3.2: Literature on allostatic load and mental health						
Hare et al. (2020)	The outpatient clinics of the Maryland Psychiatric Research Center and neighbouring outpatient clinic. Control recruited via local media advertisements	46 (32/14) patients and 31 (21/10) controls	Case-control	13 biomarkers. The authors used the distribution of the control sample to determine the percentile distribution of the biomarkers.	Schizophrenia	Patients were diagnosed using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth edition. Clinical symptoms, memory, processing speed and function were assessed using the 20-item Brief Psychiatric Rating Scale total score, the Wechsler Abbreviated Scale of Intelligence digit sequencing and digit-symbol coding subscales and the Mental Illness Research, Education and Clinical Center version of the Global Assessment of Functioning Scale.
Piotrowski et al. (2020)	The Department of Psychiatry at Wroclaw Medical University and the Department of Psychiatry at Pomeranian Medical University in Szczecin	65 (30/35) with schizophrenia-spectrum disorders and 56 (17/39) control group	Case-control	15 biomarkers. Biomarker risk was determined using the distribution in the controls.	Schizophrenia-spectrum disorders	The Operational Criteria for Psychotic Illness checklist (in line with the Diagnostic and Statistical Manual of Mental Disorders, fourth edition criteria) was used for diagnoses. The tools used for assessing symptoms and functioning include the Positive and Negative Syndrome Scale, the Montgomery-Asberg Depression Rating Scale and the Social and Occupational Functioning Assessment Scale.

Table 3.2: Literature on allostatic load and mental health						
Thorpe et al. (2020)	The Health and Retirement Study	850 black men aged 50-101	Population study	Seven biomarkers. The biomarker risk was determined using the distribution in the study sample	Depressive symptoms	The eight-item version of the Center for Epidemiological Studies-Depression scale was used to measure depressive symptoms
Berger et al. (2019)	Aboriginal and Torres Strait Islander communities in north Queensland Australia that took part in the Well Persons Health Check program and the Young Persons Check	329 (145/184)	Population study	Ten biomarkers. Berger et al used the clinical reference ranges to determine biomarker risk for high-density lipo-protein, low-density lipo-protein, triglycerides, and total cholesterol. However, other biomarkers had their risk determined based on sample distribution	Depressive symptoms	Depressive symptoms were assessed using the adapted Patient Health Questionnaire 9

Table 3.2: Literature on allostatic load and mental health						
Gillespie et al. (2019)	The Jackson Heart Study	2670 (921/1749)	Population study	12 biomarkers. Z-scores based on sample mean of each biomarker	Depressive symptoms	The Center for Epidemiologic Studies Depression Scale (CES-D)
Misiak et al. (2019)	The Centre of Mental Health (Wroclaw, Poland)	40 (21/19) with first-episode psychosis and 35 (14/21) as controls	Case-control	15 biomarkers. Biomarker risk was determined based on the distribution in controls	First episode psychosis	Patients were diagnosed using the Diagnostic and Statistical Manual of Mental Disorders, fourth edition criteria and the diagnosis of first-episode psychosis was authenticated using the Operational Criteria for Psychotic Illness checklist.
Piotrowski et al. (2019)	The Department and Clinic of Psychiatry (Wroclaw Medical University, Wroclaw, Poland) and the Department and Clinic of Psychiatry (Pomeranian Medical University, Szczecin, Poland). The control enlisted through advertisement	146 participants divided into 37 (12/25) persons at familial high risk of psychosis, 42 patients with first-episode psychosis (21/21), 25 individuals with acutely relapsed schizophrenia (14/11) and 42 (16/26) participants as the healthy control.	Case-control	15 biomarkers. The biomarkers risk was determined based on the distribution in the control group.	Familial high risk of psychosis, first-episode psychosis, schizophrenia, and healthy control	Diagnoses was done using the Operational Criteria for Psychotic Illness checklist. Psychopathological presentation and general functioning were evaluated using tools including the Positive and Negative Syndrome Scale, the Hamilton Depression Rating Scale, the Young Mania Rating Scale, the Global Assessment of Functioning, the Social and Occupational Functioning Assessment Scale and the Repeatable Battery for Assessment of Neuropsychological Status.

Table 3.2: Literature on allostatic load and mental health

Berger et al. (2018a)	The Orygen Youth Health, Parkville, Australia and headspace, Sunshine, Australia and taken from the NEURAPRO study	106 (36/70)	A subsample of a double-blind placebo-controlled randomised clinical trial	Ten biomarkers. The biomarker risk was determined using the distribution in the study sample	Ultra-high risk for psychosis	Different rating scales were used to assess the participants, including the Brief Psychiatric Rating Scale, the Scale for the Assessment of Negative Symptoms, the Social and Occupational Functioning Assessment Scale, the Montgomery-Asberg Depression Rating Scale, the Young Mania Rating Scale, the Clinical Global Impression scale and the Global Functioning Social and Role scales
Berger et al. (2018b)	A blood bank of patients with schizophrenia and the Department of Psychiatry, University of Magdeburg, Germany.	28 (19/9) with schizophrenia and 28 (15/13) with first-episode psychosis. 53 (36/17) control group.	Case-control	22 biomarkers. Percentiles were determined based on the distribution in the control group.	schizophrenia and first-episode psychosis	Diagnosed using the Diagnostic and Statistical Manual of Mental Disorders, fourth edition criteria with the Structured Clinical Interview. Psychotic symptoms and functioning were assessed using the Positive and Negative Symptoms Scale and the Global Assessment of Functioning scale.
Bey et al. (2018)	The National Health and Nutrition Examination Survey	6431 participants of which 4423 (2276/2147) were White and 2008 (1028/980) were Black	Population study	Nine biomarkers. Biomarker risk was determined based on nationally weighted	Depression	Depression was measured using the 9-item Patient Health Questionnaire

Table 3.2: Literature on allostatic load and mental health						
				empirical cut offs		
Juster et al. (2018)	The Montreal University Mental Health Institute Quebec Canada. The authors recruited the control through face-to-face visits to units, conferences, large banners, intranet advertisements and word of mouth.	Seventy-six patients with 20 (7/13) having bipolar, 13 (6/7) having depression, 19 (6/13) with anxiety, 24 (7/17) with a personality disorder. 202 (59/143) hospital workers as control.	Case-control	14 biomarkers. Distribution for biomarkers was based on the control sample.	Bipolar, depression, anxiety, personality disorder	The International Statistical Classification of Diseases and Related Health Problems.
Misiak et al. (2018)	The Centre of Mental Health (Wroclaw, Poland) and the Department and Clinic of Psychiatry (Pomeranian Medical University, Szczecin, Poland. Misiak et al recruited the controls were via advertisements.	36 (20/16) with first-episode psychosis and 31 (12/19) as controls	Case-control	15 biomarkers. The authors determined biomarker risk based on the distribution in controls.	First-episode psychosis	Diagnose was done using the Operational Criteria for Psychotic Illness checklist, which is in line with the Diagnostic and Statistical Manual of Mental Disorders, fourth edition criteria. Symptoms and functioning were assessed using the Positive and Negative Syndrome Scale, the Scale for Assessment of Positive Symptoms and the Scale for Assessment of Negative Symptoms, the Hamilton Depression Rating Scale, the Young Mania Rating Scale, the Global Assessment of Functioning, the Social and

Table 3.2: Literature on allostatic load and mental health

						Occupational Functioning Assessment Scale.
Prior et al. (2018)	The Understanding Society is the United Kingdom (UK) Household Longitudinal Study (UKHLS)	13228 (5905/7323)	Population study	13 biomarkers. Three methods were used to construct the allostatic load but only the results of a system risk score which involved assigning a risk score to each biomarker based on the sample distribution and then adding the scores.	Mental health	The mental health element of the 12-Item Short-Form Health Survey
Rodriquez et al. (2018)	the National Health and Nutrition Examination Survey from the US	12272 (5829/6443)	Population study	Ten biomarkers. Biomarker risk based on clinical cut off points	Depressive disorder	Depressive disorder was measured using the Patient Health Questionnaire
Savransky et al. (2018)	The Maryland Psychiatric Research Center and several neighboring mental health clinics. Control group were enlisted	58 patients with schizophrenia spectrum disorders (41/17) and 34 healthy controls (20/14)	Case-control	13 biomarkers. Biomarker risk was based on the distribution in the control sample	Schizophrenia	Diagnoses was confirmed or excluded using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth or fifth edition. The Brief Psychiatric

Table 3.2: Literature on allostatic load and mental health

	through local media advertisements. U.S.					Rating Scale was used to evaluate psychiatric symptoms.
Scheuer et al. (2018)	The Max Planck Institute of Psychiatry (in Munich), Bezirkskrankenhaus Augsburg, Klinikum Ingolstadt, Bezirksklinikum Regensburg, Ludwig-Maximilians Universität München, Danuvius Klinik Pfaffenhofen (in Bavaria) and at one clinical site in Basel, Switzerland	324 (165/159) patients with depression and 261 (108/153) control group	Case-control	12 biomarkers. Biomarker risk cut-off values were defined based on the distribution of the study sample	Depression	The criteria of the Diagnostic and Statistical Manual of Mental Disorders, fourth edition was used for diagnoses.
Vaccarino et al. (2018)	Vaccarino et al 2018 enlisted participants in a psychiatric hospital via clinician referral, advertisements, or word of mouth	35 (13/22) with bipolar disorder and 30 (12/18) control group without bipolar disorder	Case-control	Nine biomarkers. Biomarker risk quartiles were based on the distribution of the scores of the control group	Bipolar disorder	The Diagnostic and Statistical Manual of Mental Disorders, fourth edition standards for current diagnosis of bipolar confirmed with the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth edition
Chiappelli et al. (2017)	Chiappelli et al recruited patients from the outpatient clinics at the Maryland Psychiatric Research	44 (28/16) patients and 33 (19/14) control	Case-control	13 biomarkers. Biomarker risk was based on the distribution	Schizophrenia spectrum disorders	Diagnoses was confirmed or excluded using the Structured Clinical Interview. Symptoms were assessed using the psychosis subscale

Table 3.2: Literature on allostatic load and mental health						
	Center and the neighboring mental health clinics. Chiappelli et al enlisted the healthy control group via media advertisements.			in the control sample		of the Brief Psychiatric Rating Scale
Savransky et al. (2017)	Savransky et al 2017 enrolled patients from the outpatient clinics of the Maryland Psychiatric Research Center and neighboring outpatient clinics. The control was enlisted using local media advertisements.	44 (28/16) patients and 33 (19/14) control	Case-control	13 biomarkers. Biomarker risk was based on the distribution in the control sample	Schizophrenia	The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth editionwas used for diagnoses. Symptoms were measured using the Brief Psychiatric Rating Scale
Gale et al. (2015)	The Twenty-07 Study was started in the West of Scotland in 1986	705 (324/381)	The study by Gale et al 2015 is a longitudinal study (20 years). The authors used data gathered at Wave 1 and Wave 5 on the 1972-born cohort. The participants were aged about 16 years at Wave 1 and about 36 years at wave 5. Population study	Nine biomarkers. Standard deviation scores for each biomarker was calculated, and then the scores added to calculate the allostatic load	Anxiety and depression	At wave 5, symptoms of anxiety and depression were measured using the 12-item General Health Questionnaire (GHQ) and the Hospital Anxiety and Depression Scale

Table 3.2: Literature on allostatic load and mental health

Nugent et al. (2015)	The outpatient clinics of the Maryland Psychiatric Research Center and neighboring outpatient clinics. The healthy controls were enlisted via media advertisements and random digit dialing	30 (17/13) patients and 20 (12/8) control	Case-control	13 biomarkers. Biomarker risk was based on the distribution in the control sample.	Schizophrenia	The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth edition was used for diagnoses. Disease symptoms were evaluated using the 20-item anchored Brief Psychiatric Rating Scale.
Kobrosly et al. (2014)	Former participants in the Mindfulness to Improve Elders' Immune and Health Status study (this is a randomised controlled trial)	125 (42/83) older adults aged 65 years and above in Rochester US	Follow-up study that used both elements of a cross-sectional and longitudinal design. Population study	Seven biomarkers. Biomarker risk was based on the sample distribution	Depressive symptoms in older adults	The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders, fourth edition was used to exclude psychiatric patients. The 20-item Center for Epidemiologic Studies Depression Scale was used to measure depressive symptoms.
Kobrosly et al. (2013)	The National Health and Nutrition Examination Survey	2405 (1247/1158)	Cross-sectional population study	Ten biomarkers. Clinical cut-off values at or above the 75th percentile was used to determine biomarker risk. Quartile based on sample distribution.	Depressive symptoms	Depressive symptoms were measured using the 9-item Patient Health Questionnaire depression scale.

Table 3.2: Literature on allostatic load and mental health						
Juster et al. (2011)	The Douglas Hospital Longitudinal Study of Normal and Pathological Aging in Canada	58 (32/26) adults aged 52 and above	Population study. Longitudinal (over six years)	Seven biomarkers. Biomarker risk was based on the sample distribution.	Depressive symptoms	Depressive symptoms were measured using the 30-item Geriatric Depression Scale. The 30-item Geriatric Depression Scale was used over six consecutive years (1997 to 2002).

The methodology used in the identified literature

Most population studies used the CES-D scale and the Patient Health Questionnaire Depression Scale to assess symptoms of poor mental health. These are valid and widely accepted measurement instruments used as screening tools to assess symptoms of depression (Milette et al., 2010). Both devices use the Likert-type scale, which involves a questionnaire, and these tools are often used in research (Milette et al., 2010). Clinicians use these instruments to identify those needing clinical diagnoses (Khamseh et al., 2011).

On the other hand, the Diagnostic and Statistical Manual of Mental Disorders is a diagnostic tool that has been found to be a valid instrument used for mental illness diagnoses (Regier et al., 2013). For example, The Diagnostic and Statistical Manual of Mental Disorders is the primary tool used to diagnose and classify mental diseases in the United States of America, and it is mostly in line with the International Classification of Diseases published by the World Health Organization (WHO) (Vahia, 2013).

The population studies reviewed in this paper are mainly concerned with symptoms of poor mental health, which means participants with symptoms include both those with clinical diagnoses of mental illness and those without clinical diagnoses of mental illness. In comparison, case-control studies are clinical research studies that focus on specific mental health conditions such as depression and schizophrenia.

Discussion

Case-control studies versus population studies

As mentioned earlier, from the literature reviewed, thirteen studies are population studies, fifteen are case-control studies, and one is a Controlled Randomised Clinical Trial. All case-control studies used a cross-sectional design, four population studies used a longitudinal design, and one population study used both methods. Although case-control studies are ideal for studying rare diseases, less time-consuming and less costly, they have a small sample size, reducing statistical power (Dey et al., 2020). In addition, causal relationships between the exposure and outcome variables cannot be determined (Dey et al., 2020). On the other hand, population studies might determine the direction of causality, generally have a larger sample size, and have more statistical power (Jacobsen, 2017). Results can be generalisable to the general population (Wang & Cheng, 2020).

However, population studies are prone to attrition between waves, reducing the overall sample size and being expensive and time-consuming (Wang & Cheng, 2020). Generally, the choice of research methodology should be appropriate for the research question (Nicholas, 2018). Case-control studies are more common in clinical research, while population studies are more common in public health research and have more relevance to the approach taken in this thesis.

Higher allostatic load is linked to poor mental health, the severity of symptoms and functional impediment

Evidence from the literature reviewed in this chapter suggests that allostatic load is linked to poor mental health. Some literature suggests that allostatic load is associated with the severity of poor mental health and functional impairment symptoms. Piotrowski et al. (2020) indicate that allostatic load was raised in patients with psychotic disorders compared to the healthy control. Piotrowski et al. (2020) result is reiterated by Honkalampi et al. (2021), who showed that increased allostatic load was associated with the likelihood of having major depressive disorder than being non-depressed. Earlier studies support these findings. For example, Juster et al. (2018) demonstrate that allostatic load was raised in emergency patients with poor mental health diagnoses, including depression, bipolar, anxiety and personality disorder, in comparison to hospital workers who serve as the healthy control.

Several studies have linked increased allostatic load to the severity of symptoms of poor mental health. This is exemplified in work undertaken by Misiak et al. (2018), who examined the allostatic load score with stress coping tactics in thirty-six patients with first-episode psychosis and a group of thirty-one healthy controls. Misiak et al noted that allostatic load was higher in patients with first-episode psychosis than in the healthy control group and that higher allostatic load was linked to depressive symptoms. Likewise, Berger et al. (2018b) reported that high allostatic load was associated with increased psychotic symptoms.

Some of the studies indicate that allostatic load is connected to functional impairment and linked with the severity of poor mental health symptoms. For example, Piotrowski et al. (2019) suggest that high allostatic load was related to depressive symptoms and more severe cognitive impediments in patients with diagnoses, but no notable associations between allostatic load and cognition were found in the healthy control group. Findings by Dargél et al. (2020), who examined if allostatic load scores can be used to characterise emotional hyper-reactivity and functional outcomes in 1072 patients who have bipolar disorder, agree with the results of Piotrowski et al. (2019). Dargél et al. (2020) demonstrate that general and cognitive functioning were less in those with emotional hyperreactivity than those without emotional hyperreactivity.

The role of individual biomarkers in the allostatic load score

Some results from the literature reviewed indicate that specific individual biomarkers might play a more significant role in the allostatic load score than others. Initially, Dargél et al. (2020) used twelve biomarkers to calculate the allostatic load index in their study. However, six biomarkers were selected after carrying out an analysis to identify the best-tailored biomarkers for patients with bipolar disorder, suggesting that some biomarkers may be more likely to be associated with mental health than others. Thus there is an abundance of literature on the association of inflammatory markers (Dowlati et al., 2010), adiposity (Steptoe & Frank, 2023), metabolic markers (Snoek et al., 2015) and mental health. However, literature on other biomarkers, such as cortisol (Knezevic et al., 2023), is mixed. These results suggest that we can better understand the underlying mechanism linking allostatic load to poor mental health outcomes if we better understand the role of individual biomarkers in the allostatic load score.

Allostatic load, ageing and mental health

Another important theme that emerged from the case-control studies reviewed is the effect of ageing on allostatic load and mental health. Scheuer et al. (2018) examined if allostatic load mediated the link between childhood physical abuse and depression in adulthood. Their results show that allostatic load mediates the association between childhood physical abuse and depression in adulthood, but this mediation was moderated by age. Scheuer et al. (2018) demonstrate that high allostatic load was a risk factor for depression in participants classed as young and middle-aged but not the elderly. This perspective is also evident in the broader literature. For instance, Fernandes & Paúl (2017) suggest that ageing biological deterioration has been linked to poor mental health. A possible reason for these results is that the wear and tear associated with ageing might contribute to poor mental health through pathways other than allostatic load over time.

Higher allostatic load is related to structural and functional alterations in the brain

Three studies from the literature review (Chiappelli et al., 2017; Hare et al., 2020; Savransky et al., 2017) investigated the association between allostatic load and the brain. Overall, these studies found a link between allostatic load and alterations in the brain.

Allostatic load and mental health in population studies

Except for two population studies (Berger et al., 2019; Rodriquez et al., 2018), all the thirteen population studies reviewed found that higher allostatic load was linked to poor mental health. The two studies that failed to report an association between allostatic load and mental health used a cross-sectional design. Rodriquez et al. (2018) had 12,272 participants, a nationally representative US sample, but Berger et al. (2019) had 329 Australian ethnic minority participants. Findings from the population studies are mainly like those from the case-control studies. To illustrate, Thorpe et al. (2020) investigated the relationship between allostatic load and depressive symptoms among middle to old-age black men. The authors found that 30% of men in the high allostatic load group screened positively for depressive symptoms. In comparison, 20% of men in the low allostatic load group screened positively for depressive symptoms.

There is also evidence that higher allostatic load is linked to the severity of symptoms (Bey et al., 2018; Carbone, 2020b; Kobrosly et al., 2014). Specific individual biomarkers might be more significant in the allostatic load score than others. Carbone

(2020b) investigated whether individual biological systems or several biomarkers across systems drive the relationship between allostatic load and major depressive disorder and related outcomes. The authors found that elevated levels of allostatic load are related to increased rates of depression and anhedonia. In addition, dysregulation in the parasympathetic nervous system, immune system and metabolic system are linked to negative mental health outcomes. These results are also evident in earlier studies. For instance, Kobrosly et al. (2013) report that higher levels of allostatic load were linked to the severity of depressive symptoms in their study sample. However, they found no link between depressive symptoms and biomarkers of hepatic or renal function—the results signify that certain biomarkers may be more related to poor mental health than others.

Like the case-control studies, another important theme that emerged from the population studies reviewed is the impact of ageing on allostatic load and mental health. This is exemplified by Juster, et al. (2011), who explored whether the allostatic load was associated with self-rated depressive symptoms in 58 healthy participants over six years. Juster, et al. (2011) maintain that elevated levels of allostatic load were connected to depressive symptoms both at the baseline and at three years. However, this connection was weakened when age and sex were accounted for at three years. There was no significant link between allostatic load and symptoms of depression at six years; instead, increased age was linked to depressive symptoms. However, the results by Juster, et al. (2011) need to be interpreted cautiously due to the small sample size of 58.

Nonetheless, one population study suggests a bidirectional association between allostatic load and poor mental health. McClain et al. (2021) examined links between baseline CES-D scores and 5-year continuous allostatic load scores and links between baseline allostatic load categories and 5-year continuous CES-D scores. The results by McClain et al. (2021) indicate that there is a bidirectional link between allostatic load and depressive symptoms.

Opposing results

In contrast to most of the studies reviewed, three studies, including two population studies (Berger et al., 2019; Rodriquez et al., 2018) and one case-control study Vaccarino et al., 2018) did not find an association between allostatic load and poor mental health. Rodriquez et al. (2018) found no significant link between allostatic load and the risk of depression in their study population. In a separate study, Vaccarino et al. (2018) found that patients with bipolar disorder had similar allostatic load scores with the controls. Also, Berger et al. (2019) did not find an association between cortisol or allostatic load and depression in their study sample. This paper will turn to a controlled randomised clinical trial study.

Controlled randomised clinical trial

Berger et al. (2018a) conducted a study to determine the association between allostatic load and clinical outcomes in persons at ultra-high risk for psychosis in a subsample (106) of the NEURAPRO study. The NEURAPRO study is a double-blind, controlled randomised clinical trial of long-chain omega-3 polyunsaturated fatty acids (Berger et al., 2018a). The authors found that elevated levels of allostatic load were associated with lesser functional capacity in their study sample. They also found that a higher allostatic load was associated with an increase in the severity of psychotic symptoms within six months, but this association became insignificant after 12 months.

Inconsistency in how allostatic load is operationalised

One theme that stood out when reviewing the literature on allostatic load and mental health was the inconsistency in operationalising allostatic load. There were considerable differences in the number of biomarkers used to calculate the allostatic load index and how biomarker risk cut-off points were determined (Piotrowski et al., 2019; Savransky et al., 2018; Savransky et al., 2017). The number of biomarkers ranged from six to twenty-five. Various criteria, including the percentile based on the distribution in the healthy control group and clinical reference ranges, were used to determine the risk cut-off points for biomarkers. For example, Savransky et al. (2018) used thirteen biomarkers to calculate the allostatic load score and the percentile to determine the risk cut-off points for biomarkers. In contrast, Dargél et al. (2020) used six biomarkers to calculate the allostatic load score and clinical reference ranges to determine the risk cut-off points for all biomarkers.

About seventy-three per cent of the twenty-nine studies reviewed in this chapter included neuroendocrine biomarkers in their allostatic load index. Two studies (Gale et al., 2015; Prior et al., 2018) are from the UK. Gale et al. (2015) did not include neuroendocrine biomarkers in their allostatic load index, but Prior et al. (2018) did.

It is important to note that most authors stated data availability as one of the main factors determining the number of biomarkers included in their studies. This study will now rate the available evidence in the literature reviewed.

Rating of the actual evidence in the literature reviewed

The findings from the literature reviewed in this paper should be interpreted with caution. The fifteen case-control studies used a cross-sectional design and focused on specific mental illnesses such as depression and schizophrenia. They have small sample sizes, which limited statistical power.

Most of the population studies used a cross-sectional design and cannot provide any insight into causality or the direction of the association. In addition, some of the studies that claim to be population studies had participants representing specific ethnic groups; as such, these studies are not representative or generalisable to the general population. For example, Gillespie et al. (2019) had only African-American participants in their study. Also, the study sample of McClain et al. (2021) consists of the US Boston Puerto Rican population.

Furthermore, three of the four population studies that used longitudinal design had small sample sizes, between 620 and 714 participants. The fourth population study that used longitudinal design had only 58 participants. Even for a case-control study, 58 participants is a relatively small sample size, and it is an extremely small sample size for a population study.

The evidence from the literature on allostatic load and mental health reviewed in this paper is of poor to moderate quality. Results from the reviewed literature indicate that allostatic load could be a valuable concept for understanding the biological mechanisms underlying poor mental health and that this requires further investigation. A summary of the main findings, together with future directions, is provided in the next section.

Summary of the literature and future directions

All the studies reviewed except three indicate that allostatic load is associated with poor mental health. This discrepancy between the findings of three of the studies and the rest of the studies reviewed could be attributed to the differences in the number of biomarkers used to calculate the allostatic load score and in determining the risk cut-off points for individual biomarkers.

Although the precise mechanisms of how allostatic load may lead to poor mental health are unclear, this study concludes from the literature reviewed that allostatic load could be a valuable framework for understanding the biological mechanism underlying how the social gets under the skin to affect mental health. The allostatic load concept suggests that biological systems are individual systems that are interconnected (Prior et al., 2018). It is crucial to look at biological dysregulation's specific and collective impact (Prior et al., 2018).

Findings from the literature have shown that higher allostatic load is related to the severity of symptoms of poor mental health and functional impediment. Also, elevated allostatic load is linked to structural and functional alteration in the brain. Despite this, it is essential to note that some studies suggest that the relationship between allostatic load and severity of symptoms of poor mental health became insignificant with time. A possible explanation could be that the effects of ageing on the body surpass allostatic load in late life. Alternatively, it might be that over time, the wear and tear associated with ageing might contribute to poor mental health through pathways other than allostatic load.

Overall, the literature reviewed in this paper highlights the importance of using a large representative sample, as the small sample sizes of most of the studies limit statistical power. Most studies used US data. Given the inconsistencies in operationalising allostatic load, including considerable differences in the number of biomarkers used to calculate the allostatic load index and how biomarker risk cut-off points were determined (Piotrowski et al., 2019), there is a need for more research using large representative samples. Therefore, this chapter will now address its three sub-aims.

What is allostatic load?

Allostatic load is the collective consequence of prolonged stress and adverse life occurrences in the body (McEwen & Stellar, 1993).

Three sub-aims to examine allostatic load components

Introduction

As discussed earlier, one theme that stands out in the literature on allostatic load and mental health is the inconsistency in how allostatic load has been operationalised. There are considerable differences in the number of biomarkers used to calculate the allostatic load index (Piotrowski et al., 2019). Earlier studies on the allostatic load used ten biomarkers namely epinephrine, norepinephrine, cortisol, dehydroepiandrosterone (DHEA-S), systolic blood pressure (SBP), diastolic blood pressure (DBP), cholesterol, body mass index (BMI) glycosylated haemoglobin (HbA1c) and waist-hip ratio (Seeman et al., 2001). The initial four biomarkers are regarded as primary mediators because they are released as a direct response to a stressor during allostasis (Seeman et al., 2001). The other six biomarkers are considered secondary outcomes because they occur as impacts of the primary mediators (Seeman et al., 2001).

In addition to inconsistencies related to the components of allostatic load, there are also considerable differences in calculating the allostatic load score (Piotrowski et al., 2019). Some literature combines all the biomarkers, assuming that each biomarker contributes equally to the allostatic load (Rodriquez et al., 2019). At the same time, others calculated the allostatic load in two stages. First, individual biomarkers are recoded using clinical risk cut-off points, high-risk quartiles, or the use of medication (Dargél et al., 2020; Rodriquez et al., 2018). Lastly, varying scores are calculated for individual organ systems, such as inflammatory and cardiovascular systems (Prior et al., 2018).

The summative count method is the most common technique in determining the allostatic load score (Duong et al., 2017). Each biomarker with values equal to or higher than the 75th percentile received a score of 1, and some biomarkers, including DHEA-S and HDL, got a score of 1 if values were equal to or less than the 25th percentile, and these scores were then added to calculate the allostatic load score (Duong et al., 2017). The summative count technique infers that individual biomarkers contribute equally to the allostatic load score, but this has not been established (Rodriquez et al., 2019).

Other methods include averaging continuous z-scores of biomarker variables (Hawkley et al., 2011). This approach could nullify the impact of individual biomarker systems (Rodriquez et al., 2019). Another method is calculating the allostatic load score using clinical risk cut-offs (Dargél et al., 2020). Nonetheless, the main problem with this method is that not all biomarkers have clinical risk cut-offs (King et al., 2019).

A few studies have used factor analysis to calculate the allostatic load scores (King et al., 2019; Wiley et al., 2016). Factor analysis is a data reduction method that allows researchers to discover the hidden structure of given variables, which helps examine notions that cannot easily be measured (Finch, 2020). Allostatic load is a complex multisystem concept where the individual systems interact in a non-linear manner (Rodriquez et al., 2019). Factor analysis could help identify underlying latent variables (factors) that can elucidate the interrelations among these systems, thereby serving as a robust approach to measuring allostatic load (King et al., 2019). Additionally, biomarkers and latent variables can be handled as continuous variables, minimising the risk of losing essential data (Finch, 2020).

Given the inconsistencies in how allostatic load has been operationalised, carrying out further studies on how best to measure allostatic load is important. Therefore, this study uses seven datasets from the UK, including ELSA, UKHLS, NCDS, BCS70, NSHD, HCS and ALSPAC, that have measured similar biological systems but using different biomarkers and factor analyses to address the three sub-aims by answering three research questions. Also, the datasets were suitable and available to address the three sub-aims in Chapter Three.

Question 1: Do the variables representing each biological system affect the allostatic load factor structure?

Examining the neuroendocrine system is important as studies have linked deranged neuroendocrine biomarker profiles to ill health (Goldman et al., 2006). Relatedly, it is believed that chronic stress plays a vital contributory role in these deranged profiles (McEwen, 2006), and stress is at the heart of the allostatic load theory (Johnson et al., 2017). Also, about seventy-three per cent of the thirty studies reviewed in this chapter added primary mediators to their allostatic load index. Therefore, this study will examine question 2.

Question 2: Does including primary mediators change how biomarker variables load onto factors?

Question 3: Are the factor structures similar across different populations?

This study uses exploratory factor analysis to identify the underlying factor structure that could explain the interrelatedness among the biomarker variables used to calculate the allostatic load in the datasets.

Datasets

ELSA, UKHLS, NCDS, BCS70, NSHD, HCS, and ALSPAC have measured similar physiological systems but used different biomarkers across different ages in adulthood. Using multiple datasets and different indicators to examine the same phenomenon aids the robustness, cross-validation, and generalisability of findings and increases the potential for reproducibility in other settings (Taylor & Marchi, 2018).

Biomarkers used in this study

The biomarkers used in this study are shown in Table 3.3 below.

Table 3. 3: Biomarkers used in this study

Factors	Biomarkers	What they measure
Metabolic	Body mass index (BMI), waist circumference, high-density lipoprotein (HDL), hip circumference, waist-to-hip ratio (WHR)	Overweight and obesity
Lipid	Total cholesterol, low-density lipoprotein (LDL), triglyceride (TRIG), apolipoprotein E (APOE) (lipid metabolism), apolipoprotein A1 (APOA1)	Fat in blood
Inflammatory	Fibrinogen (FIB), C-reactive protein (CRP), white blood cell count (WBC), von Willebrand factor antigen (VWF), tissue plasminogen activator antigen (TPA), Immunoglobulin E (IGE), Interleukin 4 (IL-4), Interleukin 6 (IL-6), Cytomegalovirus (CMV), Immunoglobulin M (IgM)	Inflammation, infection
Iron	Ferritin, haemoglobin (HGB), mean corpuscular haemoglobin (MCH)	Anaemia
Glucose metabolism	Glucose, glycated haemoglobin (HBA1c)	Sugar in blood
Cardiovascular	Mean arterial pressure (MAP), pulse rate, systolic blood pressure (SBP), diastolic blood pressure (DBP)	Hypertension

Neuroendocrine	Dehydroepiandrosterone sulphate (DHEA-S), cortisol, insulin-like growth factor 1 (IGF-1), insulin-like growth factor 2 (IGF-2), insulin-like growth factor 3 (IGF-3)	A steroid hormone, a protein hormone

[6]

The biomarkers used in this study represent several biological systems. Table 3.3 has grouped the biomarkers into the systems I hypothesise they represent - namely cardiovascular, metabolic, lipid, inflammatory, iron, glucose metabolism and neuroendocrine systems.

[6] (Ruiz et al., 2017b)

Table 3. 4: Summary of the Characteristics of the Biomarkers included in Chapter Three by Dataset

Biomarkers	ELSA				UKHLS				NCDS				BCS70			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Metabolic																
Body mass index	28.27	5.30	14.70	71.10	27.92	5.52	13.30	47.70	27.38	4.96	15.47	63.52	28.41	5.36	18.21	46.65
Waist circumference	96.97	13.65	58.20	174.70	93.66	14.74	54.25	137.85	91.97	13.58	64.30	135.60	95.18	14.42	65.60	140.50
High-density lipoprotein	1.56	0.42	0.60	4.70					1.56	0.39	0.80	2.90	1.52	0.43	0.70	3.00
Lipid																
Total cholesterol	5.60	1.19	2.00	10.70	5.37	1.15	2.00	8.90	5.88	1.06	3.50	9.30	5.40	0.99	3.10	8.60
Low-density lipoprotein	3.27	1.03	0.40	8.00					3.42	0.99	1.40	6.30				
Triglyceride	1.73	1.07	0.30	25.00	1.78	1.09	0.30	7.20	2.03	1.41	0.50	9.80	1.86	1.27	0.50	8.60
Inflammatory																
Fibrinogen	3.37	0.56	1.30	5.90	2.79	0.59	0.40	4.70	2.96	0.60	1.68	5.09				
C-reactive protein	3.75	7.11	0.20	190	3.10	5.21	0.20	42.00	2.10	3.29	0.08	25.60	2.22	3.17	0.00	23.50
White blood cell count	6.42	1.98	0.80	50.68												
Von Willebrand factor antigen									122.36	40.24	47.00	267.00				
Cytomegalovirus													1.65	0.48	1.00	2.00
Tissue plasminogen activator antigen									5.18	2.73	0.80	16.10				
Immunoglobulin M													2.00	0.15	1.00	3.00
Iron																
Ferritin	121.66	117.00	2.00	1639	134.03	122.67	3.00	821.00					149.11	134.93	8.00	837.00
Haemoglobin	14.10	1.29	8.10	19.60	136.92	13.85	2.00	171.00								
Mean corpuscular haemoglobin	30.31	2.05	18.80	96.60												
Glucose Metabolism																
Glucose	4.90	0.86	2.70	15.30												
Glycated haemoglobin	5.87	0.69	3.70	13.40									36.79	7.33	27.00	93.00
Cardiovascular																
Pulse rate	58.36	14.60	21.50	132												
Systolic blood pressure					125.88	16.78	66.50	216.00	126.33	15.96	91	178.33	124.57	14.97	92.33	176.00
Diastolic blood pressure					72.88	10.86	32.00	126.50	78.73	10.61	55	111.67	77.29	10.86	52.33	110.33
Mean arterial pressure	93.77	11.75	52.50	148.50												
Neuroendocrine																
Dehydroepiandrosterone sulphate	2.41	1.78	0.30	19.60	4.59	3.20	0.10	16.60								
Insulin-like growth factor 1	15.87	5.79	2.00	65.00	18.34	7.23	2.00	49.00	18.65	5.53	7.00	38.00	18.29	4.83	8.00	33.00
Cortisol									21.37	11.55	2.40	78.50				

Table 3.4 summarises the characteristics of the biomarkers included in Chapter Three by biological systems and dataset. NCDS does not have iron biomarkers included in this chapter. UKHLS and NCDS do not have glucose metabolism biomarkers included in this chapter. In this chapter, BCS70 has only one iron biomarker, one glucose metabolism biomarker and one neuroendocrine biomarker. As a result, NCDS does not have iron factor, UKHLS and NCDS do not have glucose metabolism factors, and BCS70 does not have iron, glucose metabolism and neuroendocrine factors because a factor should have at least two variables related to the phenomenon of interest (Kevin, 2015).

Analysis approach

Biomarker variables did not have a normal distribution, and as a result, they were winsorised at 0.5 and 99.5 percentiles to help reduce the impact of outliers in the data sets (Frey, 2018). Some biomarker variables were log-transformed, but non-normality persisted. Biomarker variables were standardised, and z scores were created to ensure they have almost a similar scale to aid analysis (Gal & Rubinfeld, 2019). Missing data were removed from all biomarker variables, and then exploratory factor analysis (EFA) was conducted. Descriptive statistics, data management and EFA were done using StataMP 16(64-bit).

EFA was conducted to determine the number of factors to extract, and factor loadings above 0.3 were acceptable (Finch, 2020). In the literature, different approaches have been used to determine the number of factors to retain, but in this study, the Kaiser criterion and the scree plot have been used. The Kaiser criterion suggests that factors with an eigenvalue above one should be selected (Yeomans & Golder, 1982). At the same time, the scree plot suggests that factors above the break (elbow) should be kept (Yeomans & Golder, 1982). Both techniques were used because there are suggestions that the Kaiser criterion may be a poor approach for determining the number of factors to keep (Yeomans & Golder, 1982). Zwick & Velicer (1986) maintain that the scree plot is more accurate in determining the number of factors to extract. The results of the Kaiser criterion support the decision based on the scree plot.

Factor rotation was done to enable a better interpretation of the factors retained (Field, 2000). Allostatic load theory encompasses multisystem dysfunction that is interlinked nonlinearly (Rodriquez et al., 2019), so oblique promax rotation was done because the factors are correlated (Finch, 2020). Factor loadings can take positive and negative values and range between -1 and +1 (Mooi et al., 2018). High factor loading indicates that the biomarker contributes to the factor (Finch, 2020).

Results

Results: exploratory factor analysis

This study developed thirty-five models to address the three sub-aims by answering three research questions. However, only three models are presented as results are comparable; the other models are attached as an appendix.

Question 1: Do variables representing each biological system affect the allostatic load factor structure?

Question 2: Does including primary mediators change how biomarker variables load onto factors?

Question 3: Are the factor structures similar across different populations?

The first question was investigated using an exploratory factor analysis that examined if the variables used in representing each biological system make a difference to the allostatic load factor structure. For instance, does it matter whether pulse rate and mean arterial pressure or systolic and diastolic blood pressure are used to represent the cardiovascular system? And does it matter whether body mass index and waist circumference or hip circumference and waist-to-hip ratio are used in addition to high-density lipoprotein to represent the metabolic system?

In Table 3.5, this research conducted exploratory factor analysis with all relevant variables using ELSA wave 4 data. ELSA wave 4 was used as the first model because it contains all the variables the author needed to answer question 1 and makes a good starting point for subsequent analysis.

Table 3. 5: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 1) Number of observations = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Factor8
SBP	0.964							
DBP	0.807							
Pulse rate	0.618							-0.394
MAP	0.975							
BMI			0.884					
WAIST		0.429	0.701					
HIP			0.934					
WHR		0.713						
FIB					0.920			
CHOL				0.987				
HDL		-0.784						
LDL				0.949				
HGB		0.461					0.340	0.312
MCH							0.809	
CRP					0.638			
WBC		0.382			0.501			
TRIG		0.727		0.332				
Ferritin							0.747	
HBA1c						0.728		
Glucose						0.883		
IGF1								0.843
DHEAS								0.470

(blanks represent abs(loading)<.3)

Table 3.5 (Model 1) has eight factors that roughly correspond to the hypothesized factors, namely Factor 1: cardiovascular factor composed of systolic blood pressure, diastolic blood pressure, pulse rate and mean arterial pressure; Factor 2: metabolic factor composed of waist circumference, waist-to-hip ratio, high-density lipoprotein, haemoglobin, white blood cell count and triglyceride; Factor 3: metabolic factor composed of body mass index, waist circumference and hip circumference; Factor 4: lipid factor consisting of total cholesterol, low-density lipoprotein and triglyceride; Factor 5: inflammatory factor composed of fibrinogen, C-reactive protein and white blood cell count; Factor 6: glucose metabolism factor composed of glycated haemoglobin and glucose; Factor 7: iron factor composed of haemoglobin, mean corpuscular haemoglobin and ferritin; Factor 8: neuroendocrine factor composed of insulin-like growth factor 1, dehydroepiandrosterone sulphate, pulse rate and haemoglobin.

Next, in Table 3.6, pulse rate and mean arterial pressure are dropped from the cardiovascular system, and hip circumference and waist-to-hip ratio are dropped from the metabolic system to test if dropping these variables makes a difference to allostatic load factor structure.

Table 3. 6: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 2) Number of observations = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP				0.880			
DBP				0.866			
BMI	0.883						
WAIST	0.882						
FIB			0.790				
CHOL		0.989					
HDL	-0.619						
TRIG	0.572						
LDL		0.954					
Ferritin					0.765		
DHEAS							0.557
Glucose						0.865	
HGB					0.457		0.418
HBA1c						0.768	
IGF1							0.789
WBC			0.712				
MCH					0.818		
CRP	0.353		0.584				-0.327

(blanks represent abs(loading)<.3)

Table 3.6 (Model 2) shows that rerunning the factors analysis without pulse rate, mean arterial pressure, hip circumference, and waist-to-hip ratio reduces the number of factors from eight to seven, with only one ‘metabolic factor’ now present in the data.

Table 3. 7: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 3) Number of observations = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Pulse rate							0.818
MAP							0.816
BMI	0.926						
WAIST	0.903						
FIB			0.793				
CHOL		0.992					
HDL	-0.558						
TRIG	0.510						
LDL		0.952					
Ferritin				0.766			
DHEAS						0.572	
Glucose					0.859		
HGB				0.459		0.437	
HBA1c					0.767		
IGF1						0.782	
WBC			0.707				
MCH				0.816			
CRP	0.359		0.585			-0.327	

(blanks represent abs(loading)<.3)

Similar results showed whether systolic and diastolic blood pressure drop from the cardiovascular system and hip circumference and waist-to-hip ratio drop from the metabolic system (table 3.7).

From this point, the Tables and models are attached as an appendix to minimise duplication of the presentation of results since results are similar.

This section continued to add and remove biomarkers representing each biological system to investigate if these biomarkers made any difference in the allostatic load structure using ELSA wave 4. Like the tables above, the factor structure remains in accordance with the hypothesized factors. This study examined question 2 by conducting exploratory factor analysis using ELSA wave 4 to test whether including primary mediators changes how biomarker variables load onto factors, but there was no change.

These analyses were repeated using ELSA waves 2 and 6, UKHLS, NCDS, BCS70, NSHD 1999, NSHD 2009, HCS, and ALSPAC. And results were similar.

Discussion

The results of the exploratory factor analysis shown in 35 Models suggest that allostatic load consists of various factors representing multiple systems, including the metabolic, lipid, cardiovascular, inflammatory, iron, glucose metabolism and neuroendocrine systems. Differences in specific system biomarkers did not alter the allostatic load factor structure interpretation in all the datasets. For example, it did not matter whether pulse rate and mean arterial pressure were used or systolic and diastolic blood pressure were used; the biomarkers were still loaded as cardiovascular factors. This implies that different biomarkers representing the same biological system can be used to represent that specific biological system.

Cross-loadings could also impact the model fit to the data (Kevin, 2015). Nevertheless, cross-loadings are acceptable as this aligns with the allostatic load theory of multisystem dysfunction interlinked nonlinearly (Rodriquez et al., 2019). In most cases where there are cross-loadings, biomarkers have high loading in one factor and low loading in another, implying that certain biomarkers may impact certain body systems more than others. For instance, an iron biomarker, ferritin, is also considered an inflammatory biomarker, as it is linked to damaged cells and anaemia (Kell & Pretorius, 2014).

Another important finding from this exploratory factor analysis is that including primary mediators such as insulin-like growth factor 1, insulin-like growth factor 2, insulin-like growth factor 3, dehydroepiandrosterone sulphate and cortisol provided a more robust allostatic load factor structure. However, it did not change how biomarker variables load onto factors. This result suggests that it is best to include primary mediators, but not having them in a model does not invalidate the model. This finding is essential since measuring primary mediators is difficult (King et al., 2019).

The first four biomarkers in the initial allostatic load index are neuroendocrine, regarded as primary mediators (Seeman et al., 2001). However, as research on allostatic load progressed, researchers excluded neuroendocrine biomarkers and began to add more biomarkers to their allostatic load index (Whelan et al., 2021). Some studies even questioned whether the neuroendocrine biological system is core to the allostatic load index (Gersten, 2008).

For instance, Gersten (2008) conducted a study using the Social Environment and Biomarkers of Aging Study of Taiwan to investigate the link between stressful life histories and neuroendocrine allostatic load in 880 men and women. The neuroendocrine allostatic load is comprised of four biomarkers, including DHEA-S, cortisol, epinephrine and norepinephrine (Gersten, 2008). Overall, findings by Gersten (2008) query whether the neuroendocrine biological system is reflective of chronic stress in the allostatic load index. Unlike the allostatic load theory, Wiley et al. (2017) claimed that dehydroepiandrosterone sulphate and epinephrine did not load significantly unto the allostatic load index with epinephrine loading negatively.

Johnson et al. (2017) who carried out a systematic review of the literature on allostatic load and social and economic position in 2017 suggest that less than sixty per cent of the studies they reviewed included neuroendocrine biomarkers in their allostatic load index. Johnson et al. (2017) concluded that reworking how the allostatic load index was calculated would not significantly impact the outcome of the reviewed studies.

Findings suggest that allostatic load factor structures are similar across the seven UK datasets. The factor structures support the concept that embodies and operationalises allostatic load as multisystem dysfunction while recognising system-specific effects (Wiley et al., 2016).

The results from this study highlight important facets of allostatic load, especially its underlying factor structure. Also, the results from this study suggest that underlying allostatic load factor structure could be calculated with at least two biomarkers representing a given biological system. However, the UKHLS's model with neuroendocrine biomarkers does not have an iron factor, and BCS70 does not have a neuroendocrine factor because these systems had one variable each. Nonetheless, a factor should have at least two variables related to the phenomenon of interest (Kevin, 2015). As a result, this study will use three datasets, namely ELSA, UKHLS and NCDS, for neuroendocrine analysis.

Strengths and limitations

The results from this study should be construed in the context of some strengths and limitations. Strengths of the study include a large sample size in a number of the models and the incorporation of factor analysis. Also, this is the first study to carry out this type of analysis across seven UK datasets. However, a crucial limitation is that available data limited the range of system-specific biomarkers used in some models, likely causing differences in the inclusiveness of assessment within these models. Several models had small sample sizes because they had cortisol, supporting the notion that neuroendocrine biomarkers can be challenging to measure.

Main aim

The abovementioned evidence supports the concept that embodies and operationalises allostatic load as multisystem dysfunction. Evidence also suggests that not including neuroendocrine biomarkers did not significantly affect the interpretation of allostatic load factors. In Chapter Two, results indicate that both occupation and educational attainment as indicators of social position support the idea that a disadvantaged social position is associated with a higher risk of poor mental health when examined separately. This study now examines the association between allostatic load and mental health.

Methods

This study uses data from the larger studies ELSA, UKHLS, NCDS, and BCS70 to examine the association between allostatic load and mental health and these datasets are described above. However, BCS70 is omitted in the neuroendocrine analysis as it does not measure a neuroendocrine biological system. In this study, the allostatic load was operationalised using factor analysis. The factors were loaded onto seven factors representing seven biological systems: metabolic, lipid, inflammatory, iron, glucose metabolism, cardiovascular and neuroendocrine. This study hypothesised that allostatic load is associated with poor mental health.

Measures

The dependent variable, mental health and the independent variables, occupation and educational attainment, have been described above. In all datasets used to examine the association between allostatic load and mental health, this study adjusted for gender and age groups but not in NCDS and BCS70, as participants are of similar age groups, marital status, smoking status, alcohol consumption and physical activity. These covariates have been described above.

Analysis approach confirmatory factor analysis

After determining the number of factors to keep using exploratory factor analysis, this study did a two-step multigroup CFA using the Robust Likelihood Estimation (MLR) in Mplus8.6 (Muthén & Muthén, 2017) to confirm the factor structure of the biomarker variables (Kevin, 2015). First, the study ran a multigroup CFA; in some Models, some parameters were set to zero to enable analysis and achieve convergence. Upon achieving convergence, the last step of the multigroup CFA was performed. The residual correlation between variables with high modification indices was freed to improve model fit (Kevin, 2015). The MLR was used since the biomarker variables did not have a normal distribution (Kevin, 2015). Latent variables are unobserved and do not have a measurement scale (Kevin, 2015). By default, Mplus sets the first item on each factor to 1 (Kevin, 2015). As stated earlier, the biomarkers used in this study load onto seven factors. Table 3.8 shows the factors by datasets.

Table 3. 8: Factors by datasets

Factors	ELSA	UKHLS	NCDS	BCS70
Metabolic	Body mass index Waist circumference High-density lipoprotein	Body mass index Waist circumference	Body mass index Waist circumference High-density lipoprotein	Body mass index Waist circumference High-density lipoprotein
Lipid	Total cholesterol Low-density lipoprotein Triglyceride	Total cholesterol Triglyceride	Total cholesterol Low-density lipoprotein Triglyceride	Total cholesterol Triglyceride
Inflammatory	Fibrinogen C-reactive protein White blood cell count	Fibrinogen C-reactive protein	Fibrinogen C-reactive protein Von Willebrand factor antigen Tissue plasminogen activator antigen	Cytomegalovirus Immunoglobulin M C-reactive protein
Iron	Ferritin Haemoglobin Mean corpuscular haemoglobin	Ferritin Haemoglobin		Ferritin
Glucose Metabolism	Glucose Glycated haemoglobin			Glycated haemoglobin
Cardiovascular	Pulse rate Mean arterial pressure	Systolic blood pressure Diastolic blood pressure	Systolic blood pressure Diastolic blood pressure	Systolic blood pressure Diastolic blood pressure
Neuroendocrine	Dehydroepiandrosterone sulphate Insulin-like growth factor 1	Dehydroepiandrosterone sulphate Insulin-like growth factor 1	Cortisol Insulin-like growth factor 1	Insulin-like growth factor 1

Fit indices

CFA was evaluated for exact fit and approximate fit using the comparative fit index (CFI), Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR) in line with (Kevin, 2015). This study determined that the fit of the models ranged between poor and good. The CFA conducted in this study meets the model identification criteria because there are at least two items for each factor, and the sample size is large (Kevin, 2015). As we can see from Table 3.8, BCS70 does not meet the criteria to have a neuroendocrine factor as it has only one neuroendocrine biomarker (Kevin, 2015).

Confirmatory factor analysis: Fit indices

Table 3. 9: Fit indices for the Models without neuroendocrine biomarkers

Model	X^2	df	RMSEA	CFI	TLI	SRMR
Model 1	4924.576	953	0.067	0.914	0.903	0.073
Model 2	967.702	308	0.040	0.979	0.973	0.046
Model 3	15954.225	556	0.170	0.703	0.683	0.070
Model 4	668.327	183	0.071	0.951	0.940	0.041

Table 3.9 shows the fit indices for Models 1 to 4, which do not contain neuroendocrine biomarkers. This chapter does not present the fit indices for the models with neuroendocrine biomarkers because they are similar to those above. Also, only ELSA, UKHLS and NCDS have neuroendocrine factor scores; as such, it is better to present the results of the four datasets than three datasets. Model 1 is ELSA wave 4. Model 2 is UKHLS. Model 3 is NCDS, and Model 4 is BCS70. Table 3.9 suggests that all Models indicate a sensible fit but not an absolute fit to the data. Chi-square is significant in all Models, but this is not surprising because each Model has a

reasonably large sample size, which will almost always make chi-square significant (Kevin, 2015). Model 3 did not meet the acceptable criteria for the RMSEA, as its RMSEA was above 0.08 (Kevin, 2015). The CFI and TLI in Model 2 and the CFI in Model 4 were above the cutoff of 0.95 (Kevin, 2015). The TLI in Model 4 and the CFI and the TLI in Models 1 and 3 did not meet the acceptable cutoff of 0.95 (Kevin, 2015). All Models have an SRMR below 0.08. The fit indices for Models 1 to 4 suggest that the fit of the Models to the data ranged between poor and good.

Analytical sample

This study carried out descriptive statistics in StataMP 17(64-bit) (StataCorp., 2021). The results show the characteristics of the variables used in this chapter by dataset. These characteristics are for the models without neuroendocrine biomarkers, but they are similar to those with neuroendocrine biomarkers, presented in the appendix to prevent duplication of results.

Table 3. 10: Characteristics of variables by dataset

Variables		**Datasets**							
		ELSA		**UKHLS**		**NCDS**		**BCS70**	
		Number	%	Number	%	Number	%	Number	%
All Participants		7720	100	10056	100	5776	100	2060	100
Mental Health (Dependent variable)									
	Good Mental Health	6672	86.42	6574	65.37	5095	88.21	1741	84.51
	Poor Mental Health	1048	13.58	3482	34.63	681	11.79	319	15.49
Level of Education									
	No qualifications	1957	25.35	507	5.04	796	13.78	498	24.17
	Other Qualification	878	11.37	873	8.68	843	14.59	112	5.44
	O Level/equivalent	1505	19.49	2149	21.37	2142	37.08	536	26.02
	A Level/equivalent	665	8.61	2245	22.32	549	9.50	125	6.07
	Higher qualification below degree	1230	15.93	1387	13.79	278	4.81	205	9.95
	Degree/Above	1485	19.24	2895	28.79	1168	20.22	584	28.35
Occupation									
	Semi-routine and routine occupations	2266	29.35	2574	25.60	1053	18.23	290	14.08

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	Lower supervisory & technical occupations	746	9.66	734	7.30	625	10.82	169	8.20
	Small employers and own account workers	919	11.90	948	9.43	618	10.70	216	10.49
	Intermediate occupations	1094	14.17	1452	14.44	657	11.37	269	13.06
	Management and professional occupations	2695	34.91	4348	43.24	2823	48.87	1116	54.17
Gender									
	Male	3515	45.53	4685	46.59	2953	51.13	1073	52.09
	Female	4205	54.47	5371	53.41	2823	48.87	987	47.91
Age Group									
	16-24 years			785	7.81				
	25-34 years			1767	17.57				
	35-44 years			2583	25.69	5554	96.16		
	45-54 years	957	12.40	2738	27.23	222	3.84	2060	100
	55-64 years	3125	40.48	1802	17.92				
	65-74	2440	31.61	337	3.35				
	75-84	1198	15.52	44	0.44				
Marital Status									
	Single, that is never married	431	5.58	1571	15.62	541	9.37	342	16.60
	Married/Partnership	4362	56.50	7426	73.85	3617	62.62	1384	67.18
	Remarried/Partnership before	984	12.75			795	13.76		
	Divorced/legally separated	943	12.22	921	9.16				
	Divorced/legally separated/widowed					823	14.25	334	16.21
	Widowed	1000	12.95	138	1.37				
Smoking Status									

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	Never Smoked	3085	39.96	4314	42.90	2804	48.55	1042	50.58
	Ex-Smoker	3585	46.44	3789	37.68	1795	31.08	658	31.94
	Current Smoker	1050	13.60	1953	19.42	1177	20.38	360	17.48
Frequency of Alcoholic Drinks									
	No alcohol	662	8.58	148	1.47	280	4.85	166	8.06
	Not at all in the last 12 months	736	9.53	353	3.51				
	Once or twice a year	597	7.73	658	6.54				
	Once every couple of months	492	6.37	874	8.69				
	Once a month or less					783	13.56	365	17.72
	Once or twice a month	831	10.76	1699	16.90				
	Two to four times a month					1296	22.44	462	22.43
	Once or twice a week	1786	23.13	3183	31.65				
	Two or three days a week					1866	32.31	732	35.53
	Three or four days a week	996	12.90	1721	17.11				
	Four or more times a week					1551	26.85	335	16.26
	Five or six days a week	486	6.30	632	6.28				
	Almost everyday	1134	14.69	788	7.84				
Physical Activity									
	No activity	381	9.94	1055	10.49	2081	36.03	391	18.98
	Low activity	1686	21.84	2353	23.40			998	48.45
	Moderate activity	3990	51.68	3097	30.80			329	15.97
	High activity	1663	21.54	3551	35.31			342	16.60
	Less than once a month					2306	39.92		
	Once a month					480	8.31		

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	2 to 3 times a month					348	6.02		
	Once a week					357	6.18		
	More than once a week					204	3.53		

UKHLS has the highest number (10056) of participants. Most participants had good mental health (ELSA 86.42%, UKHLS 65.37, NCDS 88.21, BCS70 84.51%). Participants in ELSA and UKHLS were a more significant proportion of females (ELSA 54.47%, UKHLS 53.41%), and participants in NCDS and BCS70 were slightly more men (NCDS 51.13%, BCS70 52.09%). UKHLS has the highest percentage of participants with a degree or above (28.79%), while ELSA has the highest percentage of participants without qualification (25.35%). The four datasets have the highest number of management and professional occupation participants. Most participants were married (ELSA 56.50, UKHLS 73.85%, NCDS 62.62%, BCS70 67.18%) and were ex-smoker or never smoked. Most of the participants consumed alcohol moderately and engaged in low to moderate physical activity levels.

Missing data

Appendix 3.34 shows the proportion of the missing data by variables and datasets in Chapter Three. This chapter examined the association between allostatic load and mental health. Chapter Three used the biomarker data, a subset of the main data in each dataset. The percentages of missing data are similar for both datasets with neuroendocrine biomarkers and those without neuroendocrine biomarkers. Appendix 3.34 shows the results of the datasets with neuroendocrine biomarkers.

The examination of the missing data revealed that the characteristics of the variables in ELSA, including the level of education, occupation, and smoking status were similar in both the analytical and the non-analytical samples. A higher proportion of people in the analytical sample consumed alcohol moderately than in the non-analytic sample. Also, participants in the analytical sample engaged more in moderate physical activity levels, and more people in the missing data were less active. These findings were expected because of the age of the participants. The pattern in the UKHLS data is similar to that of ELSA, except that the analytical sample had more people with higher educational qualifications.

In comparison, more people in the missing data had no qualifications. This was expected as the younger participants were more likely to upgrade their education in the future, and the older participants were less likely to obtain higher educational levels. The pattern of the analytical samples was similar to the missing data in both NCDS and BCS70 datasets. Overall, the pattern of the characteristics of the analytical samples and the missing data are mostly alike, which suggests that the differences in results of the analytical sample and the missing data will not be significant. Also, the percentage of the missing data in all datasets is small and unlikely to affect the overall results significantly. Also, analysis using weighted ELSA and UKHLS data did not affect the results.

Logistic regression

The dependent variable is binary, and as such, this study fitted logistic regression models (Scott & Jeremy, 2014) in StataMP 17(64-bit) (StataCorp., 2021) to examine the association between allostatic load and mental health. Participants included in this study had complete data in all the variables. All results presented were not weighted; as in Chapter Two, there was no significant difference in the results of weighted and unweighted data. Besides, NCDS and BCS70 do not have weight variables.

Results of logistic regression

ELSA

Table 3. 11: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	1.16***	1.07	1.26	1.33***	1.22	1.45	1.32***	1.20	1.44	1.19***	1.08	1.30
Gender												
Female				2.09***	1.81	2.43	1.85***	1.59	2.15	1.64***	1.39	1.93
Age Group												
55-64 years				0.72***	0.58	0.88	0.71***	0.58	0.88	0.70***	0.57	0.87
65-74 years				0.65***	0.53	0.81	0.60***	0.48	0.74	0.54***	0.42	0.68
75-84 years				0.80	0.63	1.02	0.66***	0.51	0.85	0.48***	0.36	0.63
Education												
Other qualifications				0.74**	0.59	0.92	0.76**	0.61	0.95	0.89	0.70	1.12
0 Level/equivalent				0.59***	0.49	0.71	0.61***	0.51	0.75	0.78**	0.63	0.96
A Level/equivalent				0.52***	0.40	0.69	0.53***	0.40	0.70	0.72**	0.54	0.96
Higher qualification below degree				0.56***	0.45	0.70	0.60***	0.48	0.74	0.82	0.65	1.03
Degree/equivalent				0.51***	0.41	0.63	0.53***	0.43	0.65	0.80	0.64	1.01
Marital Status												
Married/Partnership							0.43***	0.33	0.56	0.50***	0.38	0.66
Remarried/In Partnership before							0.59***	0.43	0.80	0.68**	0.49	0.94
Divorced/legally separated							1.05	0.79	1.40	1.03	0.65	1.03
Widowed							1.11	0.83	1.49	1.22	0.89	1.66
Smoking Status												
Ex-smoker										1.12	0.95	1.31

Current smoker										1.55***	1.27	1.89
Alcohol Intake												
Not at all in the last 12 months										1.21	0.93	1.58
Once or twice a year										1.09	0.82	1.45
Once every couple of months										0.70**	0.51	0.97
Once or twice a month										0.64***	0.48	0.86
Once or twice a week										0.60***	0.47	0.78
Three or four days a week										0.52***	0.38	0.71
Five or six days a week										0.59**	0.40	0.87
Almost every day										0.59***	0.44	0.79
Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.23***	0.18	0.30
High Activity										0.18***	0.14	0.25
Constant	0.16***	0.15	0.17	0.21***	0.16	0.26	0.36***	0.26	0.50	1.23	0.79	1.92

*** p<.01, ** p<.05, * p<.1

Table 3.11 shows the results of the logistics regression examining the association between metabolic factor scores and mental health using ELSA data. Model 1 indicates that for each additional metabolic factor score, the odds of having poor mental health increase by a factor of 1.16, and the results are statistically significant (*** p<.01). This pattern remained after adjusting for covariates. Models 2 to 4 indicate that females have higher odds of having poor mental health compared to males, holding other variables constant. Older participants have decreased odds of having poor mental health compared to younger participants. Higher educational qualifications decrease the odds of having poor mental health, holding other variables constant. Being married is associated with decreased odds of having poor mental health. Smoking increases the odds of having poor mental health, holding other variables constant. Consuming alcohol reduces the odds of having poor mental health. Engaging in physical activity decreases the odds of having poor mental health. These results remained after adjusting for covariates.

Table 3. 12: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	0.93	0.86	1.02	0.92*	0.84	1.00	0.92*	0.84	1.01	1.01	0.91	1.10
Gender												
Female				1.81***	1.57	2.08	1.61***	1.39	1.85	1.48***	1.26	1.72
Age Group												
55-64 years				0.73***	0.60	0.90	0.73***	0.59	0.90	0.71***	0.57	0.88
65-74 years				0.65***	0.53	0.81	0.59***	0.48	0.74	0.53***	0.42	0.67
75-84 years				0.80*	0.63	1.02	0.65***	0.51	0.84	0.47***	0.36	0.62
Education												
Other qualifications				0.71***	0.58	0.89	0.74**	0.59	0.92	0.87	0.69	1.10
0 Level/equivalent				0.57***	0.47	0.69	0.60***	0.49	0.73	0.77**	0.63	0.95
A Level/equivalent				0.51***	0.39	0.66	0.51***	0.39	0.68	0.72**	0.54	0.95
Higher qualification below degree				0.54***	0.43	0.67	0.57***	0.46	0.71	0.80**	0.64	1.01
Degree/equivalent				0.48***	0.39	0.28	0.50***	0.40	0.62	0.78**	0.62	0.98
Marital Status												
Married/Partnership							0.43***	0.33	0.54	0.50***	0.38	0.65
Remarried/In Partnership before							0.59***	0.44	0.80	0.69**	0.50	0.95
Divorced/legally separated							1.04	0.78	1.39	1.02	0.76	1.39
Widowed							1.13	0.85	1.52	1.23	0.91	1.68
Smoking Status												
Ex-smoker										1.13	0.97	1.33
Current smoker										1.50***	1.23	1.83

Alcohol Intake												
Not at all in the last 12 months										1.22	0.94	1.59
Once or twice a year										1.11	0.84	1.47
Once every couple of months										0.72*	0.52	0.99
Once or twice a month										0.65***	0.48	0.87
Once or twice a week										0.60***	0.46	0.77
Three or four days a week										0.51***	0.38	0.70
Five or six days a week										0.58**	0.39	0.85
Almost every day										0.58***	0.44	0.78
Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.22***	0.17	0.29
High Activity										0.17***	0.13	0.23
Constant	0.16***	0.15	0.17	0.22***	0.18	0.28	0.39***	0.29	0.54	1.34	0.87	2.08

*** p<.01, ** p<.05, * p<.1

In Model 1, the results of the logistics regression examining the association between lipid factor scores and mental health using ELSA data are largely not statistically significant (Table 3.12). The pattern of the results for gender, age group, education, marital status, smoking status, alcohol intake and physical activity are similar to the results of Table 3.11

Table 3. 13: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.72***	1.53	1.92	1.60***	1.42	1.80	1.53***	1.36	1.73	1.22***	1.07	1.39
Gender												
Female				1.77***	1.54	2.03	1.58***	1.37	1.82	1.48***	1.27	1.73
Age Group												

55-64 years				0.71***	0.58	0.87	0.91***	0.58	0.87	0.70***	0.57	0.87
65-74 years				0.63***	0.51	0.78	0.58***	0.47	0.73	0.52***	0.41	0.66
75-84 years				0.75**	0.59	0.95	0.62***	0.48	0.80	0.46***	0.35	0.61
Education												
Other qualifications				0.73**	0.59	0.91	0.76**	0.61	0.94	0.88	0.70	1.11
0 Level/equivalent				0.59***	0.49	0.72	0.62***	0.51	0.75	0.78**	0.63	0.95
A Level/equivalent				0.52***	0.40	0.69	0.53***	0.40	0.70	0.72**	0.54	0.96
Higher qualification below degree				0.58***	0.47	0.72	0.62***	0.50	0.76	0.82*	0.65	1.03
Degree/equivalent				0.55***	0.44	0.68	0.57***	0.45	0.70	0.82*	0.65	1.03
Marital Status												
Married/Partnership							0.44***	0.34	0.57	0.50***	0.38	0.66
Remarried/In Partnership before							0.60***	0.44	0.82	0.69**	0.50	0.95
Divorced/legally separated							1.05	0.79	1.40	1.03	0.76	1.39
Widowed							1.12	0.84	1.50	1.22	0.90	1.67
Smoking Status												
Ex-smoker										1.12	0.96	1.31
Current smoker										1.42***	1.16	1.74
Alcohol Intake												
Not at all in the last 12 months										1.21	0.93	1.57
Once or twice a year										1.10	0.83	1.46
Once every couple of months										0.71**	0.52	0.99
Once or twice a month										0.65***	0.48	0.87
Once or twice a week										0.60***	0.47	0.78
Three or four days a week										0.52***	0.38	0.71
Five or six days a week										0.60**	0.41	0.88
Almost every day										0.60***	0.45	0.80
Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.23***	0.18	0.29
High Activity										0.18***	0.13	0.24
Constant	0.14***	0.13	0.15	0.21***	0.16	0.26	0.36***	0.26	0.49	1.28	0.83	1.99

*** p<.01, ** p<.05, * p<.1

Table 3.13 shows the results of the logistics regression examining the association between inflammatory factor scores and mental health using ELSA data. Model 1 indicates that each additional inflammatory factor score increases the odds (1.72, *** p<.01) of having poor mental health. This pattern remained after adjusting for covariates.

Table 3. 14: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Iron factor scores	0.67***	0.59	0.76	0.90	0.78	1.04	0.90	0.78	1.04	0.95	0.82	1.11
Gender												
Female				1.68***	1.44	1.97	1.50***	1.28	1.76	1.44***	1.22	1.71
Age Group												
55-64 years				0.74***	0.60	0.90	0.73***	0.60	0.90	0.71***	0.58	0.88
65-74 years				0.66***	0.53	0.82	0.60***	0.48	0.75	0.53***	0.42	0.67
75-84 years				0.81	0.64	1.03	0.66***	0.51	0.85	0.47***	0.36	0.62
Education												
Other qualifications				0.71***	0.57	0.88	0.73**	0.59	0.91	0.87	0.69	1.10
0 Level/equivalent				0.57***	0.47	0.69	0.59***	0.49	0.72	0.77**	0.63	0.95
A Level/equivalent				0.50***	0.38	0.65	0.51***	0.39	0.67	0.72**	0.54	0.95
Higher qualification below degree				0.53***	0.43	0.66	0.57***	0.46	0.70	0.80	0.64	1.01
Degree/equivalent				0.47***	0.38	0.58	0.49***	0.40	0.61	0.78**	0.62	0.99
Marital Status												
Married/Partnership							0.43***	0.33	0.55	0.50***	0.38	0.66
Remarried/In Partnership before							0.60***	0.44	0.81	0.69**	0.50	0.95
Divorced/legally separated							1.04	0.78	1.39	1.02	0.76	1.39
Widowed							1.14	0.85	1.53	1.24	0.91	1.68

Smoking Status												
Ex-smoker										1.14	0.97	1.33
Current smoker										1.50***	1.23	1.83
Alcohol Intake												
Not at all in the last 12 months										1.22	0.93	1.59
Once or twice a year										1.11	0.84	1.47
Once every couple of months										0.72*	0.52	0.99
Once or twice a month										0.65***	0.48	0.87
Once or twice a week										0.60***	0.46	0.77
Three or four days a week										0.51***	0.38	0.70
Five or six days a week										0.58**	0.39	0.85
Almost every day										0.59***	0.44	0.78
Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.22***	0.17	0.29
High Activity										0.17***	0.13	0.23
Constant	0.14***	0.13	0.15	0.23***	0.18	0.29	0.40***	0.29	0.54	1.34	0.87	2.08

*** p<.01, ** p<.05, * p<.1

Table 3.14 shows the results of the logistics regression examining the association between iron factor scores and mental health using ELSA data. Model 1 indicates that each additional iron factor score decreases the odds (0.67, *** p<.01) of having poor mental health. This pattern remained after adjusting for covariates, but the results are not statistically significant.

Table 3. 15: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												

Glucose Metabolism factor scores	0.57***	0.47	0.70	0.59***	0.48	0.73	0.62***	0.50	0.76	0.86	0.68	1.08
Gender												
Female				1.81***	1.57	2.08	1.61***	1.40	1.86	1.49***	1.27	1.73
Age Group												
55-64 years				0.71***	0.58	0.87	0.71***	0.58	0.87	0.71***	0.57	0.88
65-74 years				0.62***	0.50	0.77	0.57***	0.46	0.71	0.52***	0.41	0.66
75-84 years				0.76**	0.60	0.97	0.63***	0.49	0.81	0.47***	0.35	0.61
Education												
Other qualifications				0.72***	0.58	0.90	0.75**	0.60	0.93	0.88	0.69	1.11
0 Level/equivalent				0.58***	0.48	0.71	0.61***	0.50	0.74	0.77**	0.63	0.95
A Level/equivalent				0.52***	0.39	0.68	0.53***	0.40	0.69	0.72**	0.54	0.96
Higher qualification below degree				0.55***	0.45	0.69	0.59***	0.47	0.73	0.81	0.64	1.02
Degree/equivalent				0.50***	0.40	0.62	0.52***	0.42	0.64	0.79**	0.63	0.99
Marital Status												
Married/Partnership							0.43***	0.33	0.55	0.50***	0.38	0.65
Remarried/In Partnership before							0.59***	0.44	0.81	0.69**	0.50	0.95
Divorced/legally separated							1.03	0.76	1.38	1.02	0.75	1.38
Widowed							1.12	0.84	1.51	1.23	0.90	1.67
Smoking Status												
Ex-smoker										1.13	0.97	1.33
Current smoker										1.49***	1.22	1.82
Alcohol Intake												
Not at all in the last 12 months										1.22	0.93	1.58
Once or twice a year										1.10	0.83	1.46
Once every couple of months										0.72**	0.52	0.99
Once or twice a month										0.65***	0.48	0.87
Once or twice a week										0.60***	0.47	0.77
Three or four days a week										0.52***	0.38	0.70
Five or six days a week										0.58**	0.40	0.86
Almost every day										0.59***	0.44	0.79

Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.23***	0.18	0.29
High Activity										0.17***	0.13	0.23
Constant	0.15***	0.15	0.17	0.22***	0.18	0.28	0.39***	0.29	0.54	1.33	0.86	2.07

*** p<.01, ** p<.05, * p<.1

Table 3.15 shows the results of the logistics regression examining the association between glucose metabolism factor scores and mental health using ELSA data. Model 1 indicates that each additional glucose metabolism factor score decreases the odds (0.57, *** p<.01) of having poor mental health. This pattern remained after adjusting for gender, age group, education and marital status but became statistically insignificant after adjusting for health behaviour.

Table 3. 16: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.06*	0.97	1.12	1.04	0.98	1.11	1.04	0.98	1.11	1.03	0.97	1.10
Gender												
Female				1.78***	1.55	2.04	1.59***	1.38	1.83	1.48***	1.27	1.73
Age Group												
55-64 years				0.72***	0.59	0.89	0.72***	0.59	0.89	0.70***	0.57	0.87
65-74 years				0.63***	0.51	0.79	0.58***	0.46	0.73	0.52***	0.41	0.66
75-84 years				0.77*	0.60	1.01	0.63***	0.48	0.82	0.45***	0.34	0.61
Education												
Other qualifications				0.71***	0.57	0.89	0.74**	0.59	0.92	0.88	0.69	1.10
0 Level/equivalent				0.57***	0.47	0.69	0.60***	0.49	0.72	0.77**	0.63	0.95
A Level/equivalent				0.50***	0.38	0.66	0.51***	0.39	0.67	0.72**	0.54	0.96

Higher qualification below degree				0.53***	0.43	0.66	0.57***	0.46	0.71	0.80*	0.64	1.01
Degree/equivalent				0.48***	0.39	0.59	0.50***	0.40	0.62	0.79	0.63	0.99
Marital Status												
Married/Partnership							0.43***	0.33	0.55	0.50***	0.38	0.65
Remarried/In Partnership before							0.59***	0.44	0.81	0.69**	0.50	0.95
Divorced/legally separated							1.04	0.78	1.39	1.02	0.76	1.38
Widowed							1.13	0.85	1.52	1.23	0.90	1.68
Smoking Status												
Ex-smoker										1.14	0.97	1.33
Current smoker										1.50***	1.23	1.82
Alcohol Intake												
Not at all in the last 12 months										1.23	0.94	1.60
Once or twice a year										1.11	0.84	1.47
Once every couple of months										0.72*	0.52	0.99
Once or twice a month										0.65***	0.49	0.87
Once or twice a week										0.60***	0.47	0.77
Three or four days a week										0.51***	0.38	0.70
Five or six days a week										0.58**	0.39	0.85
Almost every day										0.58***	0.44	0.78
Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.22***	0.17	0.29
High Activity										0.17***	0.13	0.23
Constant	0.16***	0.15	0.17	0.23***	0.18	0.29	0.40***	0.29	0.55	1.36	0.88	2.11

*** p<.01, ** p<.05, * p<.1

Table 3.16 shows the results of the logistics regression examining the association between cardiovascular factor scores and mental health using ELSA data. Model 1 indicates that each additional cardiovascular factor score increases the odds (1.06, *** p<.01) of having poor mental health. However, the results became non-statistically significant after adjusting for covariates.

Table 3. 17: Logistics regression using ELSA data

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Neuroendocrine factor scores	0.40***	0.33	0.50	0.62***	0.47	0.80	0.62***	0.47	0.81	0.76*	0.58	1.00
Gender												
Female				1.54***	1.31	1.80	1.37***	1.17	1.61	1.37***	1.15	1.62
Age Group												
55-64 years				0.71***	0.58	0.87	0.71***	0.58	0.87	0.70***	0.56	0.87
65-74 years				0.61***	0.49	0.76	0.56***	0.45	0.70	0.51***	0.40	0.65
75-84 years				0.72**	0.56	0.93	0.59***	0.45	0.77	0.44***	0.33	0.59
Education												
Other qualifications				0.70***	0.57	0.87	0.73**	0.59	0.91	0.87	0.69	1.09
0 Level/equivalent				0.57***	0.47	0.68	0.59***	0.49	0.72	0.77**	0.62	0.94
A Level/equivalent				0.50***	0.39	0.65	0.51***	0.38	0.67	0.71**	0.53	0.95
Higher qualification below degree				0.54***	0.44	0.67	0.57***	0.46	0.71	0.81*	0.64	1.02
Degree/equivalent				0.48***	0.39	0.60	0.50***	0.41	0.63	0.79*	0.63	1.01
Marital Status												
Married/Partnership							0.43***	0.33	0.56	0.50***	0.38	0.66
Remarried/In Partnership before							0.60***	0.44	0.81	0.69**	0.50	0.95
Divorced/legally separated							1.04	0.78	1.39	1.02	0.75	1.38
Widowed							1.15	0.86	1.54	1.24	0.91	1.69
Smoking Status												
Ex-smoker										1.14	0.97	1.33
Current smoker										1.52***	1.24	1.85
Alcohol Intake												
Not at all in the last 12 months										1.22	0.94	1.59

Once or twice a year										1.11	0.84	1.48
Once every couple of months										0.72*	0.52	0.99
Once or twice a month										0.65***	0.48	0.87
Once or twice a week										0.60***	0.47	0.78
Three or four days a week										0.52***	0.38	0.71
Five or six days a week										0.58**	0.40	0.85
Almost every day										0.59***	0.44	0.79
Activity												
Low Activity										0.45***	0.35	0.58
Moderate Activity										0.23***	0.18	0.29
High Activity										0.17***	0.13	0.23
Constant	0.14***	0.13	0.15	0.25***	0.19	0.31	0.43***	0.31	0.59	1.38	0.89	2.14

*** p<.01, ** p<.05, * p<.1

Table 3.17 shows the results of the logistics regression examining the association between neuroendocrine factor scores and mental health using ELSA data. Model 1 indicates that each additional neuroendocrine factor score decreases the odds (0.40, *** p<.01) of having poor mental health. This pattern remained after adjusting for covariates. The pattern of association between the biological systems, namely metabolic, lipid, inflammatory, iron, glucose metabolism, cardiovascular and neuroendocrine systems and the covariates, including gender, age group, educational attainment, marital status, smoking status, alcohol intake and physical activity, are similar

Table 3. 18: Logistics regression using UKHLS data

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	0.94**	0.90	0.99	1.02	0.96	1.07	1.02	0.97	1.08	1.02	0.96	1.07

Gender											
Female			1.58***	1.45	1.72	1.56***	1.43	1.70	1.56***	1.43	1.71
Age Group											
25-32 years			1.25**	1.06	1.48	1.46***	1.22	1.76	1.43***	1.19	1.71
35-44 years			1.27**	1.08	1.49	1.51***	1.26	1.82	1.51***	1.25	1.82
45-54 years			1.46***	1.24	1.72	1.74***	1.44	2.09	1.73***	1.43	2.10
55-64 years			1.10	0.92	1.30	1.31**	1.07	1.60	1.31**	1.07	1.61
65-74 years			0.58***	0.43	0.77	0.69**	0.51	0.95	0.70**	0.51	0.96
75-84 years			0.69	0.35	1.35	0.82	0.42	1.63	0.70	0.33	1.45
Education											
Other qualifications			0.93	0.75	1.16	0.93	0.75	1.16	0.97	0.78	1.22
0 Level/equivalent			0.85	0.70	1.04	0.85	0.70	1.03	0.87	0.71	1.07
A Level/equivalent			0.87	0.71	1.05	0.86	0.71	1.05	0.91	0.74	1.12
Higher qualification below degree			0.88	0.72	1.09	0.88	0.72	1.08	0.93	0.75	1.15
Degree/equivalent			0.81**	0.67	0.98	0.81**	0.67	0.98	0.88	0.72	1.08
Marital Status											
Married/Partnership						0.74***	0.65	0.84	0.74***	0.65	0.85
Divorced/legally separated						0.97	0.81	1.16	0.96	0.80	1.16
Widowed						0.76	0.53	1.10	0.79	0.54	1.15
Smoking Status											
Ex-smoker									1.07	0.98	1.18
Current smoker									1.25***	1.12	1.40
Alcohol Intake											
Not at all in the last 12 months									1.41*	0.95	2.09
Once or twice a year									1.44*	0.99	2.08
Once every couple of months									1.21	0.84	1.73
Once or twice a month									1.12	0.79	1.58
Once or twice a week									1.00	0.71	1.41
Three or four days a week									1.03	0.73	1.47
Five or six days a week									1.30	0.89	1.89
Almost every day									1.25	0.87	1.81
Activity											

Low Activity										1.03	0.88	1.19
Moderate Activity										0.94	0.81	1.08
High Activity										0.83**	0.72	0.96
Constant	0.53***	0.52	0.56	0.40***	0.32	0.51	0.43***	0.34	0.55	0.37	0.24	0.55

*** p<.01, ** p<.05, * p<.1

Table 3.18 shows the results of the logistics regression examining the association between metabolic factor scores and mental health using UKHLS data. Model 1 indicates that each additional metabolic factor score lowers the odds (0.94, ** p<.05) of having poor mental health. These results are different from the results from ELSA. However, results became non-statistically significant after adjusting for covariates, but the direction of association became comparable to ELSA. Similar to ELSA, Models 2 to 4 indicate that females have higher odds of having poor mental health compared to males, and older participants have lower odds of having poor mental health compared to younger participants. The results of educational qualifications are not statistically significant after controlling for covariates, but the direction of association is like ELSA. Comparable to ELSA, in Model 3, being married or in a legal partnership compared to being single or never married statistically significantly decreases the odds of having poor mental health by a factor of (0.74, *** p<.01). Also, in Model 4 smoking increases the odds and engaging in physical activity decreases the odds of having poor mental health. Contrary to ELSA, consuming alcohol increases the odds of having poor mental health.

Table 3. 19: Logistics regression using UKHLS data

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	0.90	0.77	1.04	1.14	0.97	1.35	1.16*	0.98	1.37	1.14	0.96	1.35

Gender												
Female				1.60***	1.47	1.74	1.58***	1.45	1.72	1.58***	1.45	1.73
Age Group												
25-32 years				1.24**	1.05	1.47	1.46***	1.21	1.75	1.43***	1.18	1.72
35-44 years				1.26**	1.07	1.48	1.50***	1.25	1.80	1.49***	1.24	1.81
45-54 years				1.44***	1.23	1.70	1.72***	1.42	2.07	1.71***	1.41	2.07
55-64 years				1.08	0.91	1.29	1.29**	1.06	1.58	1.29**	1.05	1.59
65-74 years				0.57***	0.43	0.77	0.69**	0.50	0.94	0.69**	0.50	0.95
75-84 years				0.69	0.35	1.34	0.82	0.42	1.62	0.69	0.33	1.44
Education												
Other qualifications				0.93	0.75	1.16	0.93	0.75	1.16	0.98	0.78	1.22
0 Level/equivalent				0.85	0.70	1.04	0.85	0.70	1.03	0.87	0.71	1.07
A Level/equivalent				0.87	0.71	1.06	0.86	0.71	1.05	0.91	0.74	1.12
Higher qualification below degree				0.88	0.72	1.09	0.88	0.72	1.09	0.93	0.75	1.15
Degree/equivalent				0.81**	0.67	0.98	0.81**	0.67	0.98	0.88	0.72	1.08
Marital Status												
Married/Partnership							0.74***	0.65	0.84	0.74***	0.65	0.85
Divorced/legally separated							0.97	0.81	1.16	0.96	0.80	1.16
Widowed							0.76	0.53	1.10	0.79	0.54	1.15
Smoking Status												
Ex-smoker										1.07	0.98	1.17
Current smoker										1.25***	1.12	1.40
Alcohol Intake												
Not at all in the last 12 months										1.41*	0.95	2.09
Once or twice a year										1.43*	0.99	2.07
Once every couple of months										1.20	0.84	1.72
Once or twice a month										1.11	0.79	1.58
Once or twice a week										1.00	0.71	1.41
Three or four days a week										1.03	0.73	1.47
Five or six days a week										1.30	0.89	1.89
Almost every day										1.26	0.87	1.82
Activity												

Low Activity										1.03	0.88	1.20
Moderate Activity										0.94	0.81	1.09
High Activity										0.83**	0.72	0.96
Constant	0.54***	0.52	0.56	0.40***	0.32	0.51	0.43***	0.34	0.55	0.37***	0.24	0.56

*** p<.01, ** p<.05, * p<.1

Table 3.19 shows the results of the logistics regression examining the association between lipid factor scores and mental health using UKHLS data. Similar to ELSA, results are not statistically significant after controlling for covariates and the direction of association is the same. The pattern of the results for gender, age group, education, marital status, smoking status, alcohol intake and physical activity are similar to the results of Table 3.18 and ELSA, except for alcohol intake, whose results are different to the results of ELSA.

Table 3. 20: Logistics regression using UKHLS data

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.06**	1.01	1.11	1.04	0.99	1.10	1.04	0.99	1.10	1.03	0.98	1.08
Gender												
Female				1.56***	1.44	1.69	1.54***	1.42	1.67	1.55***	1.42	1.68
Age Group												
25-32 years				1.25**	1.05	1.48	1.46***	1.21	1.76	1.43***	1.19	1.73
35-44 years				1.26**	1.07	1.48	1.51***	1.26	1.81	1.50***	1.25	1.82
45-54 years				1.46***	1.24	1.71	1.73***	1.44	2.09	1.73***	1.43	2.09
55-64 years				1.09	0.91	1.29	1.30**	1.07	1.59	1.31**	1.06	1.60
65-74 years				0.57***	0.43	0.77	0.69**	0.50	0.94	0.70**	0.51	0.96
75-84 years				0.68	0.35	1.32	0.81	0.41	1.60	0.69	0.33	1.44
Education												
Other qualifications				0.93	0.75	1.16	0.94	0.75	1.17	0.98	0.78	1.23
0 Level/equivalent				0.86	0.71	1.05	0.85	0.70	1.04	0.88	0.72	1.08
A Level/equivalent				0.87	0.72	1.06	0.87	0.71	1.06	0.92	0.75	1.12

Higher qualification below degree				0.89	0.73	1.10	0.89	0.72	1.09	0.94	0.75	1.16
Degree/equivalent				0.82**	0.67	0.99	0.82**	0.67	0.99	0.88	0.72	1.09
Marital Status												
Married/Partnership							0.74***	0.66	0.84	0.75***	0.65	0.85
Divorced/legally separated							0.97	0.81	1.16	0.96	0.80	1.16
Widowed							0.76	0.53	1.10	0.79	0.54	1.15
Smoking Status												
Ex-smoker										1.07	0.98	1.18
Current smoker										1.25***	1.12	1.40
Alcohol Intake												
Not at all in the last 12 months										1.41*	0.95	2.09
Once or twice a year										1.44*	1.01	2.08
Once every couple of months										1.21	0.84	1.73
Once or twice a month										1.12	0.79	1.58
Once or twice a week										1.00	0.71	1.41
Three or four days a week										1.04	0.73	1.47
Five or six days a week										1.31	0.90	1.90
Almost every day										1.26	0.87	1.82
Activity												
Low Activity										1.03	0.88	1.20
Moderate Activity										0.94	0.81	1.09
High Activity										0.83**	0.72	0.96
Constant	0.54***	0.52	0.56	0.40***	0.32	0.50	0.43***	0.34	0.54	0.36***	0.24	0.55

*** p<.01, ** p<.05, * p<.1

Table 3.20 shows the results of the logistics regression examining the association between inflammatory factor scores and mental health using UKHLS data. Model 1 indicates that each additional inflammatory factor score increases the odds (1.06, ** p<.05) of having poor mental health; the results are like ELSA. However, results became statistically non-significant after adjusting for covariates, but the direction of association remained like ELSA.

Table 3. 21: Logistics regression using UKHLS data

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Iron factor scores	0.81***	0.76	0.87	0.99	0.91	1.08	1.00	0.92	1.10	1.00	0.92	1.10
Gender												
Female				1.56***	1.41	1.71	1.54***	1.40	1.70	1.55***	1.40	1.71
Age Group												
25-32 years				1.26**	1.06	1.49	1.47***	1.22	1.77	1.44***	1.19	1.74
35-44 years				1.28**	1.09	1.51	1.52***	1.27	1.83	1.52***	1.25	1.83
45-54 years				1.48***	1.26	1.74	1.75***	1.45	2.12	1.74***	1.44	2.11
55-64 years				1.11	0.93	1.32	1.32**	1.08	1.62	1.32**	1.08	1.63
65-74 years				0.59***	0.44	0.79	0.70**	0.51	0.96	0.70**	0.51	0.97
75-84 years				0.70	0.36	1.37	0.83	0.42	1.65	0.70	0.34	1.47
Education												
Other qualifications				0.93	0.75	1.16	0.93	0.75	1.16	0.97	0.78	1.22
0 Level/equivalent				0.85	0.70	1.04	0.85	0.70	1.03	0.87	0.71	1.07
A Level/equivalent				0.87	0.71	1.05	0.86	0.70	1.05	0.91	0.74	1.12
Higher qualification below degree				0.88	0.72	1.09	0.88	0.72	1.08	0.93	0.75	1.15
Degree/equivalent				0.88**	0.66	0.98	0.81**	0.66	0.98	0.88	0.72	1.08
Marital Status												
Married/Partnership							0.74***	0.66	0.84	0.75***	0.65	0.85
Divorced/legally separated							0.97	0.81	1.16	0.96	0.80	1.16
Widowed							0.76	0.53	1.10	0.79	0.54	1.15
Smoking Status												
Ex-smoker										1.07	0.98	1.18
Current smoker										1.25***	1.12	1.40

Alcohol Intake											
Not at all in the last 12 months									1.41*	0.95	2.09
Once or twice a year									1.44*	1.01	2.08
Once every couple of months									1.21	0.84	1.73
Once or twice a month									1.12	0.79	1.58
Once or twice a week									1.00	0.71	1.41
Three or four days a week									1.03	0.73	1.46
Five or six days a week									1.30	0.89	1.89
Almost every day									1.25	0.87	1.81
Activity											
Low Activity									1.03	0.88	1.19
Moderate Activity									0.94	0.81	1.08
High Activity									0.83**	0.72	0.96
Constant	0.51***	0.49	0.54	0.40***	0.32	0.50	0.43***	0.34	0.54	0.37***	0.24	0.55

*** p<.01, ** p<.05, * p<.1

Table 3.21 shows the results of the logistics regression examining the association between iron factor scores and mental health using UKHLS data. Like ELSA, Model 1 indicates that each additional iron factor score decreases the odds (0.81, *** p<.01) of having poor mental health, but results became statistically non-significant after adjusting for covariates.

Table 3. 22: Logistics regression using UKHLS data

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.02***	1.01	1.04	1.01	1.01	1.02	1.01*	1.01	1.02	1.01**	1.00	1.03
Gender												
Female				1.55***	1.43	1.69	1.53***	1.41	1.66	1.54***	1.41	1.67

Age Group								
25-32 years			1.25**	1.05 1.48	1.46***	1.21 1.76	1.42***	1.18 1.72
35-44 years			1.26**	1.07 1.48	1.51***	1.25 1.81	1.49***	1.23 1.80
45-54 years			1.46***	1.24 1.71	1.73***	1.44 2.09	1.72***	1.42 2.08
55-64 years			1.10	0.93 1.31	1.32**	1.08 1.61	1.32**	1.07 1.61
65-74 years			0.59***	0.44 0.79	0.71**	0.52 0.97	0.71**	0.52 0.98
75-84 years			0.72	0.37 1.40	0.86	0.44 1.70	0.74	0.35 1.53
Education								
Other qualifications			0.93	0.75 1.16	0.93	0.75 1.16	0.97	0.78 1.22
0 Level/equivalent			0.85	0.70 1.04	0.85	0.69 1.03	0.87	0.71 1.07
A Level/equivalent			0.86	0.71 1.05	0.86	0.70 1.04	0.91	0.74 1.12
Higher qualification below degree			0.88	0.72 1.08	0.88	0.71 1.08	0.93	0.75 1.15
Degree/equivalent			0.80**	0.66 0.97	0.80**	0.66 0.97	0.88	0.72 1.08
Marital Status								
Married/Partnership					0.74***	0.65 0.84	0.74***	0.65 0.85
Divorced/legally separated					0.97	0.81 1.16	0.96	0.80 1.15
Widowed					0.76	0.53 1.10	0.79	0.54 1.15
Smoking Status								
Ex-smoker							1.07	0.98 1.18
Current smoker							1.27***	1.13 1.42
Alcohol Intake								
Not at all in the last 12 months							1.41*	0.95 2.09
Once or twice a year							1.44*	1.01 2.08
Once every couple of months							1.20	0.84 1.73
Once or twice a month							1.11	0.79 1.58
Once or twice a week							1.00	0.71 1.41
Three or four days a week							1.03	0.72 1.46
Five or six days a week							1.30	0.89 1.89
Almost every day							1.25	0.86 1.80
Activity								
Low Activity							1.03	0.88 1.19
Moderate Activity							0.93	0.81 1.08

High Activity										0.83**	0.72	0.96
Constant	0.54***	0.52	0.56	0.41***	0.32	0.51	0.44***	0.34	0.55	0.37***	0.25	0.56

*** p<.01, ** p<.05, * p<.1

Table 3.22 shows the results of the logistics regression examining the association between cardiovascular factor scores and mental health using UKHLS data. Like ELSA, Model 1 indicates that each additional cardiovascular factor score increases the odds (1.02, *** p<.01) of having poor mental health, but unlike ELSA, results remained statistically significant after adjusting for covariates.

Table 3. 23: Logistics regression using UKHLS data

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Neuroendocrine factor scores	0.67***	0.58	0.77	0.80**	0.68	0.94	0.79**	0.68	0.93	0.80**	0.68	0.94
Gender												
Female				1.50***	1.37	1.63	1.48***	1.35	1.61	1.49***	1.36	1.62
Age Group												
25-34 years				1.24**	1.04	1.46	1.45***	1.20	1.74	1.41***	1.17	1.71
35-44 years				1.24**	1.05	1.46	1.48***	1.23	1.78	1.47***	1.22	1.78
45-54 years				1.41***	1.20	1.66	1.68***	1.39	2.03	1.67***	1.38	2.02
55-64 years				1.04	0.87	1.24	1.24**	1.02	1.52	1.24**	1.01	1.53
65-74 years				0.54***	0.40	0.72	0.65**	0.47	0.86	0.65**	0.47	0.90
75-84 years				0.65	0.33	1.26	0.77	0.39	1.52	0.65	0.31	1.36
Education												
Other qualifications				0.93	0.75	1.16	0.93	0.75	1.16	0.97	0.78	1.22
0 Level/equivalent				0.86	0.70	1.04	0.85	0.70	1.04	0.88	0.72	1.07
A Level/equivalent				0.87	0.71	1.06	0.86	0.71	1.05	0.91	0.74	1.12
Higher qualification below degree				0.88	0.72	1.09	0.88	0.72	1.08	0.93	0.75	1.15
Degree/equivalent				0.81**	0.66	0.98	0.81**	0.66	0.98	0.88	0.72	1.08

Marital Status												
Married/Partnership							0.74***	0.65	0.84	0.74***	0.65	0.85
Divorced/legally separated							0.97	0.81	1.16	0.96	0.80	1.16
Widowed							0.76	0.53	1.09	0.79	0.54	1.14
Smoking Status												
Ex-smoker										1.07	0.98	1.18
Current smoker										1.26***	1.12	1.41
Alcohol Intake												
Not at all in the last 12 months										1.41*	0.95	2.08
Once or twice a year										1.44*	0.99	2.08
Once every couple of months										1.21	0.84	1.74
Once or twice a month										1.12	0.79	1.58
Once or twice a week										1.00	0.71	1.41
Three or four days a week										1.04	0.73	1.47
Five or six days a week										1.31	0.90	1.91
Almost every day										1.26	0.87	1.83
Activity												
Low Activity										1.03	0.88	1.20
Moderate Activity										0.94	0.81	1.09
High Activity										0.83**	0.72	0.96
Constant	0.53***	0.51	0.55	0.42***	0.33	0.53	0.45***	0.36	0.57	0.38***	0.25	0.58

*** p<.01, ** p<.05, * p<.1

Table 3.23 shows the results of the logistics regression examining the association between neuroendocrine factor scores and mental health using UKHLS data. Comparable to ELSA, Model 1 indicates that each additional neuroendocrine factor score decreases the odds (0.40, *** p<.01) of having poor mental health. This pattern remained after adjusting for covariates. These results were not surprising. The pattern of association between the biological systems, namely metabolic, lipid, inflammatory, iron, glucose metabolism, cardiovascular and neuroendocrine systems and gender, age group, educational attainment, marital status, smoking status and physical activity, is similar to ELSA. However, the pattern of association of alcohol intake is different to ELSA.

Table 3. 24: Logistics regression using NCDS data

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	0.98	0.90	1.06	0.97	0.90	1.06	0.98	0.90	1.06	0.96	0.88	1.05
Gender												
Female				2.04***	1.77	2.35	2.05***	1.77	2.37	1.98***	1.70	2.31
Education												
Other qualifications				0.82*	0.65	1.02	0.86	0.68	1.08	0.88	0.69	1.12
0 Level/equivalent				0.65***	0.54	0.78	0.70***	0.58	0.84	0.78**	0.63	0.95
A Level/equivalent				0.44***	0.33	0.60	0.46***	0.34	0.62	0.55***	0.40	0.76
Higher qualification below degree				0.75*	0.54	1.04	0.79	0.56	1.11	0.89	0.62	1.26
Degree/equivalent				0.44***	0.35	0.55	0.47***	0.37	0.60	0.57***	0.44	0.74
Marital Status												
Married/Partnership							0.68***	0.54	0.85	0.79*	0.62	1.01
Remarried							0.85	0.65	1.11	0.95	0.71	1.26
Divorced/legally separated Widowed							0.96	0.74	1.25	1.04	0.79	1.37
Smoking Status												
Ex-smoker										1.17*	0.99	1.39
Current smoker										1.34***	1.11	1.61
Alcohol Intake												
Once a month or less										0.65***	0.49	0.86
Two to four times a month										0.48***	0.36	0.64
Two or three times a week										0.47***	0.36	0.62
Four or more times a week										0.60***	0.45	0.79

Activity												
Less than once a month										0.77***	0.65	0.91
Once a month										0.76*	0.56	1.01
2 to 3 times a month										0.64**	0.44	0.91
Once a week										0.78	0.57	1.07
More than once a week										0.57**	0.36	0.89
Constant	0.17***	0.15	0.18	0.17***	0.14	0.20	0.20***	0.16	0.26	0.30***	0.21	0.43

*** p<.01, ** p<.05, * p<.1

Table 3.24 shows the results of the logistics regression examining the association between metabolic factor scores and mental health using NCDS data. Unlike ELSA and partly similar to UKHLS, the results of the association between metabolic factor scores and mental health using NCDS data are not statistically significant. Similar to ELSA and UKHLS, Models 2 to 4 indicate that females have higher odds of having poor mental health compared to males. Comparable to ELSA but separate from UKHLS, higher educational qualifications decreased the odds of having poor mental health after accounting for covariates. Although the results of NCDS are statistically non-significant, the direction of association is the same. Similar to both ELSA and UKHLS, being married or in a legal partnership compared to being single or never married decreases the odds of having poor mental health. Also, smoking increases and engaging in physical activity reduces the odds of having poor mental health. Identical to ELSA but unlike UKHLS, consuming alcohol decreases the odds of having poor mental health.

Table 3. 25: Logistics regression using NCDS data

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	1.05	0.97	1.13	1.05	0.98	1.14	1.06	0.99	1.14	1.04	0.96	1.13

Gender								
Female			2.04***	1.77 2.35	2.05***	1.78 2.37	1.98***	1.70 2.31
Education								
Other qualifications			0.82*	0.65 1.02	0.86	0.68 1.07	0.88	0.69 1.12
0 Level/equivalent			0.65***	0.54 0.78	0.70***	0.58 0.84	0.78**	0.63 0.95
A Level/equivalent			0.45***	0.33 0.60	0.46***	0.34 0.62	0.56***	0.40 0.76
Higher qualification below degree			0.75	0.54 1.05	0.80	0.57 1.12	0.89	0.62 1.27
Degree/equivalent			0.44***	0.35 0.55	0.47***	0.37 0.60	0.57***	0.44 0.74
Marital Status								
Married/Partnership					0.68***	0.54 0.85	0.79*	0.62 1.00
Remarried					0.85	0.65 1.11	0.95	0.71 1.26
Divorced/legally separated Widowed					0.97	0.75 1.26	1.04	0.80 1.38
Smoking Status								
Ex-smoker							1.17*	0.99 1.39
Current smoker							1.34***	1.11 1.61
Alcohol Intake								
Once a month or less							0.65***	0.49 0.87
Two to four times a month							0.48***	0.37 0.64
Two or three times a week							0.47***	0.36 0.62
Four or more times a week							0.60***	0.46 0.79
Activity								
Less than once a month							0.77***	0.65 0.91
Once a month							0.76*	0.57 1.01
2 to 3 times a month							0.64***	0.44 0.91
Once a week							0.79	0.57 1.07
More than once a week							0.57**	0.36 0.90
Constant	0.17***	0.16 0.18	0.17***	0.14 0.18	0.20***	0.16 0.26	0.30***	0.21 0.43

*** p<.01, ** p<.05, * p<.1

Table 3.25 shows the results of the logistics regression examining the association between lipid factor scores and mental health using NCDS data. The results are partially similar to ELSA and UKHLS as they are not statistically significant, and the direction of association after controlling for covariates is identical.

Table 3. 26: Logistics regression using NCDS data

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	0.86**	0.75	0.98	0.85**	0.74	0.97	0.85**	0.74	0.97	0.82***	0.71	0.94
Gender												
Female				2.04***	1.77	2.35	2.05***	1.78	2.37	1.99***	1.70	2.31
Education												
Other qualifications				0.81*	0.65	1.02	0.85**	0.68	1.07	0.88	0.69	1.12
0 Level/equivalent				0.65***	0.54	0.78	0.69***	0.57	0.84	0.77**	0.63	0.95
A Level/equivalent				0.44***	0.33	0.59	0.46***	0.34	0.62	0.55***	0.40	0.75
Higher qualification below degree				0.76	0.54	1.05	0.80	0.57	1.12	0.89	0.63	1.27
Degree/equivalent				0.44***	0.35	0.55	0.47***	0.37	0.59	0.57***	0.44	0.74
Marital Status												
Married/Partnership							0.68***	0.54	0.85	0.79*	0.62	1.01
Remarried							0.85	0.65	1.11	0.94	0.71	1.25
Divorced/legally separated Widowed							0.96	0.74	1.24	1.04	0.79	1.37
Smoking Status												
Ex-smoker										1.17*	0.99	1.39
Current smoker										1.34***	1.11	1.61
Alcohol Intake												
Once a month or less										0.64***	0.48	0.85
Two to four times a month										0.47***	0.36	0.63
Two or three times a week										0.46***	0.35	0.61

Four or more times a week										0.59***	0.45	0.78
Activity												
Less than once a month										0.77***	0.65	0.91
Once a month										0.76*	0.57	1.01
2 to 3 times a month										0.63**	0.44	0.90
Once a week										0.78	0.57	1.07
More than once a week										0.56**	0.36	0.88
Constant	0.17***	0.16	0.18	0.17***	0.14	0.20	0.20***	0.16	0.26	0.31***	0.22	0.44

*** p<.01, ** p<.05, * p<.1

Table 3.26 shows the results of the logistics regression examining the association between inflammatory factor scores and mental health using NCDS data. Models 1 to 4 indicate that each additional inflammatory factor score decreases the odds of having poor mental health after controlling for covariates. These results were unexpected and deviated from the results of both ELSA and UKHLS. Models 2 to 4 indicate that the pattern of the results for gender, marital status, smoking status and physical activity are similar to the results of ELSA and UKHLS. The results of education and alcohol intake are identical to ELSA but not UKHLS.

Table 3. 27: Logistics regression using NCDS data

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.04	0.96	1.12	1.04	0.96	1.13	1.05	0.97	1.13	1.03	0.94	1.12
Gender												
Female				2.04***	1.77	2.35	2.05***	1.77	2.37	1.98***	1.70	2.31
Education												
Other qualifications				0.82*	0.65	1.02	0.86	0.68	1.08	0.88	0.69	1.12
0 Level/equivalent				0.65***	0.54	0.78	0.70***	0.58	0.84	0.78**	0.63	0.95

A Level/equivalent				0.45***	0.33	0.60	0.46***	0.34	0.62	0.56***	0.40	0.76
Higher qualification below degree				0.75*	0.54	1.05	0.79	0.57	1.11	0.89	0.62	1.27
Degree/equivalent				0.44***	0.35	0.55	0.47***	0.37	0.60	0.57***	0.44	0.74
Marital Status												
Married/Partnership							0.68***	0.54	0.85	0.79*	0.62	1.00
Remarried							0.85	0.65	1.11	0.95	0.71	1.26
Divorced/legally separated Widowed							0.97	0.74	1.25	1.05	0.79	1.38
Smoking Status												
Ex-smoker										1.17*	0.99	1.38
Current smoker										1.34***	1.12	1.61
Alcohol Intake												
Once a month or less										0.65***	0.49	0.87
Two to four times a month										0.48***	0.37	0.64
Two or three times a week										0.47***	0.36	0.62
Four or more times a week										0.60***	0.46	0.79
Activity												
Less than once a month										0.77***	0.65	0.91
Once a month										0.76*	0.57	1.02
2 to 3 times a month										0.63**	0.44	0.91
Once a week										0.78	0.57	1.07
More than once a week										0.57**	0.36	0.89
Constant	0.17***	0.16	0.18	0.17***	0.14	0.20	0.20***	0.16	0.26	0.30***	0.21	0.43

*** p<.01, ** p<.05, * p<.1

Table 3.27 shows the results of the logistics regression examining the association between cardiovascular factor scores and mental health using NCDS data. Unlike UKHLS, the results of both ELSA and NCDS are not statistically significant after adjusting for covariates, but the direction of association is like UKHLS. The pattern of the results for gender, marital status, smoking status and physical activity are consistent with the results of ELSA and UKHLS. The results of education and alcohol intake are similar to ELSA but unlike UKHLS results.

Table 3. 28: Logistics regression using NCDS data

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Neuroendocrine factor scores	1.00	0.81	1.24	1.00	0.80	1.24	0.96	0.77	1.19	0.95	0.76	1.19
Gender												
Female				2.04***	1.77	2.34	2.05***	1.77	2.37	1.98***	1.70	2.31
Education												
Other qualifications				0.86*	0.65	1.02	0.86	0.68	1.08	0.88	0.69	1.12
0 Level/equivalent				0.65***	0.54	0.78	0.70***	0.58	0.84	0.78**	0.63	0.95
A Level/equivalent				0.44***	0.33	0.60	0.46***	0.34	0.62	0.55***	0.40	0.76
Higher qualification below degree				0.75*	0.54	1.04	0.79	0.56	1.11	0.89	0.62	1.26
Degree/equivalent				0.44***	0.35	0.55	0.47***	0.37	0.60	0.57***	0.44	0.74
Marital Status												
Married/Partnership							0.68***	0.54	0.85	0.79*	0.62	1.00
Remarried							0.85	0.65	1.11	0.95	0.71	1.26
Divorced/legally separated Widowed							0.97	0.75	1.25	1.05	0.80	1.38
Smoking Status												
Ex-smoker										1.17*	0.99	1.39
Current smoker										1.34***	1.12	1.61
Alcohol Intake												
Once a month or less										0.65***	0.49	0.87
Two to four times a month										0.48***	0.37	0.64
Two or three times a week										0.47***	0.36	0.62
Four or more times a week										0.60***	0.46	0.79

Activity											
Less than once a month									0.77***	0.65	0.90
Once a month									0.76*	0.57	1.01
2 to 3 times a month									0.63**	0.44	0.91
Once a week									0.78	0.57	1.07
More than once a week									0.57**	0.36	0.89
Constant	0.17***	0.16	0.18	0.17***	0.14	0.20	0.20***	0.16	0.26	0.30***	0.21	0.43

*** p<.01, ** p<.05, * p<.1

Table 3.28 shows the results of the logistics regression examining the association between neuroendocrine factor scores and mental health using NCDS data. Comparable to ELSA and UKHLS, Model 1 indicates that each additional neuroendocrine factor score decreases the odds of having poor mental health, but the results are not statistically significant. This pattern remained after adjusting for covariates. The pattern of association between the neuroendocrine systems, gender, educational attainment, marital status, smoking status, and physical activity is similar to ELSA and UKHLS. However, the pattern of association of alcohol intake is like ELSA but different to UKHLS.

Table 3. 29: Logistics regression using BCS70 data

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	1.07	0.96	1.18	1.06	0.96	1.18	1.07	0.96	1.19	1.03	0.92	1.16
Gender												
Female				1.60***	1.30	1.98	1.61***	1.30	2.01	1.52***	1.22	1.91
Education												
Other qualifications				0.93	0.59	1.48	0.92	0.58	1.48	0.86	0.53	1.40
0 Level/equivalent				0.72**	0.54	0.94	0.72**	0.54	0.95	0.78	0.58	1.05

A Level/equivalent				0.66	0.41	1.08	0.69	0.42	1.12	0.78	0.47	1.30
Higher qualification below degree				0.58**	0.39	0.87	0.61**	0.41	0.91	0.69*	0.46	1.05
Degree/equivalent				0.53***	0.40	0.70	0.54***	0.40	0.72	0.65**	0.48	0.89
Marital Status												
Married/Partnership							0.48***	0.37	0.63	0.52***	0.40	0.69
Divorced/legally separated/ Widowed							0.64**	0.46	0.89	0.65**	0.46	0.92
Smoking Status												
Ex-smoker										0.99	0.77	1.28
Current smoker										1.22	0.91	1.64
Alcohol Intake												
Monthly or less										0.64**	0.44	0.94
2 -4 times a month										0.42***	0.28	0.62
2-3 times a week										0.51***	0.35	0.72
4 or more times a week										0.57**	0.38	0.85
Activity												
Low										2.25***	1.72	2.94
Moderate										1.04	0.74	1.47
High										1.05	0.76	1.46
Constant	0.21***	0.19	0.24	0.23***	0.18	0.28	0.39***	0.29	0.51	0.47***	0.30	0.74

*** p<.01, ** p<.05, * p<.1

Table 3.29 shows the results of the logistics regression examining the association between metabolic factor scores and mental health using BCS70 data. Unlike ELSA, which is partly similar to UKHLS and identical to NCDS, the results of the association between metabolic factor scores and mental health using BCS70 data are not statistically significant. Similar to the other three datasets, Models 2 to 4 indicate that females have higher odds of having poor mental health compared to males. Comparable to ELSA and NCDS but separate from UKHLS, higher educational qualifications decreased the odds of having poor mental health after accounting for covariates. Equivalent to ELSA, UKHLS and NCDS, being married or in a legal partnership compared to being single or never married decreases the odds of having poor mental health, but unlike the other datasets being divorced or legally separated statistically significantly reduces the odds of having poor mental health. Similar to ELSA and NCDS but different to UKHLS, alcohol intake decreases the odds of having poor mental health. Different from the other datasets, the results of smoking are not statistically significant and engaging in physical activity increases the odds of having poor mental health.

Table 3. 30: Logistics regression using BCS70 data

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	1.15*	0.98	1.36	1.14	0.96	1.35	1.14	0.97	1.36	1.13	0.95	1.35
Gender												
Female				1.60***	1.29	1.97	1.60***	1.29	1.98	1.52***	1.21	1.90
Education												
Other qualifications				0.94	0.59	1.49	0.93	0.58	1.48	0.87	0.53	1.40
0 Level/equivalent				0.72**	0.54	0.94	0.72**	0.54	0.95	0.78	0.58	1.05
A Level/equivalent				0.67	0.42	1.09	0.70	0.43	1.14	0.79	0.47	1.32
Higher qualification below degree				0.58**	0.39	0.87	0.61**	0.41	0.91	0.69*	0.46	1.05
Degree/equivalent				0.53***	0.40	0.71	0.54***	0.40	0.72	0.65**	0.48	0.89
Marital Status												
Married/Partnership							0.48***	0.37	0.63	0.53***	0.40	0.69
Divorced/legally separated/ Widowed							0.64**	0.46	0.89	0.66**	0.47	0.93
Smoking Status												
Ex-smoker										0.99	0.77	1.28
Current smoker										1.22	0.91	1.64

Alcohol Intake												
Monthly or less										0.65**	0.44	0.94
2 -4 times a month										0.42***	0.29	0.63
2-3 times a week										0.50***	0.35	0.72
4 or more times a week										0.57**	0.38	0.85
Activity												
Low										2.25***	1.72	2.94
Moderate										1.04	0.74	1.48
High										1.06	0.76	1.46
Constant	0.21***	0.19	0.24	0.23***	0.18	0.28	0.38***	0.29	0.51	0.46***	0.30	0.73

*** p<.01, ** p<.05, * p<.1

Table 3.30 shows the results of the logistics regression examining the association between lipid factor scores and mental health using BCS70 data. Unlike the results of the other datasets, in Model 1, each additional lipid factor score increases the odds of having poor mental health. Still, results became non-significant after controlling for covariates. The results of gender are comparable in the four datasets. Similar to ELSA and NCDS but separate from UKHLS, higher educational qualifications decreased the odds of having poor mental health after accounting for covariates. Equivalent to ELSA, UKHLS and NCDS, being married or in a legal partnership compared to being single or never married decreases the odds of having poor mental health, but unlike the other datasets being divorced or legally separated statistically significantly reduces the odds of having poor mental health. Similar to ELSA and NCDS but different to UKHLS, alcohol intake decreases the odds of having poor mental health. Different from the other datasets, the results of smoking are not statistically significant and engaging in physical activity increases the odds of having poor mental health.

Table 3. 31: Logistics regression using BCS70 data

Variables	**BCS70**

Mental Health	Model 1			Model 2			Model 3			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.26	0.85	1.89	1.26	0.84	1.89	1.24	0.82	1.88	1.25	0.82	1.91
Gender												
Female				1.60***	1.30	1.98	1.61***	1.30	1.99	1.53***	1.22	1.91
Education												
Other qualifications				0.94	0.59	1.49	0.93	0.58	1.49	0.86	0.53	1.40
0 Level/equivalent				0.71**	0.54	0.94	0.71**	0.54	0.95	0.78*	0.58	1.04
A Level/equivalent				0.67	0.41	1.08	0.69	0.42	1.13	0.79	0.47	1.30
Higher qualification below degree				0.58**	0.39	0.87	0.61**	0.41	0.91	0.69*	0.46	1.05
Degree/equivalent				0.53***	0.40	0.70	0.54***	0.40	0.72	0.65**	0.48	0.89
Marital Status												
Married/Partnership							0.48***	0.37	0.63	0.52***	0.40	0.69
Divorced/legally separated/ Widowed							0.64**	0.46	0.89	0.65**	0.46	0.92
Smoking Status												
Ex-smoker										0.99	0.77	1.29
Current smoker										1.22	0.91	1.64
Alcohol Intake												
Monthly or less										0.65**	0.44	0.94
2 -4 times a month										0.42***	0.29	0.63
2-3 times a week										0.51***	0.36	0.73
4 or more times a week										0.57**	0.38	0.86
Activity												
Low										2.26***	1.73	2.95
Moderate										1.04	0.74	1.48
High										1.05	0.76	1.46
Constant	0.21***	0.19	0.23	0.24***	0.18	0.28	0.38***	0.29	0.51	0.46***	0.29	0.72

*** p<.01, ** p<.05, * p<.1

Table 3.31 shows the results of the logistics regression examining the association between inflammatory factor scores and mental health using BCS70 data. Different to ELSA and NCDS but partially similar to UKHLS, the results of the association between inflammatory factor scores and mental health are not statistically significant. Similar to ELSA, UKHLS and NCDS, Models 2 to 4 indicate that females have higher odds of having poor mental health compared to males. The pattern of the results of the remaining covariates in relation to the pattern of the results above is comparable.

Table 3. 32: Logistics regression using BCS70 data

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.09	0.97	1.23	1.08	0.96	1.21	1.07	0.95	1.20	1.08	0.95	1.22
Gender												
Female				1.60***	1.30	1.98	1.61***	1.30	1.99	1.52***	1.22	1.91
Education												
Other qualifications				0.94	0.59	1.48	0.93	0.58	1.48	0.86	0.53	1.40
0 Level/equivalent				0.72**	0.55	0.95	0.72**	0.54	0.95	0.79	0.58	1.06
A Level/equivalent				0.67	0.41	1.09	0.70	0.43	1.14	0.79	0.47	1.31
Higher qualification below degree				0.59**	0.39	0.87	0.61**	0.41	0.92	0.70*	0.46	1.05
Degree/equivalent				0.53***	0.40	0.71	0.54***	0.41	0.73	0.65**	0.48	0.89
Marital Status												
Married/Partnership							0.49***	0.37	0.63	0.53***	0.40	0.69
Divorced/legally separated/ Widowed							0.64**	0.46	0.89	0.66**	0.46	0.93
Smoking Status												
Ex-smoker										0.99	0.77	1.28
Current smoker										1.22	0.91	1.64

Alcohol Intake								
Monthly or less							0.99	0.77 1.28
2 -4 times a month							1.22	0.91 1.64
2-3 times a week							0.99	0.77 1.28
4 or more times a week							1.22	0.91 1.64
Activity								
Low							2.25***	1.72 2.94
Moderate							1.04	0.74 1.48
High							1.05	0.76 1.45
Constant	0.22***	0.19 0.24	0.23***	0.18 0.28	0.38***	0.29 0.51	0.47***	0.30 0.74

*** p<.01, ** p<.05, * p<.1

Table 3.32 shows the results of the logistics regression examining the association between cardiovascular factor scores and mental health using BCS70 data. Like ELSA and NCDS, but contrary to UKHLS, the results of the association between cardiovascular factor scores and mental health are not statistically significant after controlling for covariates. The gender patterns are alike in the four datasets. There is a consistent pattern in the results of the other covariates concerning the other datasets.

Results after adjusting for covariates in the four datasets

To make it easier to compare the four datasets used in Chapter Three, Table 3.33 to Table 3.38 presents the results of the four datasets after controlling for covariates, including education. Table 3.39 to Table 3.45 presents the results of the four datasets after controlling for covariates, including education and occupation, respectively.

Table 3. 33: Results of the four datasets after adjusting for covariates, including education

Variables	**ELSA**	**UKHLS**	**NCDS**	**BCS70**

Mental Health	Model 4			Model 4			Model 4			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	1.19***	1.08	1.30	1.02	0.96	1.07	0.96	0.88	1.05	1.03	0.92	1.16

*** p<.01, ** p<.05, * p<

Table 3. 34: Results of the four datasets after adjusting for covariates, including education

Variables	ELSA			UKHLS			NCDS			BCS70		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	1.01	0.91	1.10	1.14	0.96	1.35	1.04	0.96	1.13	1.13	0.95	1.35

*** p<.01, ** p<.05, * p<.1

Table 3. 35: Results of the four datasets after adjusting for covariates, including education

Variables	ELSA			UKHLS			NCDS			BCS70		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.22***	1.07	1.39	1.03	0.98	1.08	0.82***	0.71	0.94	1.25	0.82	1.91

*** p<.01, ** p<.05, * p<.1

Table 3. 36: Results of ELSA and UKHLS datasets after adjusting for covariates, including education

Variables	ELSA			UKHLS		
Mental Health	**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores						
Iron factor scores	0.95	0.82	1.11	1.00	0.92	1.10

*** p<.01, ** p<.05, * p<.1

Table 3. 37: Results of the four datasets after adjusting for covariates, including education

Variables	ELSA			UKHLS			NCDS			BCS70		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.03	0.97	1.10	1.01**	1.00	1.03	1.03	0.94	1.12	1.08	0.95	1.22

*** p<.01, ** p<.05, * p<.1

Table 3. 38: Results of ELSA, UKHLS and NCDS datasets after adjusting for covariates, including education

Variables	ELSA			UKHLS			NCDS		
Mental Health	**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores									
Neuroendocrine factor scores	0.76*	0.58	1.00	0.80**	0.68	0.94	0.95	0.76	1.19

*** p<.01, ** p<.05, * p<.1

Results after adjusting for education and occupation

Given that in Chapter Two, after adjusting for occupation, education as an indicator of social position was no longer linked to mental health, this chapter investigated if results would change if education and occupation were included in the models. The full models are attached as an appendix. The tables below present the final models using the four datasets to aid the comparison of results. The main association between each biological system and mental health was consistent after adding education and occupation to the models. However, there were changes in the direction of the association between education and some biological systems.

Table 3. 39: Results of the four datasets after adjusting for covariates, including education and occupation

Variables	ELSA			UKHLS			NCDS			BCS70		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	1.17***	1.07	1.29	1.01	0.96	1.07	1.02	0.92	1.12	1.04	0.92	1.18
Gender												
Female	1.63***	1.38	1.93	1.55***	1.41	1.70	1.20***	1.67	2.39	1.49***	1.15	1.93
Age Group												
25-34 years				1.49***	1.22	1.82						
35-44 years				1.58***	1.29	1.94						
45-54 years				1.83***	1.49	2.25						
55-64 years	0.70***	0.57	0.87	1.39***	1.12	1.74						
65-74 years	0.54***	0.43	0.69	0.72*	0.51	1.01						
75-84 years	0.50***	0.38	0.66	0.63	0.28	1.41						
Education												
Other qualifications	0.94	0.75	1.20	1.02	0.80	1.29	1.11	0.83	1.48	0.86	0.48	1.51
0 Level/equivalent	0.87	0.70	1.08	0.91	0.73	1.12	0.98	0.76	1.27	0.93	0.66	1.31
A Level/equivalent	0.85	0.64	1.15	0.95	0.77	1.18	0.71*	0.48	1.04	1.12	0.64	1.95
Higher qualification below degree	1.03	0.80	1.31	0.99	0.79	1.24	1.23	0.81	1.85	0.98	0.61	1.55
Degree/equivalent	1.09	0.84	1.41	0.94	0.76	1.18	0.81	0.59	1.13	0.98	0.67	1.43
Social Position												
Lower supervisory & technical occupations	0.94	0.73	1.20	0.83*	0.69	1.00	0.90	0.66	1.21	0.71	0.42	1.20
Small employers and own account workers	0.73**	0.57	0.93	0.87	0.74	1.03	0.82	0.60	1.13	0.81	0.51	1.29
Intermediate occupations	0.71***	0.57	0.89	0.93	0.81	1.07	1.01	0.76	1.32	0.79	0.52	1.22
Management and professional occupations	0.59***	0.48	0.73	0.94	0.84	1.06	0.75**	0.59	0.95	0.60**	0.41	0.87
Marital Status												
Married/Partnership	0.49***	0.37	0.64	0.75***	0.66	0.86	0.88	0.66	1.17	0.55***	0.40	0.75
	0.67**	0.48	0.92				1.03	0.74	1.44			
Remarried/In Partnership before	1.01	0.75	1.38				1.07	0.77	1.49			
Divorced/legally separated	1.18	0.86	1.61	0.95	0.79	1.15	1.11	0.83	1.48	0.64**	0.43	0.95

Widowed				0.75	0.50	1.11						
Smoking Status	1.10	0.94	1.29									
Ex-smoker	1.48***	1.21	1.81	1.08	0.97	1.18	1.13	0.93	1.36	0.99	0.74	1.32
Current smoker				1.23***	1.09	1.38	1.17	0.95	1.45	1.01	0.72	1.42
Alcohol Intake	1.22	0.94	1.60									
Not at all in the last 12 months	1.11	0.84	1.48	1.47*	0.97	2.23						
Once or twice a year	0.74*	0.53	1.02	1.47*	1.01	2.18						
Once every couple of months	0.67**	0.50	0.90	1.26	0.86	1.86						
Once or twice a month	0.62***	0.48	0.80	1.17	0.80	1.69						
Once or twice a week	0.55***	0.40	0.74	1.02	0.71	1.47						
Three or four days a week	0.64**	0.43	0.94	1.06	0.73	1.54						
Five or six days a week	0.63***	0.47	0.84	1.35	0.91	2.00						
Almost every day	0.70***	0.57	0.87	1.29	0.87	1.89						
Once a month or less							0.74	0.52	1.07			
Two to four times a month							0.62**	0.43	0.88			
Two or three times a week							0.61***	0.43	0.86			
Four or more times a week							0.74*	0.52	1.05			
Monthly or less										0.74	0.47	1.16
2 -4 times a month										0.51***	0.32	0.80
2-3 times a week										0.58**	0.38	0.89
4 or more times a week										0.65*	0.40	1.05
										0.74	0.47	1.16
Activity												
Low Activity	0.44***	0.34	0.57	1.01	0.87	1.18				2.00***	1.46	2.73
Moderate Activity	0.23***	0.18	0.29	0.92	0.79	1.07				1.20	0.83	1.73
High Activity	0.18***	0.13	0.24	0.82**	0.70	0.95				0.99	0.68	1.43
Less than once a month							0.86	0.71	1.04			
Once a month							0.90	0.65	1.24			
2 to 3 times a month							0.79	0.54	1.16			
Once a week							0.79	0.55	1.14			
More than once a week							0.66	0.40	1.09			
Constant	1.41	0.90	2.21	0.34***	0.22	0.53	0.18***	0.11	0.29	0.45**	0.25	0.80

*** p<.01, ** p<.05, * p<.1

Table 3.39 shows the results of the logistics regression examining the association between metabolic factor scores and mental health after controlling for covariates, including occupation and education, using ELSA, UKHLS, NCDS and BCS70. These results are similar to the results of models that did not control for occupation except ELSA and NCDS. In ELSA, educational attainment results are no longer significant, but the direction of association remains the same. Unexpectedly, in NCDS, the direction of association changed, but the results remain statistically insignificant.

Table 3. 40: Results of the four datasets after adjusting for covariates, including education and occupation

Variables	ELSA			UKHLS			NCDS			BCS70		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	1.01	0.92	1.11	1.13	0.94	1.34	1.03	0.94	1.13	1.18	0.96	1.44
Gender												
Female	1.48***	1.26	1.74	1.57***	1.43	1.72	2.00***	1.68	2.39	1.48***	1.14	1.93
Age Group												
25-34 years				1.48***	1.21	1.81						
35-44 years				1.56***	1.28	1.92						
45-54 years				1.80***	1.47	2.22						
55-64 years	0.71***	0.57	0.88	1.38**	1.10	1.71						
65-74 years	0.54***	0.43	0.69	0.71**	0.51	0.99						
75-84 years	0.49***	0.37	0.65	0.62	0.29	1.40						
Education												
Other qualifications	0.93	0.74	1.18	1.02	0.80	1.29	1.11	0.83	1.48	0.86	0.49	1.52
0 Level/equivalent	0.86	0.70	1.07	0.91	0.73	1.12	0.98	0.76	1.27	0.93	0.66	1.31
A Level/equivalent	0.85	0.63	1.14	0.95	0.77	1.18	0.71*	0.48	1.04	1.14	0.66	1.99
Higher qualification below degree	1.01	0.79	1.29	0.99	0.79	1.24	1.23	0.82	1.86	0.98	0.62	1.56
Degree/equivalent	1.06	0.82	1.38	0.95	0.76	1.18	0.81	0.59	1.13	0.99	0.68	1.44

Social Position												
Lower supervisory & technical occupations	0.94	0.73	1.20	0.83*	0.69	1.00	0.90	0.66	1.22	0.69	0.41	1.18
Small employers and own account workers	0.72**	0.56	0.93	0.87	0.74	1.03	0.82	0.60	1.13	0.81	0.50	1.29
Intermediate occupations	0.70***	0.56	0.87	0.93	0.81	1.07	1.00	0.76	1.32	0.79	0.51	1.22
Management and professional occupations	0.59***	0.48	0.72	0.94	0.84	1.06	0.75**	0.59	0.95	0.59**	0.41	0.85
Marital Status												
Married/Partnership	0.49***	0.37	0.64	0.75***	0.66	0.86	0.88	0.66	1.17	0.55***	0.40	0.75
	0.67**	0.49	0.93				1.03	0.74	1.44			
Remarried/In Partnership before	1.01	0.75	1.37				1.07	0.77	1.49			
Divorced/legally separated	1.20	0.88	1.63	0.95	0.79	1.15	1.11	0.83	1.48	0.64**	0.43	0.95
Widowed				0.75	0.50	1.11						
Smoking Status	1.12	0.96	1.31									
Ex-smoker	1.44***	1.18	1.76	1.08	0.98	1.18	1.13	0.93	1.36	0.99	0.74	1.31
Current smoker				1.22***	1.09	1.37	1.17	0.95	1.45	1.00	0.71	1.41
Alcohol Intake	1.23	0.94	1.61									
Not at all in the last 12 months	1.13	0.85	1.50	1.46*	0.96	2.22						
Once or twice a year	0.75*	0.55	1.04	1.47*	0.99	2.17						
Once every couple of months	0.68**	0.50	0.91	1.25	0.85	1.84						
Once or twice a month	0.61***	0.48	0.79	1.16	0.80	1.69						
Once or twice a week	0.54***	0.40	0.74	1.02	0.71	1.47						
Three or four days a week	0.62**	0.42	0.91	1.06	0.73	1.54						
Five or six days a week	0.62***	0.46	0.83	1.35	0.91	2.00						
Almost every day	0.71***	0.57	0.88	1.28	0.87	1.89						
Once a month or less							0.74	0.52	1.07			
Two to four times a month							0.62**	0.43	0.88			
Two or three times a week							0.61***	0.43	0.85			
Four or more times a week							0.73*	0.52	1.04			
Monthly or less										0.74	0.47	1.16
2 -4 times a month										0.51***	0.32	0.81
2-3 times a week										0.58**	0.38	0.88
4 or more times a week										0.65*	0.40	1.04
										0.74	0.47	1.16
Activity												

Low Activity	0.44***	0.34	0.56	1.01	0.87	1.18				2.00***	1.46	2.72
Moderate Activity	0.22***	0.17	0.28	0.92	0.79	1.07				1.20	0.83	1.73
High Activity	0.17***	0.12	0.23	0.82**	0.71	0.95				0.98	0.68	1.42
Less than once a month							0.86	0.71	1.04			
Once a month							0.90	0.66	1.24			
2 to 3 times a month							0.79	0.54	1.16			
Once a week							0.79	0.55	1.14			
More than once a week							0.66	0.40	1.09			
Constant	1.54*	0.98	2.40	0.34***	0.22	0.54	0.18***	0.11	0.29	0.45**	0.25	0.81

*** p<.01, ** p<.05, * p<.1

Table 3.40 shows the results of the logistics regression examining the association between Lipid factor scores and mental health after controlling for covariates, including occupation and education, using ELSA, UKHLS, NCDS and BCS70. These results are similar to the models' results that did not control for occupation, except that in ELSA, NCDS and BCS70, educational attainment results are no longer statistically significant.

Table 3. 41: Results of the four datasets after adjusting for covariates, including education and occupation

Variables	**ELSA**			**UKHLS**			**NCDS**			**BCS70**		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.18**	1.04	1.35	1.02	0.97	1.07	0.87*	0.74	1.02	1.46	0.89	2.39
Gender												
Female	1.49***	1.27	1.75	1.54***	1.41	1.68	2.00***	1.68	2.39	1.49***	1.15	1.94
Age Group												
25-34 years				1.49***	1.21	1.82						
35-44 years				1.58***	1.29	1.93						
45-54 years				1.82***	1.48	2.24						
55-64 years	0.71***	0.57	0.88	1.39***	1.12	1.73						
65-74 years	0.53***	0.42	0.68	0.71**	0.51	1.00						
75-84 years	0.48***	0.36	0.63	0.62	0.28	1.40						

Education												
Other qualifications	0.93	0.74	1.18	1.02	0.80	1.29	1.11	0.83	1.48	0.86	0.49	1.52
0 Level/equivalent	0.86	0.70	1.07	0.91	0.74	1.13	0.98	0.76	1.27	0.92	0.65	1.29
A Level/equivalent	0.85	0.63	1.14	0.96	0.77	1.19	0.70*	0.48	1.03	1.12	0.64	1.95
Higher qualification below degree	1.02	0.80	1.30	0.99	0.79	1.24	1.23	0.82	1.86	0.98	0.62	1.56
Degree/equivalent	1.09	0.84	1.41	0.95	0.76	1.18	0.81	0.58	1.12	0.97	0.67	1.42
Social Position												
Lower supervisory & technical occupations	0.94	0.74	1.21	0.83*	0.69	1.00	0.90	0.66	1.22	0.70	0.41	1.19
Small employers and own account workers	0.73**	0.57	0.94	0.87	0.74	1.03	0.83	0.60	1.14	0.81	0.51	1.29
Intermediate occupations	0.71***	0.57	0.87	0.93	0.81	1.07	1.01	0.76	1.33	0.79	0.51	1.22
Management and professional occupations	0.60***	0.49	0.74	0.95	0.84	1.07	0.75**	0.60	0.95	0.60**	0.41	0.86
Marital Status												
Married/Partnership	0.49***	0.37	0.64	0.75***	0.66	0.86	0.88	0.67	1.17	0.55***	0.40	0.75
Remarried/In Partnership before	0.67**	0.49	0.94				1.03	0.74	1.44			
Divorced/legally separated	1.02	0.75	1.38	0.95	0.79	1.15	1.07	0.77	1.48	0.63**	0.43	0.94
Widowed	1.19	0.87	1.62	0.75	0.50	1.11						
Smoking Status	1.11	0.94	1.30									
Ex-smoker	1.38***	1.13	1.69	1.08	0.98	1.18	1.12	0.93	1.36	1.00	0.75	1.32
Current smoker				1.22***	1.09	1.38	1.17	0.95	1.45	1.01	0.72	1.42
Alcohol Intake	1.22	0.94	1.59									
Not at all in the last 12 months	1.12	0.85	1.49	1.47*	0.97	2.23						
Once or twice a year	0.75*	0.54	1.04	1.47*	1.00	2.18						
Once every couple of months	0.67**	0.50	0.90	1.26	0.86	1.85						
Once or twice a month	0.60***	0.48	0.80	1.17	0.81	1.69						
Once or twice a week	0.62***	0.40	0.76	1.02	0.71	1.47						
Three or four days a week	0.55**	0.43	0.94	1.06	0.73	1.54						
Five or six days a week	0.63***	0.47	0.85	1.35	0.91	2.01						
Almost every day	0.71***	0.57	0.88	1.28	0.87	1.90						
Once a month or less							0.73*	0.51	1.05			
Two to four times a month							0.61**	0.43	0.87			

Two or three times a week							0.60***	0.43	0.85			
Four or more times a week							0.73*	0.51	1.03			
Monthly or less										0.74	0.47	1.17
2 -4 times a month										0.51***	0.32	0.81
2-3 times a week										0.58**	0.38	0.89
4 or more times a week										0.66*	0.41	1.06
										0.74	0.47	1.17
Activity												
Low Activity	0.44***	0.34	0.56	1.01	0.87	1.18				2.01***	1.47	2.74
Moderate Activity	0.22***	0.17	0.29	0.92	0.79	1.07				1.20	0.83	1.73
High Activity	0.18***	0.13	0.24	0.82**	0.71	0.95				0.99	0.68	1.43
Less than once a month							0.86	0.71	1.04			
Once a month							0.90	0.65	1.24			
2 to 3 times a month							0.79	0.54	1.15			
Once a week							0.79	0.55	1.14			
More than once a week							0.65*	0.40	1.07			
Constant	1.47*	0.94	2.30	0.34***	0.22	0.53	0.18***	0.11	0.29	0.43**	0.24	0.79

*** p<.01, ** p<.05, * p<.1

Table 3.41 shows the results of the logistics regression examining the association between inflammatory factor scores and mental health after controlling for covariates, including occupation and education, using ELSA, UKHLS, NCDS and BCS70. These results are similar to the models' results that did not control for occupation, except that in BCS70, educational attainment results are no longer statistically significant.

Table 3. 42: Results of ELSA and UKHLS datasets after adjusting for covariates, including education and occupation

Variables	**ELSA**			**UKHLS**		
Mental Health	**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores						
Iron factor scores	0.98	0.84	1.14	1.00	0.92	1.10
Gender						
Female	1.47***	1.24	1.75	1.55***	1.39	1.71

Age Group						
25-34 years				1.44***	1.22	1.83
35-44 years				1.52***	1.29	1.94
45-54 years				1.74***	1.49	2.26
55-64 years	0.71***	0.58	0.89	1.32**	1.12	1.75
65-74 years	0.54***	0.43	0.69	0.70**	0.51	1.01
75-84 years	0.49***	0.37	0.65	0.70	0.28	1.42
Education						
Other qualifications	0.93	0.74	1.18	0.97	0.80	1.29
0 Level/equivalent	0.86	0.70	1.07	0.87	0.73	1.12
A Level/equivalent	0.85	0.63	1.14	0.91	0.77	1.18
Higher qualification below degree	1.01	0.79	1.29	0.93	0.79	1.24
Degree/equivalent	1.06	0.82	1.38	0.88	0.76	1.18
Social Position						
Lower supervisory & technical occupations	0.94	0.74	1.20	0.83*	0.69	1.00
Small employers and own account workers	0.72**	0.56	0.93	0.87	0.74	1.03
Intermediate occupations	0.70***	0.56	0.87	0.93	0.81	1.07
Management and professional occupations	0.59***	0.48	0.73	0.94	0.84	1.06
Marital Status						
Married/Partnership	0.49***	0.37	0.64	0.75***	0.66	0.86
Remarried/In Partnership before	0.67**	0.49	0.93			
Divorced/legally separated	1.01	0.75	1.37	0.96	0.79	1.15
Widowed	1.20	0.88	1.63	0.79	0.50	1.11
Smoking Status						
Ex-smoker	1.12	0.96	1.31	1.08	0.98	1.18
Current smoker	1.44***	1.18	1.76	1.23***	1.09	1.38
Alcohol Intake						
Not at all in the last 12 months	1.23	0.94	1.60	1.47*	0.97	2.23
Once or twice a year	1.13	0.85	1.50	1.47*	1.00	2.18

Once every couple of months	0.75*	0.55	1.04	1.26	0.86	1.85
Once or twice a month	0.68**	0.50	0.91	1.17	0.80	1.69
Once or twice a week	0.61***	0.48	0.79	1.02	0.71	1.47
Three or four days a week	0.54***	0.40	0.74	1.06	0.73	1.54
Five or six days a week	0.62**	0.42	0.91	1.35	0.91	2.00
Almost every day	0.62***	0.47	0.84	1.28	0.86	1.89
Once a month or less						
Two to four times a month						
Two or three times a week						
Four or more times a week						
Monthly or less						
2 -4 times a month						
2-3 times a week						
4 or more times a week						
Activity						
Low Activity	0.44***	0.34	0.56	1.01	0.87	1.18
Moderate Activity	0.22***	0.17	0.28	0.92	0.79	1.07
High Activity	0.17***	0.12	0.23	0.82**	0.70	0.94
Less than once a month						
Once a month						
2 to 3 times a month						
Once a week						
More than once a week						
Constant	1.53*	0.98	2.39	0.34***	0.22	0.53

*** p<.01, ** p<.05, * p<.1

These results are similar to the results that did not control for occupation.

Table 3. 43: Results of ELSA after adjusting for covariates, including education and occupation

Variables	**ELSA**		
Mental Health	**Model 4**		
	Odds ratio	[Conf.	interval]
Factor Scores			
Glucose Metabolism factor scores	0.89	0.70	1.12

Gender			
Female	1.50***	1.28	1.75
Age Group			
25-34 years			
35-44 years			
45-54 years			
55-64 years	0.71***	0.57	0.88
65-74 years	0.54***	0.42	0.68
75-84 years	0.48***	0.37	0.64
Education			
Other qualifications	0.94	0.74	1.18
0 Level/equivalent	0.87	0.70	1.07
A Level/equivalent	0.85	0.64	1.15
Higher qualification below degree	1.02	0.79	1.30
Degree/equivalent	1.07	0.82	1.38
Social Position			
Lower supervisory & technical occupations	0.94	0.74	1.20
Small employers and own account workers	0.72**	0.56	0.93
Intermediate occupations	0.70***	0.56	0.88
Management and professional occupations	0.59***	0.48	0.73
Marital Status			
Married/Partnership	0.49***	0.37	0.64
Remarried/In Partnership before	0.67**	0.49	0.93
Divorced/legally separated	1.01	0.74	1.37
Widowed	1.19	0.87	1.62
Smoking Status			
Ex-smoker	1.12	0.95	1.31
Current smoker	1.43***	1.17	1.75
Alcohol Intake			

Not at all in the last 12 months	1.23	0.94	1.60
Once or twice a year	1.13	0.85	1.50
Once every couple of months	0.75*	0.54	1.04
Once or twice a month	0.68**	0.50	0.91
Once or twice a week	0.62***	0.48	0.80
Three or four days a week	0.55***	0.40	0.75
Five or six days a week	0.62**	0.42	0.92
Almost every day	0.63***	0.47	0.84
Once a month or less			
Two to four times a month			
Two or three times a week			
Four or more times a week			
Monthly or less			
2 -4 times a month			
2-3 times a week			
4 or more times a week			
Activity			
Low Activity	0.44***	0.34	0.56
Moderate Activity	0.22***	0.17	0.28
High Activity	0.17***	0.13	0.23
Less than once a month			
Once a month			
2 to 3 times a month			
Once a week			
More than once a week			
Constant	1.52*	0.97	2.38

*** p<.01, ** p<.05, * p<.1

These results are comparable to the model results that did not control for occupation but are not statistically significant.

Table 3. 44: Results of the four datasets after adjusting for covariates, including education and occupation

Variables	**ELSA**			**UKHLS**			**NCDS**			**BCS70**		
Mental Health	**Model 4**			**Model 4**			**Model 4**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												

Cardiovascular factor scores	1.03	0.96	1.10	1.01*	1.00	1.03	1.07	0.97	1.17	1.13	0.98	1.31
Gender												
Female	1.49***	1.27	1.75	1.53***	1.40	1.67	2.01***	1.67	2.39	1.49***	1.15	1.94
Age Group												
25-34 years				1.48***	1.21	1.81						
35-44 years				1.56***	1.27	1.91						
45-54 years				1.81***	1.47	2.22						
55-64 years	0.71***	0.59	0.88	1.39***	1.12	1.73						
65-74 years	0.53***	0.42	0.67	0.73*	0.52	1.02						
75-84 years	0.47***	0.35	0.63	0.66	0.29	1.48						
Education												
Other qualifications	0.94	0.74	1.18	1.01	0.80	1.28	1.11	0.83	1.49	0.86	0.49	1.52
0 Level/equivalent	0.87	0.70	1.07	0.91	0.73	1.12	0.98	0.76	1.27	0.95	0.67	1.33
A Level/equivalent	0.85	0.64	1.15	0.95	0.77	1.18	0.71*	0.48	1.04	1.15	0.66	2.00
Higher qualification below degree	1.01	0.79	1.29	0.99	0.78	1.24	1.23	0.82	1.86	0.99	0.62	1.58
Degree/equivalent	1.07	0.82	1.39	0.94	0.75	1.18	0.81	0.59	1.13	1.00	0.68	1.45
Social Position												
Lower supervisory & technical occupations	0.94	0.73	1.20	0.83**	0.69	0.99	0.90	0.66	1.21	0.70	0.41	1.20
Small employers and own account workers	0.72**	0.56	0.93	0.87	0.74	1.03	0.82	0.60	1.13	0.81	0.51	1.29
Intermediate occupations	0.70***	0.56	0.87	0.93	0.81	1.07	1.00	0.76	1.33	0.79	0.52	1.22
Management and professional occupations	0.59***	0.48	0.73	0.95	0.84	1.07	0.75**	0.60	0.95	0.59**	0.41	0.86
Marital Status												
Married/Partnership	0.49***	0.37	0.64	0.75***	0.66	0.86	0.88	0.66	1.17	0.55***	0.41	0.75
Remarried/In Partnership before	0.67**	0.49	0.93				1.03	0.74	1.44			
Divorced/legally separated	1.01	0.75	1.37	0.95	0.79	1.14	1.07	0.77	1.49	0.64**	0.43	0.96
Widowed	1.19	0.88	1.63	0.75	0.50	1.11						
Smoking Status												
Ex-smoker	1.12	0.96	1.31	1.08	0.98	1.19	1.12	0.93	1.36	0.99	0.74	1.31
Current smoker	1.44***	1.18	1.76	1.24***	1.10	1.40	1.18	0.95	1.46	1.01	0.72	1.42

Alcohol Intake												
Not at all in the last 12 months	1.24	0.95	1.61	1.46*	0.96	2.22						
Once or twice a year	1.13	0.85	1.50	1.47*	1.01	2.18						
Once every couple of months	0.75*	0.55	1.04	1.25	0.85	1.84						
Once or twice a month	0.68**	0.51	0.91	1.16	0.80	1.69						
Once or twice a week	0.62***	0.48	0.80	1.02	0.70	1.46						
Three or four days a week	0.55***	0.40	0.74	1.05	0.72	1.53						
Five or six days a week	0.62**	0.42	0.91	1.34	0.90	1.99						
Almost every day	0.62***	0.46	0.83	1.27	0.86	1.88						
Once a month or less							0.74	0.52	1.07			
Two to four times a month							0.62**	0.43	0.88			
Two or three times a week							0.61**	0.43	0.86			
Four or more times a week							0.74*	0.52	1.06			
Monthly or less										0.73	0.46	1.14
2 -4 times a month										0.50***	0.32	0.80
2-3 times a week										0.57**	0.37	0.87
4 or more times a week										0.64*	0.39	1.03
										0.73	0.46	1.14
Activity												
Low Activity	0.44***	0.34	0.56	1.01	0.87	1.18				2.00***	1.47	2.73
Moderate Activity	0.22***	0.17	0.28	0.92	0.79	1.07				1.21	0.84	1.74
High Activity	0.17***	0.12	0.23	0.81**	0.70	0.94				0.98	0.68	1.43
Less than once a month							0.86	0.72	1.04			
Once a month							0.91	0.66	1.25			
2 to 3 times a month							0.79	0.54	1.15			
Once a week							0.79	0.55	1.14			
More than once a week							0.66	0.40	1.09			
Constant	1.55*	0.99	2.42	0.35***	0.22	0.54	0.18***	0.11	0.29	0.44**	0.25	0.80

*** p<.01, ** p<.05, * p<.1

These results are like the results of the models that did not control for occupation, but the results of the educational attainment in ELSA, NCDS and BCS70 are no longer statistically significant.

Table 3. 45: Results of ELSA, UKHLS and NCDS after adjusting for covariates, including education and occupation

Variables	**ELSA**	**UKHLS**	**NCDS**

Mental Health	Model 4			Model 4			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores									
Neuroendocrine factor scores	0.75*	0.57	1.00	0.80**	0.67	0.94	1.03	0.80	1.33
Gender									
Female	1.38***	1.16	1.65	1.48***	1.35	1.62	2.00***	1.67	2.39
Age Group									
25-34 years				1.47***	1.20	1.80			
35-44 years				1.53***	1.25	1.88			
45-54 years				1.76***	1.43	2.16			
55-64 years	0.70***	0.56	0.87	1.32**	1.05	1.65			
65-74 years	0.52***	0.41	0.66	0.66**	0.50	0.93			
75-84 years	0.46***	0.34	0.61	0.58	0.26	1.31			
Education									
Other qualifications	0.93	0.73	1.18	1.01	0.80	1.29	1.11	0.83	1.48
0 Level/equivalent	0.86	0.70	1.07	0.91	0.74	1.13	0.98	0.76	1.27
A Level/equivalent	0.85	0.63	1.14	0.96	0.77	1.19	0.71*	0.48	1.04
Higher qualification below degree	1.01	0.79	1.29	0.99	0.79	1.24	1.23	0.81	1.85
Degree/equivalent	1.07	0.83	1.39	0.94	0.76	1.18	0.81	0.58	1.13
Social Position									
Lower supervisory & technical occupations	0.94	0.74	1.21	0.84**	0.70	1.00	0.90	0.66	1.22
Small employers and own account workers	0.73**	0.57	0.93	0.89	0.74	1.04	0.82	0.60	1.13
Intermediate occupations	0.68***	0.54	0.85	0.92	0.80	1.06	1.00	0.76	1.32
Management and professional occupations	0.59***	0.48	0.73	0.95	0.84	1.07	0.75**	0.59	0.95
Marital Status									
Married/Partnership	0.49***	0.37	0.64	0.75***	0.66	0.86	0.88	0.66	1.17
Remarried/In Partnership before	0.67**	0.49	0.93				1.03	0.74	1.44
Divorced/legally separated	1.01	0.74	1.37	0.95	0.79	1.15	1.07	0.77	1.49
Widowed	1.20	0.88	1.64	0.75	0.50	1.11			
Smoking Status									

Ex-smoker	1.12	0.95	1.31	1.08	0.98	1.18	1.12	0.93	1.36
Current smoker	1.45***	1.19	1.78	1.23***	1.09	1.38	1.17	0.95	1.45
Alcohol Intake									
Not at all in the last 12 months	1.23	0.94	1.61	1.46*	0.95	2.22			
Once or twice a year	1.14	0.85	1.51	1.47*	0.99	2.17			
Once every couple of months	0.75*	0.54	1.04	1.26	0.84	1.85			
Once or twice a month	0.68**	0.51	0.91	1.17	0.79	1.69			
Once or twice a week	0.62***	0.48	0.80	1.02	0.71	1.47			
Three or four days a week	0.55***	0.40	0.75	1.06	0.73	1.54			
Five or six days a week	0.62**	0.42	0.92	1.35	0.90	2.01			
Almost every day	0.63***	0.47	0.84	1.29	0.87	1.90			
Once a month or less							0.74	0.51	1.07
Two to four times a month							0.62**	0.43	0.88
Two or three times a week							0.61**	0.43	0.85
Four or more times a week							0.73*	0.52	1.04
Monthly or less									
2 -4 times a month									
2-3 times a week									
4 or more times a week									
Activity									
Low Activity	0.44***	0.34	0.57	1.01	0.88	1.18			
Moderate Activity	0.22***	0.17	0.28	0.92	0.81	1.07			
High Activity	0.17***	0.13	0.23	0.82**	0.72	0.95			
Less than once a month							0.86	0.71	1.04
Once a month							0.90	0.65	1.24
2 to 3 times a month							0.79	0.54	1.16
Once a week							0.79	0.55	1.14
More than once a week							0.66	0.40	1.08
Constant	1.57*	1.01	2.46	0.36***	0.23	0.56	0.18***	0.11	0.29

*** p<.01, ** p<.05, * p<.1

Table 3.45 shows the results of the logistics regression examining the association between neuroendocrine factor scores and mental health after controlling for covariates, including occupation and education, using ELSA, UKHLS and NCDS. These results of ELSA and UKHLS are similar to those of the model that did not control for occupation. Surprisingly, however, the results of NCDS are in the opposite direction.

Discussion

The findings from the analysis investigating the three sub-aims of Chapter Three suggest that the variables used in representing each biological system did not make a difference to the allostatic load factor scores. Including primary mediators did not change how biomarker variables load onto factors, and finally, the factor structures are similar across the seven datasets used. We also noted that the biomarkers included in each dataset depend on available data. Generally, the Models with neuroendocrine biomarkers in this study are loaded onto seven factors representing seven biological systems: metabolic, lipid, inflammatory, iron, glucose metabolism, cardiovascular and neuroendocrine.

In ELSA, available biomarkers represented the seven biological systems; in UKHLS, the glucose metabolic biological system was not fully represented, and as a result, the glucose metabolic system was omitted. Also, UKHLS models, which contained neuroendocrine biomarkers, did not have an iron biological system. NCDS and BCS70 had metabolic, lipid, inflammatory, and cardiovascular biological systems. NCDS has the neuroendocrine biological system, but BCS70 does not have it because it has only one neuroendocrine biomarker. A factor should have at least two variables related to the phenomenon of interest (Kevin, 2015). This study built on the findings from the sub-aims of Chapter Three by examining the association between allostatic load and mental health. Overall, the findings suggest that some components of allostatic load, such as lipid and iron factors, were not associated with mental health.

Results of models which adjusted for all covariates except occupation

Metabolic factor scores

In ELSA and UKHLS, each additional metabolic factor score increased the odds of having poor mental health, but in UKHLS, the results became non-significant after adjusting for covariates. However, the results of both NCDS and BCS70 were statistically non-significant, but the direction of association for BCS70 was like ELSA. In line with the literature, the findings from ELSA suggest that high metabolic factor scores are linked to poor mental health, and these results were partially confirmed in UKHLS. Humer et al. (2020) state that several studies have linked high metabolic biomarkers to poor mental health. Similarly, Liu et al. (2022) suggest that metabolic biomarkers and other metabolites are linked to poor mental health. Concordant with these results, Julkunen et al. (2023) reported that metabolic biomarkers and other metabolites are associated with a diverse range of illnesses, including poor mental health.

Besides, it is essential to note here that some studies (Yu et al., 2021b) suggest that metabolic indicators are connected to poor mental health in the middle-aged but not in the young or elderly. Also, the literature suggests that specific medications, such as antidiabetic medications, can impact the association between metabolic biomarkers and mental health (Palmer, 2022). However, this study has not adjusted for medications because the number of participants on medications in the study sample is primarily insignificant and, therefore, unlikely to impact results significantly.

Lipid factor scores

The findings of the association between the lipid factor scores and mental health in ELSA, UKHLS, NCDS and BCS70 are not statistically significant, but the direction of the association is similar. A similar narrative emerges from the literature. For instance, van Reedt Dortland et al. (2010) found a link between lipids and major depressive disorder, but their results became statistically non-significant after controlling for covariates. However, findings by Schneider et al. (2017) imply that lipids are linked to poor mental health. On the other hand, Yu et al. (2021) propose that lipid measures were linked with poor mental health in middle-aged females but not in the young or elderly. These results support the idea that females are at higher risk of developing poor mental health compared to males (Yu et al., 2021).

These inconsistent results may indicate the complexity of the link between lipids and mental health. The findings in this study are useful because the four datasets have large sample sizes representative of the UK population. Although this study is not longitudinal, the four datasets cover different stages in life and provide a longitudinal insight.

Inflammatory factor scores

Results indicate that each additional inflammatory factor score increases the odds of having poor mental health even after adjusting for covariates in ELSA. Nevertheless, results in UKHLS became statistically non-significant after adjusting for covariates. In BCS70, the results were not statistically significant. On the other hand, results in NCDS indicate that each additional inflammatory factor score decreases the odds of having poor mental health even after controlling for covariates. These finding partly aligns with the literature. Several studies (Carbone, 2021; Milaneschi et al., 2021) have linked inflammatory biomarkers to poor mental health. However, other studies (Dowlati et al., 2010; Marques-Deak et al., 2007) found no significant relationship between inflammation and poor mental health. Hartwig et al. (2017) suggest a possible defensive impact of raised CRP levels for schizophrenia. Also, Wium-Andersen et al. (2014) indicate that CRP is not causally linked with mental health. Instead, Wium-

Andersen et al. (2014) propose that a possible explanation for these mixed results is that other comorbidities may be driving the link between CRP and poor mental health.

The results of the NCDS were unexpected, and they differ from the evidence in the literature. However, an alternative explanation could be linked to factors such as medication, the complexity of the inflammatory process and comorbidities. Some medications may impact the inflammatory process, impacting the relationship between inflammatory factors and mental health (Bullmore, 2019). However, this study has not adjusted for medications because the number of participants on medications in the study sample is primarily insignificant and, therefore, unlikely to impact results significantly.

The inflammation process is complicated, which may result in inconsistent findings (Bullmore, 2019). The presence of comorbidities has been known to impact the link between inflammatory factors and mental health (Bullmore, 2019). These findings highlight the need for more research examining the link between inflammatory factors and mental health using multiple datasets.

Iron factor scores

In both ELSA and UKHLS, the results of the logistics regression examining the association between iron factor scores and mental health indicate that each additional iron factor score decreases the odds of having poor mental health. Nonetheless, after adjusting for covariates, the results became statistically non-significant. These results are important as the literature on the link between iron and mental health is mixed. Stewart & Hirani (2012) claim that low iron levels were associated with depression, while Qiu et al. (2022) have linked iron overload to the risk of depression. On the other hand, Richardson et al. (2015) maintain that there is no link between iron and depressive symptoms in females, but there is a link in males.

Evidence suggests that iron deficiency anaemia is associated with the risk of poor mental health, irrespective of other covariates (Fekih-Romdhane & Jahrami, 2023). Evidence also suggested that medication can impact the link between iron factors and mental health. For instance, Hidese et al. (2018) indicate that taking iron supplements could mitigate this risk (Hidese et al., 2018).

This chapter investigated the link between iron factor scores and mental health using data from over 10000 participants, and results suggest there is no association. Any apparent association would be very small and likely not clinically meaningful, given the size of the study population.

Glucose metabolism factor scores

ELSA is the only dataset from the four used in this chapter with glucose metabolism factor scores. The results of the logistics regression examining the association between glucose metabolism factor scores and mental health using ELSA data show that each additional glucose metabolism factor score decreases the odds of having poor mental health even after adjusting for gender, age group, education and marital status. ELSA results were unexpected as they contradict the literature on glucose metabolism and mental health. For example, Kucukgoncu et al. (2019), who reviewed 31 studies that examined the relationship between glucose metabolism and mental health, suggest that studies consistently linked high glucose metabolism to poor mental health.

ELSA results became statistically non-significant after adjusting for health behaviour, suggesting that health behaviour may be driving these associations. A possible explanation for these results may be that physical activity has an independent link with poor mental health (Saneei et al., 2016). For instance, Hautekiet et al. (2022) propose that increased physical activity reduces the risk of poor mental health.

Cardiovascular factor scores

In ELSA, UKHLS, NCDS and BCS70, the results of the logistics regression examining the association between cardiovascular factor scores and mental health indicate that each additional cardiovascular factor score increases the odds of having poor mental health. In UKHLS, the results remained significant even after adjusting for covariates, but in ELSA, NCDS and BCS70, the results became non-statistically significant after adjusting for covariates. The evidence in the literature is mixed. Berendes et al. (2013) suggest that high blood pressure is related to less distress and better well-being. Similarly, Schaare et al. (2023) indicate that higher blood pressure is connected to better mental health.

In contrast, Kivimäki et al. (2012) have linked hypertension to poor mental health. Along similar lines, Dhingra et al. (2023) and Veeneman et al. (2023) have reported that cardiovascular risk factors are connected to increased depressive symptoms. These contradictory findings warrant further investigation.

This study suggests that unhealthy behaviours, including smoking, are implicated in the link between cardiovascular factor scores and mental health. The literature indicates that unhealthy behaviour, including smoking, alcohol consumption and a lack of physical activity, impact the association between cardiovascular factors and mental health (Penninx, 2017).

Neuroendocrine factor scores

In ELSA, UKHLS and NCDS, findings indicate that each additional neuroendocrine factor score decreases the odds of having poor mental health. Nonetheless, the NCDS results were not statistically significant. The literature on neuroendocrine biomarkers and mental health is mixed. For instance, Souza-Teodoro et al. (2016), who used ELSA data to examine the link between DHEA-S and the commencement of depression, reported that higher levels of DHEA-S, which is a neuroendocrine biomarker, shield against the commencement of depression. This aligns with Piotrowski et al. (2020), who calculated their allostatic load index and scored DHEA-S values below the 25th percentile one. On the other hand, Nikkheslat et al. (2018) suggest that higher neuroendocrine biomarkers are linked with major depressive disorder. Meanwhile, Wiley et al. (2017) report that dehydroepiandrosterone sulphate and epinephrine did not load significantly to the allostatic load index.

Evidence suggests that DHEA-S is not correlated with health in the same direction as other neuroendocrine biomarkers, as demonstrated by Piotrowski et al. (2020), who used cortisol and DHEA-S to measure the neuroendocrine system. Piotrowski et al. (2020) scored DHEA-S values below the 25th percentile one but not cortisol. These mixed findings could be due to several reasons, including individual differences such as genes. Demkow & Wolańczyk (2017) suggest that genes impact the link between biomarkers and mental health as genes can influence how individuals respond to risk factors.

Covariates and their association with mental health

The covariate structure and associations vary in the dataset used in this chapter as some factors associated with mental health in the same way across the datasets while others did not.

Gender

In the four datasets and concerning all the biological systems, females have higher odds of having poor mental health compared to males. These results are in line with the literature. As an illustration, Riecher-Rössler (2017) suggest that poor mental health is higher in females than males.

Age

Overall, in ELSA and UKHLS, an increase in age reduced the odds of having poor mental health. This association is similar across the different biological systems. This picture is different to the literature as there are opposing results. For example, González-Sanguino et al. (2020) report that ageing is linked to better mental health. On the other hand, Chen et al. (2022) suggest that the link between age and mental health is curvilinear. They stated that the link was negative in the younger participants, insignificant in the middle-aged participants and positive in participants above 70 years. This irregularity in age indicates that public health interventions also need to be purposely designed for each age group.

Educational attainment

In ELSA, NCDS and BCS70, higher education was linked to better mental health regardless of the biological system, but in UKHLS, the education results were not statistically significant. These results could be because educational attainment is not steadily beneficial across all biological systems. For instance, Stephens et al. (2020)

report that higher educational attainment was not consistently advantageous across all metabolic biomarkers. Also, Lara & Amigo (2018) suggest that low educational attainment was linked with poorer lipid biomarker profiles in females but better lipid biomarker profiles in males. These results highlight the complexity of the association between education and biomarkers.

Marital status

Marriage or partnership was linked to better mental health and biological systems in the four datasets used in this chapter. These results are unsurprising as evidence in the literature has consistently associated marriage or partnership with better health and health indicators (Ploubidis et al., 2015).

Health behaviour

In ELSA, UKHLS, NCDS and BCS70, smoking increases the odds of having poor mental health and physical activity decreases the odds of having poor mental health regardless of the biological system. On the other hand, alcohol intake reduces the odds of having poor mental health in ELSA, NCDS and BCS70 but increases it in UKHLS. These results support the evidence on the link between health behaviour and mental health. Loprinzi (2013) states that engaging in physical activity reduces the risk of depression. Similarly, Hautekiet et al. (2022) propose that a healthy lifestyle is linked to better mental health. However, this relation is not straightforward, as evidence suggests that alcohol can have both positive and negative impacts on mental health depending on the type of alcohol, the amount consumed and the social context (Ho et al., 2014).

It is important to note here that the link between allostatic load, mental health and health behaviours is complicated. This study considered health behaviours as confounders in the relationship between allostatic load and mental health. However, some studies have judged health behaviour as a mediator as they proposed that unhealthy behaviour directly contributes to allostatic load (Suvarna et al., 2020). Mokdad et al. (2004) and Adler and Stewart (2010) highlighted health behaviours as a pathway linking social factors to biological processes. They suggested that social factors greatly influence health behaviours, including smoking, alcohol consumption and physical activity, which in turn impact biological processes resulting in adverse health outcomes.

Based on the analysis conducted in this thesis, the author cannot ascertain with certainty that lifestyle factors are confounders or mediators. However, this thesis chose lifestyle factors as confounders mainly for two reasons. First, lifestyle factors relate to allostatic load and mental health (Kraft & Kraft, 2021; Walsh et al., 2013). Finally, this thesis did not conduct a longitudinal analysis and, as such, could not do a mediation analysis. Researchers are encouraged to use longitudinal data in mediation analysis as temporal dynamics provide better insights (Berli et al., 2021). However, this study must acknowledge that using lifestyle factors as confounders could be a limitation, as other studies have considered health behaviours as mediators (Kim et al., 2020).

Results when both indicators of social position education and occupation are in the same Model

This chapter examined the association between allostatic load and mental health. However, given that in Chapter Two, after adjusting for occupation, educational attainment as an indicator of social position was no longer linked to mental health, this chapter investigated if the link between allostatic load and mental health will change if both educational attainment and occupation are controlled for in the models. Results indicate that the main associations between each biological system and mental health were consistent after controlling for both education and occupation in the models in all datasets except NCDS. In NCDS, models adjusted for education and not occupation show that each additional metabolic and neuroendocrine factor score decreases the odds of poor mental health after controlling for covariates. But, the results are not statistically significant.

However, in models that adjusted for educational attainment and occupation, each additional metabolic and neuroendocrine factor score increased the odds of having poor mental health after controlling for covariates. But, the results are not statistically significant. This change in the direction of NCDS was unexpected and unexplainable. Nonetheless, the change in the results of the metabolic factor scores now aligns with the results of the other datasets. These results suggest that education and occupation are separately linked with mental health, and their impact on the link between allostatic load and mental health depends on the dataset used.

Strengths and limitations

The results from this study have some strengths and limitations. These results suggest that the main findings of this chapter are that some components of allostatic load, such as lipid and iron factors, were not associated with mental health. This chapter's findings are meaningful and add to the literature on allostatic load and mental health as they provide insights into allostatic load components that are less useful in examining inequalities in mental health. The chapter used four datasets representing the UK population with a combined sample of over twenty-five thousand participants, ensuring statistical power.

However, the cross-sectional nature of this study means that the observed associations between allostatic load and mental health represent only a snapshot of a one-time point. They cannot determine the temporal association between allostatic load and mental health. Also, most participants are White, and the results do not represent ethnic minorities. In addition, this thesis looked at each of the studies separately and did not perform a meta-analysis of the results, which I would like to do as a next step for these analyses.

Conclusion

Overall, the findings from Chapter Three suggest that some components of allostatic load, such as lipid and iron factors, were not associated with mental health and do not contribute to inequalities in mental health. Consequently, an allostatic load index with these components represented is unlikely to provide insight into mental health. The results of this chapter support the hypothesis that females are at higher risk of developing poor mental health than males because in the four datasets and concerning all the biological systems, females had higher odds of having poor mental health compared to males. Also, the younger population are at increased risk of developing poor mental health compared to the older population. Generally, individuals engaged in unhealthy behaviours are at higher risk of having poor mental health. This chapter's findings highlight the need for targeted policies and interventions to tackle mental health inequalities.

Chapter four

Key findings in Chapters Two and Three

Chapter Two examined the association between social position and mental health using occupation and education as measures of social position. Overall, both indicators of social position support the idea that a disadvantaged social position is associated with a higher risk of poor mental health when examined separately. Nonetheless, only the link with occupation persists when examined concurrently. With occupation as an indicator of social position, after adjusting for covariates, the results in UKHLS were not statistically significant, and partly, they were not statistically significant in NCDS and BCS70. Nonetheless, the direction of association was similar across the four datasets regardless of the indicator used.

Chapter Three examined the association between allostatic load and mental health. Overall, the findings from Chapter Three suggest that some components of allostatic load, such as lipid and iron factors, were not associated with mental health. The direction of association of Chapter Two and Three results are shown in Table 4.1 below.

Table 4. 1: The direction of association of the results of Chapter Two and Chapter Three

Variables	**Datasets**			
	ELSA	**UKHLS**	**NCDS**	**BCS70**
Social position and mental health using occupation as a measure of social position				
Occupation class				
Unadjusted	⇩	⇩	⇩	⇩
+gender, age, education	⇩	⇩	⇩	⇩
+marital status	⇩	⇩	⇩	⇩
+health behaviours	⇩	⇩	⇩	⇩
Social position and mental health using education as a measure of social position				
Educational attainment				
Unadjusted	⇩	⇩	⇩	⇩
+gender, age, education	⇩	⇩	⇩	⇩
+marital status	⇩	⇩	⇩	⇩
+health behaviours	⇩	⇩	⇩	⇩
Allostatic load and mental health using education as a measure of social position				

Variables	Datasets			
	ELSA	UKHLS	NCDS	BCS70
Metabolic factor scores				
Unadjusted	⬆	⬇	⇩	⇧
+gender, age, education	⬆	⇧	⇩	⇧
+marital status	⬆	⇧	⇩	⇧
+health behaviours	⬆	⇧	⇩	⇧
Lipid factor scores				
Unadjusted	⇩	⇩	⇧	⬆
+gender, age, education	⬇	⇧	⇧	⇧
+marital status	⬇	⬆	⇧	⇧
+health behaviours	⇧	⇧	⇧	⇧
Inflammatory factor scores				
Unadjusted	⬆	⬆	⬇	⇧
+gender, age, education	⬆	⇧	⬇	⇧
+marital status	⬆	⇧	⬇	⇧
+health behaviours	⬆	⇧	⬇	⇧
Iron factor scores				
Unadjusted	⬇	⬇		
+gender, age, education	⇩	⇩		
+marital status	⇩	Odds ratio 1		
+health behaviours	⇩	Odds ratio 1		
Glucose meatbolism factor scores				
Unadjusted	⬇			
+gender, age, education	⬇			
+marital status	⬇			
+health behaviour	⇩			
Cardiovascular factor scores				
Unadjusted	⬆	⬆	⇧	⇧
+gender, age, education	⇧	⇧	⇧	⇧
+marital status	⇧	⬆	⇧	⇧
+health behaviours	⇧	⬆	⇧	⇧
Neuroendocrine factor scores				
Unadjusted	⬇	⬇	Odds ratio 1	
+gender, age, education	⬇	⬇	Odds ratio 1	
+marital status	⬇	⬇	⇩	
+health behaviours	⬇	⬇	⇩	

Social position and mental health

⬇ Less odds of having poor mental health in a more advantaged social position.

⇩ Less odds of having poor mental health in more advantaged social positions, but results are mostly not statistically significant.

⬆ More odds of having poor mental health in a more advantaged social position.

⇧ More odds of having poor mental health in more advantaged social positions, but results are mostly not statistically significant.

Allostatic load and mental health

Less odds of having poor mental health with each additional factor score.

Less odds of having poor mental health with each additional factor score, but the results are not statistically significant.

More odds of having poor mental health with each additional factor score.

More odds of having poor mental health with each additional factor score, but the results are not statistically significant.

The original conceptual framework has been modified to reflect results from Chapter Three, as shown in Figure 4.1.

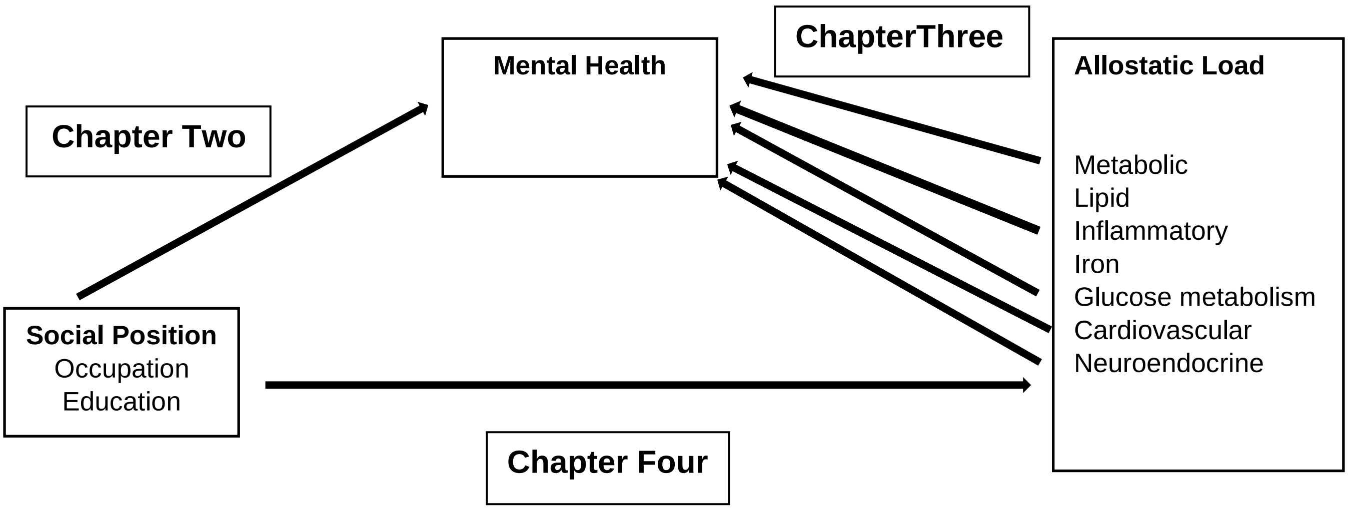


Figure 4. 1: Modified Conceptual Model of this study (Chapter Four)

Introduction

We know a disadvantaged social position is associated with poorer health (Johnson et al., 2017). One notion explaining this association lies in the connection between disadvantaged social position and chronic stress (Baum et al., 1999; Gruenewald et al., 2012). Chronic stress causes a weathering on physiological functioning called allostatic load (McEwen & Stellar, 1993).

The allostatic load theory offers insight into the processes that impact health (Guidi et al., 2020). Earlier studies on the allostatic load used ten biomarkers. The initial four biomarkers are neuroendocrine, regarded as primary mediators because they are released as a direct response to a stressor during allostasis (Seeman et al., 2001). The other six biomarkers are considered secondary outcomes because they occur as impacts of the primary mediators (Seeman et al., 2001).

Earlier allostatic load studies adhered more to the initial allostatic load index, but with time, researchers excluded primary mediators and began to add more biomarkers to their allostatic load index (Whelan et al., 2021). This contributes to the current debate on allostatic load (Whelan et al., 2021), as some researchers call for including primary mediators in the allostatic load index. While other researchers do not think including primary biomarkers is necessary (Johnson et al., 2017; Piazza et al., 2010) as they argue that the initial allostatic load index was not considered the gold standard; instead, it was regarded as the initial effort to operationalise allostatic load (O'malley et al., 2019).

The findings from the exploratory factor analysis in Chapter Three suggest that including primary mediators such as insulin-like growth factor 1, insulin-like growth factor 2, insulin-like growth factor 3, dehydroepiandrosterone sulphate and cortisol provided a more robust allostatic load factor structure. However, it did not change how biomarker variables load onto factors. This result suggests that it is best to include primary mediators, but not having them in a model does not invalidate the model. Therefore, this chapter contains neuroendocrine factor scores in its analyses.

This study now builds on the results of Chapters Two and Three by examining the association between social position and allostatic load. The chapter begins with a literature review on social position and allostatic load.

Literature review on social position and allostatic load

Chapter Four aims to examine the association between social position and allostatic load. As a result, a critical review of the literature on social position and allostatic load is required. The literature review summarises earlier research in the subject area to identify gaps in the literature (Booth et al., 2016). Johnson et al. (2017) conducted a systematic review of the literature on allostatic load and social and economic position in 2017 and concluded that the allostatic load literature did not adhere to its theoretical underpinnings by not including primary mediators. Therefore, this study reviewed articles on social position and allostatic load published between 2017 and 2023 to understand whether this remains true.

Search strategy and study selection

This study searched Medline with full text, Pubmed, Web of Science, APA PsycInfo, APA PsycArticles, ProQuest, CINAHL Complete, Ovid, Scopus, SAGE Journals and the Cochrane Library. This study limited the articles reviewed here to peer-reviewed articles on humans published between 2017 and 2023, which focussed on the link between social position as the independent variable and allostatic load as the dependent variable to ensure the studies reviewed were pertinent to the research interest. Search terms included "Social position", “Socioeconomic status”, “Social status”, "allostatic load", and "Physiological dysregulation". Boolean operators such as "AND" were used. The study also searched the literature using Google, and articles were scrutinised for studies that were not already recognised. This study initially screened titles and abstracts, and then studies with full text were further scrutinised to select the relevant publications.

Search results

This study reviewed sixteen studies investigating the relationship between social position and allostatic load. Most of the studies (Christensen et al., 2018; Graves & Nowakowski, 2017; Gugushvili et al., 2021; McCrory et al., 2019; Podber & Gruenewald, 2023; Prior, 2021; Richards et al., 2023; Richardson et al., 2021; Sims & Coley, 2019; Whitley et al., 2022) used longitudinal design. About 31% of the studies (Ding et al., 2019; Geronimus et al., 2020; Mao et al., 2019; Rodriquez et al., 2019; Veronesi et al., 2020) used a cross-sectional design and one study (Xu, 2018) used a cross-sectional and time-lagged design. About 50% (8) of the studies were done in the US, 25% (4) in the UK, two studies in China, one study in Denmark and the remaining one study in Europe.

The biomarkers used to calculate the allostatic load scores ranged from five to twenty-four. About 50% of the studies used the quartile cutoffs to determine the biomarker risk cutoff point. The remaining 50% of the studies used either the mean of the risk values within respective systems, gender and age-specific risk cutoffs, z-scores, count-based summary method, clinical risk cutoffs, quintile cutoffs or sample-based risk cutoffs to determine biomarker risk cutoff points. Just over 37% (6) of the studies included neuroendocrine biomarkers in their allostatic load scores. All the studies reviewed showed a link between social position and allostatic load, but there were ethnic differences. Overall, the articles reviewed here were of moderate to high quality.

Table 4. 2: Literature on social position and allostatic load

Table 4.2: Literature on social position and allostatic load						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**The measure of social position**	**Number of biomarkers**	**Main findings**
Podber & Gruenewald (2023)	The Midlife Development in the United States	2096	Longitudinal study	Five indicators of adult socioeconomic status, namely educational attainment, current financial level, sufficient money to meet basic needs, difficulty paying bills and household-adjusted income-to-poverty ratio, were added to form a composite indicator of cumulative socioeconomic status.	Twenty-four biomarkers. A risk ratio score was computed for the seven systems using the mean of the risk values within the respective systems.	Higher cumulative socioeconomic status was connected to lower allostatic load, and positive experiences weakly mediate this connection.
Richards et al. (2023)	The English Longitudinal Study of Ageing (ELSA)	4505	Longitudinal study	Subjective social status	Nine biomarkers. If available, the authors used the clinical risk cutoff point and the high-risk quartile for those without a clinical risk cutoff point.	Higher subjective social status was linked to lower allostatic load between participants but not within participants over time.
Whitley et al. (2022)	The Understanding Society, the UK Household Longitudinal Study (UKHLS)	Biomarker sample (5003)	Longitudinal study	Three social class mechanisms, namely Bourdieusian (includes parental occupation, parental education and the age at which the participant left school). Marxist (includes dancing, singing, reading for pleasure). Weberian	Eleven biomarkers. Whitley et al. 2022 used risk cutoffs based on gender and age.	Advantaged social position, according to all indicators of social position, was associated with better mental health and lower allostatic load.

Table 4.2: Literature on social position and allostatic load						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**The measure of social position**	**Number of biomarkers**	**Main findings**
				(includes own educational attainment, income and occupation).		
Prior (2021)	The British Household Panel Survey (BHPS) and the Understanding Society the UK Household Longitudinal Study (UKHLS)	3210	Longitudinal study	Neighbourhood disadvantage exposure histories constructed using the Townsend deprivation scores	Thirteen biomarkers. Prior 2021 determined biomarker risk cutoffs based on the sample. The lowest quartile (<25th percentile) is the risk cutoffs for DHEA-S, HDL cholesterol and albumin and the high-risk quartiles (>75th percentile) are for the other biomarkers.	Exposure to higher disadvantage over time is connected to higher allostatic load.
Gugushvili et al. (2021)	The National Longitudinal Study of Adolescent Health (Add Health)	4713	Longitudinal study	Used educational and occupational attainment to create a socioeconomic position index	Seven biomarkers. Gugushvili et al. 2021 used z-scores of mean allostatic load score.	Higher socioeconomic position and upward mobility were linked to lower allostatic load scores.
Saneei et al. (2016)	The National Longitudinal Study of Adolescent to Adult Health	11807 (5671/6136)	Longitudinal study	Educational attainment and race	Ten biomarkers. The authors determined biomarker risk cutoffs based on the sample. The highest quartiles (>80th percentile) for triglycerides and total cholesterol (<20th percentile) for high-density lipoprotein	Black women had higher allostatic load than Black, White, and Mexican men and White and Mexican women. However, black men with higher educational attainment had higher allostatic load

Table 4.2: Literature on social position and allostatic load

Author(s)	Data	Participants (Male/Female)	Type of study	The measure of social position	Number of biomarkers	Main findings
					(HDL) cholesterol and (>75th) for the other biomarkers.	than black men with no education.
Geronimus et al. (2020)	The Healthy Environments Partnership and the National Health and Nutrition Examination Survey Detroit, Michigan	Healthy Environments Partnership (205) and National Health and Nutrition Examination Survey (1447)	Cross-sectional study	Poverty-to-income ratio	Fourteen biomarkers. Geronimus et al. 2020 determined risk using two methods, namely the count-based summary method and a binary allostatic load score.	A disadvantaged social position was connected to higher levels of allostatic load. Disadvantaged White and Mexican participants in Detroit had a greater allostatic load in comparison to their equivalent nationally. In contrast, Black individuals in both Detroit and nationally have identical levels of allostatic load.
Veronesi et al. (2020)	The Biomarker for Cardiovascular Risk Assessment in Europe consortium and in the MONICA Risk Genetics Archiving and Monograph project	53757 (27019/26738)	Cross-sectional study	Education	Eight biomarkers. Veronesi et al. 2020 calculated the allostatic load scores using the summed Z-scores of the eight biomarkers.	Higher mean allostatic load scores were associated with lower educational attainment, consistent in all three biological systems.

Table 4.2: Literature on social position and allostatic load

Author(s)	Data	Participants (Male/Female)	Type of study	The measure of social position	Number of biomarkers	Main findings
Sims & Coley (2019)	The National Longitudinal Study of Adolescent Health	12672 (6301/6371)	Longitudinal study	Participants' educational attainment and composite family socioeconomic status were created using family income, parental educational achievement, and parental job prestige.	Five biomarkers. The authors used clinical risk cutoffs for systolic and diastolic blood pressures, BMI, and C-reactive protein. The top risk quartile (>75th) based on sample distribution was used for Epstein-Barr Virus as it does not have a clinical risk cutoff point.	Higher educational attainment was connected with lower allostatic load. However, these connections differed across race but not across the composite family socioeconomic status.
Rodriquez et al. (2019)	The National Survey of Midlife Development in the United States	1190 (518/672)	Cross-sectional study	Education and household-adjusted poverty-to-income ratio and three subjective measures include current financial situation, having money to meet basic needs and paying bills.	Twenty-four biomarkers. Seven indices of biological risk were created for the biomarkers used to calculate the allostatic load score. Biomarker risk was calculated using the proportion of each biological system that achieved high-risk quartile values (upper or lower quartile, determined by the biomarker). 0 means no biological system achieved a high-risk quartile, and one means all no biological systems achieved a high-risk quartile. Scores were added,	Lower allostatic load was linked to higher social classes regardless of the measure used.

Table 4.2: Literature on social position and allostatic load						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**The measure of social position**	**Number of biomarkers**	**Main findings**
					and they ranged from 0 to seven.	
Ding et al. (2019)	The Health and Retirement Study	3935	Cross-sectional study	Educational attainment is measured using polygenic scores.	Nine biomarkers. Clinical risk cutoff points were used to determine biomarker risk cutoff points.	Higher educational attainment was linked with lower allostatic load scores.
McCrory et al. (2019)	The Irish Longitudinal Study on Ageing	490 (244/246)	Longitudinal study	Occupation, education and income	Fourteen biomarkers Biomarkers risk was determined using sex-specific quartiles of risk.	Lower socioeconomic position was linked with higher allostatic load regardless of the indicator of adult socioeconomic position used but there was no significant link between childhood socioeconomic position and allostatic load.
Mao et al. (2019)	The China Chronic Disease and Risk Factors Surveillance	96466 (44108/52358)	Cross-sectional study	Individual educational attainment and area-level educational attainment	Nine biomarkers. First, clinical risk cutoffs were used to determine biomarker risk cutoffs. Second, Quartile cutoffs (below <25th for HDL and >75th for other biomarkers). Lastly, quintile cutoffs (<20th for HDL and >80th for other biomarkers). The	Lower personal educational attainment was linked to a higher allostatic load. However, they also found higher allostatic load among individuals living in counties with higher levels of educational

Table 4.2: Literature on social position and allostatic load						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**The measure of social position**	**Number of biomarkers**	**Main findings**
					scores were added, and they ranged from 0 to nine.	attainment. These results were consistent across the three measures of allostatic load scores.
Xu (2018)	The 2009 wave of the China Health and Nutrition Survey	7857	Cross-sectional and time-lagged design	Individual- educational attainment and occupational. Household- annual household income. Community-level- an urbanization index.	Fifteen biomarkers. Xu 2018 determined biomarker risk cutoffs based on the sample.	Advantaged social position was linked to a higher allostatic load except for educational attainment.
Christensen et al. (2018)	Participants in the Copenhagen Perinatal Cohort who partook in two successive studies: the Prenatal Development Project and the Copenhagen Aging and Midlife Biobank study	361 (181/180)	Longitudinal study	Parental socioeconomic position at one year which was created using information on the occupation of the breadwinner, type of income of the breadwinner, education of the breadwinner and quality of living accommodation.	Fourteen biomarkers. The risk cutoffs were based on sex-specific sample distribution. Biomarkers' values at the 75th percentile or above, except for HDL, which was below the 25th percentile, received a score of 1, and scores were added to calculate the allostatic load scores.	Parental socioeconomic position was linked with lower allostatic load in midlife. And educational attainment was the only factor that partially mediated this link.
Graves & Nowakowski (2017)	The National Social Life, Health, and Aging Project	1365	Longitudinal study	Childhood socioeconomic status was measured using responses to the question, "*During the time from about age 6 to age 16, would you say your family was very well off financially, fairly well off, about average, not so*	Eight biomarkers. The risk cutoffs were determined using the quartile cutoffs based on the sample distribution. Biomarker values above the 75th quartile were scored 1,	Low childhood socioeconomic status was connected to a higher allostatic load in adulthood, but after adjusting for education, this

Table 4.2: Literature on social position and allostatic load						
Author(s)	**Data**	**Participants (Male/Female)**	**Type of study**	**The measure of social position**	**Number of biomarkers**	**Main findings**
				well off, or not well off at all?" Meanwhile, adulthood socioeconomic status was measured using educational attainment.	indicating high risk, except for DHEA-S, where values in the lower quartile (<25th) represented high risk. Biomarker values were then added, and scores ranged from 0 to 8.	connection disappeared.

Discussion

Operationalising social position

There were substantial differences in how the studies reviewed here operationalised social position. Educational attainment was the most common indicator used. One study Ding et al. (2019) used polygenic educational attainment scores, and another Mao et al (2019), used area-level educational attainment. Four studies (Christensen et al., 2018; Gugushvili et al., 2021; Podber & Gruenewald, 2023; Sims & Coley, 2019) used composite measures to operationalise social position. One study Richards et al. (2023) used subjective social status to measure social position. Most studies used logistic and linear regression analyses to assess connections. These differences in how social position has been operationalised have led to debates on which indicators to use (Diemer et al., 2013). Although there are differences in how social position was operationalised in the literature reviewed here, results have linked disadvantaged social positions to higher allostatic load regardless of the measure used.

Overall, a disadvantaged social position was linked to a higher allostatic load. However, there were differences along ethnic group lines. Sims & Coley (2019) report that White and Asian participants had less allostatic load than Black and Mexican participants living in the United States. Instead, Black and Mexican participants with higher educational qualifications had higher allostatic load than counterparts with lower educational attainment (Sims & Coley, 2019). A possible explanation for these results could be that endeavouring for higher educational qualifications in the face of social hindrances, such as racism experienced by Black and Mexican groups in America, creates biological dysregulation (Sims & Coley, 2019). Another possible explanation for these findings could be the disparity in the gains of education along racial lines, as

Day & Newburger (2002) suggest that Whites and Asians earn higher than Black and Latin American counterparts at similar levels of educational qualifications.

Childhood social position and allostatic load

Some studies (Christensen et al., 2018; Graves & Nowakowski, 2017; McCrory et al., 2019) suggest that higher childhood socioeconomic status was connected with lower allostatic load in adulthood, but participants' own educational attainment mediated this connection. These results indicate that educational attainment protects against biological dysfunction (Christensen et al., 2018) and buffers against childhood social disadvantage.

Operationalising allostatic load

The theme from the literature on social position and allostatic load reviewed in this study is that there was no standardised way of calculating the allostatic load scores. The biomarkers used to calculate the allostatic load scores across the sixteen articles reviewed here ranged from five biomarkers (Sims & Coley, 2019) to twenty-four biomarkers (Podber & Gruenewald, 2023; Rodriquez et al., 2019), and none aligned with the biomarkers used in the MacArthur study (Seeman et al., 2001).

Interestingly, over 37% of the sixteen studies reviewed here included neuroendocrine biomarkers (primary mediators) in their allostatic load scores. In comparison, less than 60% of the twenty-six studies reviewed by Johnson et al. (2017) included neuroendocrine biomarkers, suggesting that more recent studies are omitting neuroendocrine biomarkers in their allostatic load scores. These findings underscore the need for more studies with neuroendocrine biomarkers in their allostatic load scores. Findings in Chapter Three suggest that including neuroendocrine biomarkers did not significantly impact the allostatic load factor scores. However, the results were more robust, which could provide more nuanced insights into the associations between allostatic load and mental health and between social position and allostatic load.

Most studies used the summative count technique, z-scores or clinical risk cut-offs to operationalise allostatic load. However, no study used factor analysis, despite evidence suggesting that factor analysis could be a robust approach to measuring allostatic load (King et al., 2019). Furthermore, in Chapter Three, we observed that summative methods may serve to obscure associations. Therefore, this study operationalises allostatic load using factor analysis to fill this gap.

Conclusion

In conclusion, there were substantial differences in how the studies reviewed here operationalised social position. Educational attainment was the most common indicator used. However, regardless of the indicator of social position used, findings from the literature reviewed suggest that a disadvantaged social position is linked to a higher allostatic load.

The biomarkers used to calculate the allostatic load scores across the sixteen articles reviewed here ranged from five (Sims & Coley, 2019) to twenty-four (Podber & Gruenewald, 2023). There was no standardised way of calculating the allostatic load scores. Furthermore, no study used factor analysis, despite evidence suggesting that factor analysis could be a robust approach to measuring allostatic load (King et al., 2019). Therefore, this study operationalises allostatic load using factor analysis to fill this gap. This study will now examine the link between the indicators of social position and allostatic load.

The current study

Methods

Datasets

We used four datasets from the UK, including ELSA waves 4, UKHLS, NCDS, and BCS70. A description of these datasets is in Chapter One. The results of the exploratory factor analysis conducted in Chapter Three suggest that allostatic load consists of various factors representing multiple systems, including the metabolic, lipid, cardiovascular, inflammatory, iron, glucose metabolism and neuroendocrine systems. As highlighted earlier, BCS70 does not contain neuroendocrine factor scores. This study hypothesised that social position is associated with allostatic load.

Measures

The dependent variable, allostatic load and the independent variables, educational attainment and occupation, have been described above. In all datasets used to examine the association between social position and allostatic load, this study adjusted for gender and age groups (but not in NCDS and BCS70, as participants are of similar age groups), marital status, smoking status, alcohol consumption and physical activity. These covariates have been described above.

Measurement of Social Class

In this chapter, educational attainment and occupation are the indicators of social position.

Analysis approach

In Chapter Three, EFA was conducted to determine the number of factors to extract, and factor loadings above 0.3 were acceptable (Finch, 2020). Factor rotation was done to enable a better interpretation of the factors retained (Field, 2000). Allostatic load theory encompasses multisystem dysfunction that is interlinked nonlinearly (Rodriquez et al., 2019), so oblique promax rotation was done because the factors are correlated (Finch, 2020). The biomarkers were loaded onto seven biological systems: cardiovascular, metabolic, lipid, inflammatory, iron, glucose metabolism and neuroendocrine.

After determining the number of factors to keep using exploratory factor analysis, this study did a two-step multigroup CFA using the MLR in Mplus8.6 (Muthén & Muthén, 2017) to confirm the factor structure of the biomarker variables (Kevin, 2015). First, the study ran a multigroup CFA; in some Models, some parameters were set to zero to enable analysis and achieve convergence. Upon achieving convergence, the last step of the multigroup CFA was performed. The residual correlation between variables with high modification indices was freed to improve model fit (Kevin, 2015). The MLR was used since the biomarker variables did not have a normal distribution (Kevin, 2015). Latent variables are unobserved and do not have a measurement scale (Kevin, 2015). By default, Mplus sets the first item on each factor to 1 (Kevin, 2015).

Analysis by Groups

After this study determined that differences in specific system biomarkers did not alter the allostatic load factor structure, the study carried out CFA on two groups per study. Group 1, containing neuroendocrine biomarkers, was referred to as Group A. Group 2 was called Group B and did not include neuroendocrine biomarkers. Groups A and B were developed to help answer the questions in this chapter.

Questions

What is the association between social position and allostatic load?

a. Does factor scores vary by social class within each study and across studies?

b. Does including primary mediators change the factor scores by social class?

c. Is the association independent of covariates?

For each study, factor scores were extracted for Group A and Group B. Generalised linear models were used to compare factor scores per biological system across the social class classifications and within and across the studies, except for BCS70 where factor scores were extracted for only Group B because it did not have Group A.

Fit indices

CFA was evaluated for exact fit and approximate fit using the CFI, TLI, RMSEA, and SRMR in line with (Kevin, 2015). It was determined that the fit of the Models ranged between poor and good. The CFA conducted in this study meets the model identification criteria because there are at least two items for each factor, and the sample size is large (Kevin, 2015).

Results

Confirmatory factor analysis: Fit indices

Table 4. 3: Fit indices for the Models with neuroendocrine biomarkers (Group A)

Model	X^2	df	RMSEA	CFI	TLI	SRMR
Model 1	5810.774	1192	0.065	0.904	0.889	0.074
Model 2	2300.472	511	0.051	0.950	0.942	0.058
Model 3	16403.710	742	0.148	0.715	0.685	0.073

Table 4.3 shows the fit indices for Group A, the models with neuroendocrine biomarkers. Model 1 is ELSA wave 4, Model 2 is UKHLS and Model 3 is NCDS. Table 4.3 suggests that all Models indicate a sensible fit but not an absolute fit to the data. Chi-square is significant in all Models, but this is not surprising because each Model has a reasonably large sample size, which will almost always make chi-square significant (Kevin, 2015).

Model 3 did not meet the acceptable criteria for the RMSEA, as its RMSEA was above 0.08 (Kevin 2015). In all models, the CFI and TLI did not meet the acceptable cutoff of 0.95 (Kevin, 2015), except for Model 2 (CFI: 0.950). All Models have an SRMR below 0.08. The fit indices for the Models in Group A indicate that the fit of the Models to the data ranged between poor and good.

Table 4. 4: Fit indices for the Models without neuroendocrine biomarkers (Group B)

Model	X^2	df	RMSEA	CFI	TLI	SRMR
Model 1	4924.576	953	0.067	0.914	0.903	0.073
Model 2	967.702	308	0.040	0.979	0.973	0.046
Model 3	15954.225	556	0.170	0.703	0.683	0.070
Model 4	668.327	183	0.071	0.951	0.940	0.041

Table 4.4 shows the fit indices for Models 1 to 4, which do not contain neuroendocrine biomarkers. Model 1 is ELSA wave 4. Model 2 is UKHLS. Model 3 is NCDS, and Model 4 is BCS70. Table 4.4 suggests that all Models indicate a sensible fit but not an absolute fit to the data. Chi-square is significant in all Models, but this is not surprising because each Model has a reasonably large sample size, which will almost always make chi-square significant (Kevin, 2015). Model 3 did not meet the acceptable criteria for the RMSEA, as its RMSEA was above 0.08 (Kevin, 2015). The CFI and TLI in Model 2 and the CFI in Model 4 were above the cutoff of 0.95 (Kevin, 2015). The TLI in Model 4 and the CFI and the TLI in Models 1 and 3 did not meet the acceptable cutoff of 0.95 (Kevin, 2015). All Models have an SRMR below 0.08. The fit indices for Models 1 to 4 suggest that the fit of the Models to the data ranged between poor and good.

Characteristics of variables by datasets and the factors by datasets

The characteristics of variables by datasets and the factors by datasets are similar to the ones in Chapter Three; therefore, to avoid repetition, refer to Chapter Three.

Factor scores by the biological system and by social position

Figures 4.2 to 4.53 show the factor scores per biological system by social class groups for the datasets within Group A (containing neuroendocrine markers) and Group B (no neuroendocrine markers). Each dataset is indicated by the colour of the line next to it. For example, the orange line in Group A is ELSA wave 4. This study used ELSA, UKHLS, NCDS and BCS70 to examine if factor scores vary by social class within each study and across studies. And to investigate if including neuroendocrine biomarkers will change the factor scores by social class.

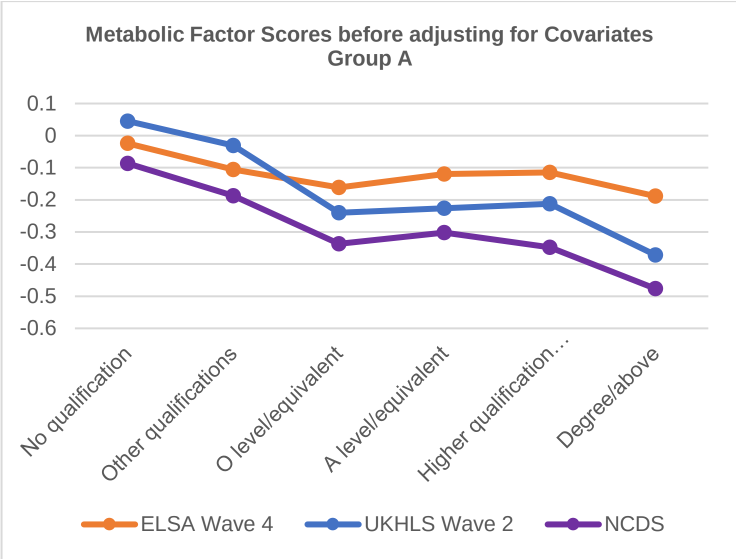


Figure 4. 2: (Education as a measure of social position)

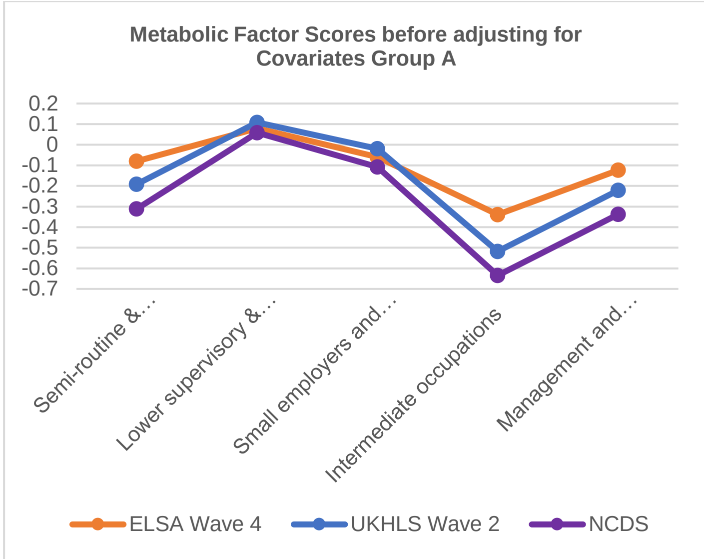


Figure 4. 3: (Occupation as a measure of social position)

Figure 4.2 shows the metabolic factor scores before adjusting for covariates for each study in Group A using education as an indicator of social position. Figure 4.3 shows the metabolic factor scores before adjusting for covariates for each study in Group A using occupation as an indicator of social position. In Figure 4.2, the metabolic factor scores are socially patterned. Participants without educational qualifications have the highest metabolic factor scores, and the patterns are similar across the studies. ELSA wave 4 appears to have the smallest differences between social class groups, and UKHLS appears to have the largest differences between social class groups. However, Figure 4.3 shows that these associations are less defined if occupation indicates social position. There is no BCS70 because Group A requires a neuroendocrine factor which BCS70 does not have.

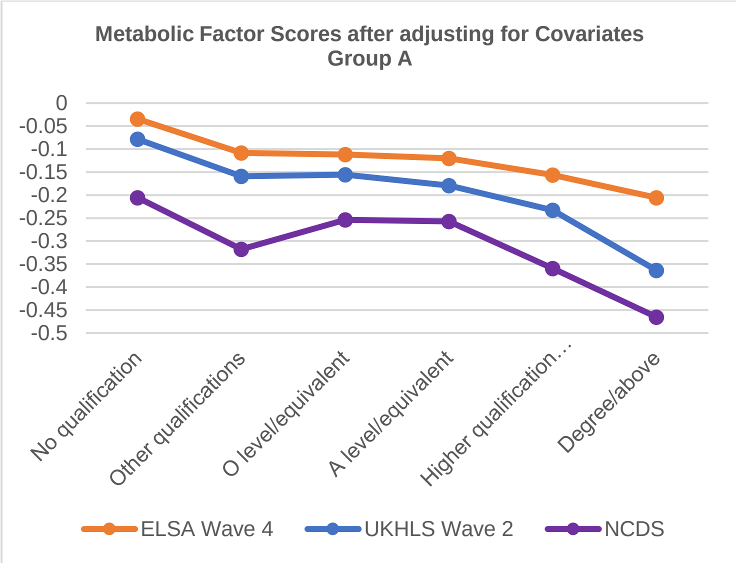


Figure 4. 4: (Education as a measure of social position)

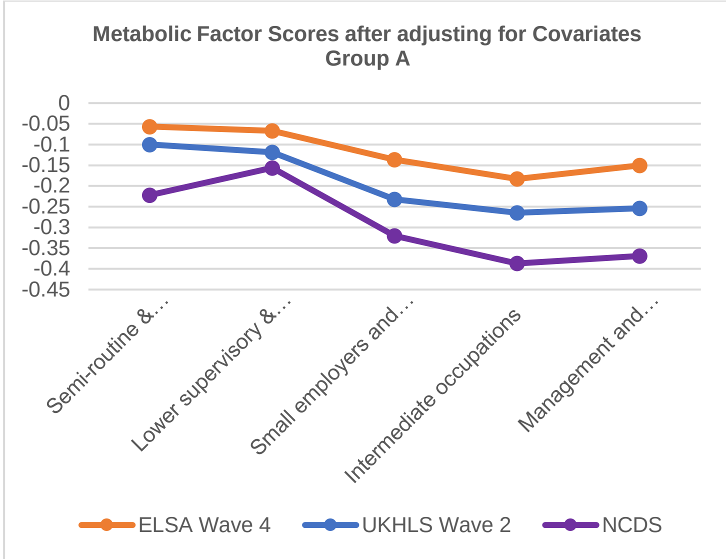


Figure 4. 5: (Occupation as a measure of social position)

Figure 4.4 shows the metabolic factor scores after adjusting for covariates for each study in Group A using education as an indicator of social position. Figure 4.5 shows the metabolic factor scores after adjusting for covariates for each study in Group A using occupation as an indicator of social position. Figure 4.4 illustrates that the link between social position and metabolic factor scores remains after adjusting for covariates. On the other hand, unlike Figure 4.3, Figure 4.5 displays a clearly defined social gradient with individuals from higher occupational groups having lower metabolic factor scores compared to those from lower occupational groups, meaning that covariates impact the link between occupation and metabolic factor scores.

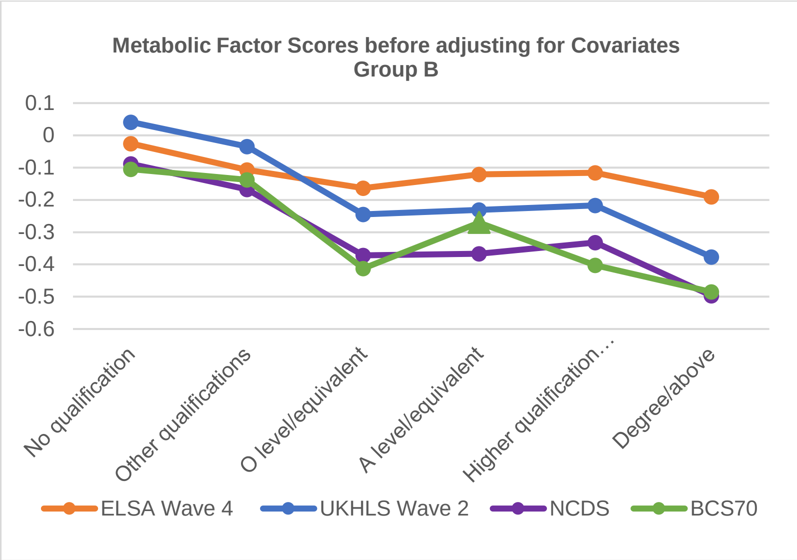


Figure 4. 6: (Education as a measure of social position)

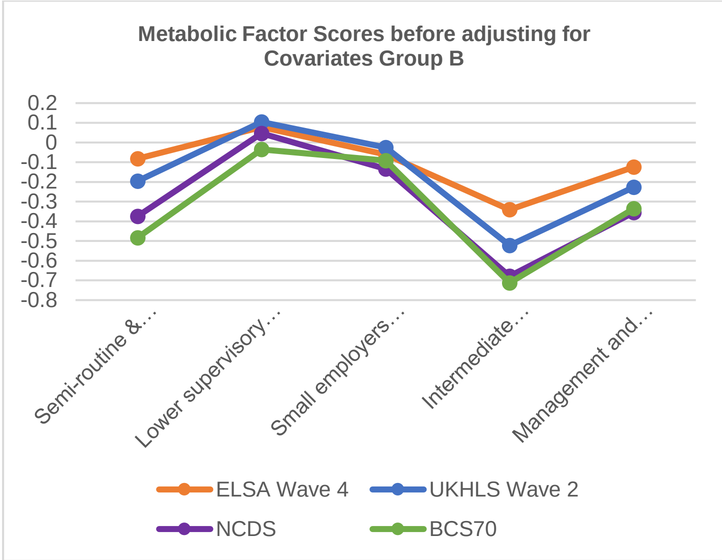


Figure 4. 7: (Occupation as a measure of social position)

Figures 4.6 and 4.7 show the metabolic factor scores for each study by social class in Group B before adjusting for covariates using education and occupation as measures of social position, respectively. The patterns are similar to Group A except for BCS70. Generally, in Figure 4.6, BCS70 shows a social gradient but deviates in those with A level or equivalent. The BCS70 results of the A level or equivalent in Figure 4.6 were insignificant, as indicated by a triangle.

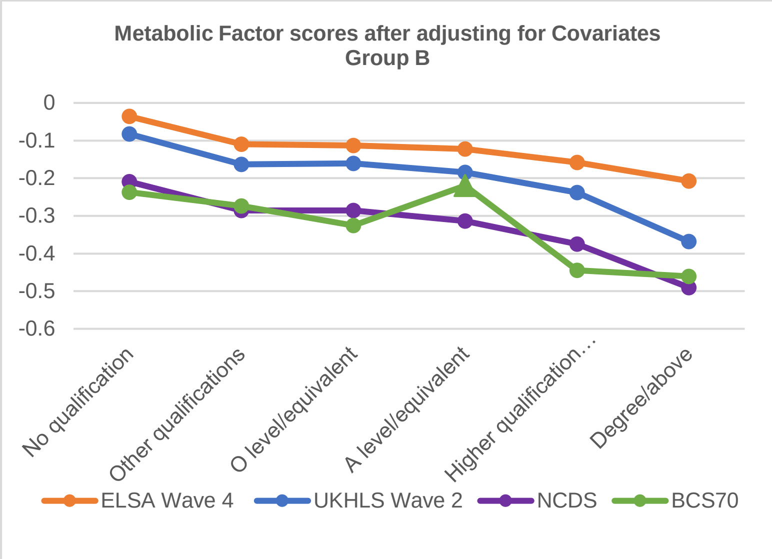


Figure 4. 8: (Education as a measure of social position)

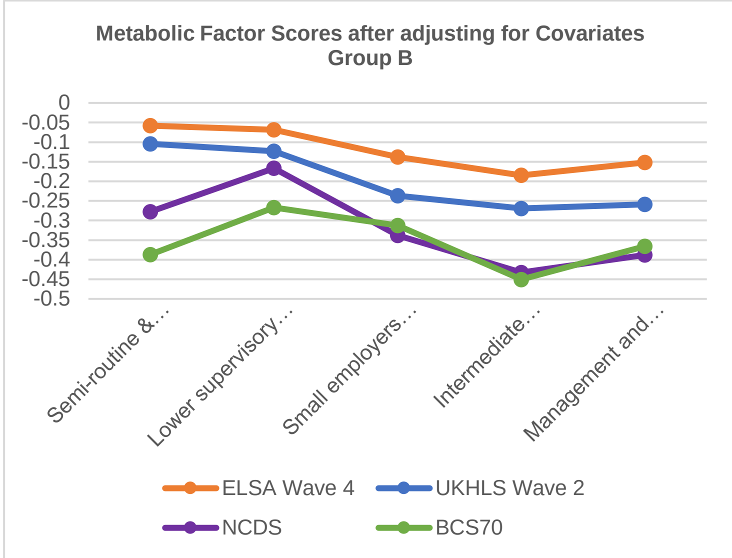


Figure 4. 9: (Occupation as a measure of social position)

Figures 4.8 and 4.9 show the metabolic factor scores for each study by social class in Group B after adjusting for covariates using education and occupation as measures of social position, respectively. The patterns are similar to those of Group A except for BCS70. Generally, BCS70 shows a social gradient but deviates in those with A level or equivalent. The BCS70 results of the A level or equivalent in Figure 4.8 were insignificant, as indicated by a triangle.

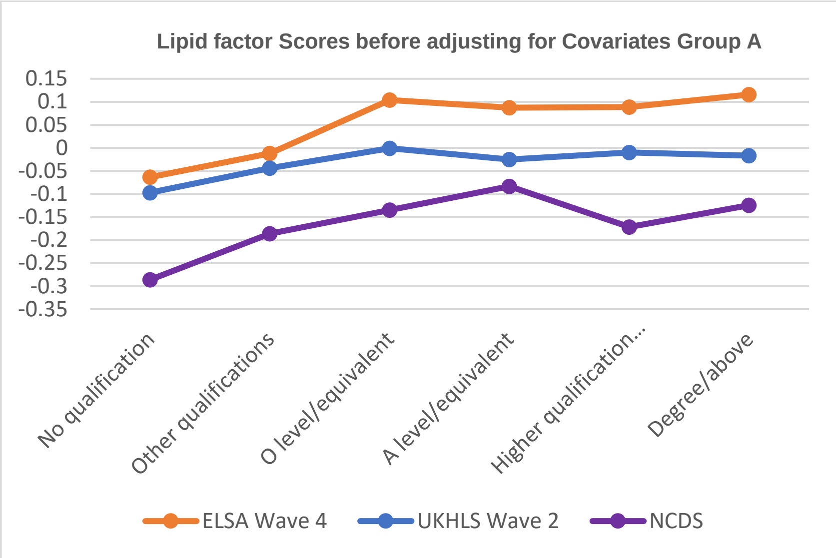


Figure 4. 10: (Education as a measure of social position)

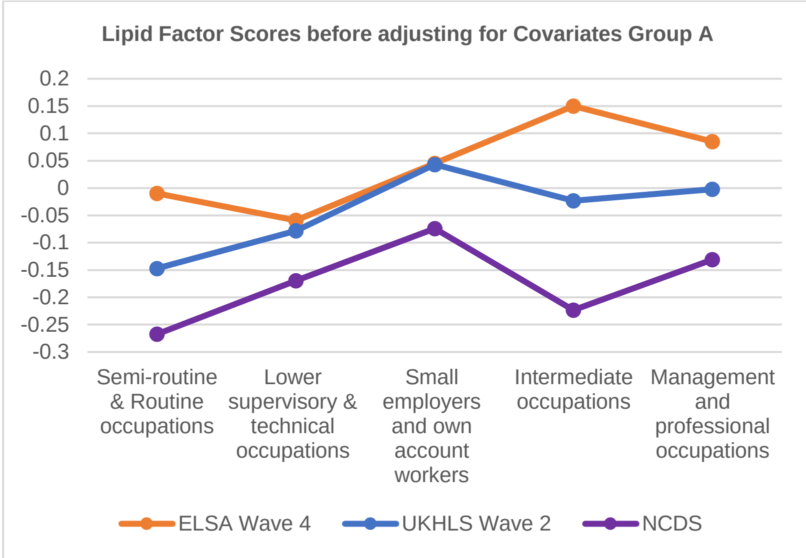


Figure 4. 11: (Occupation as a measure of social position)

Figures 4.10 and 4.11 show the lipid factor scores before adjusting for covariates for each study in Group A using educational attainment and occupation as indicators of social position, respectively. The lipid factor scores are socially patterned, but individuals from advantaged social positions have higher lipid factor scores across the studies.

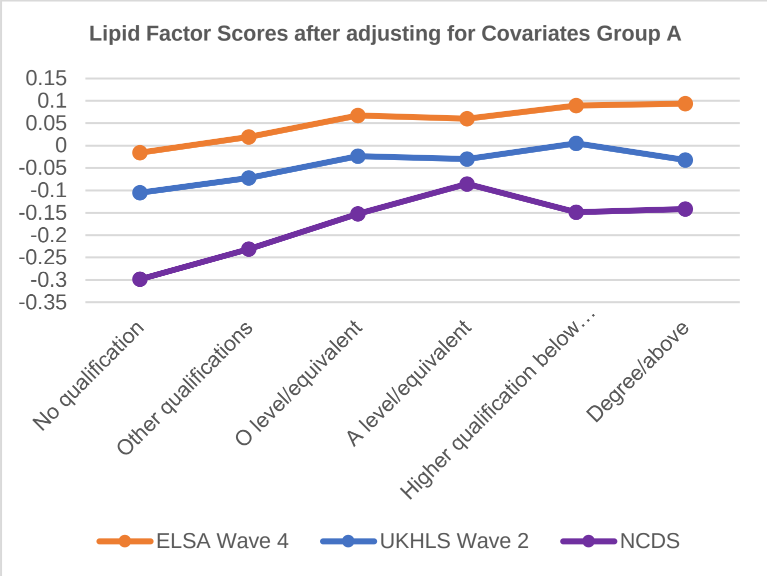


Figure 4. 12: (Education as a measure of social position)

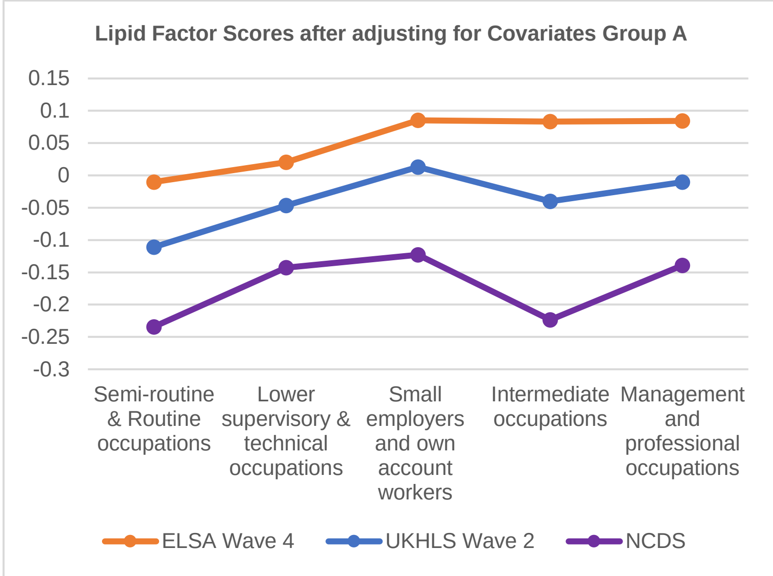


Figure 4. 13: (Occupation as a measure of social position)

Figures 4.12 and 4.13 show the lipid factor scores after adjusting for covariates for each study in Group A using education and occupation as indicators of social position, respectively. These patterns are similar to Figures 4.10 and 4.11, indicating that covariates had little impact on the link between social position and lipid factor scores.

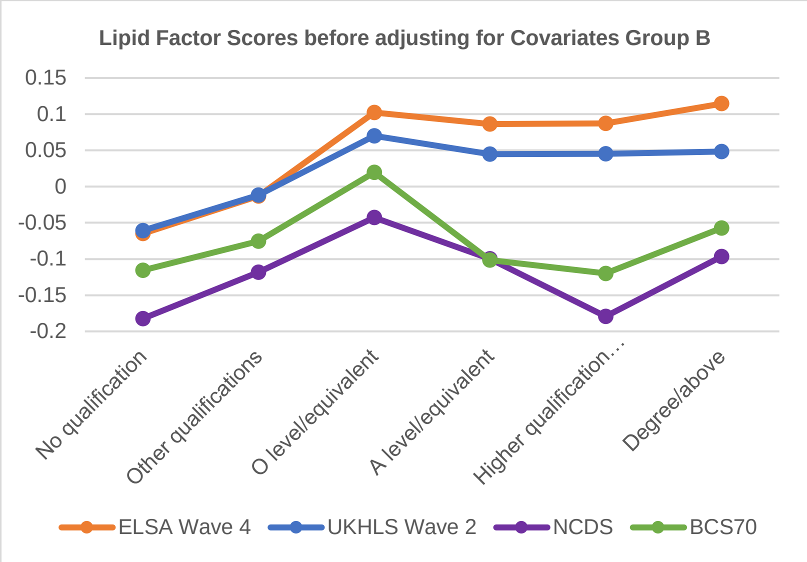


Figure 4. 14: (Education as a measure of social position)

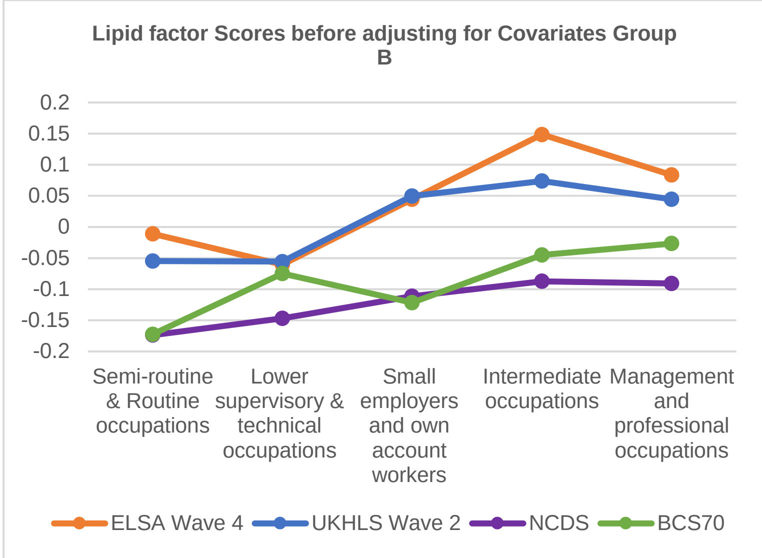


Figure 4. 15: (Occupation as a measure of social position)

Figures 4.14 and 4.15 show the lipid factor scores before adjusting for covariates for each study in Group B using education and occupation as indicators of social position, respectively. These patterns are similar to the patterns in Group A.

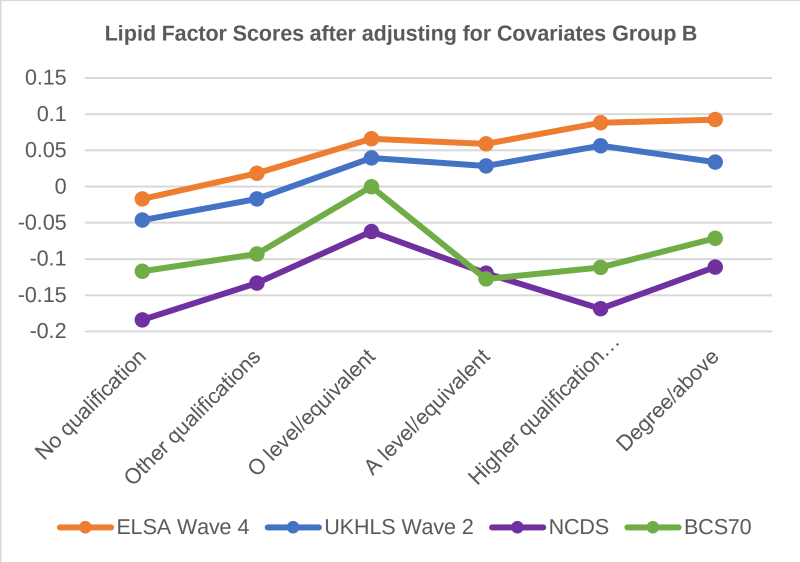


Figure 4. 16: (Education as a measure of social position)

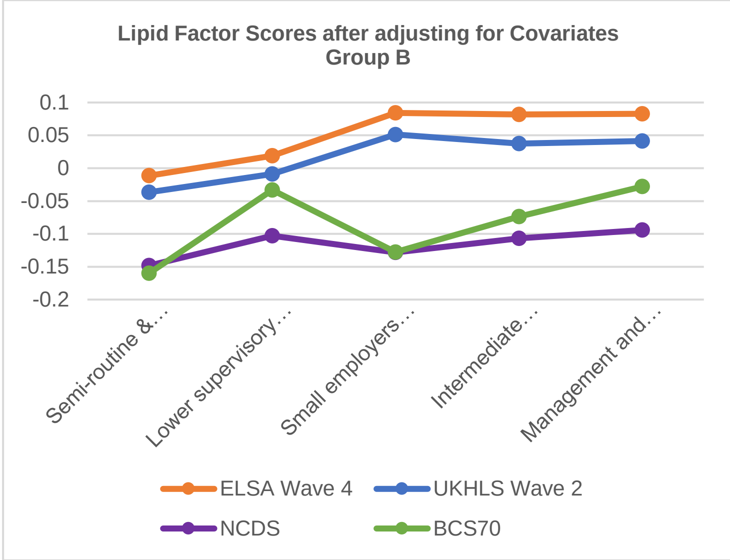


Figure 4. 17: (Occupation as a measure of social position)

Figures 4.16 and 4.17 show the lipid factor scores after adjusting for covariates for each study in Group B using education and occupation as indicators of social position, respectively. These patterns are similar to those in Group A and before adjusting for covariates in Group B.

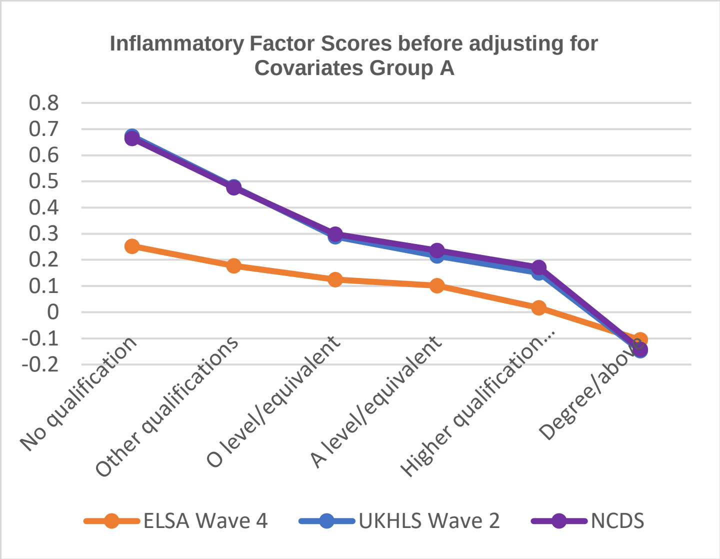


Figure 4. 18: (Education as a measure of social position)

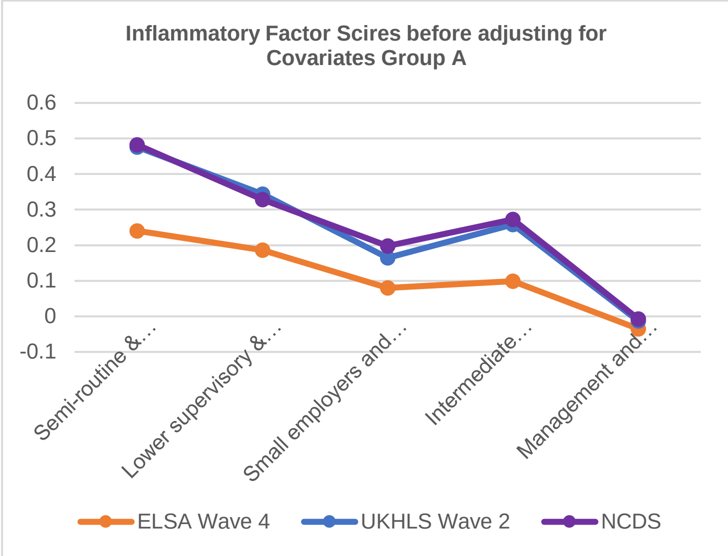
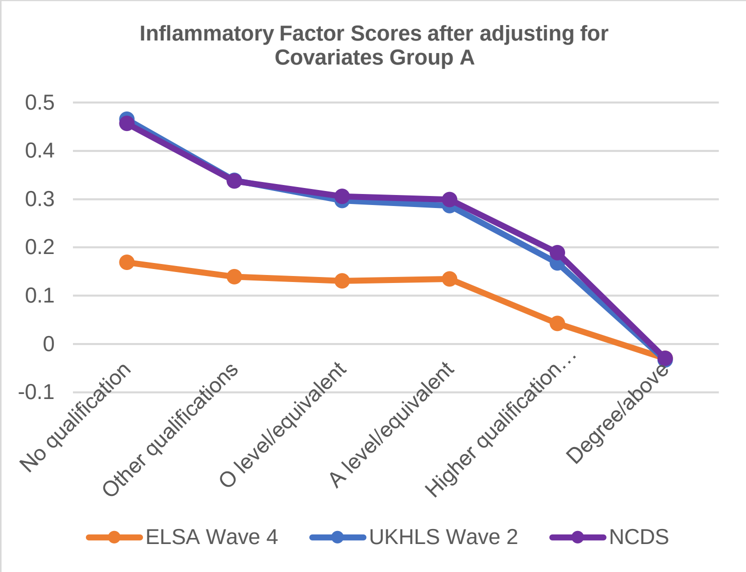


Figure 4. 19: (Occupation as a measure of social position)

Figures 4.18 and 4.19 have comparable outlines and show the inflammatory factor scores before adjusting for covariates for each study in Group A using education and occupation as indicators of social position, respectively. The Inflammatory factor scores are socially patterned, with individuals from disadvantaged social positions having higher inflammatory factor scores across the studies.



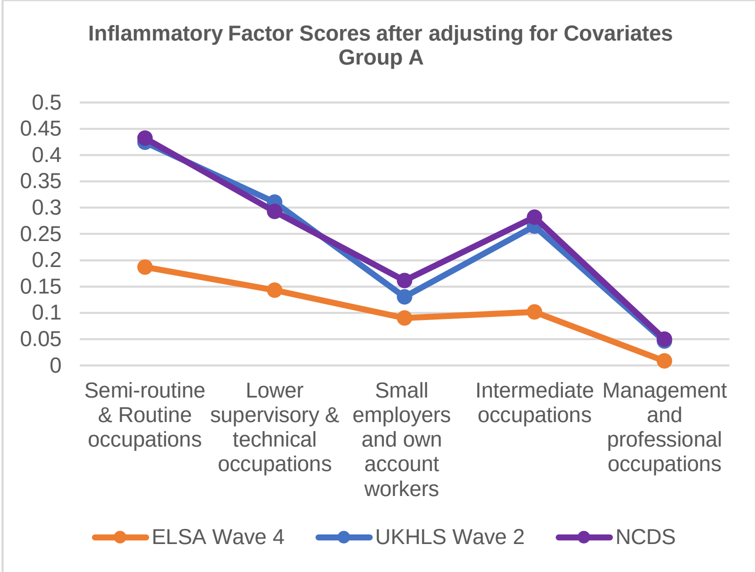


Figure 4. 20: (Education as a measure of social position)

Figure 4. 21: (Occupation as a measure of social position)

Figures 4.20 and 4.21 have comparable outlines and show the inflammatory factor scores after adjusting for covariates for each study in Group A using education and occupation as indicators of social position, respectively. These designs and the designs in Figures 4.18 and 4.19 are alike.

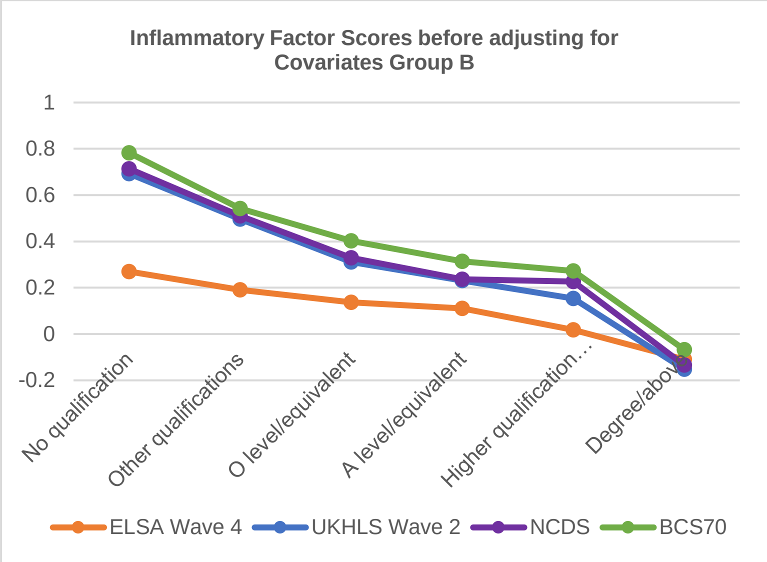


Figure 4. 22: (Education as a measure of social position)

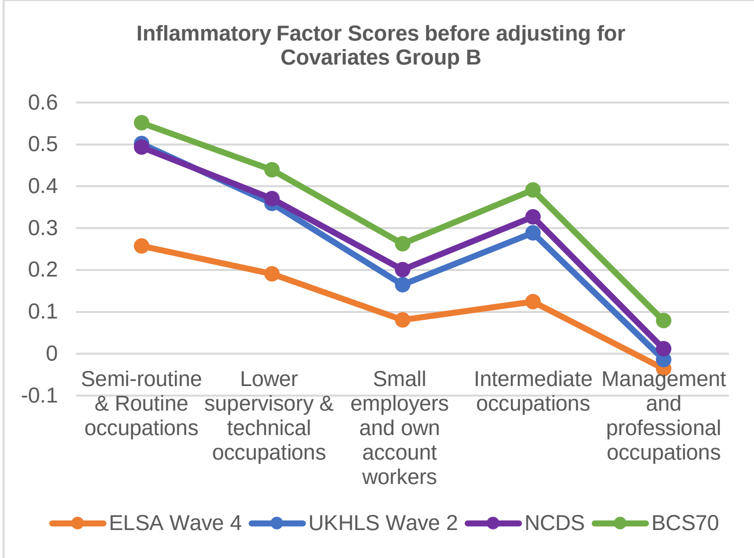


Figure 4. 23: (Occupation as a measure of social position)

Figures 4.22 and 4.23 have comparable outlines and show the inflammatory factor scores before adjusting for covariates for each study in Group B using education and occupation as indicators of social position, respectively. Figures 4.22 and 4.23 are like the Figures in Group A.

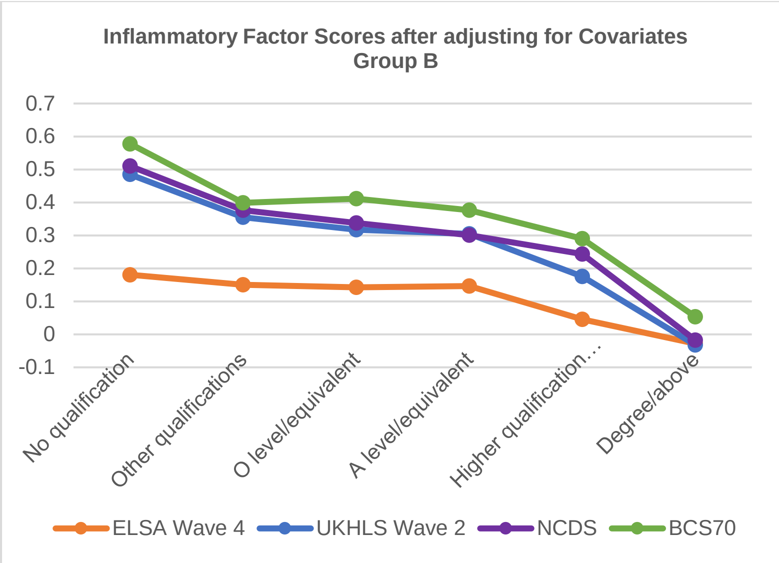


Figure 4. 24: (Education as a measure of social position)

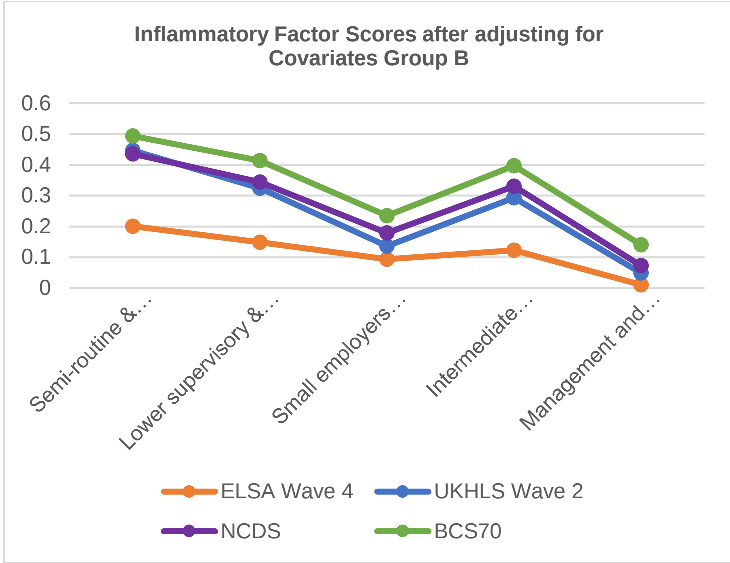


Figure 4. 25: (Occupation as a measure of social position)

Figures 4.24 and 4.25 show the inflammatory factor scores for the studies by social class in Group B after adjusting for covariates.

The pattern is similar between Group A and Group B.

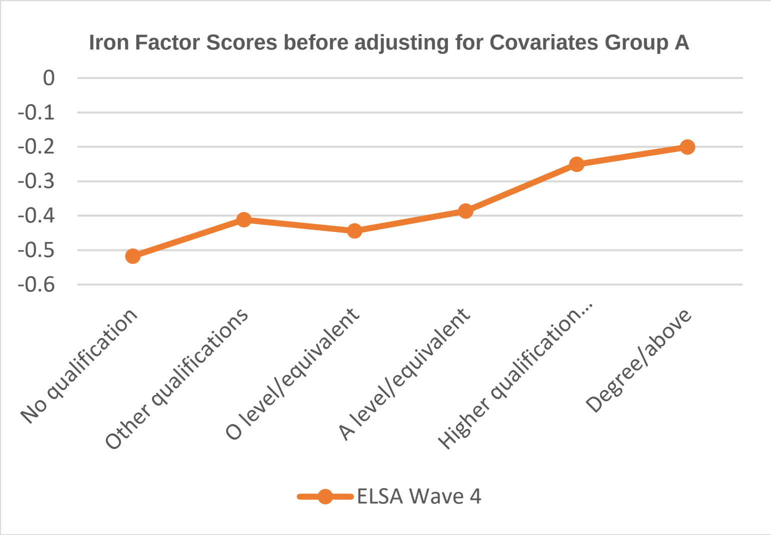


Figure 4. 26: (Education as a measure of social position)

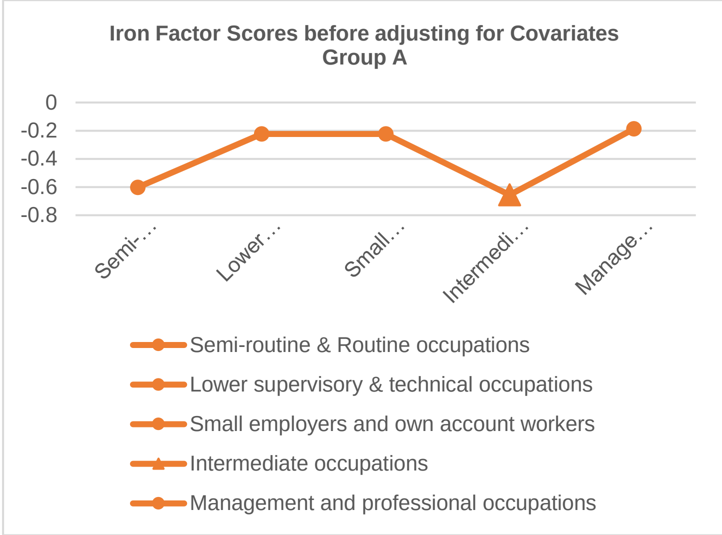


Figure 4. 27: (Occupation as a measure of social position)

Figures 4.26 and 4.27 show the iron factor scores for ELSA wave 4 by social class in Group A before adjusting for covariates. Results are socially patterned, with participants from advantaged social positions having higher iron factor scores than those from disadvantaged social positions. However, participants in the Intermediate occupations have lower iron factor scores than those in other occupational classes. The results of the Intermediate occupations in Figure 4.27 were insignificant, as indicated by the triangle. There is no UKHLS because Group A contains neuroendocrine biomarkers and UKHLS models with neuroendocrine biomarkers do not contain iron factor scores.

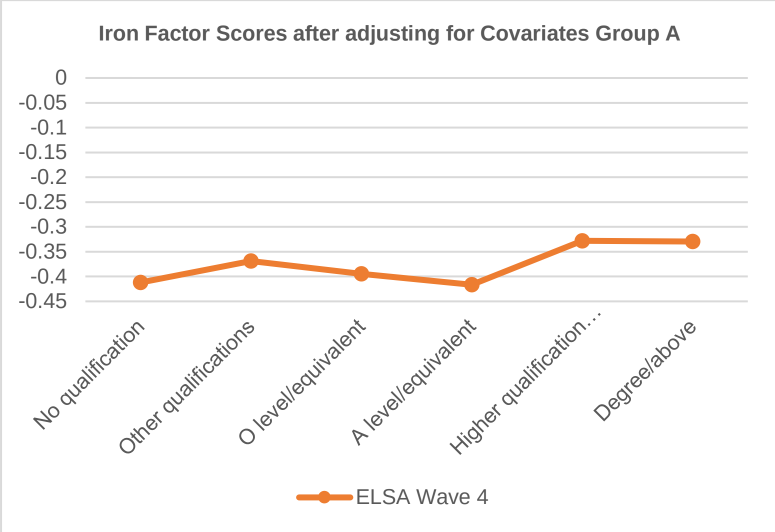


Figure 4. 28: (Education as a measure of social position)

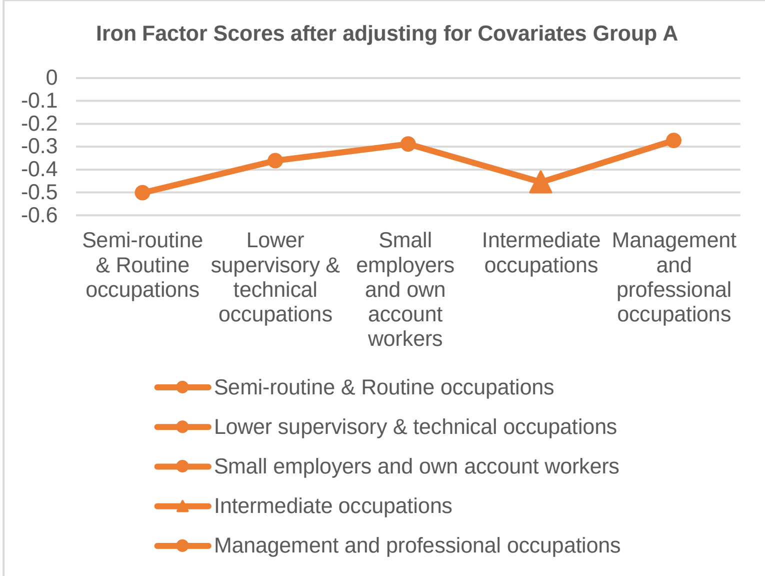


Figure 4. 29: (Occupation as a measure of social position)

Figures 4.28 and 4.29 show the iron factor scores for ELSA wave 4 by social class in Group A after adjusting for covariates. The patterns are similar to Figures 4.26 and 4.27, but the lines are flatter, suggesting that covariates impact the link between social position and iron factor scores. The results of the Intermediate occupations in Figure 4.29 were insignificant, as indicated by the triangle.

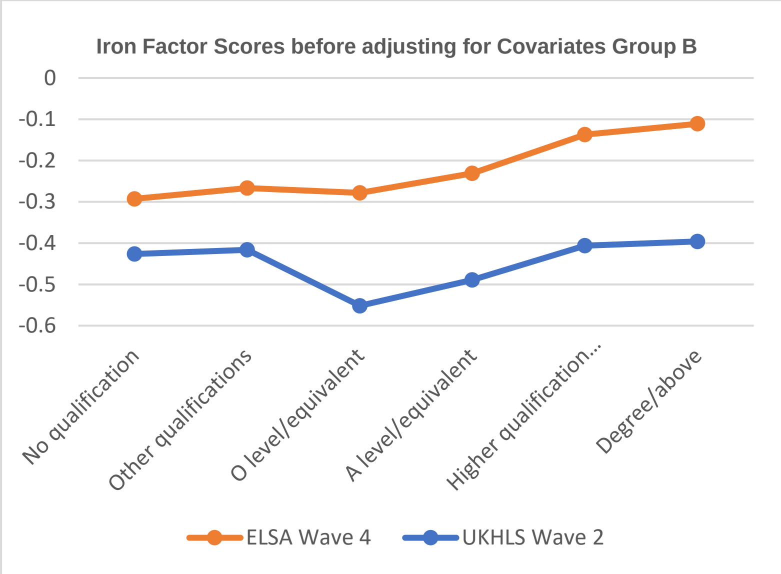


Figure 4. 30: (Education as a measure of social position)

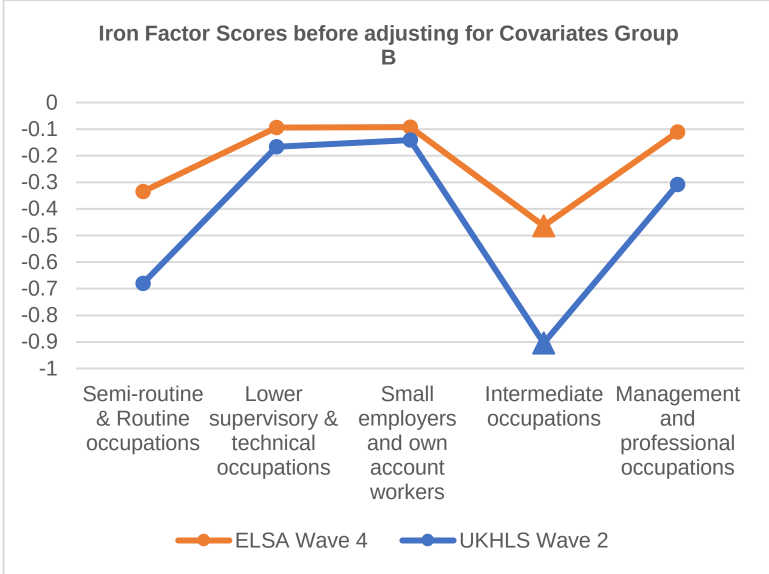


Figure 4. 31: (Occupation as a measure of social position)

Figures 4.30 and 4.31 show the iron factor scores for the studies by social class in Group B before adjusting for covariates. The outline is like the outline in Group A. Similar to Figure 4.29, the results of the Intermediate occupations in Figure 4.31 were insignificant, as indicated by the triangle.

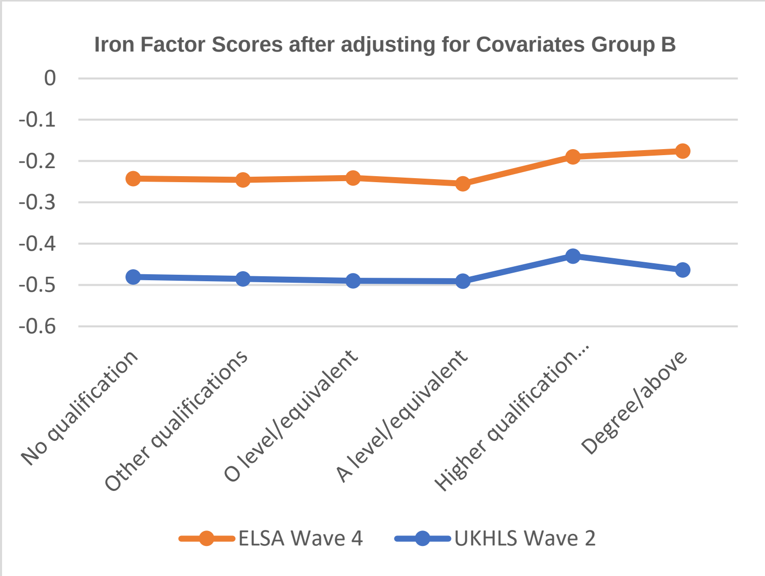


Figure 4. 32: (Education as a measure of social position)

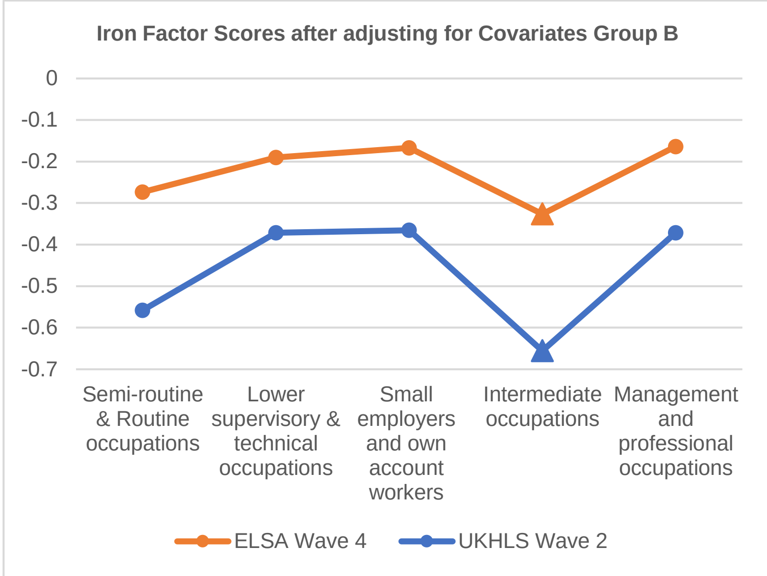


Figure 4. 33: (Occupation as a measure of social position)

Figures 4.32 and 4.33 show the iron factor scores for the studies by social class in Group B after adjusting for covariates. The outline is like before adjusting for covariates, but the lines are flatter, suggesting that covariates impact the link between social position and iron factor scores. The patterns are similar to the patterns in Group A. In Figure 4.33, the results of the Intermediate occupations are insignificant.

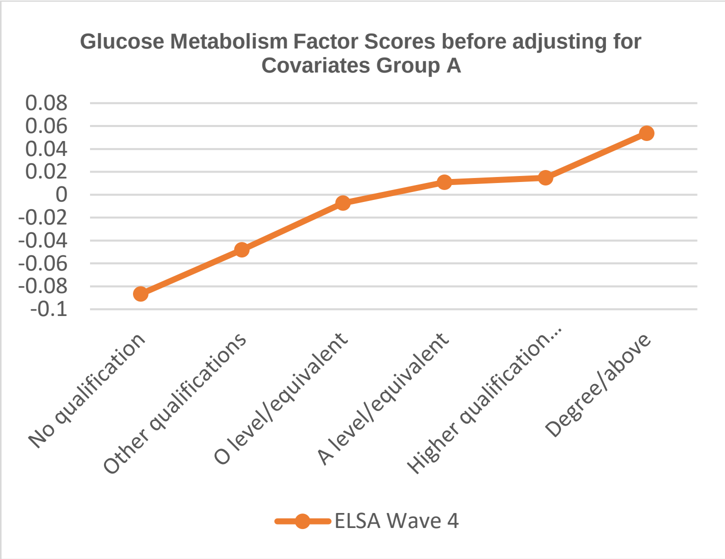


Figure 4. 34: (Education as a measure of social position)

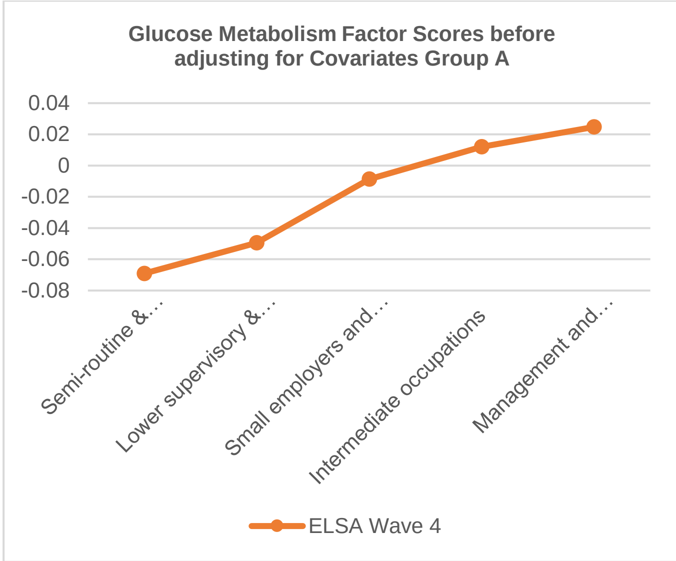


Figure 4. 35: (Occupation as a measure of social position)

Figures 4.34 and 4.35 show the glucose metabolism factor scores for ELSA wave 4 by social class in Group A before adjusting for covariates. Participants from advantaged social positions have the highest glucose metabolism factor scores compared to those from disadvantaged social positions. There is no UKHLS because Group A contains neuroendocrine biomarkers and UKHLS models with neuroendocrine biomarkers do not contain Glucose metabolism factor scores.

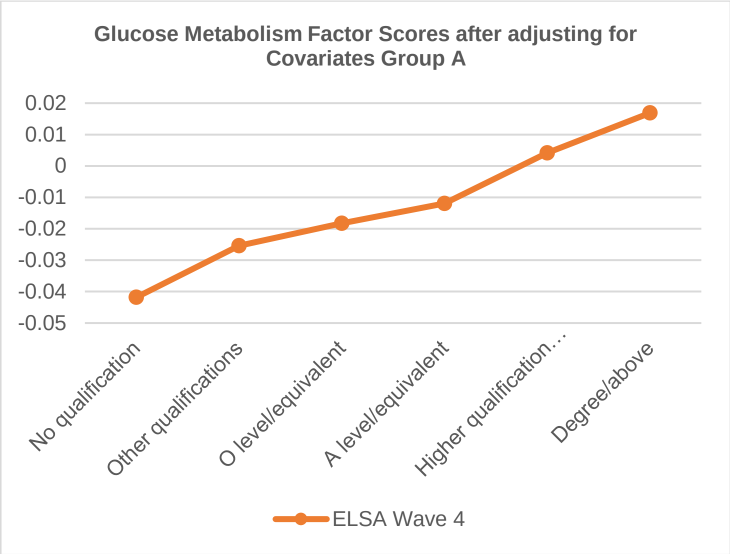


Figure 4. 36: (Education as a measure of social position)

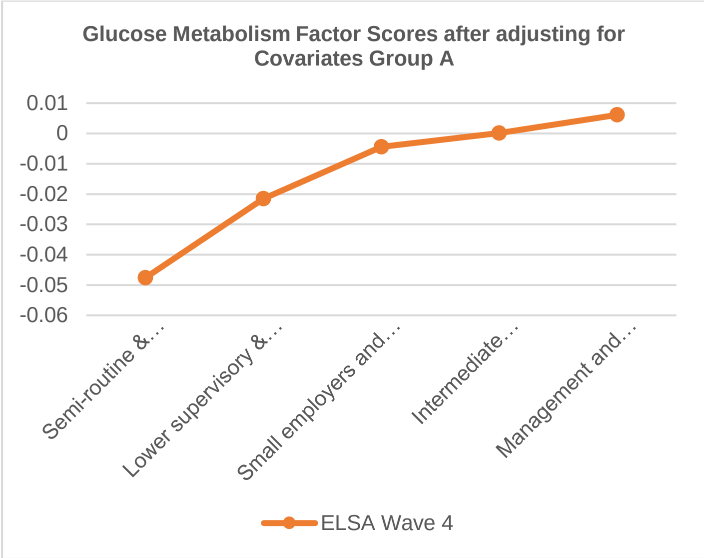


Figure 4. 37: (Occupation as a measure of social position)

Figures 4.36 and 4.37 show the glucose metabolism factor scores for ELSA wave 4 by social class in Group A after adjusting for covariates. The patterns are comparable to Figures 4.34 and 4.35.

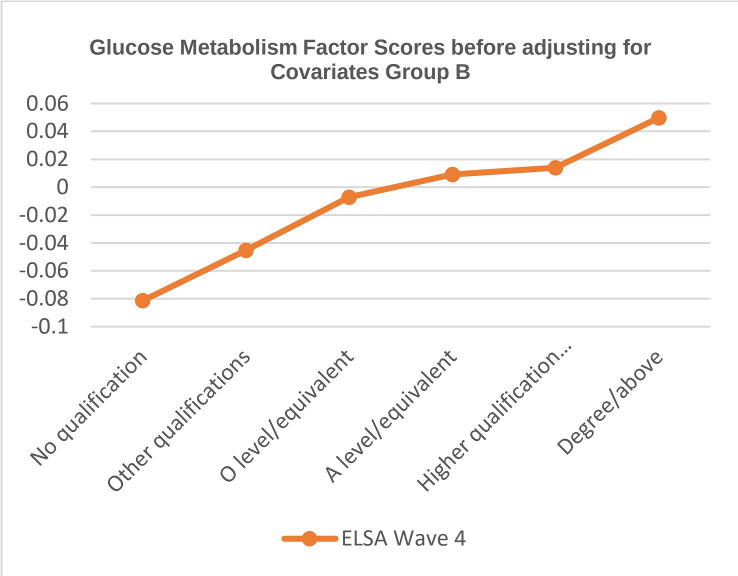


Figure 4. 38: (Education as a measure of social position)

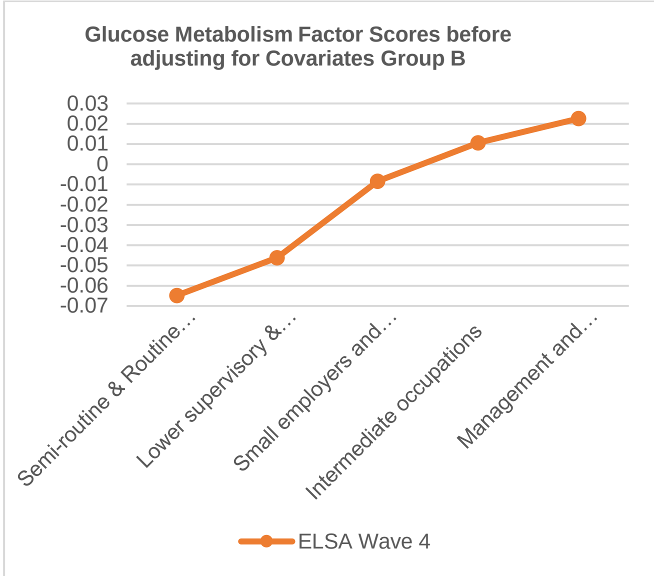


Figure 4. 39: (Occupation as a measure of social position)

Figures 4.38 and 4.39 show the glucose metabolism factor scores for ELSA wave 4 by social class in Group B before adjusting for covariates. The patterns are similar to Group A, and the results are unexpected.

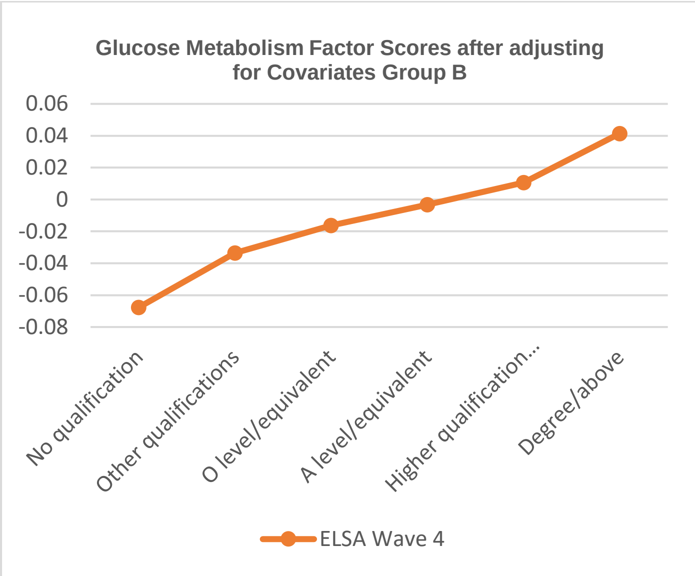


Figure 4. 40: (Education as a measure of social position)

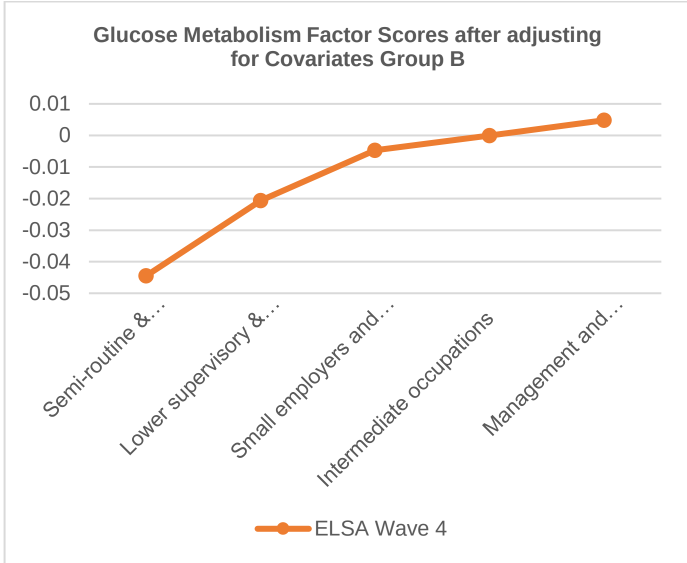


Figure 4. 41: (Occupation as a measure of social position)

Figures 4.40 and 4.41 show the glucose metabolism factor scores for ELSA wave 4 by social class in Group B after adjusting for covariates. The patterns are similar to those in Figures 4.38 and 4.39 and Group A.

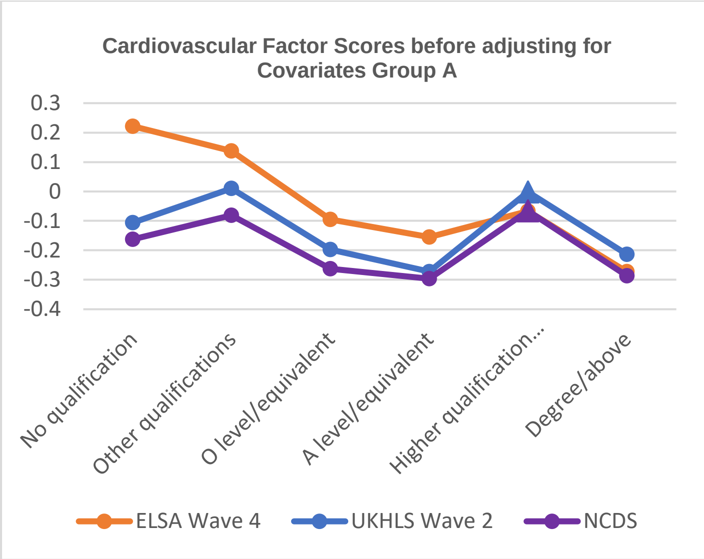


Figure 4. 42: (Education as a measure of social position)

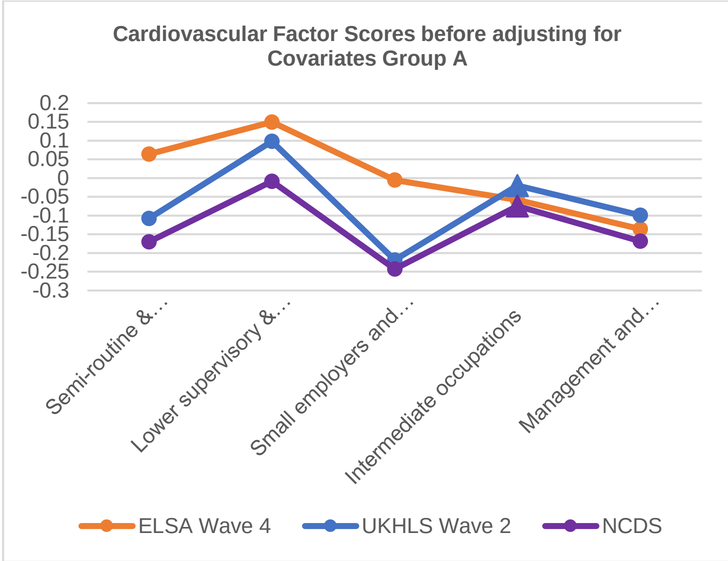


Figure 4. 43: (Occupation as a measure of social position)

Figures 4.42 and 4.43 are comparable, and they display the cardiovascular factor scores for the studies by social class in Group A before adjusting for covariates. ELSA shows a clear gradient with factor scores decreasing with more advantaged social positions. UKHLS and NCDS show inconsistent gradients in cardiovascular factor scores. The UKHLS and NCDS results of the Higher qualifications and Intermediate occupations in Figures 4.42 and 4.43 were insignificant, and the triangles indicate them.

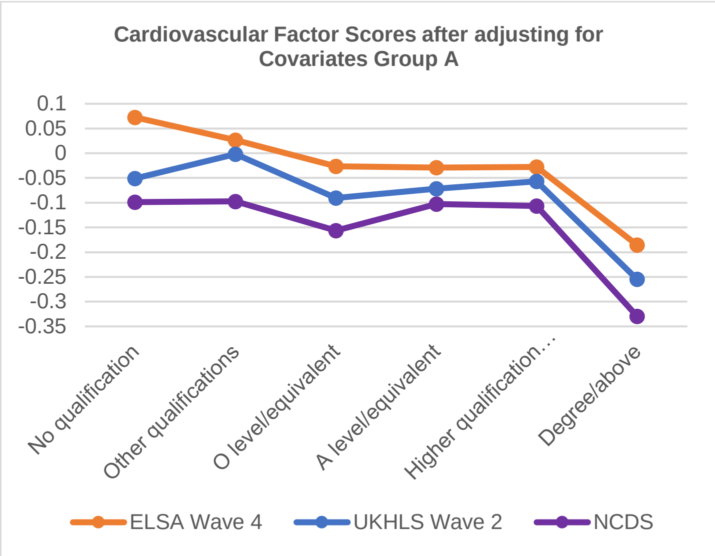


Figure 4. 44: (Education as a measure of social position)

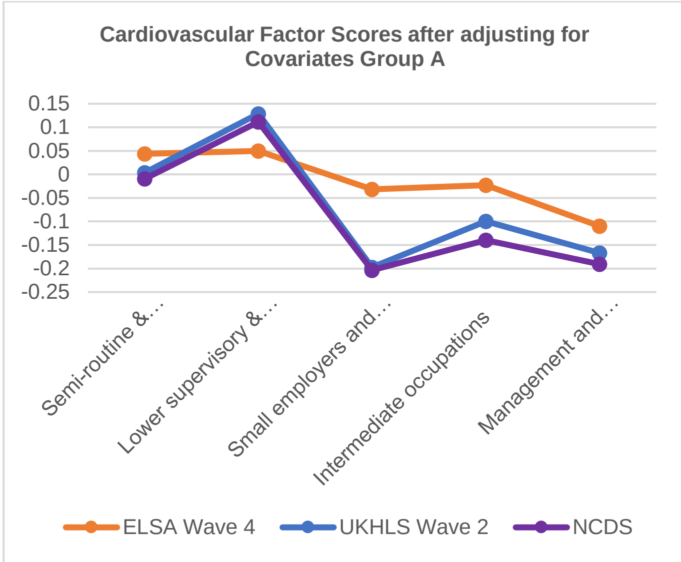


Figure 4. 45: (Occupation as a measure of social position)

Figures 4.44 and 4.45 display the cardiovascular factor scores for the studies by social class in Group A after adjusting for covariates. The outlines are similar to the outlines in Figures 4.42 and 4.43.

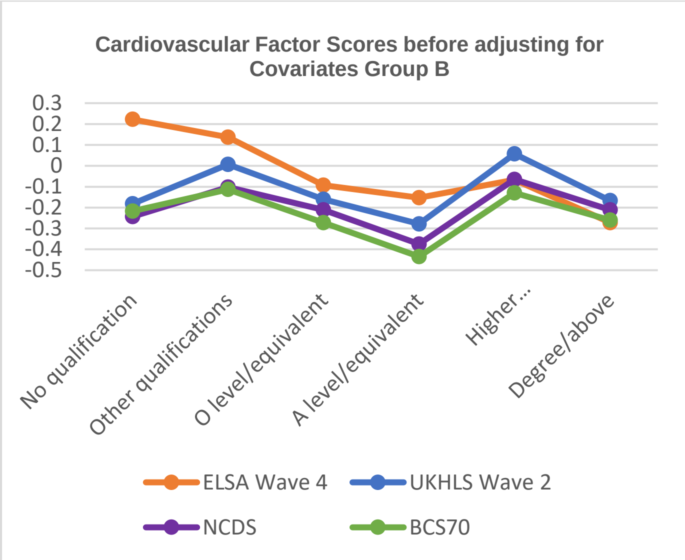


Figure 4. 46: (Education as a measure of social position)

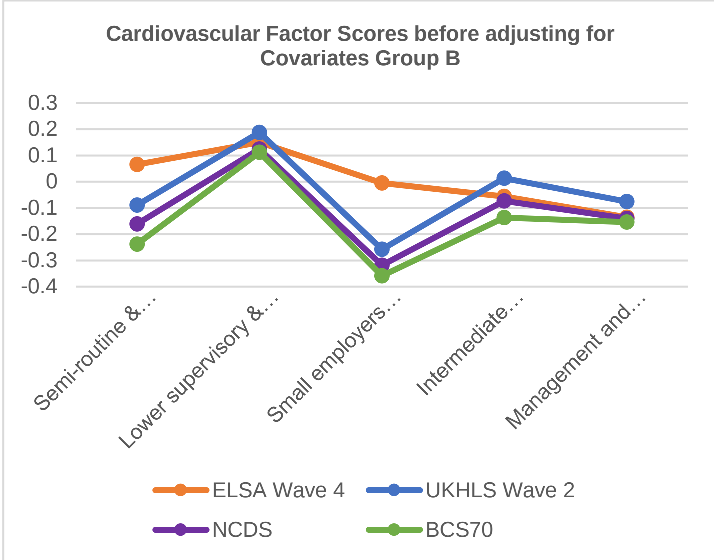


Figure 4. 47: (Occupation as a measure of social position)

Figures 4.46 and 4.47 show the cardiovascular factor scores for the studies by social class in Group B before adjusting for covariates. The patterns are comparable to Group A.

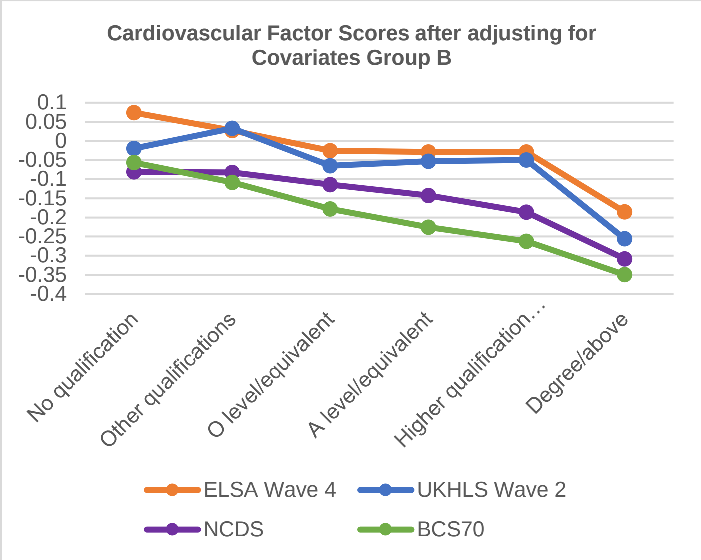


Figure 4. 48: (Education as a measure of social position)

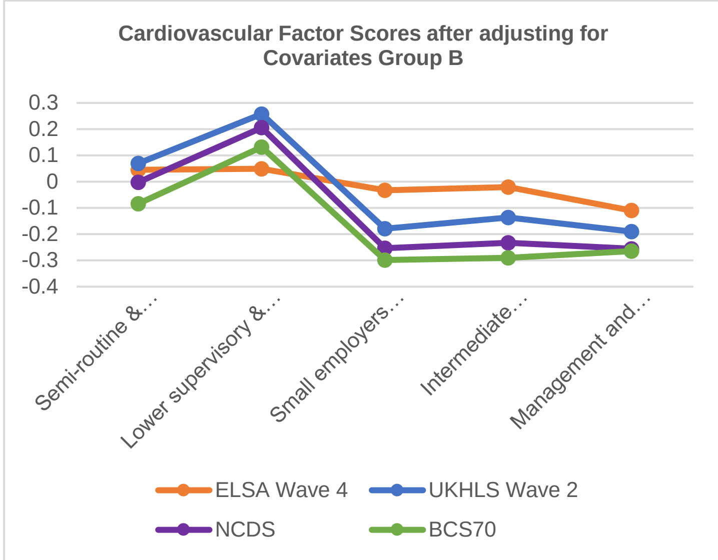


Figure 4. 49: (Occupation as a measure of social position)

Figures 4.48 and 4.49 show the cardiovascular factor scores for the studies by social class in Group B after adjusting for covariates.

The patterns are comparable to Figures 4.46 and 4.47 and Group A.

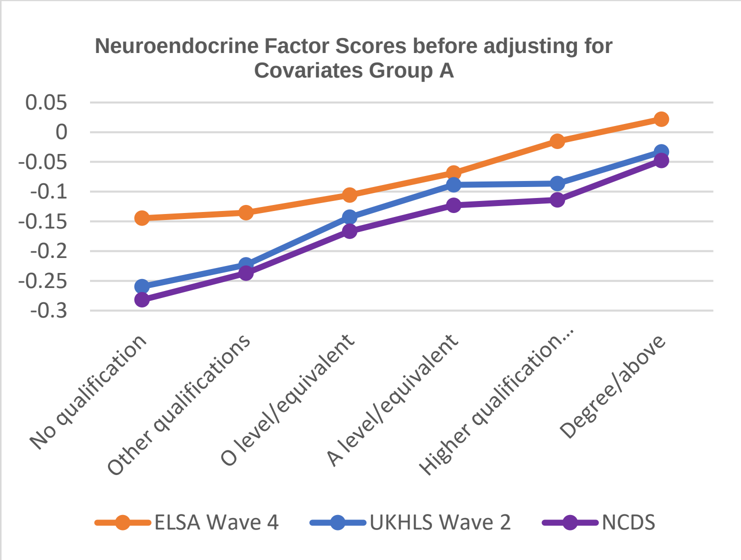


Figure 4. 50: (Education as a measure of social position)

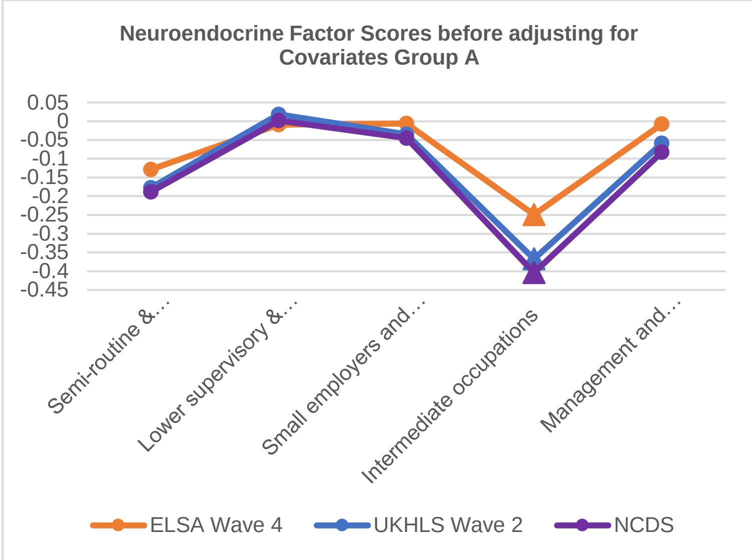


Figure 4. 51: (Occupation as a measure of social position)

Figures 4.50 and 4.51 display the neuroendocrine factor scores by social class for Group A before adjusting for covariates. The neuroendocrine factor scores are socially patterned, with participants in more advantaged social positions having higher scores than those in disadvantaged social positions. The patterns are similar across the studies. However, the design deviated in participants in the Intermediate occupations, which was surprising. The results of the Intermediate occupations in the datasets in Figure 4.51 were insignificant, and the triangles indicate them.

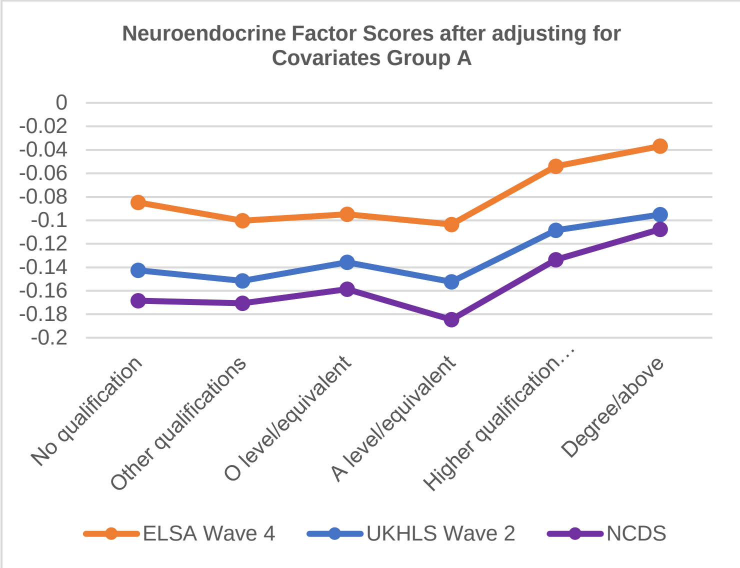


Figure 4. 52: (Education as a measure of social position)

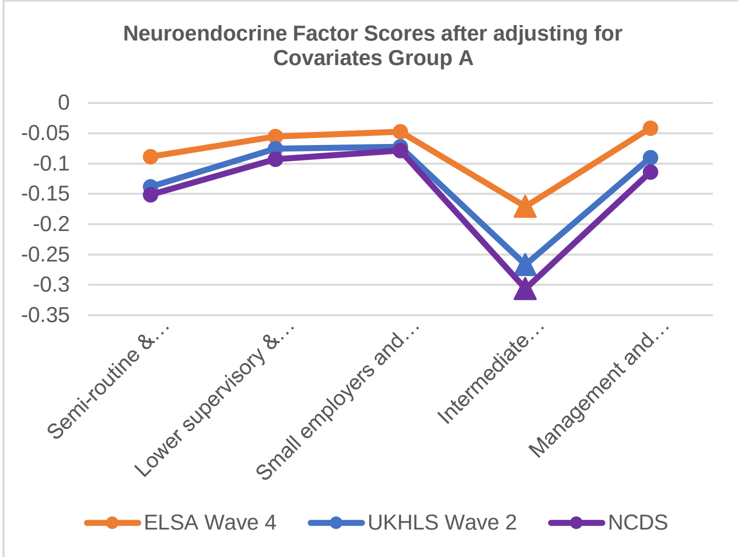


Figure 4. 53: (Occupation as a measure of social position)

Figures 4.52 and 4.53 show the neuroendocrine factor scores by social class for Group A after adjusting for covariates. The patterns are similar across the studies. The patterns are also identical to Figures 4.50 and 4.51, but the lines are flatter, indicating the influence of covariates in the link between social position and neuroendocrine factor scores. Similar to Figure 4.51, the results of the Intermediate occupations in Figure 4.53 were insignificant, and the triangles indicate them.

Discussion

This study examined whether factor scores varied by social class within and across studies using educational attainment and occupation as indicators of social position. It also investigated whether including neuroendocrine biomarkers changed the factor scores by social class. The picture that emerges from the analysis above is that the social inequality gradient in biological risk differed across biological systems. This picture is consistent with Hawkley et al. (2011), who reported that the social gradient observed in the link between social position and allostatic load component systems identified using factor analyses was system-specific.

This study found that metabolic factor scores, which are composed largely of measures of adiposity and triglycerides, were socially patterned, with the highest levels observed in disadvantaged individuals, but these associations were less defined in the occupational classes before adjusting for covariates. However, after adjusting for covariates, it was evident that participants in lower occupational classes had higher metabolic factor scores, and results were more identical to those of the educational attainment group. These findings suggest that occupation still has an apparent association with metabolic factor scores but to a lesser extent due to the impacts of the covariates. These results are comparable to those reported by Zaninotto & Lassale (2019) in that individuals from poorer backgrounds have higher BMI and waist circumference than those from more affluent backgrounds.

Likewise, the results of this study are consistent with Robinson et al. (2020) in that lower educational attainment and occupational class were associated with higher metabolic biomarkers. However, unlike our study, Robinson et al. (2020) did not observe the impact of covariates on the association between occupational class and metabolic biomarkers. We cannot explain these differences, but they may relate to the quality of measurement of covariates in the studies examined. For instance, We adjusted for health behaviour, but Robinson et al. (2020) did not.

On the other hand, this study found that the lipid factor scores were higher in participants from advantaged social positions than those from disadvantaged social positions, irrespective of the indicator of social position. The findings of the lipid factor scores are partly in line with the literature, as there are conflicting results. Espírito Santo et al. (2019) who examined the link between lipids and social position reported that individuals from advantaged social positions had higher lipid levels than those from disadvantaged social positions.

Espírito Santo et al. (2019) suggested that a possible explanation for these results could be that individuals from advantaged social positions have easy access to several desirable unhealthy behaviours, including alcohol consumption, smoking and sedentary lifestyles. However, our study disagrees with Espírito Santo et al. (2019) because we have controlled for the above factors, and these associations remained.

In contrast, Kohler et al. (2013) and Trias-Llimós et al. (2022) found that advantaged social position was linked to lower lipid biomarkers, but this link was attenuated after adjusting for covariates. Another conflicting result was by Hawkley et al. (2011), who reported that the lipid factors showed nonsignificant connections with socioeconomic status. A possible explanation for these results could be that variations occur throughout the life course, and the cross-sectional nature of these studies is less informative. As such, it is not easy to establish firm conclusions. Consequently, longitudinal studies are needed to unravel this complexity in the link between social position and lipid factor scores.

Also, this study found that the inflammatory factor scores are substantially higher in participants from disadvantaged social classes than those from more advantaged ones, regardless of the indicator of social position used. This finding is consistent with previous research. Based on data from a sub-sample of the Finnish Platelet Aggregation and Inflammation Study, Jousilahti et al. (2003) demonstrate that CRP and fibrinogen levels were higher in men from a disadvantaged social position in comparison to men from an advantaged social position and the association was stronger in younger men. As in the present study, Tabassum et al. (2008) found that participants in a more disadvantaged social class had higher inflammatory biomarker (CRP and fibrinogen) levels than those from a more advantaged social class. Similarly, Berger et al. (2019b), who examined social differences in inflammatory biomarkers across six cohort studies, including ELSA and NCDS, reported a consistent association between advantaged social position and lower levels of inflammatory biomarkers.

This study's result is also similar to recent findings by Muscatell et al. (2020), who performed a meta-analysis of 43 papers to investigate the connection between socioeconomic status and inflammatory biomarkers. Overall, they found that participants with disadvantaged socioeconomic status had higher levels of both CRP and IL-6. This is noteworthy, given that inflammation is a risk factor for depression, a mental illness (Gimeno et al., 2009). Results in Chapter Three suggest that each additional inflammatory factor score increases the odds of having poor mental health even after adjusting for covariates in ELSA. However, we observed opposite results in NCDS.

Contrarily, the iron factor scores showed an ascending trend: the more educated, the higher the iron factor scores. Similarly, higher occupational class is linked to higher iron factor scores except in Intermediate occupations. Unlike the other biomarkers, where lower factor scores indicate better health, low iron levels indicate anaemia (iron deficiency) (Piskin et al., 2022). Iron deficiency is a global health problem affecting pregnant women, children and individuals from disadvantaged social positions (Piskin et al., 2022). Earlier findings by Gupta et al. (2011) show that anaemia was higher in persons from low socioeconomic backgrounds than in persons from advantaged socioeconomic backgrounds.

Along similar lines, Yang et al. (2018) suggest that anaemia was higher in nonpregnant women and children from a disadvantaged social position than those from an advantaged social position in low and middle-income countries. Likewise, Didzun et al. (2019) demonstrate that anaemia was higher in individuals from disadvantaged social positions compared to those from advantaged social positions. The results of the study by Kumar et al. (2021) indicate that men from the poorest wealth quintile were more likely to be anaemic than those from the richer wealth quintile.

Following a similar pattern, participants with higher educational qualifications and from higher occupational classes have higher glucose metabolism factor scores than those with lower qualifications and from lower occupational classes. This outline remained after controlling for covariates. These findings were unexpected as glucose is socially patterned, and disadvantage is associated with greater metabolic disturbance. Williams et al. (2012b) suggest that living in disadvantaged areas increases the risk of developing abnormal glucose metabolism.

On the contrary, Rahman et al. (2015) indicate that diabetes, which results from abnormal glucose metabolism, is higher among individuals from advantaged social positions than those from disadvantaged social positions. Rahman et al. (2015)

maintain that their results could be due to several reasons, including restricted access to refined foods in rural areas, which reduces food intake and impairs glucose metabolism. Another reason could be that individuals in rural areas are more likely to engage in jobs and activities that are more physically demanding, which aids glucose metabolism (Akhter et al., 2011).

There were also notable differences in the cardiovascular factor scores. Despite some inconsistencies, participants from advantaged social positions seem to have lower cardiovascular factor scores overall. This outcome is similar to Liew et al. (2019), who suggests that a disadvantaged social position is associated with hypertension. Also, a recent study by Nakagomi et al. (2022) indicates that low socioeconomic status is linked to hypertension.

In contrast, participants with higher educational attainment seem to have higher neuroendocrine factor scores. Likewise, participants from higher occupational classes have higher neuroendocrine factor scores except those in Intermediate occupations; this study cannot explain the reason for this deviation. The evidence in the literature is mixed. The study by Dowd & Goldman (2006) demonstrates a lack of relationship between socioeconomic status and neuroendocrine biomarkers (cortisol, adrenaline and noradrenaline). Also, Gersten et al. (2015) examined whether a disadvantaged social position was related to riskier neuroendocrine biomarker profiles (DHEA-S, adrenaline, noradrenaline, cortisol and dopamine) individually and together as an index. Gersten et al. (2015) found that only DHEA-S had some non-statistically significant link with a disadvantaged social position; the other neuroendocrine biomarkers had no link. Additionally, Glei et al. (2013) found a link between higher cardiovascular and inflammatory biomarkers and lower socioeconomic status but no connection with neuroendocrine biomarkers.

On the other hand, Kumari et al. (2008) show that lower levels of IGF-1 are connected with lower social position. Also, Chandola et al. (2017) indicate that British civil servants in disadvantaged occupational classes had worse diurnal cortisol slopes than those in advantaged occupational classes. In addition, results by Hamilton & Steptoe (2023) infer that riskier levels of inflammation and IGF-1 are connected to individuals from a disadvantaged social position. These contradictory results require more research investigating the link between social position and allostatic load.

Overall, results suggest that factor scores vary by social class within each study but not across the studies, and including neuroendocrine biomarkers did not change the factor scores by social class. These findings are like the results in Chapter Three, as analyses show that not including neuroendocrine biomarkers did not significantly impact the interpretation of the allostatic load factors. The lack of impact from biomarkers considered the primary mediators of the stress response on the factor scores by social class was not expected. This finding contradicts the hypotheses that the neuroendocrine system is vital to the stress pathway and that chronic stress underpins the allostatic load theory.

Some studies (Robertson et al., 2015) highlight unhealthy behaviour and material factors as influences that explain much of the link between social position and allostatic load. Similarly, Forrester et al. (2019) claim that physical activity and alcohol use impact this link. However, this chapter adjusted for gender, marital status, smoking, alcohol intake, physical activity and age groups but not in NCDS and BCS70, as participants are of similar age groups. The results of this study indicate that covariates, including gender, age, marital status and health behaviour, influence the link between social position and specific biological systems. For instance, covariates influenced the link between occupational class and metabolic factor scores but not the link between measures of social position and inflammatory factor scores. Nonetheless, they did not explain much of the link between social position and allostatic load.

Some other studies have also highlighted medication as another factor that may impact these associations, as some participants may have been taking medications to control system-specific biomarkers (Gromova et al., 2020). Nonetheless, this study has not adjusted for medications because the number of participants on medications in the study sample is primarily insignificant and, therefore, unlikely to impact results significantly.

Based on the analysis conducted in this thesis, the author cannot ascertain with certainty that lifestyle factors are confounders or mediators. However, this thesis chose lifestyle factors as confounders mainly for two reasons. First, lifestyle factors relate to allostatic load and mental health (Kraft & Kraft, 2021; Walsh et al., 2013). Finally, this thesis did not conduct a longitudinal analysis and, as such, could not do a mediation analysis. Researchers are encouraged to use longitudinal data in mediation analysis as temporal dynamics provide better insights (Berli et al., 2021). However, this study must acknowledge that using lifestyle factors as confounders could be a limitation, as other studies have considered health behaviours as mediators (Kim et al., 2020).

Conclusion

In conclusion, this chapter contributes to the literature on social position and allostatic load by operationalising allostatic load using factor analysis. This method promises to be a robust approach to measuring allostatic load (King et al., 2019). Yet a few studies have used factor analysis to calculate the allostatic load scores (King et al., 2019). None of the studies reviewed in this chapter used factor analysis to operationalise allostatic load.

Findings from this study suggest that the social inequality gradient in biological risk differed across biological systems. These findings align with the literature. Hawkley et al. (2011) reported that the social gradient observed in the link between social position and allostatic load components is system-specific. These findings have implications for policy as they highlight the need for targeted policies and interventions in tackling biological factors that underpin mental health inequalities. Overall, these results contribute to the literature on social position and allostatic load and indicate that allostatic load is socially patterned. Also, the results suggest that of the allostatic load variables, the inflammatory and glucose metabolism biomarkers are the most consistently associated with social position but in opposing directions.

Chapter Five

Overall Discussions

The overall aim of this thesis was to examine the social and biological factors that underpin inequalities in mental health. The thesis conducted three substantive analyses in chapters Two, Three, and Four to achieve its overall aim.

Chapter aims

The aims of the three substantive analyses are:

Aim 1: Chapter Two to examine the association between social position and mental health.

Aim 2: Chapter Three to examine the association between allostatic load and mental health.

Aim 3: Chapter Four to examine the association between social position and allostatic load.

The results from this thesis contribute to the literature on social position, allostatic load, and mental health. It builds upon the existing knowledge of the link between occupation and education as indicators of social position, mental health, and allostatic load. This section restates the main findings and discusses the strengths, limitations, overall conclusions, policy implications, and suggestions for further research.

Main findings

Education is working through occupation in its association with mental health

The first research aim of this study was to examine the association between social position and mental health. Higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health; however, only the link with occupational class persisted when both variables were investigated concurrently. The results suggest that education is working through occupational class in its association with mental health. These findings were unexpected, as previous studies have reported causal links between education and health (Domènech-Abella et al., 2018). However, our results were not totally out of place as other studies (Geyer et al., 2006) have also demonstrated that the link between social position and health depends on the indicators of social position used.

As suggested in the discussion segment of Chapter Two, a possible reason for these findings could be selection. Persons are selected into different occupational classes based on factors including educational attainment and endowments (Ravesteijn et al., 2013). Ravesteijn et al. (2013) reported that individuals in higher occupational classes generally had higher educational attainments than those in lower occupational classes. An alternative explanation for these results could be that impacts outside those of knowledge are implicated in these associations (Smith et al., 1998). For instance, evidence suggests that work characteristics are other pathways through which occupation might be associated with health (van Veldhoven et al., 2005). Also, personal factors such as resilience, family dynamics, and genes have been reported to influence the link between social position and health (Kawachi et al., 2013).

Allostatic load is composed of several biological systems

The second research aim of this study was to examine the association between allostatic load and mental health. However, there are inconsistencies in how allostatic load has been operationalised, but evidence suggests that factor analysis could be a robust approach to measuring allostatic load (King et al., 2019). Therefore, this study operationalised allostatic load using factor analysis. Tavakol & Wetzel (2020) report that factor analysis can be useful for operationalising constructs that cannot easily be measured, including allostatic load.

This study conducted EFA to determine the number of factors to extract, and factor loadings above 0.3 were acceptable (Finch, 2020). The factors were loaded onto seven factors representing seven biological systems: metabolic, lipid, inflammatory, iron, glucose metabolism, cardiovascular and neuroendocrine. After determining the number of factors to keep, this study did a two-step multigroup CFA using the Robust Likelihood Estimation (MLR) in Mplus8.6 (Muthén & Muthén, 2017) to confirm the factor structure of the biomarker variables (Kevin, 2015). CFA was evaluated for exact fit and approximate fit using the CFI, TLI, RMSEA, and SRMR in line with Kevin (2015). Results suggest that all Models indicate a sensible fit but not an absolute fit to the data.

Using both EFA and CFA allowed this study to identify the biological systems that comprised the allostatic load components. Consequently, the study examined the link between the allostatic load components and mental health and the link between social position and allostatic load components. Therefore, we better understood the associations between the exposures and outcomes.

This study could have used other methods, including the summative count method, averaging continuous z-scores of biomarker variables, and clinical risk cut-offs to operationalise allostatic load (Dargél et al., 2020; Hawkley et al., 2011; Prior et al., 2018). However, none of these other methods would have provided comparable valuable insights into how allostatic load components are linked to mental health and social position. For example, Hawkley et al. (2011) reported that the cardiovascular biological system was linked to socioeconomic status, but the lipid biological system showed nonsignificant connections with socioeconomic status. Also, Glei et al. (2013) found a link between higher cardiovascular and inflammatory biomarkers and lower socioeconomic status but no connection with neuroendocrine biomarkers. Additionally, a recent study by Navyte et al. (2024) demonstrated an association of touch with the neuroendocrine sub-component but not the metabolic or cardiovascular sub-components in participants from the National Social Life, Health, and Aging Project.

These insights are essential given the findings in this study that components of allostatic load have varying connections with mental health and social position.

This study examined the association between allostatic load and mental health in Chapter Three and the association between social position and allostatic load in Chapter Four. We hypothesised that a higher allostatic load is associated with poor mental health and that a disadvantaged social position is associated with a poorer allostatic load. The results suggest that the association between allostatic load and mental health and social position and allostatic load differed across the biological systems that comprise the allostatic load components. As seen earlier in Chapter Three, the biomarkers used in this study grouped into the systems I hypothesised they represent: metabolic, lipid, inflammatory, iron, glucose metabolism, cardiovascular, and neuroendocrine.

Higher metabolic and cardiovascular factor scores were associated with poor mental health and disadvantaged social position. These findings are in line with the evidence. For example, Liu et al. (2022) and Julkunen et al. (2023) suggest that higher metabolic biomarkers and other metabolites are linked to poor mental health. Also, Robinson et al. (2020) report that disadvantaged social positions were associated with higher metabolic biomarkers. Nevertheless, the results of NCDS in models that adjusted for education and not occupation show that higher metabolic factor scores were linked with better mental health, but the results were not statistically significant. The literature on the link between cardiovascular biomarkers and mental health is inconsistent. Our findings accord with Kivimäki et al. (2012), who have linked hypertension to poor mental health. In contrast, Schaare et al. (2023) indicate that higher blood pressure is connected to better mental health.

Similar to metabolic and cardiovascular factor scores, higher inflammatory factor scores were associated with poor mental health and disadvantaged social position, except for the results of NCDS, which showed that higher inflammatory factor scores were linked with better mental health. These findings partly align with the literature as several studies (Carbone, 2021; Milaneschi et al., 2021) have linked inflammatory biomarkers to poor mental health. Other studies (Dowlati et al., 2010; Marques-Deak et al., 2007) found no significant relationship between inflammation and poor mental health. The results of the NCDS were unexpected, and they differ from the evidence in the literature. A possible explanation could be linked to factors such as medication; however, the number of participants on medicines in the study sample is primarily insignificant and, therefore, unlikely to impact results significantly.

On the other hand, higher glucose metabolism factor scores were associated with better mental health and an advantaged social position. The mental health associations were robust to the adjustment of gender, age group, social position and marital status but became statistically non-significant after adjusting for health behaviour. This suggests that the association between glucose metabolism and mental health is driven by health behaviour (Saneei et al., 2016), which accords with Hautekiet et al. (2022), who propose that increased physical activity reduces the risk of poor mental health.

The social position associations are partially in accord with the evidence, as results in the literature are varied. The conclusions of this study support Rahman et al. (2015), who suggests that diabetes, which results from abnormal glucose metabolism, is higher among individuals from advantaged social positions than those from disadvantaged social positions. On the contrary, Williams et al. (2012a) suggest that living in disadvantaged areas increases the risk of developing abnormal glucose metabolism.

Unlike other biological systems, the lipid and iron factor scores were not linked to mental health. An inconsistent narrative emerges from the literature. For instance, van Reedt Dortland et al. (2010) found a link between lipids and major depressive disorder, but their results became statistically non-significant after controlling for covariates. However, findings by Schneider et al. (2017) imply that lipids are linked to poor mental health. Also, Stewart & Hirani (2012) claim that low iron levels were associated with depression, while Qiu et al. (2022) have linked iron overload to the risk of depression.

Some studies have argued that factors including medication can impact the link between lipid, iron, and mental health (Hidese et al., 2018). However, the number of participants on medications in this study’s sample is primarily insignificant and, therefore, unlikely to impact results significantly. In addition, this study investigated the link between lipid and iron factor scores and mental health using data from over 10000 participants, and results suggest there is no association. Any apparent association would be very small and likely not clinically meaningful, given the size of the study population.

In contrast to the association between lipid and iron factor scores and mental health, an advantaged social position was associated with higher lipid and iron factor scores. The findings of the lipid factor scores are partly in line with the literature, as there are conflicting results. For instance, Espírito Santo et al. (2019) reported that individuals from advantaged social positions had higher lipid levels than those from disadvantaged social positions. In contrast, Kohler et al. (2013) and Trias-Llimós et al. (2022) found that advantaged social position was linked to lower lipid biomarkers, but this link was attenuated after adjusting for covariates.

The findings of this study are essential, given the conflicting results. van Reedt Dortland et al. (2010) and Sironi (2012), who found a link between advantaged social position and lower lipid biomarkers, had samples below 5000 participants in their studies. Our study sample is over 10000 participants, which suggests that our study sample is more representative of the population and we have more statistical power, suggesting our results are reliable (Kraemer & Blasey, 2016). Moreover, the associations found by Kohler et al. (2013) and Trias-Llimós et al. (2022) were attenuated after adjusting for covariates, meaning covariates were the driver of their results.

Our findings of the links between social position and iron factor scores are consistent with the literature. For example, Carbone (2020a) demonstrated that anaemia was higher in individuals from disadvantaged social positions than those from advantaged social positions.

Higher neuroendocrine factor scores were also associated with better mental health and advantaged social position. However, the results of NCDS in models that adjusted for both educational attainment and occupation show that higher neuroendocrine factor scores were linked with poorer mental health. The literature on neuroendocrine biomarkers and mental health is mixed. For instance, in line with our study, Souza-Teodoro et al. (2016) reported that higher levels of DHEA-S, which is a neuroendocrine biomarker, shield against the commencement of depression. On the contrary, Nikkheslat et al. (2018) suggest that higher neuroendocrine biomarkers are linked with major depressive disorder. These mixed findings could be due to several reasons, including individual differences such as genes (Demkow & Wolańczyk, 2017).

The impact of Covariates in these associations

The covariate structure and associations vary in the dataset used in examining the aims of the three substantive analyses. In the four datasets and concerning all the biological systems, females had higher odds of having poor mental health compared to males. Ageing and marriage are linked with better mental health in this thesis. Educational attainment and occupation were linked with mental health separately; however, only the link with occupational class persisted when both variables were investigated in their association with mental health.

Unhealthy behaviour was linked to increased odds of having poor mental health, except for alcohol intake, which had mixed results. These results accord with the literature as results are mixed (Xu et al., 2010). A study by Velten et al. (2018), who examined the link between lifestyle choices and mental health using German and Chinese data, reported that higher levels of alcohol consumption were linked to better mental health in German participants but not in Chinese participants. A possible explanation for these results is that the alcohol relation is not straightforward, as evidence suggests that alcohol can have both positive and negative impacts on mental health depending on the type of alcohol, the amount consumed and the social context (Ho et al., 2014).

Also, residual confounding could be a concern. This study adjusted for several relevant covariates but did not examine other aspects of participants' lives that may have played a role in the associations examined. For instance, this study did not adjust for early life factors, such as childhood adversity, which are known to play a role in the development of poor mental health (Gondek et al., 2021). The findings of associations of occupational class with mental health suggest a role for work characteristics.

Revised conceptual framework

A summary of the findings in this thesis is shown in Figure 5.1 in a revised form of Figure 4.1's conceptual framework. Similar thickness arrows to Figure 4.1 conceptual framework indicate partly supported pathways (the path from social position to mental health, since education is working through occupation; the path from allostatic load to mental health, since some allostatic load components, namely lipid and iron factor scores, were not associated with mental health). The double-thickness arrow indicates a fully supported pathway (the path from social position to allostatic load as both occupation and education were linked to allostatic load).

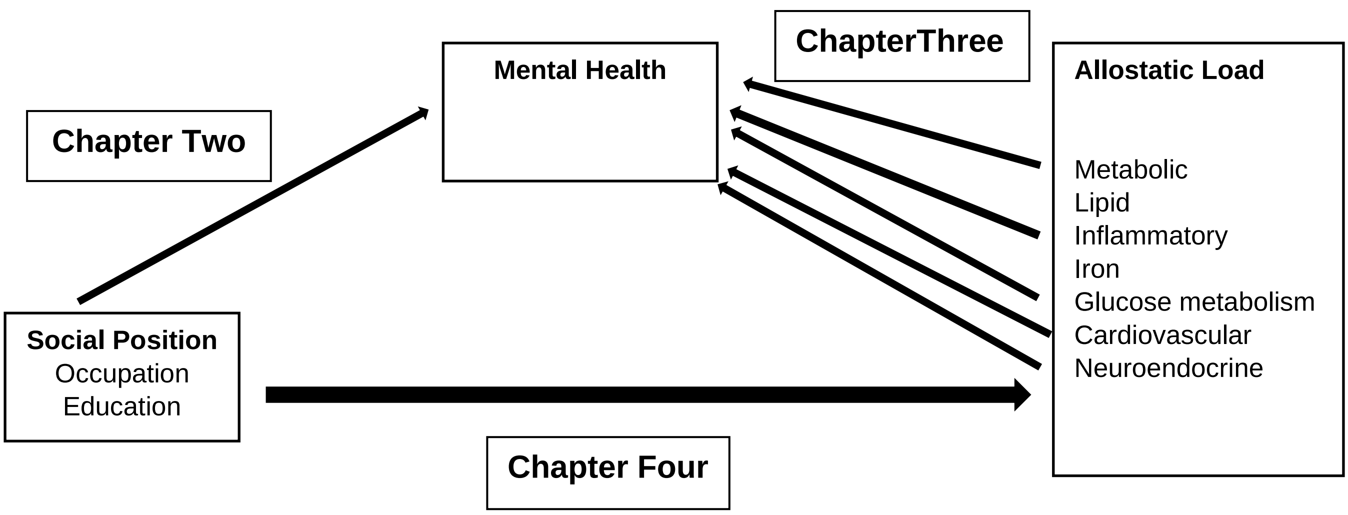


Figure 5. 1: Revised Conceptual Framework

The results of this thesis partially fit its conceptual framework (Figure 1.2). In the revised conceptual framework, education works through occupation; some allostatic load components are linked to mental health, and occupation and education are linked to allostatic load. In the original conceptual framework, education and occupation are independently linked to mental health; all allostatic load components are linked to mental health, and occupation and education are linked to allostatic load. This study did not conduct mediation analysis; however, results suggest that allostatic load components will not mediate the association between social position and mental health.

Strengths and Limitations

Datasets

This thesis used seven datasets, including ELSA, UKHLS, NCDS, BCS70, NSHD, HCS and ALSPAC, to address the three sub-aims in Chapter Three and four datasets, including ELSA, UKHLS, NCDS and BCS70, to answer its three main research questions. Using different datasets to investigate the same phenomenon aids in verifying the consistency of findings across varied measurement processes (Lipton, 2020). Other instruments are often used to collect information on similar topics in various datasets (Taylor & Marchi, 2018). In addition, it enhances the generalisability of results as similar conclusions from different datasets broaden the population covered (Taylor & Marchi, 2018). It also increases the potential for reproducibility in other settings (Taylor & Marchi, 2018). Furthermore, using different datasets to investigate its three main research questions, this study provided a better understanding of the associations between the exposures and the outcomes (Lipton, 2020). The four datasets have large sample sizes representative of the UK population, providing the statistical power to investigate the three main questions of this thesis.

To the author's knowledge, this is the first study that examined if allostatic load factor structures are similar across the seven UK datasets named above. It is also the first to use data from ELSA, UKHLS, NCDS and BCS70 to 1) examine the association between social position and mental health using occupation and education as measures of social position. 2) Examine the association between allostatic load and mental health. 3) Examine the association between social position and allostatic load using occupation and education as indicators of social position.

The main strength of Chapter Two was showing that educational attainment is associated with mental health but not if the occupational class is in the model. These findings support the literature on social position and mental health and provide better insights into how education is linked with mental health.

Results from Chapter Three highlight important facets of allostatic load, especially its underlying factor structure. The chapter also suggests that lipid and iron factors were not associated with mental health and are unlikely to underpin any social differences in mental health.

Results from Chapter Four contribute to the discussion on social position and allostatic load by examining whether factor scores vary by social class within four UK datasets and across the studies. It also studied whether including neuroendocrine biomarkers changed the factor scores by social class. And it is the first study to do so. The results suggest that the social inequality gradient in biological risk differed across biological systems, and not all components were consistently patterned across all studies examined.

The cross-sectional nature of this study is a limitation as it provides only a snapshot of a one-time point and cannot determine the temporal associations between the independent variables and the dependent variables or causality (West-Pavlov, 2013). Also, participants were primarily White or European, so findings may not apply to ethnic minority groups (Smart & Harrison, 2017). Additionally, restricting the study sample to participants with complete data on all the variables may have caused residual confounding.

Conclusions, policy implications, and future research

The overall aim of this thesis was to examine the social and biological factors that underpin inequalities in mental health. The findings from this thesis provide further support for the link between disadvantaged social positions and poor mental health and provide better insights into how education is linked with mental health. Higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health when examined separately. The results of this thesis have important implications for the design of interventions addressing social inequalities in mental health. Policymakers should ensure policies are comprehensive, recognising and addressing the different impacts of the indicators of social position.

As highlighted earlier, higher occupational class and higher educational attainment were linked with decreased odds of having poor mental health when examined separately. However, only the link with occupational class persisted when both variables were investigated concurrently. These results suggest that education works through occupational class in its association with mental health, indicating that occupation is an essential social factor underpinning inequality in mental health (Green & Benzeval, 2013). These results also highlight the need for multiple social position indicators in research on inequalities in health. Previous studies have highlighted the possible benefits of using various indicators of social position to investigate social gradient in health (Braveman et al., 2005; Volkers et al., 2007; Hare et al., 2020). This study contributes to the literature on inequalities in health by providing a better understanding of the diversity of the associations between the different indicators of social position and mental health.

The insights provided by this study on the mechanisms underpinning associations between social position and mental health could assist policymakers in the fight against poor mental health. Partnerships between educators and policymakers in public health will go a long way in the fight against inequalities in health (Kippin, 2023). Policymakers should ensure policies and interventions promote education equity (Kippin, 2023). Ravesteijn et al. (2013) reported that individuals in higher occupational classes generally had higher educational attainments than those in lower occupational classes. Education equity gives individuals from disadvantaged social positions opportunities to achieve higher educational attainment, which enhances their chances of employment in higher occupational classes (Kippin, 2023). This, in turn, can potentially reduce social inequalities in mental health.

Also, the results highlight important facets of allostatic load, especially its underlying factor structure. The allostatic load consists of various factors representing multiple systems, including the metabolic, lipid, cardiovascular, inflammatory, iron, glucose metabolism, and neuroendocrine systems. Differences in specific system biomarkers did not alter the allostatic load factor structure interpretation in all the datasets. Results support the concept that embodies and operationalises allostatic load as multisystem dysfunction. The findings in this study indicate that the measure of allostatic load was robust to the choice of biomarkers. This aligns with the literature on allostatic load. For example, Carbone (2020a), who operationalised allostatic load using factor analysis, reported similar physiological systems and linked inflammatory biomarkers to poor mental health.

There appear to be no plausible explanations for some of the unusual results in NCDS. Therefore, future research should aim to replicate these analyses in NCDS using longitudinal data. Longitudinal data allows researchers to determine temporal associations, determine causality, and track patterns and trends, which is vital for understanding complex associations and provides a more thorough and nuanced viewpoint (Liu, 2016).

A disadvantaged social position damages biological and mental health outcomes (Comes et al., 2018). Evidence suggests that the dysregulation of biological systems, which leads to allostatic load, could explain how social factors get under the skin to impact health (Krieger, 2005). Generally, advances in tackling poor mental health have been made (World Health Organization, 2022). Several countries have reinforced their fight against poor mental health through policies and initiatives (World Health Organization, 2022). However, despite these advances, the prevalence of poor mental health continues to rise, with Covid-19 exacerbating this rise (Banks, 2019).

The continued increase in poor mental health despite efforts to tackle it underscores the importance of targeted policies and interventions as an approach to addressing inequalities in mental health. Findings indicate that education works through occupation to impact mental health. And that the association between allostatic load and mental health and social position and allostatic load differed across the biological systems that comprise the allostatic load components. These findings could open new opportunities for the development of targeted and more efficient policies, interventions, treatment and management of poor mental health.

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Appendices to Chapter Two

Appendix 2.1: Weighted results of the logistics regression using ELSA Data and Occupation as a measure of social position

Variables	ELSA											
Mental Health	Model 1			Model 2			Model 3			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Occupation												
Lower supervisory & technical occupations	0.70***	0.57	0.87	0.85	0.68	1.06	0.86	0.69	1.08	0.89	0.70	1.14
Small employers and own account workers	0.57***	0.46	0.71	0.71***	0.56	0.89	0.76**	0.60	0.96	0.79*	0.62	1.01
Intermediate occupations	0.60***	0.49	0.73	0.61***	0.50	0.75	0.64***	0.52	0.80	0.71***	0.57	0.89
Management and professional occupations	0.41***	0.35	0.48	0.52***	0.43	0.64	0.54***	0.44	0.66	0.60***	0.49	0.74
Gender												
Female				1.60***	1.39	1.85	1.48***	1.28	1.71	1.42***	1.21	1.65
Age Group												
55-64 years				0.81*	0.66	1.01	0.84*	0.68	1.03	0.82*	0.66	1.02
65-74 years				0.71***	0.57	0.88	0.67***	0.54	0.84	0.61***	0.48	0.77
75-84 years				0.89	0.70	1.13	0.74**	0.57	0.96	0.53***	0.40	0.70
Education												
Other qualifications				0.77**	0.63	0.95	0.80**	0.65	0.99	0.92	0.74	1.16
0 Level/equivalent				0.69***	0.57	0.84	0.72***	0.59	0.88	0.92	0.75	1.13
A Level/equivalent				0.64***	0.49	0.85	0.65***	0.49	0.85	0.88	0.66	1.16
Higher qualification below degree				0.68***	0.54	0.86	0.72***	0.57	0.91	1.02	0.80	1.30
Degree/equivalent				0.64***	0.50	0.82	0.66***	0.51	0.85	0.99	0.75	1.29
Marital Status												
Married/Partnership							0.41***	0.32	0.52	0.48***	0.37	0.63

Remarried/In Partnership before							0.54***	0.40	0.73	0.63***	0.46	0.87
Divorced/legally separated							0.91	0.70	1.20	0.91	0.68	1.22
Widowed							1.05	0.80	1.39	1.17	0.87	1.57
Smoking Status												
Ex-smoker										1.27***	1.08	1.48
Current smoker										1.52***	1.25	1.85
Alcohol Intake												
Not at all in the last 12 months										1.08	0.84	1.38
Once or twice a year										1.15	0.89	1.50
Once every couple of months										0.76*	0.56	1.04
Once or twice a month										0.69**	0.53	0.91
Once or twice a week										0.58***	0.46	0.73
Three or four days a week										0.49***	0.37	0.67
Five or six days a week										0.59***	0.41	0.85
Almost every day										0.56***	0.42	0.73
Activity												
Low Activity										0.51***	0.40	0.65
Moderate Activity										0.25***	0.20	0.32
High Activity										0.20***	0.15	0.26
Constant	0.26***	0.24	0.29	0.28***	0.22	0.36	0.48***	0.35	0.66	1.26	0.83	1.92

*** p<.01, ** p<.05, * p<.1

Appendix 2.2: Weighted results of the logistics regression using ELSA Data and Education as a measure of social position

Variables	ELSA											
Mental Health	Model 1			Model 2			Model 3			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.68***	0.55	0.83	0.70***	0.57	0.85	0.73***	0.59	0.90	0.87	0.70	1.09
0 Level/equivalent	0.60***	0.50	0.72	0.59***	0.49	0.71	0.62***	0.52	0.75	0.84*	0.69	1.03
A Level/equivalent	0.50***	0.39	0.65	0.50***	0.39	0.66	0.52***	0.40	0.68	0.75**	0.57	0.98
Higher qualification below degree	0.48***	0.39	0.59	0.51***	0.41	0.63	0.55***	0.44	0.68	0.83	0.66	1.04
Degree/equivalent	0.41***	0.33	0.50	0.43***	0.35	0.53	0.45***	0.37	0.56	0.75**	0.60	0.95

Gender												
Female				1.62***	1.42	1.85	1.48***	1.29	1.70	1.40***	1.21	1.63
Age Group												
55-64 years				0.80**	0.65	0.98	0.82*	0.67	1.01	0.81*	0.65	1.01
65-74 years				0.68***	0.55	0.84	0.65***	0.52	0.81	0.59***	0.47	0.75
75-84 years				0.87	0.69	1.10	0.72**	0.56	0.92	0.52***	0.39	0.68
Marital Status												
Married/Partnership							0.42***	0.33	0.53	0.50***	0.38	0.65
Remarried/In Partnership before							0.55***	0.41	0.73	0.66**	0.48	0.89
Divorced/legally separated							0.96	0.73	1.26	0.95	0.71	1.26
Widowed							1.10	0.83	1.44	1.22	0.91	1.64
Smoking Status												
Ex-smoker										1.28***	1.10	1.50
Current smoker										1.64***	1.35	2.10
Alcohol Intake												
Not at all in the last 12 months										1.07	0.84	1.37
Once or twice a year										1.18	0.91	1.53
Once every couple of months										0.77*	0.57	1.05
Once or twice a month										0.67***	0.51	0.88
Once or twice a week										0.57***	0.46	0.72
Three or four days a week										0.48***	0.35	0.64
Five or six days a week										0.55***	0.38	0.78
Almost every day										0.54***	0.41	0.70
Activity												
Low Activity										0.52***	0.41	0.66
Moderate Activity										0.25***	0.20	0.32
High Activity										0.20***	0.15	0.26
Constant	0.27***	0.24	0.30	0.25***	0.20	0.31	0.43***	0.31	0.58	1.09	0.72	1.63

*** p<.01, ** p<.05, * p<.1

Appendix 2.3: Weighted results of the logistics regression using UKHLS Data and Occupation as a measure of social position

Variables	UKHLS											
Mental Health	Model 1			Model 2			Model 3			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Occupation												
Lower supervisory & technical occupations	0.73***	0.65	0.83	0.79***	0.70	0.90	0.80***	0.71	0.91	0.78***	0.69	0.89
Small employers and own account workers	0.82***	0.74	0.92	0.89*	0.79	1.01	0.90*	0.80	1.02	0.91	0.80	1.02
Intermediate occupations	1.04	0.95	1.15	0.97	0.88	1.07	0.98	0.89	1.08	0.98	0.88	1.08
Management and professional occupations	0.93*	0.87	1.00	0.93*	0.85	1.01	0.94	0.86	1.02	0.96	0.88	1.04
Gender												
Female				1.46***	1.37	1.55	1.44***	1.35	1.53	1.45***	1.36	1.55
Age Group												
25-34 years				1.16**	1.03	1.31	1.24***	1.09	1.41	1.22***	1.07	1.39
35-44 years				1.23***	1.10	1.38	1.34***	1.17	1.52	1.32***	1.15	1.51
45-54 years				1.37***	1.22	1.53	1.47***	1.29	1.68	1.47***	1.28	1.68
55-64 years				1.07	0.94	1.21	1.15*	0.99	1.32	1.14*	0.99	1.33
65-74 years				0.61***	0.49	0.75	0.65***	0.52	0.82	0.67***	0.53	0.84
75-84 years				1.14	0.74	1.76	1.24	0.79	1.93	0.97	0.60	1.58
Education												
Other qualifications				1.03	0.88	1.21	1.03	0.88	1.21	1.04	0.88	1.23
0 Level/equivalent				1.05	0.91	1.20	1.04	0.90	1.20	1.06	0.92	1.23
A Level/equivalent				1.07	0.93	1.24	1.07	0.92	1.23	1.12	0.97	1.30
Higher qualification below degree				1.04	0.89	1.22	1.04	0.89	1.21	1.08	0.92	1.27
Degree/equivalent				0.98	0.85	1.14	0.98	0.85	1.14	1.06	0.91	1.24
Marital Status												
Married/Partnership							0.86***	0.78	0.94	0.84***	0.77	0.92
Divorced/legally separated							1.14*	1.01	1.30	1.10	0.96	1.26
Widowed							1.01	0.75	1.32	1.00	0.75	1.34
Smoking Status												
Ex-smoker										1.13***	1.06	1.22
Current smoker										1.34***	1.23	1.45

Alcohol Intake												
Not at all in the last 12 months										1.35**	1.07	1.72
Once or twice a year										1.47***	1.18	1.82
Once every couple of months										1.21*	0.98	1.49
Once or twice a month										1.11	0.91	1.36
Once or twice a week										1.02	0.84	1.24
Three or four days a week										1.04	0.85	1.27
Five or six days a week										1.16	0.92	1.45
Almost every day										1.30**	1.04	1.62
Activity												
Low Activity										1.01	0.91	1.12
Moderate Activity										0.89**	0.80	0.99
High Activity										0.84***	0.76	0.93
Constant	0.54***	0.51	0.57	0.37***	0.31	0.44	0.38***	0.33	0.45	0.33***	0.25	0.42

*** p<.01, ** p<.05, * p<.1

Appendix 2.4: Weighted results of the logistics regression using UKHLS Data and Education as a measure of social position

Variables	UKHLS											
Mental Health	Model 1			Model 2			Model 3			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Education												
Other qualifications	0.82***	0.75	0.90	0.77***	0.71	0.85	0.78***	0.71	0.85	0.84***	0.76	0.92
0 Level/equivalent	0.79***	0.73	0.85	0.71***	0.66	0.77	0.72***	0.67	0.78	0.80***	0.73	0.87
A Level/equivalent	0.76***	0.70	0.81	0.72***	0.66	0.78	0.72***	0.67	0.79	0.85***	0.78	0.92
Higher qualification below degree	0.74***	0.68	0.80	0.65***	0.59	0.71	0.66***	0.60	0.72	0.77***	0.70	0.85
Degree/equivalent	0.66***	0.61	0.71	0.58***	0.53	0.63	0.59***	0.55	0.64	0.75***	0.69	0.82
Gender												
Female				1.44***	1.37	1.50	1.41***	1.35	1.47	1.43***	1.37	1.50
Age Group												
25-34 years				1.21***	1.11	1.33	1.35***	1.22	1.49	1.27***	1.15	1.41
35-44 years				1.31***	1.20	1.42	1.48***	1.34	1.64	1.41***	1.27	1.56
45-54 years				1.43***	1.32	1.56	1.61***	1.45	1.78	1.56***	1.40	1.73

55-64 years				1.11**	1.02	1.21	1.25***	1.12	1.39	1.20***	1.08	1.34
65-74 years				0.78***	0.71	0.86	0.88**	0.79	0.99	0.84***	0.74	0.94
75-84 years				0.98	0.87	1.10	1.09	0.95	1.24	0.97	0.84	1.11
Marital Status												
Married/Partnership							0.80***	0.74	0.86	0.80***	0.74	0.86
Divorced/legally separated							1.23***	1.11	1.36	1.15**	1.03	1.27
Widowed							0.93	0.82	1.06	0.92	0.81	1.05
Smoking Status												
Ex-smoker										1.16***	1.10	1.23
Current smoker										1.53***	1.43	1.62
Alcohol Intake												
Not at all in the last 12 months										1.31***	1.13	1.52
Once or twice a year										1.30***	1.13	1.49
Once every couple of months										1.04	0.91	1.20
Once or twice a month										0.96	0.84	1.09
Once or twice a week										0.86**	0.76	0.98
Three or four days a week										0.88*	0.77	1.00
Five or six days a week										0.99	0.85	1.16
Almost every day										1.07	0.92	1.24
Activity												
Low Activity										0.73***	0.68	0.79
Moderate Activity										0.64***	0.60	0.69
High Activity										0.60***	0.56	0.64
Constant	0.75***	0.71	0.80	0.59***	0.54	0.65	0.61***	0.55	0.67	0.70***	0.60	0.82

*** p<.01, ** p<.05, * p<.1

Appendices to Chapter Three

Appendix 3.1: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 1) Number of obs = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Pulse rate							0.818
MAP							0.816
BMI	0.926						
WAIST	0.903						
FIB			0.793				
CHOL		0.992					
HDL	-0.558						
TRIG	0.510						
LDL		0.952					
Ferritin				0.766			
DHEAS						0.572	
Glucose					0.859		
HGB				0.459		0.437	
HBA1c					0.767		
IGF1						0.782	
WBC			0.707				
MCH				0.816			
CRP	0.359		0.585			-0.327	

(blanks represent abs(loading)<.3)

Similar results were apparent whether systolic blood pressure and diastolic blood pressure are dropped (Appendix 3.1) or MAP and pulse (Appendix 3.5) from the cardiovascular system, and hip circumference and waist-to-hip ratio are dropped (Appendix 3.1) or BMI and waist circumference (Appendix 3.9) from the metabolic system.

Appendix 3.2: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 2) Number of obs = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Pulse rate				0.853			
MAP				0.842			
HIP			0.307				
WHR	0.670						
FIB			0.932				
CHOL		0.986					
HDL	-0.850						
TRIG	0.780						
LDL		0.950					

Ferritin					0.768		
DHEAS							0.479
Glucose						0.909	
HGB	0.423				0.358		
HBA1c						0.694	
IGF1							0.871
WBC			0.429				
MCH					0.831		
CRP			0.730				

(blanks represent abs(loading)<.3)

Appendix 3.3: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 3) Number of obs = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP		0.961					
DBP		0.797					
Pulse rate		0.623				-0.373	
MAP		0.967					
BMI	0.904						
WAIST	0.715		0.375				
HIP	0.956						
WHR			0.666				
FIB					0.803		
CHOL				0.989			
HDL			-0.742				
LDL				0.951			
HGB			0.652				0.334
MCH							0.773
CRP	0.316				0.712		
WBC			0.414		0.505		
TRIG			0.616	0.314			
Ferritin							0.715
HBA1c						0.728	
Glucose						0.814	

(blanks represent abs(loading)<.3)

Appendix 3.4: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 4) Number of obs = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Pulse rate						0.824
MAP						0.787
BMI	0.931					
WAIST	0.898					

FIB			0.776		
CHOL		0.992			
HDL	-0.526				
TRIG	0.475				
LDL		0.953			
Ferritin				0.708	
Glucose					0.849
HGB				0.721	
HBA1c					0.800
WBC			0.731		
MCH				0.658	
CRP	0.314		0.597		

(blanks represent abs(loading)<.3)

Appendix 3.5: Rotated factor loadings ELSA wave 4 (pattern matrix) (Model 5) Number of obs = 3182

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP				0.879			
DBP				0.866			
BMI	0.917						
WAIST	0.878						
FIB							0.835
CHOL		0.986					
HDL	-0.498		-0.473				
TRIG	0.453	0.308	0.417				
LDL		0.951					
Ferritin					0.785		
Glucose						0.867	
HGB			0.431		0.494		
HBA1c						0.781	
WBC			0.837				0.311
MCH					0.786		
CRP	0.367						0.721

(blanks represent abs(loading)<.3)

Appendix 3.6: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 6) Number of obs = 382

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP	0.979						
DBP	0.794						
Pulse rate	0.680						-0.337
MAP	0.966						
BMI		0.972					
WAIST		0.767					
HIP		1.014					

WHR				0.439	0.413			
FIB						0.903		
CHOL			0.976					
HDL			0.534	-0.593				
LDL			0.908					
HGB					0.797			
CRP						0.753		
TRIG				0.848				
Ferritin					0.783			
APOE			0.588	0.423				
HBA1c					0.344		0.754	
Glucose							0.755	
Cortisol				-0.300	0.314	0.347		

(blanks represent abs(loading)<.3)

Appendix 3.7: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 7) Number of obs = 382

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
SBP			0.886			
DBP			0.877			
BMI		0.849				
Waist		0.860				
FIB				0.891		
CHOL	0.953					
HDL	0.383	-0.491				
LDL	0.878					
HGB					0.767	
CRP		0.316		0.738		
TRIG	0.438	0.458				
Ferritin					0.804	
APOE	0.678					
HBA1c					0.316	0.844
Glucose						0.752
Cortisol				0.395		

(blanks represent abs(loading)<.3)

Appendix 3.7 (Model 7) contains biomarkers in ELSA wave 2 without pulse rate, mean arterial pressure, hip circumference, and waist-to-hip ratio. Model 7 has six factors, namely Factor 1: lipid factor, which includes total cholesterol, low-density lipoprotein, triglyceride, apolipoprotein E and high-density lipoprotein; Factor 2: metabolic factor, which includes body mass index, waist circumference, high-density lipoprotein, C-reactive protein and triglyceride; Factor 3: cardiovascular factor which includes systolic blood pressure and diastolic blood pressure; Factor 4: inflammatory factor which includes fibrinogen, C-reactive protein and cortisol; Factor 5: iron factor which includes haemoglobin, ferritin and glycated haemoglobin; Factor 6: glucose metabolism factor which includes glycated haemoglobin and glucose. Model 7 has a comparable factor structure to Models 1 to 6.

Appendix 3.8: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 8) Number of obs = 382

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Pulse rate						0.842
MAP						0.815
BMI		0.903				
Waist		0.888				
FIB			0.904			
CHOL	0.958					
HDL	0.415	-0.385				
LDL	0.878					
HGB				0.788		
CRP			0.746			
TRIG	0.414	0.355			-0.361	
Ferritin				0.804		
APOE	0.673					
HBA1c				0.306	0.845	
Glucose					0.720	
Cortisol			0.372			

(blanks represent abs(loading)<.3)

Appendix 3.9: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 9) Number of obs = 382

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Pulse rate					0.856	
MAP					0.852	
HIP			0.407			
WHR		0.441	0.457			
FIB				0.899		
CHOL	0.973					
HDL	0.508		-0.498			
LDL	0.901					
HGB		0.809				
CRP				0.798		
TRIG			0.765			
Ferritin		0.786				

APOE	0.591		0.439			
HBA1c		0.319				0.830
Glucose						0.701
Cortisol			-0.423	0.340		

(blanks represent abs(loading)<.3)

Appendix 3.10: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 10) Number of obs = 2774

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP		0.984					
DBP		0.746					
Pulse rate		0.718		0.362			
MAP		0.945					
BMI	0.945						
WAIST	0.716			0.325			
HIP	0.983						
WHR				0.531	0.444		
FIB						0.947	
CHOL			0.975				
HDL			0.379	-0.578			
LDL			0.893				
HGB					0.846		
CRP						0.737	
TRIG			0.365	0.775			
Ferritin					0.722		
APOE			0.634				
HBA1c							0.780
Glucose							0.858

(blanks represent abs(loading)<.3)

Appendix 3.11: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 11) Number of obs = 2774

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Pulse rate						0.851
MAP						0.833
BMI	0.881					
Waist	0.847					
FIB				0.940		
CHOL		0.973				
HDL	-0.543	0.401				
LDL		0.890				
HGB			0.827			

CRP	0.311			0.721	
TRIG	0.629	0.340			
Ferritin			0.794		
APOE		0.629			
HBA1c					0.783
Glucose					0.853

(blanks represent abs(loading)<.3)

Appendix 3.12: Rotated factor loadings ELSA wave 2 (pattern matrix) (Model 12) Number of obs = 2774

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
SBP			0.879			
DBP			0.881			
BMI	0.845					
Waist	0.828					
FIB				0.937		
CHOL		0.970				
HDL	-0.585	0.377				
LDL		0.888				
HGB					0.811	
CRP	0.306			0.725		
TRIG	0.671	0.363				
Ferritin					0.799	
APOE		0.634				
HBA1c						0.784
Glucose						0.853

(blanks represent abs(loading)<.3)

Appendix 3.13: Rotated factor loadings ELSA wave 6 (pattern matrix) (Model 13) Number of obs = 1935

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP				0.880			
DBP				0.906			
BMI	0.671						
Waist	0.742						
CHOL		0.977					
HDL	-0.873						
TRIG	0.708	0.337					
LDL		0.961					
Ferritin					0.789		
CRP			0.692				
IGF1							0.756

HBA1c						-0.733	
Glucose						0.892	
FIB			0.865				
HGB					0.611		0.370
MCH					0.828		
WBC			0.422				0.403
Cortisol			-0.311				

(blanks represent abs(loading)<.3)

Appendix 3.14: Rotated factor loadings ELSA wave 6 (pattern matrix) (Model 14) Number of obs = 1935

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Pulse rate					0.844		
MAP					0.848		
BMI	0.738						
Waist	0.790						
CHOL		0.984					
HDL	-0.797						
TRIG	0.649	0.321					
LDL		0.958					
Ferritin				0.771			
CRP	0.323		0.684				
IGF1							0.689
HBA1c						0.665	
Glucose						0.860	
FIB			0.856				
HGB				0.643			0.383
MCH				0.809			
WBC			0.347				0.518
Cortisol			-0.345				

(blanks represent abs(loading)<.3)

Appendix 3.15: Rotated factor loadings ELSA wave 6 (pattern matrix) (Model 15) Number of obs = 2759

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Pulse rate							0.841
MAP							0.837
BMI	0.896						
Waist	0.843						
CHOL		0.981					
HDL	-0.373		- 0.662				
TRIG		0.312	0.671				

LDL		0.958				
Ferritin				0.757		
CRP	0.354				0.718	
HBA1c						0.741
Glucose						0.867
FIB					0.857	
HGB			0.340	0.671		
MCH				0.816		
WBC	-0.302		0.687		0.376	

(blanks represent abs(loading)<.3)

Appendix 3.16: Rotated factor loadings ELSA wave 6 (pattern matrix) (Model 16) Number of obs = 1935

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
SBP					0.867		
DBP					0.882		
BMI	0.886						
Waist	0.871						
CHOL		0.977					
HDL	-0.580			-0.454			
TRIG	0.373	0.326		0.521			
LDL		0.963					
Ferritin			0.780				
CRP	0.346						0.694
HBA1c						-0.766	
Glucose						0.873	
FIB							0.861
HGB			0.663				
MCH			0.818				
WBC				0.832			0.313

(blanks represent abs(loading)<.3)

Appendix 3.17: Rotated factor loadings UKHLS (pattern matrix) (Model 17) Number of obs = 12094

Variable	Factor1	Factor2	Factor3	Factor4	Factor5
SBP	0.991				
DBP	0.991				
WAIST				0.782	
BMI				0.857	
CHOL		0.769			
TRIG		0.720			
Ferritin		0.554			

HGB					0.609
CRP			0.799		
FIB			0.890		
DHEAS					0.710
IGF1		-0.372			0.622

(blanks represent abs(loading)<.3)

Appendix 3.18: Rotated factor loadings UKHLS (pattern matrix) (Model 18) Number of obs = 12094

Variable	Factor1	Factor2	Factor3	Factor4	Factor5
SBP	0.991				
DBP	0.991				
WAIST		0.838			
BMI		0.890			
CHOL				0.898	
TRIG				0.730	
Ferritin				0.304	0.502
HGB					0.918
CRP			0.853		
FIB			0.902		

(blanks represent abs(loading)<.3)

Appendix 3.19: Rotated factor loadings NCDS (pattern matrix) (Model 19) Number of obs = 8620

Variable	Factor1	Factor2	Factor3	Factor4	Factor5
SBP		0.961			
DBP		0.962			
BMI	0.641				
WAIST	0.741				
CHOL			1.001		
TRIG	0.748				
HDL	-0.903				
LDL			0.965		
FIB				0.863	
IGF1					0.864
VWF				0.578	
CRP				0.736	
TPA	0.444				
Cortisol					0.528

(blanks represent abs(loading)<.3)

Appendix 3.20: Rotated factor loadings NCDS (pattern matrix) (Model 20)   Number of obs = 8616

Variable	Factor1	Factor2	Factor3	Factor4
SBP		0.965		
DBP		0.971		
BMI	0.661			
WAIST	0.748			
CHOL			0.999	
TRIG	0.753			
HDL	-0.887			
LDL			0.961	
FIB				0.862
VWF				0.582
CRP				0.750
TPA	0.438			

(blanks represent abs(loading)<.3)

Appendix 3.21: Rotated factor loadings NCDS (pattern matrix) (Model 21) Number of obs = 8620

Variable	Factor1	Factor2	Factor3	Factor4	Factor5
SBP		0.955			
DBP		0.954			
BMI	0.612				
WAIST	0.717				
CHOL			0.994		
TRIG	0.757				
HDL	-0.891				
LDL			0.959		
FIB				0.904	
IGF1					0.848
CRP				0.806	
Cortisol					0.561

(blanks represent abs(loading)<.3)

Appendix 3.22: Rotated factor loadings NCDS (pattern matrix) (Model 22)   Number of obs = 8616

Variable	Factor1	Factor2	Factor3	Factor4
SBP		0.960		
DBP		0.965		
BMI	0.634			
WAIST	0.731			
CHOL			0.991	

TRIG	0.774			
HDL	-0.882			
LDL			0.956	
FIB				0.918
CRP				0.819

(blanks represent abs(loading)<.3)

Appendix 3.23: Rotated factor loadings BCS 70 (pattern matrix) (Model 23) Number of obs = 2650

Variable	Factor1	Factor2	Factor3	Factor4	Factor5
SBP		0.912			
DBP		0.930			
WAIST	0.782				
CHOL			0.838		
HBA1c	0.480				
BMI	0.730				
CRP	0.501			0.496	
HDL	-0.833				
IGF1				-0.845	
Ferritin			0.483		
TRIG	0.590		0.572		
CMG					0.674
CMM					0.780

(blanks represent abs(loading)<.3)

Appendix 3.24: Rotated factor loadings BCS70 (pattern matrix) (Model 24) Number of obs = 2650

Variable	Factor1	Factor2	Factor3	Factor4
SBP		0.884		
DBP		0.902		
WAIST	0.816			
CHOL			0.804	
BMI	0.835			
CRP	0.650			
HDL	-0.685			
TRIG	0.375		0.754	
CMG				0.720
CMM				0.745

(blanks represent abs(loading)<.3)

Appendix 3.25: Rotated factor loadings NSHD (pattern matrix) (Model 25) Number of obs = 668

Variable	Factor1	Factor2	Factor3	Factor4
SBP			0.917	
DBP			0.910	
BMI	0.792			
WAIST	0.855			
CHOL		0.924		
TRIG	0.604	0.363		
HDL	-0.790			
LDL		0.884		
IGF1				0.665
IGF2				0.763
IGF3				0.760

(blanks represent abs(loading)<.3)

Appendix 3.26: Rotated factor loadings NSHD (pattern matrix) (Model 26) Number of obs = 668

Variable	Factor1	Factor2	Factor3
SBP		0.921	
DBP		0.910	
BMI	0.780		
WAIST	0.855		
CHOL			0.927
TRIG	0.618		0.358
HDL	-0.780		
LDL			0.889

(blanks represent abs(loading)<.3)

Appendix 3.27: Rotated factor loadings NSHD (pattern matrix) (Model 27) Number of obs = 668

Variable	Factor1	Factor2	Factor3	Factor4
SBP			0.914	
DBP			0.918	
BMI	0.817			
WAIST	0.868			
CHOL		0.983		
TRIG	0.697	0.331		
HDL	-0.686			
LDL		0.948		
IGF1				0.810
IGF2				0.587
IGF3				0.789

(blanks represent abs(loading)<.3)

Appendix 3.28: Rotated factor loadings NSHD (pattern matrix) (Model 28) Number of obs = 668

Variable	Factor1	Factor2	Factor3
SBP			0.914
DBP			0.921
BMI	0.820		
WAIST	0.876		
CHOL		0.987	
TRIG	0.694	0.330	
HDL	-0.680		
LDL		0.950	

(blanks represent abs(loading)<.3)

Appendix 3.29: Rotated factor loadings HCS (pattern matrix) (Model 29) Number of obs = 187

Variable	Factor1	Factor2	Factor3	Factor4
SBP			0.882	
DBP			0.890	
BMI	0.829			
WAIST	0.816			
HDL	-0.725			
CHOL		0.953		
TRIG	0.614	0.449		
LDL		0.930		
FIB				0.807
CRP				0.760
Cortisol			0.404	

(blanks represent abs(loading)<.3)

Appendix 3.30: Rotated factor loadings HCS (pattern matrix) (Model 30) Number of obs = 330

Variable	Factor1	Factor2	Factor3	Factor4
SBP			0.887	
DBP			0.908	
BMI	0.862			
WAIST	0.866			
HDL	-0.688			
CHOL		0.979		

TRIG	0.650	0.408		
LDL		0.936		
FIB				0.888
CRP				0.669

(blanks represent abs(loading)<.3)

Appendix 3.31: Rotated factor loadings ALSPAC (pattern matrix) (Model 31) Number of obs = 116

Variable	Factor1	Factor2	Factor3	Factor4
SBP	0.577			
DBP	0.635			
BMI	0.755			
CHOL		0.993		
HDL	-0.563		0.327	-0.417
LDL		0.943		
TRIG	0.675			
Glucose			0.382	0.542
HBA1c				0.816
IGF1			0.832	
DHEAS			0.517	

(blanks represent abs(loading)<.3)

Appendix 3.32: Rotated factor loadings ALSPAC (pattern matrix) (Model 32) Number of obs = 685

Variable	Factor1	Factor2	Factor3	Factor4
SBP		0.791		
DBP		0.883		
BMI		0.563		
CHOL	1.004			
HDL			0.966	
LDL	0.931			
TRIG	0.350		-0.592	
Glucose				0.679
HBA1c				0.859

(blanks represent abs(loading)<.3)

Appendix 3.33 : Characteristics of Analytical Sample with Neuroendocrine Biomarkers by Dataset (Group A) same as without neuroendocrine biomarkers

Variables		Datasets							
		ELSA		**UKHLS**		**NCDS**		**BCS70**	
		Number	%	Number	%	Number	%	Number	%
All Participants		7720	100	10056	100	6533	100	2394	100
Mental Health (Dependent variable)									
	Good Mental Health	6672	86.42	6574	65.37	5622	86.06	1973	82.41
	Poor Mental Health	1048	13.58	3482	34.63	911	13.94	421	17.59
Level of Education									
	No qualifications	1957	25.35	507	5.04	1004	15.37	613	25.61
	Other Qualification	878	11.37	873	8.68	945	14.47	128	5.35
	O Level/equivalent	1505	19.49	2149	21.37	2390	36.58	612	25.56
	A Level/equivalent	665	8.61	2245	22.32	621	9.51	137	5.72
	Higher qualification below degree	1230	15.93	1387	13.79	305	4.67	236	9.86
	Degree/Above	1485	19.24	289 5	28.79	1265	19.41	668	27.90
Gender									
	Male	3515	45.53	4685	46.59	3165	48.45	1174	49.04
	Female	4205	54.47	5371	53.41	3368	51.55	1220	50.96
Age Group									
	16-24 years			785	7.81				
	25-34 years			1767	17.57				
	35-44 years			2583	25.69				

Variables		Datasets							
		ELSA		UKHLS		NCDS		BCS70	
	45-54 years	957	12.40	2738	27.23				
	55-64 years	3125	40.48	1802	17.92				
	65-74	2440	31.61	337	3.35				
	75-84	1198	15.52	44	0.44				
Marital Status									
	Single, that is never married	431	5.58	1571	15.62	652	9.98	412	17.21
	Married/Partnership	4362	56.50	7426	73.85	4009	61.37	1588	66.33
	Remarried/Partnership before	984	12.75			906	13.87		
	Divorced/legally separated	943	12.22	921	9.16				
	Divorced/legally separated/widowed					966	14.79	394	16.46
	Widowed	1000	12.95	138	1.37				
Smoking Status									
	Never Smoked	3085	39.96	4314	42.90	3090	47.30	1190	49.71
	Ex-Smoker	3585	46.44	3789	37.68	2010	30.77	770	32.16
	Current Smoker	1050	13.60	1953	19.42	1433	21.93	434	18.13
Frequency of Alcoholic Drinks									
	No alcohol	662	8.58	148	1.47	398	6.09	225	9.40
	Not at all in the last 12 months	736	9.53	353	3.51				
	Once or twice a year	597	7.73	658	6.54				
	Once every couple of months	492	6.37	874	8.69				
	Once a month or less					928	14.20	438	18.30
	Once or twice a month	831	10.76	1699	16.90				
	Two to four times a month					1423	21.78	522	21.80

Variables		Datasets ELSA		UKHLS		NCDS		BCS70	
	Once or twice a week	1786	23.13	3183	31.65				
	Two or three days a week					2069	31.67	817	34.13
	Three or four days a week	996	12.90	1721	17.11				
	Four or more times a week					1715	26.25	392	16.37
	Five or six days a week	486	6.30	632	6.28				
	Almost everyday	1134	14.69	788	7.84				
Physical Activity									
	No activity	381	9.94	1055	10.49	2461	37.67	494	20.63
	Low activity	1686	21.84	2353	23.40			1137	47.49
	Moderate activity	3990	51.68	3097	30.80			358	14.95
	High activity	1663	21.54	3551	35.31			405	16.37
	Less than once a month					2521	38.59		
	Once a month					537	8.22		
	2 to 3 times a month					383	5.86		
	Once a week					402	6.15		
	More than once a week					229	3.51		

Appendix 3.34: The proportion of missing data by variables and datasets in Chapter Three

Variables	ELSA (7992)		UKHLS (11916)		NCDS (7694)		BCS70 (3077)	
	Percentage	**Number**	**Percentage**	**Number**	**Percentage**	**Number**	**Percentage**	**Number**
Mental Health	0	7992	1038 (8.71%)	10878	61 (0.79%)	7633	125 (4.06%)	2952
Education	59 (0.74%)	7933	85 (0.71%)	11831	0	7694	52 (1.69%)	3025
Occupation	7 (0.09%)	7985	599 (5.03%)	11317	918 (11.93%)	6776	427 (13.88%)	2650
Gender	0	7992	0	11916	0	7694	0	3077

Age Group	272 (3.40%)	7720	1860 (15.61%)	10056				
Marital status	0	7992	2 (0.02%)	11914	183 (2.38%)	7511	62 (2.01%)	3015
Smoking status	49 (0.61%)	7943	42 (0.35%)	11874	195 (2.53%)	7499	0	3077
Alcohol intake	153 (1.91%)	7839	1229 (10.31%)	10687	26 (0.34%)	7668	13 (0.42%)	3064
Physical Activity	5 (0.06%)	7987	60 (0.50%)	11856	289 (3.76%)	7405	58 (1.88%)	3019
Metabolic	0	7992	0	11916	627 (8.15%)	7067	427 (13.88%)	2650
Lipid	0	7992	0	11916	627 (8.15%)	7067	427 (13.88%)	2650
Inflammatory	0	7992	0	11916	627 (8.15%)	7067	427 (13.88%)	2650
Iron	0	7992	0	11916				
Glucose Metabolism	0	7992						
Cardiovascular	0	7992	0	11916	627 (8.15%)	7067	427 (13.88%)	2650
Neuroendocrine	0	7992	0	11916	627 (8.15%)	7067		

Appendix 3.35: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	1.16***	1.07	1.26	1.31***	1.20	1.43	1.30***	1.19	1.42	1.17***	1.07	1.29
Gender												
Female				2.07***	1.80	2.41	1.85***	1.58	2.16	1.63***	1.38	1.93
Age Group												
55-64 years				0.71***	0.58	0.88	0.72***	0.58	0.88	0.70***	0.57	0.87
65-74 years				0.66***	0.53	0.82	0.61***	0.49	0.76	0.54***	0.43	0.69
75-84 years				0.83	0.65	1.06	0.69***	0.53	0.89	0.50***	0.38	0.66
Education												
Other qualifications				0.80*	0.64	1.01	0.82*	0.66	1.03	0.94	0.75	1.20
0 Level/equivalent				0.68***	0.56	0.83	0.70***	0.58	0.86	0.87	0.70	1.08
A Level/equivalent				0.64***	0.48	0.85	0.65***	0.49	0.86	0.85	0.64	1.15
Higher qualification below degree				0.72**	0.58	0.91	0.77**	0.61	0.97	1.03	0.80	1.31

Degree/equivalent				0.73**	0.57	0.93	0.75**	0.59	0.96	1.09	0.84	1.41
Occupation												
Lower supervisory & technical occupations				0.91	0.72	1.15	0.91	0.72	1.15	0.94	0.73	1.20
Small employers and own account workers				0.70***	0.55	0.88	0.72**	0.57	0.91	0.73**	0.57	0.93
Intermediate occupations				0.64***	0.52	0.80	0.66***	0.53	0.82	0.71***	0.57	0.89
Management and professional occupations				0.56***	0.46	0.68	0.56***	0.46	0.68	0.59***	0.48	0.73
Marital Status												
Married/Partnership							0.42***	0.32	0.55	0.49***	0.37	0.64
Remarried/In Partnership before							0.58***	0.42	0.78	0.67**	0.48	0.92
Divorced/legally separated							1.02	0.76	1.37	1.01	0.75	1.38
Widowed							1.08	0.80	1.45	1.18	0.86	1.61
Smoking Status												
Ex-smoker										1.10	0.94	1.29
Current smoker										1.48***	1.21	1.81
Alcohol Intake												
Not at all in the last 12 months										1.22	0.94	1.60
Once or twice a year										1.11	0.84	1.48
Once every couple of months										0.74*	0.53	1.02
Once or twice a month										0.67**	0.50	0.90
Once or twice a week										0.62***	0.48	0.80
Three or four days a week										0.55***	0.40	0.74
Five or six days a week										0.64**	0.43	0.94
Almost every day										0.63***	0.47	0.84
Activity												
Low Activity										0.44***	0.34	0.57
Moderate Activity										0.23***	0.18	0.29
High Activity										0.18***	0.13	0.24
Constant	0.16***	0.15	0.17	0.24***	0.18	0.30	0.42***	0.30	0.58	1.41	0.90	2.21

*** p<.01, ** p<.05, * p<.1

Appendix 3.36: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	0.93	0.86	1.02	0.93	0.85	1.02	0.94	0.85	1.03	1.01	0.92	1.11
Gender												
Female				1.81***	1.56	2.09	1.62***	1.39	1.87	1.48***	1.26	1.74
Age Group												
55-64 years				0.73***	0.60	0.90	0.73***	0.59	0.90	0.71***	0.57	0.88
65-74 years				0.66***	0.53	0.82	0.61***	0.49	0.76	0.54***	0.43	0.69
75-84 years				0.83	0.65	1.06	0.69***	0.53	0.89	0.49***	0.37	0.65
Education												
Other qualifications				0.78**	0.63	0.97	0.80*	0.64	1.00	0.93	0.74	1.18
0 Level/equivalent				0.66***	0.54	0.81	0.69***	0.56	0.84	0.86	0.70	1.07
A Level/equivalent				0.62***	0.47	0.82	0.63***	0.48	0.84	0.85	0.63	1.14
Higher qualification below degree				0.70***	0.55	0.88	0.74**	0.59	0.94	1.01	0.79	1.29
Degree/equivalent				0.69***	0.54	0.87	0.71**	0.56	0.91	1.06	0.82	1.38
Occupation												
Lower supervisory & technical occupations				0.91	0.72	1.15	0.91	0.72	1.15	0.94	0.73	1.20
Small employers and own account workers				0.68***	0.54	0.86	0.70***	0.57	0.89	0.72**	0.56	0.93
Intermediate occupations				0.62***	0.50	0.77	0.64***	0.52	0.79	0.70***	0.56	0.87
Management and professional occupations				0.55***	0.45	0.67	0.55***	0.46	0.68	0.59***	0.48	0.72
Marital Status												
Married/Partnership							0.42***	0.32	0.55	0.49***	0.37	0.64
Remarried/In Partnership before							0.58***	0.43	0.79	0.67**	0.49	0.93
Divorced/legally separated							1.02	0.76	1.38	1.01	0.75	1.37
Widowed							1.09	0.81	1.47	1.20	0.88	1.63
Smoking Status												

Ex-smoker										1.12	0.96	1.31
Current smoker										1.44***	1.18	1.76
Alcohol Intake												
Not at all in the last 12 months										1.23	0.94	1.61
Once or twice a year										1.13	0.85	1.50
Once every couple of months										0.75*	0.55	1.04
Once or twice a month										0.68**	0.50	0.91
Once or twice a week										0.61***	0.48	0.79
Three or four days a week										0.54***	0.40	0.74
Five or six days a week										0.62**	0.42	0.91
Almost every day										0.62***	0.46	0.83
Activity												
Low Activity										0.44***	0.34	0.56
Moderate Activity										0.22***	0.17	0.28
High Activity										0.17***	0.12	0.23
Constant	0.16***	0.15	0.17	0.26***	0.20	0.33	0.45***	0.33	0.63	1.54*	0.98	2.40

*** p<.01, ** p<.05, * p<.1

Appendix 3.37: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.72***	1.53	1.92	1.53***	1.36	1.73	1.47***	1.30	1.66	1.18**	1.04	1.35
Gender												
Female				1.78***	1.54	2.05	1.59***	1.38	1.85	1.49***	1.27	1.75
Age Group												
55-64 years				0.71***	0.58	0.87	0.71***	0.58	0.87	0.71***	0.57	0.88
65-74 years				0.64***	0.52	0.80	0.60***	0.48	0.74	0.53***	0.42	0.68
75-84 years				0.78**	0.61	0.99	0.65***	0.51	0.84	0.48***	0.36	0.63
Education												
Other qualifications				0.79**	0.64	0.99	0.81*	0.65	1.02	0.93	0.74	1.18

0 Level/equivalent			0.67***	0.55 0.82	0.70***	0.57 0.85	0.86	0.70 1.07
A Level/equivalent			0.63***	0.48 0.84	0.64***	0.48 0.85	0.85	0.63 1.14
Higher qualification below degree			0.73**	0.58 0.92	0.77**	0.61 0.98	1.02	0.80 1.30
Degree/equivalent			0.75**	0.59 0.96	0.77**	0.60 0.99	1.09	0.84 1.41
Occupation								
Lower supervisory & technical occupations			0.92	0.73 1.16	0.91	0.72 1.16	0.94	0.74 1.21
Small employers and own account workers			0.72**	0.57 0.91	0.74**	0.58 0.93	0.73**	0.57 0.94
Intermediate occupations			0.65***	0.52 0.80	0.66***	0.54 0.82	0.71***	0.57 0.87
Management and professional occupations			0.59***	0.48 0.72	0.59***	0.48 0.72	0.60***	0.49 0.74
Marital Status								
Married/Partnership					0.43***	0.33 0.56	0.49***	0.37 0.64
Remarried/In Partnership before					0.59***	0.43 0.80	0.67**	0.49 0.94
Divorced/legally separated					1.02	0.77 1.37	1.02	0.75 1.38
Widowed					1.08	0.81 1.46	1.19	0.87 1.62
Smoking Status								
Ex-smoker							1.11	0.94 1.30
Current smoker							1.38***	1.13 1.69
Alcohol Intake								
Not at all in the last 12 months							1.22	0.94 1.59
Once or twice a year							1.12	0.85 1.49
Once every couple of months							0.75*	0.54 1.04
Once or twice a month							0.67**	0.50 0.90
Once or twice a week							0.60***	0.48 0.80
Three or four days a week							0.62***	0.40 0.76
Five or six days a week							0.55**	0.43 0.94
Almost every day							0.63***	0.47 0.85
Activity								
Low Activity							0.44***	0.34 0.56
Moderate Activity							0.22***	0.17 0.29
High Activity							0.18***	0.13 0.24

Constant	0.14***	0.13	0.15	0.23***	0.18	0.30	0.41***	0.29	0.57	1.47*	0.94	2.30

*** p<.01, ** p<.05, * p<.1

Appendix 3.38: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Iron factor scores	0.67***	0.59	0.76	0.93	0.80	1.07	0.93	0.80	1.08	0.98	0.84	1.14
Gender												
Female				1.71***	1.46	2.01	1.54***	1.31	1.81	1.47***	1.24	1.75
Age Group												
55-64 years				0.73***	0.60	0.90	0.73***	0.60	0.90	0.71***	0.58	0.89
65-74 years				0.67***	0.54	0.83	0.61***	0.49	0.77	0.54***	0.43	0.69
75-84 years				0.84	0.66	1.07	0.69**	0.54	0.89	0.49***	0.37	0.65
Education												
Other qualifications				0.78**	0.62	0.96	0.80*	0.64	1.01	0.93	0.74	1.18
0 Level/equivalent				0.66***	0.54	0.80	0.68***	0.56	0.83	0.86	0.70	1.07
A Level/equivalent				0.62***	0.47	0.82	0.62***	0.47	0.83	0.85	0.63	1.14
Higher qualification below degree				0.69***	0.55	0.87	0.74**	0.58	0.93	1.01	0.79	1.29
Degree/equivalent				0.68***	0.53	0.86	0.70**	0.55	0.90	1.06	0.82	1.38
Occupation												
Lower supervisory & technical occupations				0.91	0.73	1.15	0.91	0.72	1.15	0.94	0.74	1.20
Small employers and own account workers				0.69***	0.54	0.87	0.71***	0.56	0.89	0.72**	0.56	0.93
Intermediate occupations				0.62***	0.50	0.76	0.63***	0.51	0.79	0.70***	0.56	0.87
Management and professional occupations				0.55***	0.45	0.67	0.56***	0.46	0.68	0.59***	0.48	0.73
Marital Status												
Married/Partnership							0.42***	0.32	0.55	0.49***	0.37	0.64
Remarried/In Partnership before							0.58***	0.43	0.79	0.67**	0.49	0.93

Divorced/legally separated							1.02	0.76	1.36	1.01	0.75	1.37
Widowed							1.10	0.82	1.47	1.20	0.88	1.63
Smoking Status												
Ex-smoker										1.12	0.96	1.31
Current smoker										1.44***	1.18	1.76
Alcohol Intake												
Not at all in the last 12 months										1.23	0.94	1.60
Once or twice a year										1.13	0.85	1.50
Once every couple of months										0.75*	0.55	1.04
Once or twice a month										0.68**	0.50	0.91
Once or twice a week										0.61***	0.48	0.79
Three or four days a week										0.54***	0.40	0.74
Five or six days a week										0.62**	0.42	0.91
Almost every day										0.62***	0.47	0.84
Activity												
Low Activity										0.44***	0.34	0.56
Moderate Activity										0.22***	0.17	0.28
High Activity										0.17***	0.12	0.23
Constant	0.14***	0.13	0.15	0.26***	0.20	0.33	0.46***	0.33	0.63	1.53*	0.98	2.39

*** p<.01, ** p<.05, * p<.1

Appendix 3.39: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	**ELSA**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Glucose Metabolism factor scores	0.57***	0.47	0.70	0.61***	0.50	0.76	0.64***	0.51	0.79	0.89	0.70	1.12
Gender												
Female				1.81***	1.57	2.09	1.62***	1.40	1.88	1.50***	1.28	1.75
Age Group												
55-64 years				0.71***	0.58	0.87	0.71***	0.58	0.88	0.71***	0.57	0.88

65-74 years			0.63***	0.51 0.79	0.59***	0.47 0.73	0.54***	0.42 0.68
75-84 years			0.79*	0.62 1.01	0.66***	0.51 0.85	0.48***	0.37 0.64
Education								
Other qualifications			0.79**	0.63 0.98	0.81*	0.65 1.01	0.94	0.74 1.18
0 Level/equivalent			0.67***	0.55 0.82	0.70***	0.57 0.85	0.87	0.70 1.07
A Level/equivalent			0.63***	0.48 0.84	0.64***	0.48 0.85	0.85	0.64 1.15
Higher qualification below degree			0.71***	0.57 0.90	0.76**	0.60 0.96	1.02	0.79 1.30
Degree/equivalent			0.71**	0.56 0.90	0.73**	0.57 0.94	1.07	0.82 1.38
Occupation								
Lower supervisory & technical occupations			0.92	0.73 1.16	0.91	0.72 1.15	0.94	0.74 1.20
Small employers and own account workers			0.69***	0.55 0.87	0.71**	0.56 0.90	0.72**	0.56 0.93
Intermediate occupations			0.63***	0.51 0.79	0.65***	0.53 0.81	0.70***	0.56 0.88
Management and professional occupations			0.56***	0.46 0.68	0.56***	0.46 0.68	0.59***	0.48 0.73
Marital Status								
Married/Partnership					0.42***	0.32 0.55	0.49***	0.37 0.64
Remarried/In Partnership before					0.58***	0.43 0.79	0.67**	0.49 0.93
Divorced/legally separated					1.01	0.76 1.35	1.01	0.74 1.37
Widowed					1.09	0.81 1.46	1.19	0.87 1.62
Smoking Status								
Ex-smoker							1.12	0.95 1.31
Current smoker							1.43***	1.17 1.75
Alcohol Intake								
Not at all in the last 12 months							1.23	0.94 1.60
Once or twice a year							1.13	0.85 1.50
Once every couple of months							0.75*	0.54 1.04
Once or twice a month							0.68**	0.50 0.91
Once or twice a week							0.62***	0.48 0.80
Three or four days a week							0.55***	0.40 0.75
Five or six days a week							0.62**	0.42 0.92
Almost every day							0.63***	0.47 0.84

Activity											
Low Activity									0.44***	0.34	0.56
Moderate Activity									0.22***	0.17	0.28
High Activity									0.17***	0.13	0.23
Constant	0.15***	0.15	0.17	0.25***	0.20	0.32	0.45***	0.32	0.62	1.52*	0.97	2.38

*** p<.01, ** p<.05, * p<.1

Appendix 3.40: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	ELSA											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.06*	0.97	1.12	1.04	0.98	1.11	1.04	0.97	1.11	1.03	0.96	1.10
Gender												
Female				1.78***	1.54	2.06	1.60***	1.38	1.85	1.49***	1.27	1.75
Age Group												
55-64 years				0.72***	0.59	0.89	0.72***	0.59	0.89	0.71***	0.59	0.88
65-74 years				0.65***	0.52	0.81	0.60***	0.47	0.75	0.53***	0.42	0.67
75-84 years				0.81	0.63	1.04	0.66***	0.51	0.87	0.47***	0.35	0.63
Education												
Other qualifications				0.78**	0.63	0.97	0.80*	0.64	1.00	0.94	0.74	1.18
0 Level/equivalent				0.66***	0.54	0.81	0.69***	0.56	0.84	0.87	0.70	1.07
A Level/equivalent				0.62***	0.47	0.82	0.63***	0.48	0.84	0.85	0.64	1.15
Higher qualification below degree				0.70***	0.55	0.88	0.74**	0.59	0.93	1.01	0.79	1.29
Degree/equivalent				0.69***	0.54	0.87	0.71**	0.56	0.91	1.07	0.82	1.39
Occupation												
Lower supervisory & technical occupations				0.91	0.72	1.14	0.91	0.72	1.14	0.94	0.73	1.20
Small employers and own account workers				0.68***	0.54	0.86	0.70***	0.55	0.89	0.72**	0.56	0.93
Intermediate occupations				0.62***	0.50	0.77	0.64***	0.52	0.79	0.70***	0.56	0.87

Management and professional occupations			0.55***	0.45 0.67	0.55***	0.45 0.67	0.59***	0.48 0.73
Marital Status								
Married/Partnership					0.42***	0.32 0.54	0.49***	0.37 0.64
Remarried/In Partnership before					0.58***	0.43 0.79	0.67**	0.49 0.93
Divorced/legally separated					1.02	0.76 1.36	1.01	0.75 1.37
Widowed					1.09	0.81 1.47	1.19	0.88 1.63
Smoking Status								
Ex-smoker							1.12	0.96 1.31
Current smoker							1.44***	1.18 1.76
Alcohol Intake								
Not at all in the last 12 months							1.24	0.95 1.61
Once or twice a year							1.13	0.85 1.50
Once every couple of months							0.75*	0.55 1.04
Once or twice a month							0.68**	0.51 0.91
Once or twice a week							0.62***	0.48 0.80
Three or four days a week							0.55***	0.40 0.74
Five or six days a week							0.62**	0.42 0.91
Almost every day							0.62***	0.46 0.83
Activity								
Low Activity							0.44***	0.34 0.56
Moderate Activity							0.22***	0.17 0.28
High Activity							0.17***	0.12 0.23
Constant	0.16***	0.15 0.17	0.26***	0.21 0.34	0.46***	0.33 0.64	1.55*	0.99 2.42

*** p<.01, ** p<.05, * p<.1

Appendix 3.41: Logistics regression using ELSA Data and adjusting for education and occupation

Variables	**ELSA**							
Mental Health	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
	Odds ratio	[Conf. interval]	Odds ratio	[Conf. interval]	Odds ratio	[Conf. interval]	Odds ratio	[Conf. interval]
Factor Scores								

Neuroendocrine factor scores	0.40***	0.33	0.50	0.60***	0.47	0.78	0.61***	0.46	0.80	0.75*	0.57	1.00
Gender												
Female				1.55***	1.32	1.82	1.39***	1.18	1.64	1.38***	1.16	1.65
Age Group												
55-64 years				0.71***	0.58	0.87	0.71***	0.58	0.87	0.70***	0.56	0.87
65-74 years				0.62***	0.50	0.77	0.57***	0.45	0.71	0.52***	0.41	0.66
75-84 years				0.75**	0.58	0.96	0.62***	0.47	0.80	0.46***	0.34	0.61
Education												
Other qualifications				0.77**	0.62	0.96	0.80*	0.64	1.01	0.93	0.73	1.18
0 Level/equivalent				0.66***	0.54	0.80	0.69***	0.56	0.84	0.86	0.70	1.07
A Level/equivalent				0.62***	0.47	0.81	0.62***	0.47	0.83	0.85	0.63	1.14
Higher qualification below degree				0.70***	0.56	0.88	0.74**	0.59	0.94	1.01	0.79	1.29
Degree/equivalent				0.69***	0.54	0.88	0.72**	0.56	0.92	1.07	0.83	1.39
Occupation												
Lower supervisory & technical occupations				0.92	0.73	1.16	0.92	0.72	1.16	0.94	0.74	1.21
Small employers and own account workers				0.69***	0.55	0.87	0.71**	0.56	0.90	0.73**	0.57	0.93
Intermediate occupations				0.59***	0.48	0.73	0.61***	0.49	0.76	0.68***	0.54	0.85
Management and professional occupations				0.56***	0.46	0.68	0.56***	0.46	0.68	0.59***	0.48	0.73
Marital Status												
Married/Partnership							0.42***	0.32	0.55	0.49***	0.37	0.64
Remarried/In Partnership before							0.59***	0.43	0.80	0.67**	0.49	0.93
Divorced/legally separated							1.02	0.76	1.36	1.01	0.74	1.37
Widowed							1.10	0.82	1.48	1.20	0.88	1.64
Smoking Status												
Ex-smoker										1.12	0.95	1.31
Current smoker										1.45***	1.19	1.78
Alcohol Intake												
Not at all in the last 12 months										1.23	0.94	1.61

Once or twice a year										1.14	0.85	1.51
Once every couple of months										0.75*	0.54	1.04
Once or twice a month										0.68**	0.51	0.91
Once or twice a week										0.62***	0.48	0.80
Three or four days a week										0.55***	0.40	0.75
Five or six days a week										0.62**	0.42	0.92
Almost every day										0.63***	0.47	0.84
Activity												
Low Activity										0.44***	0.34	0.57
Moderate Activity										0.22***	0.17	0.28
High Activity										0.17***	0.13	0.23
Constant	0.14***	0.13	0.15	0.28***	0.22	0.36	0.49***	0.35	0.68	1.57*	1.01	2.46

*** p<.01, ** p<.05, * p<.1

Appendix 3.42: Logistics regression using UKHLS Data and adjusting for education and occupation

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	0.94**	0.90	0.99	1.01	0.96	1.07	1.02	0.96	1.07	1.01	0.96	1.07
Gender												
Female				1.57***	1.43	1.71	1.55***	1.42	1.70	1.55***	1.41	1.70
Age Group												
25-32 years				1.30**	1.08	1.56	1.49***	1.22	1.82	1.49***	1.22	1.82
35-44 years				1.33***	1.11	1.59	1.56***	1.27	1.91	1.58***	1.29	1.94
45-54 years				1.55***	1.29	1.85	1.81***	1.48	2.22	1.83***	1.49	2.25
55-64 years				1.17	0.96	1.41	1.37**	1.11	1.70	1.39***	1.12	1.74
65-74 years				0.60***	0.43	0.82	0.71**	0.51	0.98	0.72*	0.51	1.01
75-84 years				0.66	0.32	1.35	0.78	0.37	1.62	0.63	0.28	1.41
Education												
Other qualifications				0.99	0.79	1.24	0.99	0.79	1.24	1.02	0.80	1.29
0 Level/equivalent				0.90	0.73	1.10	0.89	0.72	1.09	0.91	0.73	1.12
A Level/equivalent				0.92	0.75	1.14	0.91	0.74	1.13	0.95	0.77	1.18

Higher qualification below degree				0.967	0.77	1.19	0.95	0.76	1.19	0.99	0.79	1.24
Degree/equivalent				0.89	0.72	1.10	0.88	0.71	1.09	0.94	0.76	1.18
Occupation												
Lower supervisory & technical occupations				0.84*	0.70	1.00	0.84*	0.71	1.00	0.83*	0.69	1.00
Small employers and own account workers				0.87*	0.74	1.02	0.88	0.75	1.04	0.87	0.74	1.03
Intermediate occupations				0.92	0.80	1.06	0.93	0.81	1.06	0.93	0.81	1.07
Management and professional occupations				0.92	0.82	1.03	0.93	0.83	1.05	0.94	0.84	1.06
Marital Status												
Married/Partnership							0.75***	0.66	0.86	0.75***	0.66	0.86
Divorced/legally separated							0.97	0.81	1.17	0.95	0.79	1.15
Widowed							0.73	0.49	1.07	0.75	0.50	1.11
Smoking Status												
Ex-smoker										1.08	0.97	1.18
Current smoker										1.23***	1.09	1.38
Alcohol Intake												
Not at all in the last 12 months										1.47*	0.97	2.23
Once or twice a year										1.47*	1.01	2.18
Once every couple of months										1.26	0.86	1.86
Once or twice a month										1.17	0.80	1.69
Once or twice a week										1.02	0.71	1.47
Three or four days a week										1.06	0.73	1.54
Five or six days a week										1.35	0.91	2.00
Almost every day										1.29	0.87	1.89
Activity												
Low Activity										1.01	0.87	1.18
Moderate Activity										0.92	0.79	1.07
High Activity										0.82**	0.70	0.95
Constant	0.53***	0.52	0.56	0.38***	0.29	0.48	0.41***	0.32	0.52	0.34***	0.22	0.53

*** p<.01, ** p<.05, * p<.1

Appendix 3.43: Logistics regression using UKHLS Data and adjusting for education and occupation

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	0.90	0.77	1.04	1.13	0.95	1.34	1.14	0.96	1.35	1.13	0.94	1.34
Gender												
Female				1.59***	1.45	1.73	1.57***	1.44	1.72	1.57***	1.43	1.72
Age Group												
25-32 years				1.29**	1.07	1.55	1.49***	1.22	1.81	1.48***	1.21	1.81
35-44 years				1.32***	1.10	1.57	1.55***	1.27	1.89	1.56***	1.28	1.92
45-54 years				1.53***	1.28	1.83	1.79***	1.46	2.19	1.80***	1.47	2.22
55-64 years				1.15	0.95	1.39	1.36**	1.09	1.68	1.38**	1.10	1.71
65-74 years				0.59***	0.43	0.81	0.70**	0.50	0.98	0.71**	0.51	0.99
75-84 years				0.65	0.32	1.34	0.77	0.37	1.61	0.62	0.29	1.40
Education												
Other qualifications				0.99	0.79	1.24	0.99	0.79	1.25	1.02	0.80	1.29
0 Level/equivalent				0.90	0.73	1.10	0.89	0.72	1.09	0.91	0.73	1.12
A Level/equivalent				0.92	0.75	1.14	0.91	0.74	1.13	0.95	0.77	1.18
Higher qualification below degree				0.96	0.76	1.19	0.95	0.76	1.19	0.99	0.79	1.24
Degree/equivalent				0.89**	0.72	1.10	0.88	0.72	1.09	0.95	0.76	1.18
Occupation												
Lower supervisory & technical occupations				0.84*	0.70	1.00	0.84*	0.71	1.00	0.83*	0.69	1.00
Small employers and own account workers				0.87*	0.74	1.02	0.88	0.75	1.04	0.87	0.74	1.03
Intermediate occupations				0.92	0.81	1.06	0.93	0.81	1.07	0.93	0.81	1.07
Management and professional occupations				0.92	0.82	1.04	0.93	0.83	1.05	0.94	0.84	1.06
Marital Status												
Married/Partnership							0.75***	0.65	0.86	0.75***	0.66	0.86
Divorced/legally separated							0.97	0.81	1.17	0.95	0.79	1.15
Widowed							0.72	0.49	1.06	0.75	0.50	1.11

Smoking Status												
Ex-smoker										1.08	0.98	1.18
Current smoker										1.22***	1.09	1.37
Alcohol Intake												
Not at all in the last 12 months										1.46*	0.96	2.22
Once or twice a year										1.47*	0.99	2.17
Once every couple of months										1.25	0.85	1.84
Once or twice a month										1.16	0.80	1.69
Once or twice a week										1.02	0.71	1.47
Three or four days a week										1.06	0.73	1.54
Five or six days a week										1.35	0.91	2.00
Almost every day										1.28	0.87	1.89
Activity												
Low Activity										1.01	0.87	1.18
Moderate Activity										0.92	0.79	1.07
High Activity										0.82**	0.71	0.95
Constant	0.54***	0.52	0.56	0.38***	0.30	0.49	0.41***	0.32	0.52	0.34***	0.22	0.54

*** p<.01, ** p<.05, * p<.1

Appendix 3.44: Logistics regression using UKHLS Data and adjusting for education and occupation

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.06**	1.01	1.11	1.03	0.98	1.09	1.03	0.98	1.09	1.02	0.97	1.07
Gender												
Female				1.55***	1.43	1.69	1.54***	1.41	1.67	1.54***	1.41	1.68
Age Group												
25-32 years				1.29**	1.07	1.56	1.49***	1.22	1.82	1.49***	1.21	1.82
35-44 years				1.32***	1.11	1.58	1.56***	1.27	1.90	1.58***	1.29	1.93
45-54 years				1.54***	1.29	1.84	1.81***	1.48	2.21	1.82***	1.48	2.24
55-64 years				1.16	0.96	1.40	1.36***	1.10	1.69	1.39***	1.12	1.73
65-74 years				0.59***	0.43	0.81	0.70**	0.50	0.98	0.71**	0.51	1.00

75-84 years				0.65	0.31	1.33	0.77	0.37	1.60	0.62	0.28	1.40
Education												
Other qualifications				0.99	0.79	1.25	0.99	0.79	1.25	1.02	0.80	1.29
0 Level/equivalent				0.90	0.73	1.11	0.89	0.73	1.10	0.91	0.74	1.13
A Level/equivalent				0.92	0.75	1.14	0.92	0.74	1.13	0.96	0.77	1.19
Higher qualification below degree				0.96	0.77	1.20	0.96	0.77	1.19	0.99	0.79	1.24
Degree/equivalent				0.90	0.72	1.11	0.89	0.72	1.10	0.95	0.76	1.18
Occupation												
Lower supervisory & technical occupations				0.84*	0.70	1.00	0.84*	0.71	1.01	0.83*	0.69	1.00
Small employers and own account workers				0.87*	0.74	1.03	0.89	0.75	1.04	0.87	0.74	1.03
Intermediate occupations				0.92	0.81	1.06	0.93	0.81	1.06	0.93	0.81	1.07
Management and professional occupations				0.93	0.82	1.04	0.94	0.83	1.05	0.95	0.84	1.07
Marital Status												
Married/Partnership							0.75***	0.66	0.86	0.75***	0.66	0.86
Divorced/legally separated							0.97	0.81	1.17	0.95	0.79	1.15
Widowed							0.72	0.49	1.06	0.75	0.50	1.11
Smoking Status												
Ex-smoker										1.08	0.98	1.18
Current smoker										1.22***	1.09	1.38
Alcohol Intake												
Not at all in the last 12 months										1.47*	0.97	2.23
Once or twice a year										1.47*	1.00	2.18
Once every couple of months										1.26	0.86	1.85
Once or twice a month										1.17	0.81	1.69
Once or twice a week										1.02	0.71	1.47
Three or four days a week										1.06	0.73	1.54
Five or six days a week										1.35	0.91	2.01
Almost every day										1.28	0.87	1.90
Activity												
Low Activity										1.01	0.87	1.18

Moderate Activity									0.92	0.79	1.07
High Activity									0.82**	0.71	0.95
Constant	0.54***	0.52	0.56	0.38***	0.29	0.48	0.40***	0.31	0.52	0.34***	0.22	0.53

*** p<.01, ** p<.05, * p<.1

Appendix 3.45: Logistics regression using UKHLS Data and adjusting for education and occupation

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Iron factor scores	0.81***	0.76	0.87	0.99	0.91	1.09	1.00	0.92	1.10	1.00	0.92	1.10
Gender												
Female				1.55***	1.40	1.71	1.54***	1.40	1.71	1.55***	1.39	1.71
Age Group												
25-32 years				1.30**	1.08	1.57	1.50***	1.23	1.83	1.44***	1.22	1.83
35-44 years				1.34***	1.12	1.60	1.57***	1.29	1.92	1.52***	1.29	1.94
45-54 years				1.56***	1.31	1.87	1.83***	1.49	2.24	1.74***	1.49	2.26
55-64 years				1.18	0.97	1.43	1.38***	1.12	1.72	1.32**	1.12	1.75
65-74 years				0.60***	0.44	0.83	0.71**	0.51	0.99	0.70**	0.51	1.01
75-84 years				0.66	0.32	1.37	0.79	0.38	1.64	0.70	0.28	1.42
Education												
Other qualifications				0.99	0.79	1.24	0.99	0.79	1.24	0.97	0.80	1.29
0 Level/equivalent				0.90	0.73	1.10	0.89	0.72	1.09	0.87	0.73	1.12
A Level/equivalent				0.92	0.75	1.14	0.91	0.74	1.12	0.91	0.77	1.18
Higher qualification below degree				0.96	0.77	1.19	0.95	0.76	1.19	0.93	0.79	1.24
Degree/equivalent				0.89	0.72	1.10	0.88	0.71	1.09	0.88	0.76	1.18
Occupation												
Lower supervisory & technical occupations				0.84*	0.70	1.00	0.84*	0.70	1.00	0.83*	0.69	1.00
Small employers and own account workers				0.87*	0.74	1.02	0.88	0.75	1.03	0.87	0.74	1.03
Intermediate occupations				0.92	0.80	1.06	0.93	0.81	1.06	0.93	0.81	1.07
Management and professional occupations				0.92	0.82	1.04	0.93	0.83	1.05	0.94	0.84	1.06

Marital Status												
Married/Partnership							0.75***	0.66	0.86	0.75***	0.66	0.86
Divorced/legally separated							0.97	0.81	1.17	0.96	0.79	1.15
Widowed							0.73	0.50	1.07	0.79	0.50	1.11
Smoking Status												
Ex-smoker										1.08	0.98	1.18
Current smoker										1.23***	1.09	1.38
Alcohol Intake												
Not at all in the last 12 months										1.47*	0.97	2.23
Once or twice a year										1.47*	1.00	2.18
Once every couple of months										1.26	0.86	1.85
Once or twice a month										1.17	0.80	1.69
Once or twice a week										1.02	0.71	1.47
Three or four days a week										1.06	0.73	1.54
Five or six days a week										1.35	0.91	2.00
Almost every day										1.28	0.86	1.89
Activity												
Low Activity										1.01	0.87	1.18
Moderate Activity										0.92	0.79	1.07
High Activity										0.82**	0.70	0.94
Constant	0.51***	0.49	0.54	0.38***	0.29	0.48	0.41***	0.31	0.52	0.34***	0.22	0.53

*** p<.01, ** p<.05, * p<.1

Appendix 3.46: Logistics regression using UKHLS Data and adjusting for education and occupation

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.02***	1.01	1.04	1.01	1.01	1.02	1.01	1.01	1.02	1.01*	1.00	1.03
Gender												
Female				1.55***	1.42	1.69	1.53***	1.40	1.67	1.53***	1.40	1.67

Age Group								
25-32 years			1.29**	1.07 1.55	1.49***	1.22 1.82	1.48***	1.21 1.81
35-44 years			1.32***	1.10 1.58	1.55***	1.27 1.89	1.56***	1.27 1.91
45-54 years			1.54***	1.29 1.84	1.81***	1.48 2.21	1.81***	1.47 2.22
55-64 years			1.17	0.97 1.41	1.39***	1.11 1.71	1.39***	1.12 1.73
65-74 years			0.60***	0.44 0.82	0.72*	0.52 1.00	0.73*	0.52 1.02
75-84 years			0.68	0.33 1.40	0.81	0.39 1.69	0.66	0.29 1.48
Education								
Other qualifications			0.99	0.79 1.24	0.99	0.79 1.24	1.01	0.80 1.28
0 Level/equivalent			0.90	0.73 1.10	0.89	0.72 1.09	0.91	0.73 1.12
A Level/equivalent			0.92	0.75 1.13	0.91	0.74 1.12	0.95	0.77 1.18
Higher qualification below degree			0.95	0.77 1.19	0.95	0.76 1.18	0.99	0.78 1.24
Degree/equivalent			0.88**	0.72 1.09	0.88	0.71 1.09	0.94	0.75 1.18
Occupation								
Lower supervisory & technical occupations			0.84*	0.70 1.00	0.84*	0.70 1.00	0.83**	0.69 0.99
Small employers and own account workers			0.87*	0.74 1.02	0.88	0.75 1.04	0.87	0.74 1.03
Intermediate occupations			0.92	0.80 1.06	0.93	0.81 1.06	0.93	0.81 1.07
Management and professional occupations			0.88	0.82 1.04	0.93	0.83 1.05	0.95	0.84 1.07
Marital Status								
Married/Partnership					0.75***	0.66 0.86	0.75***	0.66 0.86
Divorced/legally separated					0.97	0.80 1.16	0.95	0.79 1.14
Widowed					0.73	0.50 1.07	0.75	0.50 1.11
Smoking Status								
Ex-smoker							1.08	0.98 1.19
Current smoker							1.24***	1.10 1.40
Alcohol Intake								
Not at all in the last 12 months							1.46*	0.96 2.22
Once or twice a year							1.47*	1.01 2.18
Once every couple of months							1.25	0.85 1.84
Once or twice a month							1.16	0.80 1.69

Once or twice a week										1.02	0.70	1.46
Three or four days a week										1.05	0.72	1.53
Five or six days a week										1.34	0.90	1.99
Almost every day										1.27	0.86	1.88
Activity												
Low Activity										1.01	0.87	1.18
Moderate Activity										0.92	0.79	1.07
High Activity										0.81**	0.70	0.94
Constant	0.54***	0.52	0.56	0.38***	0.29	0.49	0.41***	0.32	0.53	0.35***	0.22	0.54

*** p<.01, ** p<.05, * p<.1

Appendix 3.47: Logistics regression using UKHLS Data and adjusting for education and occupation

Variables	**UKHLS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Neuroendocrine factor scores	0.67***	0.58	0.77	0.79**	0.67	0.93	0.78**	0.66	0.93	0.80**	0.67	0.94
Gender												
Female				1.49***	1.36	1.63	1.47***	1.34	1.61	1.48***	1.35	1.62
Age Group												
25-34 years				1.28**	1.06	1.54	1.47***	1.21	1.80	1.47***	1.20	1.80
35-44 years				1.29**	1.08	1.54	1.52***	1.24	1.85	1.53***	1.25	1.88
45-54 years				1.49***	1.24	1.78	1.74***	1.42	2.14	1.76***	1.43	2.16
55-64 years				1.10	0.91	1.33	1.30**	1.04	1.61	1.32**	1.05	1.65
65-74 years				0.55***	0.40	0.76	0.65**	0.47	0.91	0.66**	0.50	0.93
75-84 years				0.61	0.29	1.26	0.72	0.35	1.51	0.58	0.26	1.31
Education												
Other qualifications				0.99	0.79	1.25	0.99	0.79	1.25	1.01	0.80	1.29
0 Level/equivalent				0.90	0.73	1.11	0.90	0.73	1.10	0.91	0.74	1.13
A Level/equivalent				0.93	0.75	1.14	0.92	0.74	1.13	0.96	0.77	1.19
Higher qualification below degree				0.96	0.77	1.20	0.95	0.76	1.19	0.99	0.79	1.24
Degree/equivalent				0.89	0.72	1.10	0.88	0.71	1.09	0.94	0.76	1.18

Occupation												
Lower supervisory & technical occupations				0.84*	0.71	1.01	0.85*	0.71	1.01	0.84**	0.70	1.00
Small employers and own account workers				0.87	0.74	1.02	0.88	0.75	1.04	0.89	0.74	1.04
Intermediate occupations				0.91	0.79	1.04	0.92	0.80	1.05	0.92	0.80	1.06
Management and professional occupations				0.92	0.82	1.04	0.93	0.83	1.05	0.95	0.84	1.07
Marital Status												
Married/Partnership							0.75***	0.66	0.86	0.75***	0.66	0.86
Divorced/legally separated							0.97	0.81	1.17	0.95	0.79	1.15
Widowed							0.72	0.49	1.06	0.75	0.50	1.11
Smoking Status												
Ex-smoker										1.08	0.98	1.18
Current smoker										1.23***	1.09	1.38
Alcohol Intake												
Not at all in the last 12 months										1.46*	0.95	2.22
Once or twice a year										1.47*	0.99	2.17
Once every couple of months										1.26	0.84	1.85
Once or twice a month										1.17	0.79	1.69
Once or twice a week										1.02	0.71	1.47
Three or four days a week										1.06	0.73	1.54
Five or six days a week										1.35	0.90	2.01
Almost every day										1.29	0.87	1.90
Activity												
Low Activity										1.01	0.88	1.18
Moderate Activity										0.92	0.81	1.07
High Activity										0.82**	0.72	0.95
Constant	0.53***	0.51	0.55	0.39***	0.31	0.51	0.43***	0.33	0.55	0.36***	0.23	0.56

*** p<.01, ** p<.05, * p<.1

Appendix 3.48: Logistics regression using NCDS Data and adjusting for education and occupation

Variables	**NCDS**

Mental Health	Model 1			Model 2			Model 3			Model 4		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	0.98	0.90	1.06	1.02	0.93	1.12	1.03	0.93	1.13	1.02	0.92	1.12
Gender												
Female				2.03***	1.71	2.39	2.01***	1.69	2.38	1.20***	1.67	2.39
Education												
Other qualifications				1.08	0.82	1.41	1.11	0.84	1.45	1.11	0.83	1.48
0 Level/equivalent				0.89	0.70	1.13	0.94	0.74	1.20	0.98	0.76	1.27
A Level/equivalent				0.65**	0.45	0.92	0.64**	0.45	0.93	0.71*	0.48	1.04
Higher qualification below degree				1.14	0.77	1.68	1.21	0.81	1.80	1.23	0.81	1.85
Degree/equivalent				0.71**	0.53	0.96	0.77*	0.57	1.04	0.81	0.59	1.13
Occupation												
Lower supervisory & technical occupations				0.93	0.70	1.23	0.87	0.65	1.16	0.90	0.66	1.21
Small employers and own account workers				0.78	0.57	1.05	0.77*	0.56	1.04	0.82	0.60	1.13
Intermediate occupations				0.99	0.76	1.28	0.98	0.75	1.27	1.01	0.76	1.32
Management and professional occupations				0.72***	0.57	0.90	0.67***	0.55	0.86	0.75**	0.59	0.95
Marital Status												
Married/Partnership							0.81	0.62	1.06	0.88	0.66	1.17
Remarried							0.97	0.71	1.34	1.03	0.74	1.44
Divorced/legally separated Widowed							1.02	0.75	1.40	1.07	0.77	1.49
Smoking Status												
Ex-smoker										1.13	0.93	1.36
Current smoker										1.17	0.95	1.45
Alcohol Intake												
Once a month or less										0.74	0.52	1.07
Two to four times a month										0.62**	0.43	0.88
Two or three times a week										0.61***	0.43	0.86
Four or more times a week										0.74*	0.52	1.05

Activity												
Less than once a month										0.86	0.71	1.04
Once a month										0.90	0.65	1.24
2 to 3 times a month										0.79	0.54	1.16
Once a week										0.79	0.55	1.14
More than once a week										0.66	0.40	1.09
Constant	0.17***	0.15	0.18	0.13***	0.10	0.16	0.14***	0.10	0.20	0.18***	0.11	0.29

*** p<.01, ** p<.05, * p<.1

Appendix 3.49: Logistics regression using NCDS Data and adjusting for education and occupation

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	1.05	0.97	1.13	1.03	0.95	1.12	1.04	0.95	1.13	1.03	0.94	1.13
Gender												
Female				2.03***	1.72	2.40	2.01***	1.70	2.38	2.00***	1.68	2.39
Education												
Other qualifications				1.07	0.82	1.41	1.11	0.84	1.45	1.11	0.83	1.48
0 Level/equivalent				0.89	0.70	1.13	0.94	0.74	1.20	0.98	0.76	1.27
A Level/equivalent				0.65**	0.45	0.93	0.64**	0.45	0.93	0.71*	0.48	1.04
Higher qualification below degree				1.14	0.77	1.69	1.22	0.82	1.81	1.23	0.82	1.86
Degree/equivalent				0.72**	0.53	0.97	0.77*	0.57	1.04	0.81	0.59	1.13
Occupation												
Lower supervisory & technical occupations				0.93	0.70	1.24	0.87	0.65	1.17	0.90	0.66	1.22
Small employers and own account workers				0.78	0.57	1.06	0.77	0.57	1.05	0.82	0.60	1.13
Intermediate occupations				0.99	0.76	1.29	0.98	0.75	1.28	1.00	0.76	1.32
Management and professional occupations				0.72***	0.57	0.90	0.69***	0.55	0.86	0.75**	0.59	0.95
Marital Status												
Married/Partnership							0.81	0.62	1.06	0.88	0.66	1.17
Remarried							0.98	0.71	1.34	1.03	0.74	1.44

Divorced/legally separated Widowed							1.03	0.75	1.40	1.07	0.77	1.49
Smoking Status												
Ex-smoker										1.13	0.93	1.36
Current smoker										1.17	0.95	1.45
Alcohol Intake												
Once a month or less										0.74	0.52	1.07
Two to four times a month										0.62**	0.43	0.88
Two or three times a week										0.61***	0.43	0.85
Four or more times a week										0.73*	0.52	1.04
Activity												
Less than once a month										0.86	0.71	1.04
Once a month										0.90	0.66	1.24
2 to 3 times a month										0.79	0.54	1.16
Once a week										0.79	0.55	1.14
More than once a week										0.66	0.40	1.09
Constant	0.17***	0.16	0.18	0.13***	0.10	0.16	0.14***	0.10	0.20	0.18***	0.11	0.29

*** p<.01, ** p<.05, * p<.1

Appendix 3.50: Logistics regression using NCDS Data and adjusting for education and occupation

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	0.86**	0.75	0.98	0.91	0.78	1.06	0.90	0.77	1.05	0.87*	0.74	1.02
Gender												
Female				2.03***	1.71	2.40	2.01***	1.69	2.38	2.00***	1.68	2.39
Education												
Other qualifications				1.07	0.82	1.40	1.10	0.84	1.45	1.11	0.83	1.48
0 Level/equivalent				0.89	0.70	1.13	0.94	0.74	1.20	0.98	0.76	1.27
A Level/equivalent				0.64**	0.45	0.92	0.64**	0.44	0.93	0.70*	0.48	1.03
Higher qualification below degree				1.14	0.77	1.69	1.22	0.82	1.81	1.23	0.82	1.86
Degree/equivalent				0.71**	0.53	0.96	0.76*	0.56	1.04	0.81	0.58	1.12

Occupation								
Lower supervisory & technical occupations			0.93	0.70 1.24	0.87	0.65 1.17	0.90	0.66 1.22
Small employers and own account workers			0.78	0.57 1.06	0.77	0.57 1.05	0.83	0.60 1.14
Intermediate occupations			0.99	0.76 1.29	0.98	0.75 1.28	1.01	0.76 1.33
Management and professional occupations			0.72***	0.57 0.90	0.69***	0.55 0.86	0.75**	0.60 0.95
Marital Status								
Married/Partnership					0.81	0.62 1.06	0.88	0.67 1.17
Remarried					0.97	0.71 1.34	1.03	0.74 1.44
Divorced/legally separated Widowed					1.02	0.74 1.39	1.07	0.77 1.48
Smoking Status								
Ex-smoker							1.12	0.93 1.36
Current smoker							1.17	0.95 1.45
Alcohol Intake								
Once a month or less							0.73*	0.51 1.05
Two to four times a month							0.61**	0.43 0.87
Two or three times a week							0.60***	0.43 0.85
Four or more times a week							0.73*	0.51 1.03
Activity								
Less than once a month							0.86	0.71 1.04
Once a month							0.90	0.65 1.24
2 to 3 times a month							0.79	0.54 1.15
Once a week							0.79	0.55 1.14
More than once a week							0.65*	0.40 1.07
Constant	0.17***	0.16 0.18	0.13***	0.10 0.16	0.14***	0.10 0.20	0.18***	0.11 0.29

*** p<.01, ** p<.05, * p<.1

Appendix 3.51: Logistics regression using NCDS Data and adjusting for education and occupation

Variables	**NCDS**							
Mental Health	**Model 1**		**Model 2**		**Model 3**		**Model 4**	
	Odds ratio	[Conf. interval]	Odds ratio	[Conf. interval]	Odds ratio	[Conf. interval]	Odds ratio	[Conf. interval]

Factor Scores								
Cardiovascular factor scores	1.04	0.96 1.12	1.08	0.99 1.18	1.09*	0.99 1.19	1.07	0.97 1.17
Gender								
Female			2.02***	1.71 2.39	2.00***	1.69 2.38	2.01***	1.67 2.39
Education								
Other qualifications			1.08	0.83 1.41	1.11	0.85 1.46	1.11	0.83 1.49
0 Level/equivalent			0.89	0.70 1.13	0.94	0.74 1.20	0.98	0.76 1.27
A Level/equivalent			0.65**	0.45 0.93	0.65**	0.44 0.94	0.71*	0.48 1.04
Higher qualification below degree			1.14	0.77 1.69	1.22	0.82 1.81	1.23	0.82 1.86
Degree/equivalent			0.71**	0.53 0.96	0.77*	0.56 1.04	0.81	0.59 1.13
Occupation								
Lower supervisory & technical occupations			0.93	0.70 1.23	0.87	0.65 1.16	0.90	0.66 1.21
Small employers and own account workers			0.78	0.57 1.05	0.77*	0.57 1.05	0.82	0.60 1.13
Intermediate occupations			0.99	0.76 1.29	0.98	0.75 1.28	1.00	0.76 1.33
Management and professional occupations			0.72***	0.57 0.90	0.69***	0.55 0.86	0.75**	0.60 0.95
Marital Status								
Married/Partnership					0.81	0.62 1.06	0.88	0.66 1.17
Remarried					0.97	0.71 1.34	1.03	0.74 1.44
Divorced/legally separated Widowed					1.02	0.75 1.39	1.07	0.77 1.49
Smoking Status								
Ex-smoker							1.12	0.93 1.36
Current smoker							1.18	0.95 1.46
Alcohol Intake								
Once a month or less							0.74	0.52 1.07
Two to four times a month							0.62**	0.43 0.88
Two or three times a week							0.61**	0.43 0.86
Four or more times a week							0.74*	0.52 1.06
Activity								
Less than once a month							0.86	0.72 1.04

Once a month										0.91	0.66	1.25
2 to 3 times a month										0.79	0.54	1.15
Once a week										0.79	0.55	1.14
More than once a week										0.66	0.40	1.09
Constant	0.17***	0.16	0.18	0.13***	0.10	0.16	0.14***	0.10	0.20	0.18***	0.11	0.29

*** p<.01, ** p<.05, * p<.1

Appendix 3.52: Logistics regression using NCDS Data and adjusting for education and occupation

Variables	**NCDS**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Neuroendocrine factor scores	1.00	0.81	1.24	1.08	0.85	1.38	1.04	0.81	1.33	1.03	0.80	1.33
Gender												
Female				2.02***	1.71	2.39	2.01***	1.69	2.38	2.00***	1.67	2.39
Education												
Other qualifications				1.07	0.82	1.41	1.11	0.84	1.45	1.11	0.83	1.48
0 Level/equivalent				0.89	0.70	1.13	0.94	0.74	1.20	0.98	0.76	1.27
A Level/equivalent				0.65**	0.45	0.92	0.62**	0.44	0.93	0.71*	0.48	1.04
Higher qualification below degree				1.14	0.77	1.68	1.21	0.82	1.80	1.23	0.81	1.85
Degree/equivalent				0.71**	0.53	0.96	0.77*	0.56	1.04	0.81	0.58	1.13
Occupation												
Lower supervisory & technical occupations				0.93	0.70	1.23	0.87	0.65	1.17	0.90	0.66	1.22
Small employers and own account workers				0.78	0.57	1.05	0.77*	0.57	1.04	0.82	0.60	1.13
Intermediate occupations				0.99	0.76	1.29	0.98	0.75	1.28	1.00	0.76	1.32
Management and professional occupations				0.72***	0.57	0.90	0.69***	0.55	0.86	0.75**	0.59	0.95
Marital Status												
Married/Partnership							0.81	0.62	1.06	0.88	0.66	1.17
Remarried							0.98	0.71	1.34	1.03	0.74	1.44

Divorced/legally separated Widowed							1.02	0.75	1.40	1.07	0.77	1.49
Smoking Status												
Ex-smoker										1.12	0.93	1.36
Current smoker										1.17	0.95	1.45
Alcohol Intake												
Once a month or less										0.74	0.51	1.07
Two to four times a month										0.62**	0.43	0.88
Two or three times a week										0.61**	0.43	0.85
Four or more times a week										0.73*	0.52	1.04
Activity												
Less than once a month										0.86	0.71	1.04
Once a month										0.90	0.65	1.24
2 to 3 times a month										0.79	0.54	1.16
Once a week										0.79	0.55	1.14
More than once a week										0.66	0.40	1.08
Constant	0.17***	0.16	0.18	0.12***	0.10	0.16	0.14***	0.10	0.20	0.18***	0.11	0.29

*** p<.01, ** p<.05, * p<.1

Appendix 3.53: Logistics regression using BCS70 Data and adjusting for education and occupation

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Metabolic factor scores	1.07	0.96	1.18	1.08	0.96	1.22	1.08	0.96	1.23	1.04	0.92	1.18
Gender												
Female				1.55***	1.21	1.99	1.56***	1.21	2.01	1.49***	1.15	1.93
Education												
Other qualifications				1.00	0.58	1.71	0.96	0.55	1.66	0.86	0.48	1.51
0 Level/equivalent				0.96	0.69	1.33	0.93	0.67	0.30	0.93	0.66	1.31
A Level/equivalent				1.09	0.64	1.85	1.10	0.64	1.88	1.12	0.64	1.95
Higher qualification below degree				0.91	0.58	1.44	0.93	0.59	1.47	0.98	0.61	1.55
Degree/equivalent				0.93	0.65	1.33	0.93	0.64	1.34	0.98	0.67	1.43

Occupation											
Lower supervisory & technical occupations				0.66	0.40	1.10	0.71*	0.43	1.18	0.71	0.42	1.20
Small employers and own account workers				0.77	0.49	1.20	0.79	0.50	1.24	0.81	0.51	1.29
Intermediate occupations				0.72	0.48	1.09	0.76	0.50	1.16	0.79	0.52	1.22
Management and professional occupations				0.53***	0.37	0.74	0.56***	0.39	0.80	0.60**	0.41	0.87
Marital Status												
Married/Partnership							0.52***	0.39	0.71	0.55***	0.40	0.75
Divorced/legally separated/ Widowed							0.61**	0.41	0.89	0.64**	0.43	0.95
Smoking Status												
Ex-smoker										0.99	0.74	1.32
Current smoker										1.01	0.72	1.42
Alcohol Intake												
Monthly or less										0.74	0.47	1.16
2 -4 times a month										0.51***	0.32	0.80
2-3 times a week										0.58**	0.38	0.89
4 or more times a week										0.65*	0.40	1.05
Activity												
Low										2.00***	1.46	2.73
Moderate										1.20	0.83	1.73
High										0.99	0.68	1.43
Constant	0.21***	0.19	0.24	0.23***	0.16	0.33	0.37***	0.24	0.55	0.45**	0.25	0.80

*** p<.01, ** p<.05, * p<.1

Appendix 3.54: Logistics regression using BCS70 Data and adjusting for education and occupation

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Lipid factor scores	1.15*	0.98	1.36	1.19*	0.98	1.44	1.20*	0.99	1.46	1.18	0.96	1.44

Gender												
Female				1.54***	1.20	1.98	1.55***	1.20	2.00	1.48***	1.14	1.93
Education												
Other qualifications				1.00	0.59	1.72	0.96	0.55	1.66	0.86	0.49	1.52
0 Level/equivalent				0.96	0.69	1.33	0.93	0.67	1.30	0.93	0.66	1.31
A Level/equivalent				1.12	0.66	1.90	1.13	0.66	1.93	1.14	0.66	1.99
Higher qualification below degree				0.92	0.58	1.45	0.93	0.59	1.47	0.98	0.62	1.56
Degree/equivalent				0.94	0.66	1.35	0.94	0.65	1.35	0.99	0.68	1.44
Occupation												
Lower supervisory & technical occupations				0.65	0.39	1.08	0.70	0.42	1.16	0.69	0.41	1.18
Small employers and own account workers				0.77	0.50	1.21	0.79	0.50	1.24	0.81	0.50	1.29
Intermediate occupations				0.72	0.48	1.08	0.76	0.50	1.16	0.79	0.51	1.22
Management and professional occupations				0.52***	0.37	0.74	0.55***	0.39	0.79	0.59**	0.41	0.85
Marital Status												
Married/Partnership							0.52***	0.39	0.71	0.55***	0.40	0.75
Divorced/legally separated/ Widowed							0.61**	0.42	0.89	0.64**	0.43	0.95
Smoking Status												
Ex-smoker										0.99	0.74	1.31
Current smoker										1.00	0.71	1.41
Alcohol Intake												
Monthly or less										0.74	0.47	1.16
2 -4 times a month										0.51***	0.32	0.81
2-3 times a week										0.58**	0.38	0.88
4 or more times a week										0.65*	0.40	1.04
Activity												
Low										2.00***	1.46	2.72
Moderate										1.20	0.83	1.73
High										0.98	0.68	1.42
Constant	0.21***	0.19	0.24	0.23***	0.16	0.33	0.36***	0.24	0.55	0.45**	0.25	0.81

*** p<.01, ** p<.05, * p<.1

Appendix 3.55: Logistics regression using BCS70 Data and adjusting for education and occupation

Variables	BCS70											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Inflammatory factor scores	1.26	0.85	1.89	1.45	0.90	2.34	1.45	0.90	2.34	1.46	0.89	2.39
Gender												
Female				1.55***	1.20	1.98	1.56***	1.21	2.00	1.49***	1.15	1.94
Education												
Other qualifications				1.00	0.59	1.72	0.96	0.55	1.67	0.86	0.49	1.52
0 Level/equivalent				0.95	0.68	1.31	0.92	0.66	1.28	0.92	0.65	1.29
A Level/equivalent				1.09	0.64	1.86	1.10	0.65	1.89	1.12	0.64	1.95
Higher qualification below degree				0.91	0.58	1.44	0.93	0.59	1.47	0.98	0.62	1.56
Degree/equivalent				0.93	0.65	1.33	0.92	0.64	1.33	0.97	0.67	1.42
Occupation												
Lower supervisory & technical occupations				0.66	0.40	1.09	0.71	0.43	1.17	0.70	0.41	1.19
Small employers and own account workers				0.77	0.49	1.21	0.79	0.50	1.24	0.81	0.51	1.29
Intermediate occupations				0.72	0.48	1.09	0.76	0.50	1.16	0.79	0.51	1.22
Management and professional occupations				0.53***	0.37	0.75	0.56***	0.39	0.80	0.60**	0.41	0.86
Marital Status												
Married/Partnership							0.52***	0.39	0.70	0.55***	0.40	0.75
Divorced/legally separated/ Widowed							0.60**	0.41	0.88	0.63**	0.43	0.94
Smoking Status												
Ex-smoker										1.00	0.75	1.32
Current smoker										1.01	0.72	1.42
Alcohol Intake												
Monthly or less										0.74	0.47	1.17
2 -4 times a month										0.51***	0.32	0.81
2-3 times a week										0.58**	0.38	0.89

4 or more times a week										0.66*	0.41	1.06
Activity												
Low										2.01***	1.47	2.74
Moderate										1.20	0.83	1.73
High										0.99	0.68	1.43
Constant	0.21***	0.19	0.23	0.23***	0.16	0.32	0.36***	0.24	0.54	0.43**	0.24	0.79

*** p<.01, ** p<.05, * p<.1

Appendix 3.56: Logistics regression using BCS70 Data and adjusting for education and occupation

Variables	**BCS70**											
Mental Health	**Model 1**			**Model 2**			**Model 3**			**Model 4**		
	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]	Odds ratio	[Conf.	interval]
Factor Scores												
Cardiovascular factor scores	1.09	0.97	1.23	1.15*	1.00	1.32	1.14*	0.99	1.31	1.13	0.98	1.31
Gender												
Female				1.56***	1.21	2.00	1.57***	1.22	2.02	1.49***	1.15	1.94
Education												
Other qualifications				1.01	0.59	1.73	0.97	0.56	1.68	0.86	0.49	1.52
0 Level/equivalent				0.97	0.70	1.35	0.94	0.68	1.32	0.95	0.67	1.33
A Level/equivalent				1.12	0.66	1.91	1.13	0.66	1.93	1.15	0.66	2.00
Higher qualification below degree				0.93	0.59	1.46	0.94	0.60	1.49	0.99	0.62	1.58
Degree/equivalent				0.95	0.66	1.36	0.94	0.65	1.36	1.00	0.68	1.45
Occupation												
Lower supervisory & technical occupations				0.66	0.40	1.08	0.71	0.43	1.17	0.70	0.41	1.20
Small employers and own account workers				0.77	0.49	1.21	0.79	0.50	1.24	0.81	0.51	1.29
Intermediate occupations				0.72	0.48	1.08	0.77	0.50	1.16	0.79	0.52	1.22
Management and professional occupations				0.52***	0.37	0.74	0.55***	0.39	0.79	0.59**	0.41	0.86
Marital Status												
Married/Partnership							0.53***	0.39	0.71	0.55***	0.41	0.75

Divorced/legally separated/ Widowed							0.61**	0.42	0.90	0.64**	0.43	0.96
Smoking Status												
Ex-smoker										0.99	0.74	1.31
Current smoker										1.01	0.72	1.42
Alcohol Intake												
Monthly or less										0.73	0.46	1.14
2 -4 times a month										0.50***	0.32	0.80
2-3 times a week										0.57**	0.37	0.87
4 or more times a week										0.64*	0.39	1.03
Activity												
Low										2.00***	1.47	2.73
Moderate										1.21	0.84	1.74
High										0.98	0.68	1.43
Constant	0.21***	0.19	0.24	0.23***	0.16	0.32	0.36***	0.24	0.54	0.44**	0.25	0.80

*** p<.01, ** p<.05, * p<.1