The environmental impacts and wellbeing benefits of sport: Assessing spectator and participant dominated sports in England

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Dedication

I dedicate this thesis to God and to my late parents Mr Samuel Adelani Dosumu (who died 29th November 1982) and Mrs Patience Oluwafunmilayo Dosumu who died during this research on 11th March 2013. From childhood you instilled in me a desire to learn and you both sacrificed a lot to make me what I am today. Without your support I would not be where I am today.

Abstract

Greenhouse gas (GHG) emissions from waste and transportation are of environmental concern. Globally, every year, waste contributes an estimated 5% and transport approximately 23% of the total anthropogenic GHG emissions. Sport contributes to GHG emissions by spectators and participants travelling to/from sporting venues and generating waste. Whilst a small reduction in an individual’s travel and waste may be perceived as having negligible impact, if these are aggregated over a population, the resultant GHG emissions can be significant. Although there is scientific evidence of the environmental impact of major sporting events there is limited research on it at the grassroots level. In addition watching and participating in sport results in wellbeing benefits such as improved self-esteem and mood. This research quantitatively examined both the environmental impacts and wellbeing benefits of sport at the grassroots level focusing on both spectator-dominated and participant-dominated sports in England.

Three studies were conducted examining spectator-dominated sport: 1) GHG emissions relating to travel to and from football games; 2) GHG emissions relating to waste at football games and 3) the effects of watching football on mental wellbeing. Two further studies were also conducted assessing participant-dominated sport: 4) GHG emissions from travel to and from running location; and the effects of sport (running) on mental wellbeing and connection with nature and 5) the effects of running outdoors on mental wellbeing (pre and post study).

The research showed that both spectators and participants’ sport considerably generated GHG emissions from travel and waste when extrapolated nationally. However, engaging in spectator-dominated or participant-dominated sports resulted in wellbeing benefits. Watching football resulted in better mental wellbeing, while running particularly outdoors resulted in improvements in wellbeing such as improved mood and increase in self-esteem after participating in sport. This research suggests that participating in sport can initiate a positive change in a person’s relationship with the natural world. These findings on the environmental impact and wellbeing benefits of both spectator-dominated and participant-dominated sports have implications for individuals, private sectors, sporting organisations, policy makers and government authorities.

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List of abbreviations

ANOVA	Analysis of variance
CNS	Connectedness to Nature Scale
CO_2	Carbon Dioxide
CO_2e	Carbon dioxide equivalent
DECC	Department for Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DoH	Department for Health
EU	European Union
FA	Football Association
FIFA	Federation of International Football Association
$kgCO_2e$	Kilogram of Carbon dioxide equivalent
LOCOG	London Organising Committee of the Olympic and Paralympic Games
M	Mean
MANOVA	Multivariate Analysis of Variance
Mdn	Median
NR	Nature Relatedness
NR Exp	Nature Relatedness Experience
NR Persp	Nature Relatedness Perspective
NR Self	Nature Relatedness Self
ONS	Office of National Statistics
PASW	Predictive Analytical Software
POMS	Profile of Mood States
RSES	Rosenberg Self-Esteem Scale
SD	Standard Deviation
SE	Self Esteem
SPSS	Software Package for Social Sciences
tCO_2e	Tonnes of carbon dioxide equivalent
TMD	Total Mood Disturbance
UK	United Kingdom
UN	United Nations
WEMWBS	Warwick Edinburgh Mental Wellbeing Scale
WHO	World Health Organisation

1. Sports, Environment and Wellbeing

1.1 Sport

1.1.1 Definition of sport

Sport has historically played an important role in all societies, be it in the form of competition, physical activity or play (Bellotti, 2012). Before 1880, globally sport was essentially a combination of hunting, shooting and fishing (Allison, 1986). However, by 1930, sport was simply defined as human competitions such as athletics and organised games, where demonstrations of skill and power were key (Allison, 1986).

The definition of sport usually includes activities suitable for people of all ages and abilities, with an emphasis on the positive values (Hirvensalo and Lintunen, 2011). The definition of sport used in this research is defined by the United Nations as *"all forms of physical activity that contributes to physical fitness, mental wellbeing and social interaction, such as play, recreation, organised or competitive sport and indigenous sports and games"* (United Nations, 2012).

1.1.2 Categorisation of sport

Sports can be categorised based on a number of factors such as: the purpose of the sport; the environment; the equipment; number of participants; age; gender; approach to sport; physical exertion; typical season; regional criteria; importance of sport and way of performance (Koudelková and Kosová, 2007) – see Figure 1.1.

Figure 1.1: Levels of various types of sport, adapted from (Koudelková and Kosová, 2007)

Despite the vast categorisation of sports, this research will examine the category of sport based on approach to sport, which can either be participant-dominated or spectator-dominated. A participant-dominated sport is any sport where many people take part such as running and spectator-dominated sport consist of many people watching the sport e.g. football (Jaeger, 1990). Both sports (running and football) are popular sports nationally.

1.1.3 Worldwide scale of sport

Billions of people worldwide engage in sports, either as a spectator or a participant (Ratten, 2011) and the top ten most popular sports in the world are: football, running, cricket, hockey, tennis, volleyball, table tennis, baseball, golf and basketball (Giulianotti, 2012). In England alone, 15.51 million people engaged in a range of different sports at least once a week during 2012 (Vinson *et al.*, 2013) and the most popular sport (spectator-dominated) nationally is football (Collin and MacKenzie, 2006; Whannel, 2009; Staffordshire and Team, 2010).

It is reported that more than 265 million football players are registered worldwide (Weiler *et al.*, 2012), making football one of the most popular and highly participated sports in the world. In the UK, football is the highest profile and most popular sport with 2,119,200 people participating at least once a week (Sport England, 2012). There were over 2,828 professional footballers in the English Premier League, the Championship, League One and League Two during the 2009-2010 season (Fleming and Fleming, 2012).

The Football League in England is a series of interconnected leagues from various parts of the country under the supervision of The Football Association and their affiliates. The system has a hierarchical format, consisting of 11 football tiers. The first four tiers make up the league system, while the rest of the tiers (tier 5 to tier 11) make up the non-league system (see Table 1.1). The non-league system has progressively more semi-professional and amateur leagues and a greater number of clubs. They also cover smaller geographical areas and consist of more than 6,000 clubs (Nair, 2007).

Table 1.1: Football League System in England in 2012/13

Football Tier	Name of League/Non-League	Number of clubs	Annual attendance 2012/13 season
1	Premier League	20	13,567,311
2	Football League Championship	24	9,656,106
3	Football League One	24	3,473,154
4	Football League Two	24	2,422,218
5	Conference Premier	24	1,041,886
6	Conference North & South	44	552,684
7	Northern, Southern & Isthmian League Premier Division	66	411,048
8	Northern, Southern & Isthmian League Lower Division	123	273,390
9	Top tier of 14 regionally based leagues	291	502,557
10	15 divisions in 2nd tier of regionally based feeder leagues	285	268,470
11	46 largely county-based feeder leagues	Over 327	Not known

Source: (EMF, 2013; FA, 2013; NLM, 2013; www.isthmian.co.uk, 2013)

Apart from spectator dominated sport (football), running (participant-dominated) is also one of the most popular sports in the world (Junior *et al.*, 2015). Currently, approximately 2 million people in UK run for at least 30 minutes a week (Sport England, 2012), of which about 1.6 million people run alone (VLM, 2012). The location of these running sessions varies from outside in parks, on roads to treadmills in gyms and homes. There are over 5,900 gymnasia and health clubs in the UK, and 12.1% of the UK population are now registered as members of a health and fitness club, totalling over 7.6 million members (Panter *et al.*, 2008). Also, there are over 1,765 running clubs in the UK, with over 2 million members (www.parkrun.org.uk, 2012).

1.2 Environment

1.2.1 Definition of environment

There are several definitions for the term 'environment'. Larson (1957) defines the term environment broadly as comprised of water, air, soil, fauna and flora (Larsson, 1957). The 1972 Stockholm Declaration subsequently included especially representative samples of the natural ecosystem in the definition of environment (United Nations Environment Programme, 2014). From these definitions, the environment could literally mean one's surroundings and everything that affects an organism during its lifetime. Thus, environment includes all the physical and biological surroundings and their interaction. Studying the environment provides an approach towards understanding the planet and the impact of human beings upon it. This study will use the UNEP (2014) definition of environment. In consequence, the term environment is multidisciplinary and global in nature.

This study is primarily concerned at examining human impacts on the environment using Defra's methodology on calculation of GHG emissions for travel and waste and the wellbeing benefits attached to engaging with the environment for both spectator-dominated sport (football) and participant-dominated sport (running).

1.2.2. Greenhouse gases and climate change

Climate change is one of the major problems facing the world today. Many lines of evidence suggest that human activities are changing the earth's climate. Studies have shown that the effect of climate change has resulted in warming of the atmosphere and oceans, thereby resulting in sea level rise, a strong decline in Artic ice and other climate related changes (IPCC, 2014). The human-induced emissions of greenhouse gases (GHG) have altered the natural process of heat (radiation) exchange between the earth and atmosphere and in turn have led to an increase in climate change, with associated negative impacts worldwide (Solomon *et al.*, 2007). The source of GHG emissions includes: transportation, waste, food and drink (particularly from manufacturing), and energy (Armaroli and Balzani, 2011; Panwar *et al.*, 2011; Den Elzen *et al.*, 2013).

One of the major drivers of the growth in the emissions of GHG, both in the developed and developing countries is an increase in transportation activities (Timilsina and Shrestha, 2009). In particular, road transport contributes about a quarter of the European Union's total emissions of carbon dioxide (CO_2). Since the transport sector is almost entirely reliant on petroleum, which is a major source of carbon emissions, the CO_2 (the main greenhouse gas) from transport is also increasing. Transport emissions represent 14% of global (GHG) emissions (Cassara and Prager, 2005), and the transport sector remains a critical avenue in the attempt to reduce carbon emissions. Within the European Union (EU), transport is responsible for about 34% of Europe's CO_2 emissions (Paravantis and Georgakellos, 2007). Thus, any significant effort to reduce emissions will need to address public and private transport (Greene and Plotkin, 2011) .

The generation of waste and its deposition in landfill sites also results in GHG emissions. Methane is the main GHG released at landfill during the breakdown of organic matter. Other forms of waste disposal such as: composting and combustion also produce GHGs, but mainly in the form of carbon dioxide (CO_2) (Chan *et al.*, 2010; Ermolaev *et al.*, 2014; Ritter and Chitikela, 2014). Aerobic composting process releases heat but most of the carbon contained in the organic matter is retained in the compost and therefore not released into the atmosphere (Morris *et al.*, 2013). Also, waste combustion releases CO_2 and nitrous oxide (N_2O), which is approximately 300 times more potent than CO_2, but making up a fraction of the total emissions from waste (Hermann *et al.*, 2011; Farmer and Cook, 2013; Wiedinmyer *et al.*, 2014). Diverting waste from landfill and recycling will therefore reduce the amount of GHG emissions, which will have a positive impact on the environment (Baker, 2004).

1.2.3 The environmental impact of sport

There is strong evidence that taking part in sport improves health and has associated economic and social benefits (Dalton *et al.*, 2015). Sport can also have negative effects on the environment as a result of direct participation and also from indirect action such as spectating through associated activities such as GHG emissions from travel and waste. Clearing tracts of land to make way for golf courses and the construction of ski resorts for example can also result in habitat destruction. Both sport spectators and participants activities particularly their GHG emissions from travel and from waste sent to land fill can have negative impact on the environment.

A way of measuring the environmental impact of an event is by calculating the Ecological Footprint, measured in global hectares, which is derived from a study area by estimating the land areas necessary to support demand resulting from energy use, travel, agricultural production, the built environment, waste and water consumption. The total area is then compared with population of the study area and the footprint is then compared to a ‘fair earth share’ footprint estimated at 1.9 hectares per person (Munday and Roberts, 2006; Collins *et al.*, 2012). The Ecological footprint is very unique because it addresses if human beings are living within the biological capacity of the planet and it encourages human being to understand that the environment has limits. It is a powerful tool used to communicate the ideas of global sustainability, it is also used to model different scenarios thereby informing strategies and planning by examining the possible impacts of policies and actions in a number of areas such as economics, waste and transport planning and the environment. The method can be used to assist to identify unsustainable trends which can create opportunities for none sustainable management of resources. Lastly, the ecological footprint of a locality includes a complete assessment of all types of consumption, ranging from transport, energy and other services, which allows comparisons to be made between different policy areas, unlike other methods. However, ecological footprint only addresses ecological sustainability and not indicative of quality of life of people, but it may just indicate what conditions will be like in the future. The method is also a quantitative measure and does not measure the quality of the environment (Simion *et al.*, 2013).

Millions of people are involved in sport on a regular basis, hence waste generated at sporting venues has become of great concern to people involved in sport management due to the climatic impacts from the associated GHG emissions (Subic, 2007; Subic *et al.*, 2009; Lucas *et al.*, 2013). Hinch and Higham (2001) claim that sport-based travel has increased dramatically over the past two decades and has recently become the focus of concern to researchers, particularly regarding greenhouse gas emissions (Hinch and Higham, 2001). Spectator-dominated sports with large numbers of spectators attending on a periodic basis at a fixed location in the UK, such as Football Association Cup Finals, Six Nations Rugby matches, Wimbledon, the London marathon and test match cricket have significant environmental impacts. As a result, there are calls for sporting events organisers to improve their environmental performance and reduce environmental impacts (Walters, 2012).

1.2.4 Studies into the environmental impacts of sporting events

There are several methods to measure the environmental impact of human activities, and a number of scholars have applied the environmental footprint analysis. This is an accounting tool that measures human demand on ecosystem services required to support a certain level and type of consumption by an individual, product or population (Bosshard, 2008; Wiedmann and Minx, 2008; Daughton and Ruhoy, 2009)

Coalter and Taylor (2009) estimated the Ecological Footprint of the final of the 2004 FA Cup, which they claim was over 3000 global hectares (gha), or 0.0422 gha/visitor. The amount of waste generated by the event and how it was subsequently disposed of resulted in a total waste footprint of 146 gha or 0.002 gha/visitor, which is less than half the average global ‘earthshare’ per person per day that is 0.0049 gha (Coalter and Taylor, 2009).

Moreover, the study accounted for four footprint components (travel, food and drink, event infrastructure and waste), and implied that if the average visitor at the event were compared with the average ‘earthshare’ per person per day (i.e. 0.0049 gha), the impact would have been nine times greater. However, the Ecological Footprint method used was based on arbitrary assumptions:

for instance, the choice of CO_2 emissions was subjective (Min *et al.*, 2001). Furthermore, data collection did not include other environmental factors (for example, air quality). Thus, the findings may not be adequate for policy making.

The Centre for Business Relationships Accountability Sustainability and Society (BRASS) at Cardiff University conducted a study to measure the environmental and economic impact of a Six Nations Rugby International. Another environmental measurement, the Environmental Input-Output Analysis (ENVIO), was used as an environmental accounting tool to reflect production and consumption structures within several economies. ENVIO relies upon well used and easily understood input-output relationship and modelling, it also examines impacts on activity-by-activity basis, it is flexible regarding impact metrics: such as CO_2, water, waste and other impacts, it can be used to compare with economic impact and mainly used to measure local or regional or national impacts. However, the ENVIO is limited because it requires well developed regional economic account, it has countless input-output limitations and modelling assumptions and largely a measure of local or regional or national impact (Jones, 2008).

The study measured the environmental and economic impacts of the Scotland versus Wales match in the 2006 Six Nations Championship. There were approximately 85,499 visitors who generated money with a total of £16.4 million for the Cardiff economy and 1,700 tonnes of greenhouse gas emissions. BRASS (2006) calculated the event's ecological footprint by measuring supporter travel to the event, supporter' food and drink consumption, energy use in visitor accommodation, the infrastructure of the event venue, and event-related waste. The total visitor ecological footprint was 3,578 global hectares (gha) or 0.042 gha per visitor. Visitor food and drink totalled 61% of the event footprint and visitor travel was 31%, while the waste footprint was just 1.6% (Collins and Roberts, 2007).

Replacing 50% of the car travel with public transport such as rail and coach could have reduced the travel footprint of the event by 15%, while recycling 100% paper, glass and cardboard could have reduced the waste footprint by 22%. This method of calculating footprint is beneficial because it helps in supporting information-based environmental and economic policies, for example, the Six Nations Rugby International events, and future events could ensure maximum economic impact while minimising environmental impact.

Coalter and Taylor (2004) also considered ENVIO, which provided an account on impacts from a very local perspective (focusing on emissions created in Cardiff as a result of spending on food, drinks, travel and accommodation). The study reported that in 2004, visitors to the FA Cup Final spent £2.9 million. This was a gross figure and therefore included imports into Cardiff and any taxes paid. The benefits of the above method include: the indirect and induced effects of additional consumption of event-related visitation; it identifies environmental externalities directly associated with the event, such as spending; and it presents findings in monetary terms and in terms of physical units of various pollutants produced. This review demonstrated the value of two different methods with which to access the environmental consequences of a major sporting event. Moreover, such appraisals should become commonplace in the investigation of the effects of such events. Both studies above demonstrated how two methods can work alongside one another to provide a relatively sophisticated and rigorous examination of the economic and environmental effects of a major event. The economic benefits of hosting the event were small, but its global environmental impacts were significant and should not be ignored in future event and tourism planning (Collins *et al.*, 2007).

Studies into the environmental impacts from sport have used different methods to assess different types of environmental impacts, carbon footprint, the ecological footprint and Environmental Input-Output Analysis.

Carbon footprint measures the mass of cumulated CO_2 emissions from either a supply chain or through the life-cycle of a product and not the measure of area like the ecological footprint (Hertwich and Peters, 2009). Carbon footprint however has a much broader appeal than the ecological footprint because it is modest, is easy to calculate and can be easily understood. Also, it is a focal indicator of environmental responsibility, which helps to identify climate impacts and lower them cost-effectively and sensibly. The calculation results can be used in operative and strategic planning, constructing a climate policy, environmental reporting and planning cost savings. The unit is measured in $kgCO_2$ or when other GHGs such as CH_4 and N_2O are considered is measured in $kgCO_2$ equivalent or tonnes of CO_2 (tCO_2). The only limitation of the method is that it focuses on only the carbon emission aspects.

However, the input-output analysis (IOA) focuses on regional and national levels. The strengths of this method is that the calculation is simple, if the data were available and the result is complete and comprehensive, but the limitation of this tool is that the calculation is less detailed and less accurate and the input-output (IO) table is published every five years, therefore data is old. Also, the Life Cycle Analysis (LCA) focuses on micro level, such as product and process. The benefit of this tool is that it can avoid burden shifting between lifecycle stages of territories and the calculation is more detailed and accurate. However, the limitation of this method is that it ignores indirect flows outside the boundary and leads to truncation errors and it also needs lots of process data and is more time and labour consuming (Dong *et al.*, 2016). More details on various environmental measuring tools is further explained in chapter 2.

Best Foot Forward (BFF) and the Centre for Sustainable Energy undertook a total carbon footprint analysis of the 2009 Wimbledon tournament. Their analysis and recommendations focused on emissions sources, which consistently have a high environmental burden at events, such as: spectator travel, waste, catering and merchandising (BFF, 2009). However, the study findings were not made available to the public.

In another study by the Event Impact Organisation, which looked at the 2008 BUPA Great Yorkshire Run, three evaluation themes were investigated: i) attendance; ii) social impacts (identity, image and place); and iii) social Impacts (participation). However, the investigation omitted examination of the environmental impacts of the event (EIO, 2008), which is an important consideration for sustainability.

UNEP and the Indian Cricket Premier League organised a ‘Green Cricket Match’ in 2009 that claimed to be the first ever carbon-neutral cricket match recorded. According to UNEP, emissions calculations for the game took account of the travel, accommodation and food consumption of all players and officials, as well as local fans travelling to the venue. Offsetting an estimated 580 tonnes of match-related carbon dioxide emissions minimised the carbon footprint from the game. Over US$10,000 went towards supporting an internationally recognised biomass project in India (UNEP, 2010). However, the support given by UNEP could also have been extended to other cricket organisations in other countries in order that the game of cricket could be more sustainable.

In 2007, Ipswich Town football club claimed to be the first football club in the UK to become carbon-neutral (Baldwin, 2010). In the 2006/07-football season, the club produced 3,200 tonnes of carbon dioxide, and claimed to successfully offset this by asking supporters to make pledges to save energy; in total 14,000 pledges were made. Since 2007, the club has changed the way the stadium is run and some of the players have been involved in car-pooling. Moreover, the calculation of carbon emissions of the club has raised awareness about the need to conserve energy and reduce the club’s environmental impact. The fulfilments of the pledges of spectators have not been verified, making the degree to which the club is carbon-neutral questionable.

Forest Green Football Club has reportedly become the greenest football club in UK and has gained Eco-Management and Audit Scheme (EMAS) qualification with a gold standard for environmental performance. As a result, the club has an organic pitch with no pesticides or manmade chemicals used; the club recycle all the water that lands on the pitch and reuse it. The club is possibly the first meat free club in the country and in Europe by serving fully vegetarian food at the clubhouse. It has made provision for electric pumps to charge electric cars and the stadium stand has solar panels installed to power the stadium and all its facilities. The club has also reduced their emissions of 135 tonnes of CO_2e by buying electric cars for staff and operational travelling of almost 690,000 km a season (SIS, 2016).

Also, in 2012, Dartford football club received Observer Ethical Award for Sport because of its sustainable practices. The stadium has a range of environmental features, including sustainable materials, solar panels, rainwater harvesting and additional insulation. The club used engineered timbers and green roofs for the clubhouse and the terraces, thereby making the building to blend with its parkland surroundings and enjoys natural air filtration system. The club encourage the use of public transport to and from games and the club has designated stadium bus stops so that supporters can access the stadium easily and avoid driving to the games. The club reduced their CO_2 emissions by installing low energy efficient lighting at the stadium (SIS, 2016).

Similarly, Manchester United Football club have demonstrated best practice in terms of sustainability by receiving many eco-standards: Carbon Reduction Commitment 2011 for energy management and carbon reduction; ISO14001: for establishing an environmental management system (EMS); The Carbon Trust for Energy Efficiency and Carbon Reduction and ISO20121: for event sustainability management. Examples of sustainable practices of the club include: rainwater that is harvested at the stadium that is recycled and used for pitch irrigation; creation of nature reserve at their training ground in Carrington which is important for habitat of wildlife. The waste produced at the club is diverted completely from the landfill and any product that cannot be recycled is sent to a local Waste to Energy (WtE) plant and food waste is also sent for composting (SIS, 2016).

Letteney (2016) affirmed that more football clubs have started to engage in sustainable practices. For example, Rochdale FC, Tottenham Hotspurs FC and Aston Villa FC have all upgraded their lighting fittings to reduce their GHG emissions, save energy and maintenance cost, while Coventry City FC have installed a voltage optimiser to regulate their incoming electricity so as to reduce their GHG emissions. Undoubtedly, football spectators' travel plays a large part in GHG emissions. But, some clubs in UK such as Brighton & Hove Albion FC, Southampton FC and Lincoln FC have offered their spectators' Combi tickets or match day ticket including public transport to reduce their GHG emissions. While Oldham FC have encouraged their supporters to utilise public transport to match venues through their website and printed leaflets to reduce their environmental impact. Many football clubs do not put environmental policies and mitigations in place to demonstrate that their club wants to minimise its environmental impacts and particularly GHG emissions from waste sent to landfill, travel and energy consumption. Manchester City FC is one of the few football clubs that have a written environmental policy with a detailed estimation of carbon emissions and steps to mitigate them (Letteney, 2016). However, there are many studies reporting the environmental impacts of other major sporting events.

Spectator-dominated mobile sporting events that move from one location to another on periodic bases, such as the FIFA World Cup, Olympic Games and Commonwealth Games have various environmental impacts. There is now overwhelming evidence and justification for the need for all negative impacts of sports to be examined and either eliminated, reduced, or, in relation to carbon emissions, offset (McCrory, 2006; Roper, 2006; Min, 2009).

The FIFA World Cup, for example, has become one of the world's biggest sporting events with 64 matches (Grundling and Steynberg, 2008). FIFA initiated the 'Green Goal initiative' in 2006 to address environmental issues pertaining to the World Cup. According to McCrory (2006), the FIFA World Cup in Germany is an example where the Ecological Footprint method was used to calculate the environmental impact of the games. Owing to the size and scope of the games, the emissions were approximately 250,000 tonnes of greenhouse gas. Each game used between 2 and 3 million kilowatts of energy and each match generated 5 to 10 tonnes of waste (McCrory, 2006).

The carbon footprint for the FIFA World Cup in 2010 in South Africa was higher than that of 2006. UNEP (2010) concluded that the 2010 World Cup resulted in 1.65 million tonnes of carbon dioxide equivalent, which is just 60% of the figure that had been projected (UNEP, 2010). This was partly due to fewer visitors than expected, carpooling and park and ride schemes, thereby cutting energy use by 30 %. The South African Government and UNEP worked on a project to promote initiatives that cut the tournament’s carbon footprint, such as reducing waste and water use and enhancing biodiversity. Other successful measures taken to cut the carbon emissions of the games included the improvement of South Africa’s transportation system, which included a rapid bus network, cycling paths and walkways in major sites, the reuse of demolition waste, energy efficient lighting and reducing water waste in various stadia (UNEP, 2010). Such initiatives could be employed more widely in future FIFA World Cups.

Large sporting events like the Olympic Games contribute to climate change by using considerable energy to heat buildings, to power equipment and to transport both people and goods (Atos, 2009). Since the inception of the Olympic Games in 1896 in Athens, sustainability and environmental issues have not gained much prominence until the Seoul Olympics in 1988, where the Olympic Committee made these issues their focus (Orueta and Fainstein, 2008). The Barcelona Olympics in 1992 saw the introduction of a green design for the Olympic village (Gold and Gold, 2008) and the momentum built up further in 2000, as Sydney hosted the first ‘Green Games’. But it was the Beijing Olympics of 2008 which raised the bar for green games (Chen and Spaans, 2009). The carbon footprint of the Beijing Olympics was 1.2 $MtCO_2e$ (Hayes and Horne, 2011), and a total of 22,000 tonnes of GHG emissions were avoided during the games due to various measures, including: clean fuel in public transport, clean fuel buses in the Olympic Green district, solar energy power generator and hot water system, green lighting system and geo-thermal (waste water) heat pump (Laing and Frost, 2010).

As shown above, sports can play a major role in addressing issues on sustainability, and the UNEP has been cooperating with the International Olympic Committee (IOC) since the mid-1990s in helping to improve the environmental impact of the games, particularly in Athens in 2004, Beijing in 2008 and London in 2012 (Naul and Holze, 2011).

The London 2012 Olympic Games has earned its title as the ‘greenest games ever’, achieving carbon savings of 400,000 tonnes, meeting key zero waste targets and demonstrating the business case for sustainability (Coaffee, 2012; Keenan, 2012; McNicholas *et al.*, 2012). But the huge success of the London Games pushed up the carbon footprint attributed to spectators by more than a quarter. The total carbon footprint of the games measured 3.3 million tonnes of CO_2e, according to LOCOG’s Post-Games sustainability report (LOCOG, 2012). Early estimates had put London 2012’s carbon footprint at 3.4 million tonnes of CO_2e (Mero, 2012). The better than predicted performance was attributed to efforts to minimise the environmental impact of the construction and staging of the games. London 2012 was the first games to use the carbon footprint as a tool to inform decisions to minimise environmental impacts.

The Post-Games report provided the final results of the sustainability programme and reviewed how and whether targets were met across energy, waste, resources, transport and the economy. Notably, it showed that 400,000 tonnes of carbon emissions were saved, compared to what was originally estimated might be achieved. Other highlights included a 34% saving on venue energy use, a 30% carbon reduction for domestic spectators’ travel because initially all was by public transport and 100% of event operations’ waste diverted from landfill.

However, LOCOG under-estimated the number of visitors that visited the games. This excluded 15 million people who lined the route of the Olympic Torch Relay and millions that filled up the venues during the games. It was estimated that spectators' carbon footprint (excluding those that were not counted) accounted for 670,000 tCO_2e, but the actual footprint came to 913,000 tCO_2e, more than 25 per cent above the original figure. The increase in the spectator carbon footprint was mainly due to the impact of travel, although accommodation, catering, merchandise and waste also played their part (LOCOG, 2012).

The Commonwealth Games also have an impact on the environment, and the games incorporated an environmental dimension of sustainability in its green games vision (KAS, 2011).
The environmental impact of 2010 Commonwealth Games in India was substantial. The organising committee estimated that the emissions generated at the games after taking sustainable measures were 524,689 (tCO_2e), as reported by (Thynell *et al.*, 2010). However, the Indian Institute of Management-Ahmedabad (2010) in another study reported carbon emissions of 128,000 (tCO2e) (IIMA, 2010). The different carbon emissions reported are confusing and made it difficult to establish the true environmental impact of the Commonwealth Games.

Nationally, transportation continues to contribute a large proportion of GHG emissions, studies have shown that there are existing opportunities for the sector to deliver GHG reductions by encouraging low-carbon fuels, new and improved vehicle technologies, strategies to reduce the number of vehicle miles travelled and operating vehicles more efficiently are all approaches to reducing GHG emissions from transportation (Reichmuth *et al.*, 2013). Combining behavioural changes with these factors can reduce transportation related emissions significantly. For example, the NHS reduced its travel GHG emission by 5% from 2.9 $MtCO_2e$ to 2.8 $MtCO_2e$. Other sectors should also steadily reduce their travel carbon footprint because NHS identified business, commuter, visitor, patient and supplier travel as areas where it can influence and reduce emissions (NHS, 2016). Moreover, travel GHG emissions of staff and student at the University of Strathclyde in 2013 was approximately 6,600 tCO_2e, this represented an estimated 5% of the total carbon footprint of the university which was approximately 132,000 tCO_2e (James, 2014).

Moreover, the disposal and treatment of waste can produce emissions of several GHG, which contributes to global climate change. Waste prevention and recycling should be encouraged at all levels so as to help to address global climate change and as a result decrease the amount of GHG emissions. The waste sector primarily have key role to play in improving waste management practices resulting in reduction of GHG emissions. But, globally population growth has resulted in more resources consumption than ever. It is estimated that human consumption could increase to about 140 billion tonnes by 2050 (Sevigné Itoiz *et al.*, 2014). The earth has limited resources and the increase in the use of the resources in production has led to increase in consumption pattern which has profound environmental impacts such as over-exploitation, scarcity of resources, pollution, land use change, loss of biodiversity and climate change. The global system of production, consumption has predominantly linear based on extraction and waste disposal. Conversely, the vast quantity of waste generated end up in landfills (Sevigné Itoiz *et al.*, 2014).

Currently, global annual total waste generation is approximately 17 billion tonnes and about 1.3 billion tonnes are from municipal solid waste. With the resultant GHG emissions from waste sent to landfill, there should be other sustainable means to reduce the use of resources consumption and this should result in less waste generation, but to attain sustainable global patterns of resource use will be a major economic and environmental challenge. Improved waste management is an essential element in efforts to make the country more resource efficient. Waste is generated among different sources such as households, industries, commercial activities including sport, construction and mining, at agricultural sites and from the generation of energy (EAA, 2013). The relationship between waste management and GHG emissions has been enhanced based on the idea that treatment and disposal of waste produce significant amounts of direct and indirect GHG emissions but proper waste management can avoid GHG emissions due to controlled composting of organic waste recycling, through the conservation of raw materials and fossil fuel (Solomon *et al.*, 2007). For example, the National Health Service (NHS) is the largest emitter of GHG in the public sector, they have used the Defra's method to calculate their carbon footprint for several years and in 2015 the carbon footprint was about 22.8 $MtCO_2e$. The carbon footprint has reduced between 2007 and 2015 by 11% despite the increase in inpatient admissions over the same period (NHS, 2016). The reduction in the carbon footprint of the NHS should be extended to other sectors.

Although different methods using different units have been used to examine the environmental impact of sport this study will consider not just CO_2 but will consider other GHG emissions from sport using a carbon footprint reported in $kgCO_2e$ or tCO_2e and applying Defra's GHG conversion factors depending on the activity. This study will consider the GHG emissions from travel and waste from both participant and spectator dominated sports using carbon footprint method and the mental wellbeing benefits of both sports, football and running (Wright *et al.*, 2011). Furthermore, this study will look at ways to make participants and spectator dominated sport sustainable.

1.2.5. Sustainability and sport

The term sustainable refer to the ability to maintain resource over time (Schell *et al.*, 2013). Individuals, organisations and other groups all share a vital role in making the society and resources sustainable and in avoiding failure or collapse (Heinberg, 2010). Unfortunately, the word is widely used to refer to practices that are judged to be marginally more environmentally sound than others. Although no human being can exist forever and this makes sustainability a relative term.

Traditionally, the concept of sustainability was embedded in many indigenous people; dated back to Great Law of peace or the Iroquois Gayanashagowa that chiefs believe the effect of their decisions on the seventh generations to come. Heinberg (2010), recorded that the first European use of the concept sustainability also known in German as: 'Nachhaltigkei' occurred in 1712 in the book Sylvicultura Oeconomica by German forestry scientist Hannss Carl von Carlowitz, who recommended planting trees to avoid deforestation (Heinberg, 2010).

Currently, the concept of sustainability or sustainable development has become an important issue, particularly environmentally, economically and socially (Bonevac, 2010). The concept refers to a process or the end goal of some form of sustainable society and now continues to take a greater place in the public view (Dovers, 1990).

The term sustainability has gained widespread usage particularly after 1987 among several people and organisations (Brundtland *et al.*, 1987). Sustainable development is a type of development that meets the current needs, without conceding future generations to respond to their needs (Butlin, 1989). Over the past three decades, the underlying issues of sustainability have developed within many disciplines, including ecology, resource economics, social theory and developmental studies (Dovers, 1990). The Brundtland Report opened the way for other non-governmental organisations (NGOs) to explore various aspect of sustainability including environmental and developmental issues, especially at first Earth Summit in Rio de Janeiro in 1992. Brundtland report refers to sustainable development as the type that meets the requirements of the present-day without depriving the ability of upcoming generations to meet their own needs (Brundtland *et al.*, 1987). This definition is quite optimistic but laced with challenges and contradictions because it suggests that in the process of developing, people have a moral responsibility to consider the effects of present activities on the welfare of future inhabitants of our planet. Thus, it could be said that sustainability addresses both intergenerational and intragenerational equity. However, this presents an enormous challenge because we are clearly not meeting the needs of everyone in present generations much less being able to consider the quality of life of future peoples and their ability to survive. In spite of these challenges, the concept of sustainability has evolved to become a framework for making complex and challenging decisions. Contemporary sustainability derives some of the main ideas of sustainability from the Brundtland Report, especially the view that the needs of both present and future generations should be taken into consideration in decision making. It adds to this concept the need to balance environmental protection and restoration with the requirement of a healthy economy and the needs of human society. At the heart of this evolved notion of sustainability are several ethical issues, among them the right of future peoples, the obligation to consider the impacts of technology, the rights of non-human species and others (Kibert *et al.*, 2011) . There are other propositions on sustainability.

Heinberg (2007) postulated five axioms on sustainability namely:

1. Any society that continuously use critical resources unsustainably will collapse.

2. The increase in population or growth in the rates of exhaustion of resources cannot be continued.

3. To maintain sustainability level, the use of renewable resources must progress at a rate that is equal or less to the amount of natural replacement.

4. To be sustainable, the use of non-renewable resources must proceed at a rate that is reducing, and the rate of reduction must be greater than or equal to the rate of depletion.

5. Sustainability demands that materials introduced into the environment by human actions be decreased and rendered undamaging to biosphere roles.

These five axioms could tend to lead to relatively higher levels of economic and political equity (Heinberg, 2007).

Rio de Janeiro hosted the first earth summit in 1992 and it focused on the state of the global environment and the relationship between science, economics and the environment in a political context and all member states agreed to demonstrate their commitment to sustainable development (Redclift, 2005).

Robert and Mark (2006) developed a consensus on requirements for a sustainable society in four structures on sustainability, which turns out to be the basis for organisation, the Natural Step. Subsequently, several businesses and councils around the world pledged to abide by Natural Step conditions. The four conditions show that in a sustainable society, nature is not subject to systematically increase in:

1. Concentrations of materials extracted from the earth's crust.

2. Concentrations of substances produced by society.

3. Degradation by physical means.

4. Human being are not exposed to conditions that systematically destabilised them. Moreover, no continuous rate of use of any non-renewable resource is sustainable (Robèrt and Mack, 2006).

Sustainability comprises of complex processes with several loops and synergies. Just as social, environmental and economic dimensions of sustainability can reinforce each other, so can sustainable practices at work and at home. Professionals, as citizens, family members and consumers, can strengthen the values of sustainability on multiple fronts, by primarily educating themselves about choices that will make a difference and the seeking changes, both personally and structurally, that can enable those options to take root. A transformed society cannot be obtained if an aspect of sustainability is isolated from our lives. Instead, we must see and seek out connections among diverse activities at work, at home, at school and in the community (Kibert *et al.*, 2011).

Sustainability involves three elements, namely: economic, social and environmental (Scrucca *et al.*, 2016). The environmental dimension involves impacts through processes, products or services. These may include air, water, land, natural resources, flora, fauna and human health.

Assessing the sustainability performance of sporting events involves environmental, social and economic aspects. The Economic aspect of sustainability is the ability of an economy to support a defined level of commercial production indefinitely. Both environmental and economic sustainability have been greatly addressed to date, unlike social sustainability where academics, policymakers and professionals hold varying perspectives on the social concept, how it can be assessed and implemented. However, social sustainability examines the social relationships, interactions and institutions that affect, and are affected by sustainable development, by focusing on the quality of the society (Polèse and Stren, 2000; Littig and Grießler, 2005). Apart from the sustainability benefits that sports can bring, it also results in wellbeing benefits. In a study that investigated the importance of air quality on individual wellbeing found a significantly negative relationship between air pollution and individuals self-reported life satisfaction (Orru *et al.*, 2015). The findings align with the conclusion from other studies (MacKerron and Mourato, 2009; Antaramian *et al.*, 2015; Liao *et al.*, 2015). Studies have shown that for pro-environmental behaviour to increase well-being, it is important to convince people that their behaviour is right and meaningful, and stimulate people to choose this behaviour of their own free will (Venhoeven *et al.*, 2013).

1.3 Wellbeing

1.3.1 Definition

'Wellbeing' described by Defra (2007) as *"a positive physical, social and mental state; it is not just the absence of pain, discomfort and incapacity. It requires that basic needs are met, that individuals have a sense of purpose, and that they feel able to achieve important personal goals and participate in society. It is enhanced by conditions that include supportive personal relationships,* *strong and inclusive communities, good health, financial and personal security, rewarding employment, and a healthy and attractive environment" (DEFRA, 2007).*

This study will use the above Defra's definition to examine the wellbeing benefits of both participant (running) and spectator-dominated (football) sport. Studies worldwide are increasingly reporting the effect sports play in physical, mental and social wellbeing of the people involved and in general improvement in their quality of life (Kunz, 2009; Marlier *et al.*, 2014).

Morris (2003) claims there are key ways in which exposure to the natural environment can have wellbeing benefits. These are:

1. Increased physical health
2. Enhanced personal and social communication skills
3. Enhanced spiritual, sensory and aesthetic awareness
4. Enhanced mental and spiritual health

Increased physical health

Walking and other outdoor sports such as running and cycling are being increasingly recognised as one of the best ways to improve people's physical health and mental wellbeing (Countryside Agency, 2000). Various studies recommend brisk walking as a way of developing and maintaining cardio-respiratory fitness, body composition, muscular strength and endurance in adults (NHS, 2001; Lee and Buchner, 2008; Sellers *et al.*, 2012). Sellers *et al.* (2012) investigated whether differences exist between a 30-minute brisk walk taken in two different environments (park) and (urban) in order to determine which environment best facilitates physical activity guidelines. The study revealed that participants accumulated more moderate-to-vigorous current physical activity in bouts ≥ 10 minutes during park walks due to the lack of interruptions in walking (Sellers *et al.*, 2012). The study indicates that brisk walking in a park leads to higher intensity exercise than in an urban environment, although further research involving a larger sample size will be necessary.

Enhanced personal and social communication skills

The extent to which participation in activities within the natural environment encourages individuals to build self-esteem and confidence, develop basic social skills and maintain or improve their quality of life and how this might be measured is a contested issue (Morris, 2003). There is no agreed definition for the term “quality of life” and there is little information, which outlines the ways in which health professionals understand the term. In the last few decades, though, scientists have offered alternative approaches to defining and measuring quality of life: social indicators such as health and level of crime, subjective wellbeing measures assessing people’s reactions to their lives and societies, and economic indices (Diener and Suh, 1997). Brock (1993) claims that there are three major philosophical approaches to determining the quality of life (Brock, 1993).

The first approach describes the characteristics of a good life that are dictated by normative ideals based on religious, philosophical or other systems. An example is to believe that a quality of life must include helping others, because this is indicated by people’s religious principles. These approaches to quality of life depend neither on the subjective experience of people nor on the fulfilment of their wishes, but it is most clearly related to the social indicators in the social sciences. The second approach to defining quality of life is based on the satisfaction of preference. Within the constraints of the resources they possess, the assumption is that people will select those things that will most enhance their quality of life. Thus, in this tradition, the definition of the quality of life of a society is based on whether the citizen can obtain the things they desire. People select the best quality of life for themselves that is commensurate with their resources and their individual desires. The third definition of quality of life is in terms of the experience of individuals. If a person experiences his or her life as good and desirable, it is assumed to be so. In this approach, factors such as feelings of joy, pleasure, contentment and life satisfaction are paramount. Clearly, this approach to defining the quality of life is most associated with the subjective wellbeing tradition in the behavioural sciences. However, these three approaches to defining quality of life have often competed in political and philosophical thought (Diener and Suh, 1997). Scottish Natural Heritage (2004) reported that outdoor activities provide an opportunity to increase quality of life and heighten social interaction, particularly when meeting people or going out in small groups, which helps to enhance community spirit and foster a more socially inclusive society (Scottish Natural Heritage, 2004).

Many studies conclude that interaction with plants and earth enables sensory stimulation, provides an opportunity to keep warm through activity and exposes the body to fresh air. It can also help people gain basic and social skills, obtain qualifications, rebuild their lives and maintain or improve their quality of life (Browne, 1992; Ryan, 1992).

Enhanced spiritual, sensory and aesthetic awareness

According to Edensor (2000), outdoor physical activity, particularly walking, is a multi-sensual and stimulating experience that frees the mind and generates reflexivity, philosophical and intellectual thought, aesthetic contemplation and opens up a more natural self (Edensor, 2000). Oussett *et al.* (1998) state that the water running out of the pond, the heat of the sun warming the skin, the smell of the damp soil and playing in the garden outdoor with hands bring about feeling of physical and mental wellbeing (Ousset *et al.*, 1998). Moreover, participants at the Health Walk and Green Gym stated that being in the countryside and in contact with nature were their primary reasons to be active (Bird, 2002). Edensor (2000) concluded that walking outdoors in nature is a practice that can restore natural perception and reconnect human beings with the physical world of nature.

Grant (2001) examined participation in physical activity during later life. The study reported that increasing numbers of older people are choosing to participate in a diverse range of leisure pursuits (Grant, 2001). As a result, the stereotypical views and images associated with old age are gradually being challenged (Greenwald, 1997).

Enhanced mental and spiritual health

Physical activity is associated with improvements in psychological and spiritual health (Crowther *et al.*, 2002; Powell *et al.*, 2003; Cotton *et al.*, 2006). Moreover, physical activity in the natural environment not only aids an increased life span, greater wellbeing, fewer symptoms of depression, and lower rates of smoking and substance misuse, but also an increased ability to function better at home and at work (World Health Organization, 2001; Morris, 2003).

Wellbeing and Sustainability

Human wellbeing is dependent on a healthy natural environment in many ways such as stable climate, food, clean air, water and other natural resources. Forest Research (2010) provided a wealth of evidence on how access to green spaces contributes to physical and mental health and social cohesion. Improving access to green spaces could yield health benefits of access to good quality green spaces such as better self-rated health, lower body mass index, obesity and overweight levels and increase longevity (Forest Research, 2010; Coutts and Hahn, 2015). Although, there is imbalanced access to green spaces across England and this results in people living in the most underprivileged parts are less likely to live near green spaces and will, therefore, have fewer chances to experience the health benefits of green space compared to people living in less deprived areas.

It is notable that green infrastructure can help deliver key benefits for public health and wellbeing. This recognition is based on a growing body of evidence, which shows that green spaces can, in particular, assist with the delivery of priorities for increased life expectancy, and reduced health inequalities, which are related to income deprivation, are lower in populations in the greenest areas. The effect holds for all caused mortality from circulatory diseases, improvement in levels of physical activity and health and psychological health and mental wellbeing (O'Brien *et al.*, 2010).

Sporting organisations are also faced with sustainable practices and all aspects of the sport now strive to operate with least effect on the ecosystem with the least possible running cost for waste, water and energy.

1.4 Connection to nature and its links with wellbeing

People connected to nature have been found to be healthier overall than individuals that are not connected to nature. There is currently an increasing evidence base to show that exposure to the natural environment positively affects physical health and mental wellbeing (Bowler *et al.*, 2010). Researchers have long maintained that human beings derive physical and psychological benefits from spending time in the natural world (Leopold, 1970; Berry, 1978; Thompson Coon *et al.*, 2011). The past two decades of research have highlighted the benefits of contact with nature and wellbeing (Pretty *et al.*, 2005; Mayer *et al.*, 2009; Barton and Pretty, 2010). Spending time in nature or even viewing nature does not only reduce stress, but can also reduce aggression and violence (Kaplan, 1995). Also, an innate closeness to nature increases wellbeing (Pretty *et al.*, 2003). Wilson (1984) explains this behaviour through his 'Biophilia' hypothesis where he suggests that humans have an inherent inclination to affiliate with nature (Wilson and Wilson, 1984; McVay *et al.*, 1995). Biophilia implies affection for plants and other living things.

For over a decade, researchers at the University of Essex have conducted several studies to investigate the synergistic benefits of engaging in physical activities whilst simultaneously being exposed to nature referred to as 'green exercise' (Pretty *et al.*, 2005; Barton and Pretty, 2010; Gladwell *et al.*, 2013; Wood *et al.*, 2014).

Green exercise has positive social benefits because it brings about social cohesion, inclusion and integration (Newton, 2007). Several studies show how green spaces in parks, streets and allotment in urban areas encourage more social interaction and bring people together (Peters *et al.*, 2010; Okvat and Zautra, 2011).

There is mounting empirical evidence that interacting with nature delivers measurable mental and psychological benefits to people (Pretty *et al.*, 2009; Barton *et al.*, 2012; Keniger *et al.*, 2013). In a study led by Pretty in 2005, the emotional responses of participants exposed to a sequence of natural and urban landscape images while running on a treadmill in a laboratory were examined. Mood and self-esteem both improved with exposure to natural scenes, thereby emphasising that exercise may deliver greater benefits when it occurs in the presence of nature (Pretty, 2005; Pretty *et al.*, 2006).

Pretty et al. (2007) investigated the effects of green exercise initiatives in the UK, and found that participants' mood and self-esteem (as measured by self-report surveys) were significantly improved after exercise, implying that exercise in natural environments can improve psychological wellbeing. This study did not however include a control treatment (with exercise in a non-natural setting) and so it was not clear whether the natural environment itself was contributing to the effect or whether exercises in the natural environment or exercise alone was sufficient.

In a recent literature review led by Keniger and colleagues, they classified settings, interactions and potential benefits of people-nature experiences and used these to organise an assessment of the benefits of interacting with nature (Keniger *et al.*, 2013). They discovered that the benefit of interacting with nature is geographically biased towards high latitudes and Western societies, potentially contributing to a focus on certain types of settings and benefits. The assessment noted that social scientists have been the most active researchers in this field. Contributions from ecologists are few in numbers, possibly impeding the identification of key ecological features of the natural environment that deliver human benefits. Although many types of benefits have been studied, as reported earlier, benefits to physical health, cognitive performance and psychological wellbeing have received much more attention than social or spiritual benefits of interacting with nature, despite the potential for important consequences arising from the latter. The evidence for most benefits is correlational, and although there are several experimental studies, little as yet is known about the mechanisms that are important for delivering these benefits. For example, the review stated that it was not known which characteristics of natural settings (e.g. biodiversity, level of disturbance, proximity, accessibility) are most important for triggering a beneficial interaction and how these characteristics vary in importance among cultures, geographical regions and socio-economic groups (Keniger *et al.*, 2013).

Metzgar (2012) aimed to reframe the sustainability of exercise by looking at physical activity from a natural perspective. The report focused on all aspects of sustainability, and the possibilities for how and where to engage in bodily exercise beyond traditional gym where a series of manoeuvres are presented to people in a more formal, and developmentally appropriate manner. The article reported that other models of physical activity besides traditional gym exercise, such as the green gym (which is a way to get fit and healthy by being more physically active in the outdoors), might both reduce energy consumption and increase health outcomes. However, the possibility of a shift towards exercise in outdoor location raised several concerns (Metzgar, 2012). The first concern was the sufficiency of access to the natural environment, which in urban settings may be limited to parks (Veugelers *et al.*, 2008). The second concern was the issue of climate, for it has been previously shown that season or time of year affects the level of recreational physical activities (Burton *et al.*, 2003). Therefore, exercise in a natural setting may be less appealing in certain climates or seasons. The third concern was the inclement weather, such as rain or snow, and how that may hinder motivation to engage in nature outdoors, which Nies and Motyta (2006) also supported. The fourth concern was the potential for over-exposure to sunlight and its associated risks, although these could be lessened through simple measures such as sunscreens and education. The last concern was the issue of social support, which is primary to behavioural change, particularly since people generally prefer exercising in a social setting (Nies and Motyka, 2006; Greaves, 2011).

Further research by Coon et al. (2011) compared the effects of physical activity on mental and physical wellbeing, health-related quality of life and long-term adherence to physical activity and participation in physical activity in natural environments to physical activity indoors. The researchers conducted a systemic review of literature from 11 clinical studies involving 833 adult subjects, each of which compared the effects of outdoor exercise initiatives with indoor activities. The results showed some improvement in mental wellbeing on one or other of the outcome measures. Compared to exercising indoors, exercising outdoors was associated with greater feelings of revitalisation, positive engagement and increased energy, plus a decrease in tension, confusion, anger and depression. However, the results suggested that feelings of calmness might decrease following outdoor exercise. Participants in the research also reported greater enjoyment and satisfaction with outdoor activity and declared a greater intent to repeat the activity at a later date. However, this research did not measure the effects of physical activity on wellbeing or the effect of natural environments on exercise adherence. This review has shown some encouraging outcomes on self-reported mental wellbeing immediately following exercise in nature, which are not seen following similar exercise indoors (Thompson-Coon *et al.*, 2011).

A multi-study analysis by Pretty and Barton (2010) assessed the best regime of doses of acute exposure to green exercise required to improve self-esteem and mood, which are both indicators of mental health. They used a meta-analysis methodology to analyse 10 UK studies. The research looked at many different outdoor activities including walking, gardening, cycling, fishing, horse riding and farming in locations such as a park, garden and natural trail. Dose responses were assessed for exercise intensity and exposure duration (Barton and Pretty, 2010). The results showed that the greatest effect was seen within just five minutes of engaging in physical activity outdoors, and, with longer periods of time exercising in a green environment, the positive effects were clearly apparent but were of smaller magnitude. These research results will be of great value for policy recommendations (Pretty, 2006), but the challenge for policy makers is that such recommendations on physical activities are clearly identified but unlikely to be implemented widely.

A review by Gladwell and her colleagues (2013) considered the declining levels of physical activity, particularly in the Western world, and how the environment may help motivate and facilitate physical activity. The review also addressed the additional physiological and mental health benefits that appear to occur when exercise is performed in an outdoor environment (Gladwell *et al.*, 2013). The review claims that participating in physical activity in a natural environment, or green exercise, might engage people in physical activity by increasing enjoyment of participation, offering social interaction and increasing frequency of activity. This is evident from the study that outdoor natural environments may provide some of the best all-round health benefits by increasing physical activity levels with lower levels of perceived exertion, altering physiological functioning including stress reduction, plus restoring mental fatigue and improving mood, self-esteem and perceived health.

A study by Barton et al. (2009) focused on evaluating changes in self-esteem and mood after walking in four different National Trust sites in the East of England, pre and post activity. The findings from the study found that self-esteem scores for visitors leaving the sites were significantly higher than those just arriving and overall mood also significantly improved. Feelings of anger, depression, tension and confusion all significantly reduced while vigour increased. The study concluded that the environment plays an important role in facilitating physical activities and helps to address sedentary behaviours. Walking in particular can serve many purposes, including exercise, relaxation, travel, recreation and restoration. Moreover, walking in green space or the natural environment may offer a more sustainable option, as the primary reward is enhanced emotional wellbeing through both exposure to nature and participation in exercise (Barton *et al.*, 2009).

Studies have reported that connection to nature results in lower levels of overall state cognitive and trait cognitive anxiety (Martyn and Brymer, 2014). Also, connection to nature predicts pro-environmental behaviour and personal wellbeing (Sanguinetti, 2014). Research have suggested that contact with nature generally improves mood, cognition and health (Capaldi *et al.*, 2014).

The location where people engage in sport is important. If people love nature they will always behave in an environmentally friendly way by engaging in sport outdoors thereby enhancing their wellbeing. Therefore, this research will examine the benefits associated with involving in sport in the natural environment.

Currently, the world physical activities guidelines suggest that adults aged 18-64 should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or can do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate-and-intensity activity (Cooper *et al.*, 2015; Sparling *et al.*, 2015). Aerobic activity involves movement of large muscles, such as those in the arms and legs and causes a slight or significant increase in breathing and heart rate depending on the intensity. Examples of moderate-intensity aerobic activity include: brisk walking, leisure swimming, leisure cycling, line dancing and playing tennis, while examples of vigorous-intensity aerobic activity includes jogging or running, playing singles tennis, skipping with a rope, playing basketball or football and swimming continuously (Lonsdale *et al.*, 2013).

There is much literature to suggest that physical activity or sport has positive benefits on people's health and wellbeing across several physical and mental health outcomes (Oja *et al.*, 2011; Khan *et al.*, 2012; Nielsen *et al.*, 2014; Stanton *et al.*, 2014). The benefits range from desirable health outcomes across a variety of physical conditions, such as type 2 diabeties, cardiovascular disease,obesity and other diseases. Similarly, participants in randomised clinical trials of physical activity interventions show better outcomes, including better general and health-related quality of life, better functional capacity and better mood states (Townsend *et al.*, 2002; Penedo and Dahn, 2005).

The additional benefits of physical activity or sports outdoor also known as green exercise include: improvement in mood and increases in self-esteem above and beyond that of exercise alone, may reduce rating or perceived exertion, it makes you more likely to continue to participate in physical activity in the future and it adds some variety and fun (Network, 2015). Research has confirmed that engaging in physical activities in an indoor and outdoor environment, such as running, walking and gardening, frequently results in improved wellbeing (Peacock *et al.*, 2007; Sugiyama and Thompson, 2007; Barton and Pretty, 2010; Bowler *et al.*, 2010; Bergstad *et al.*, 2011; Coon *et al.*, 2011; Nisbet *et al.*, 2011). Studies also indicate that there may even be synergistic benefits from being physically active, whilst simultaneously being directly exposed to nature.

1.5 Justification for this thesis

Running (participant-dominated) and football (spectator-dominated) sports are popular in England. Travel GHG emissions of runners have not been examined. Although, many studies have evaluated GHG emissions from mega sporting events including FIFA world cup and FA cup games, the GHG emissions from travel and waste at football games on a weekly basis across the football tiers in England have not been examined. Although, there are substantial quantitative data on the impact of mega sporting events on the environment such as the Olympic Games, World Cup and Commonwealth Games (Essex and Chalkley, 2003; Zagorianakos, 2004; Kim and Petrick, 2005; Cornelissen and Swart, 2006; Collins and Flynn, 2008; Collins *et al.*, 2009; Konstantaki and Wickens, 2010; Gursoy *et al.*, 2011; Qiao *et al.*, 2011; Hall, 2012). However, very limited research has been carried out on GHG emissions from travel and waste of lower level sport such as football in England, where the non-league comprises relatively small numbers of spectators attending each game but with a large number of games nationally. When the impact is aggregated it could have a significant environmental impact. Moreover, there are supported evidence that there are very real mental health benefits to watching football, although there could be blood pressure rises during football games or hormone such as testosterone plunges after a loss of a game. But watching football enhances high levels of wellbeing and general happiness. Other benefits include social benefits when people watch together thereby reducing levels of alienation and loneliness.

Moreover, running is a popular sport nationally, but there seems to be limited literature on the GHG emissions from this participant-dominated sports, undertaken as leisure activities, often with families, friends and coaches, (e.g. non-elite running). For approximately 2 million people who run in the UK for at least 30 minutes once a week, there is lack of evidence of their GHG emissions from travel and the benefits of running outdoors and resultant wellbeing benefits. No previous research has investigated these three components. Therefore, this study will address these gaps using both spectator (football) and participant dominated (running) sports.

1.6 Thesis aims and objectives

Aims

The overall aims of this thesis are to:

1. Evaluate the impact of sport on the environment through the calculation of GHG emissions from travel and waste generation and to extrapolate this to a national level.
2. To determine if both spectator and participant dominated sport affects wellbeing and connection to nature.

Specific thesis objectives:

The specific objectives of this thesis are highlighted in Table 1.2

Table 1.2 Thesis map outlining individual study objectives

Chapter	Objectives
3. Spectator dominated sport: GHG emissions relating to travel and waste	1. To evaluate the impact of spectator-dominated sport (football) on the environment through the calculation of GHG emissions relating to travel and waste. 2. To extrapolate the impacts to national level
4. Spectator-dominated sport: Effect of watching football on mental wellbeing	1. To determine if watching football determine mental wellbeing
5. Participant dominated sport: GHG emissions from travel, contact with nature and wellbeing benefits	1. To evaluate the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions relating to travel. 2.To extrapolate the impact to national level. 3.To assess connection to nature and mental wellbeing when participating in running.
6. Participant-dominated sport: Effects of running on mental wellbeing and connection to nature	1. To evaluate if participant-dominated sport (running) affects connection to nature over time. 2. To evaluate if participants-dominated sport (running) affects mental wellbeing over time.
7. General Discussion and Conclusion	1. To discuss the results from different studies in this thesis as a whole. 2. To summarise the main findings of the studies. 3. To state the recommendations of the study and future projects.

2. Methods of measuring environmental impact, connection to nature and wellbeing

2.1 Measuring environmental impacts

All human beings and their activities depend on nature. Wackernagel *et al.* (1999) claimed that, from the activity of a single individual to a whole country, all have an impact on the environment because they consume the products and services of nature. Human ecological impact corresponds to the amount of nature they occupy in order to live, and these are to a large extent measurable quantities of natural capacity they require in order to function (Wackernagel *et al.*, 1999).

As highlighted in section 1.2.4, researchers have used several methods to calculate environmental footprints. These include: Ecological Footprint (Wackernagel and Rees, 1998; Gaube *et al.*, 2013; Wackernagel, 2014); Input-output analysis (IOA); Life Cycle Analysis (LCA); Material Footprint (Wiedmann *et al.*, 2013; Lettenmeier *et al.*, 2014); Carbon Footprint (Wiedmann and Minx, 2008; Benjaafar *et al.*, 2013; Lizarralde *et al.*, 2014); Nitrogen Footprint (Leach *et al.*, 2012; Leip *et al.*, 2013; Stevens *et al.*, 2014) and Water Footprint (Chapagain *et al.*, 2006; Aldaya *et al.*, 2012; Hoekstra and Mekonnen, 2012). The environmental footprint methods listed above can be classified into two broad categories of analyses. Firstly, the streamlined life-cycle assessments that use a single unit indicator such as carbon dioxide equivalent (Perez-Garcia *et al.*, 2005; Weidema *et al.*, 2008; Campbell *et al.*, 2011); and secondly, the location specific analyses, such as the ecological footprint of a city (Collins and Flynn, 2007; Collins *et al.*, 2007; Collins and Flynn, 2008).

2.1.1 Ecological footprint

Ecological footprint (EF) measures the amount of land and/or ocean required to support a certain level and type of consumption by an individual or population. This measurement is estimated by assessing the total biologically productive land and ocean areas required to produce the resources consumed and mitigate the associated waste for a certain human activity or population (Wackernagel and Rees, 1998; Chambers *et al.*, 2014). Hoekstra and Mekonnen (2012) confirm that ecological footprint is expressed in hectares and can be calculated for individuals as well as well-defined communities such as villages, towns, cities, provinces, nations or global population and organisations, particularly human activities or specific goods or services (Hoekstra and Mekonnen, 2012). The total ecological footprint of an individual or community could be broken down into a number of components. However, six components are distinguished (Monfreda *et al.*, 2004): use of arable land (for food, feed and other agricultural products), use of pasture land (for animal grazing), use of woodland or forest (for timber), use of built-up land (for living), use of productive sea space (for fish), and use of forest land to absorb CO_2 that is emitted due to human activities. The first three categories are often referred to as the use of productive land (Monfreda *et al.*, 2004).

The ecological footprint method is different from other methods in two ways: firstly, it expresses the impact of humanity on the environment in one common unit (use of bioproductive space); and secondly, the method can be related to the carrying capacity of the earth (the available bioproductive space, which is regarded by experts in ecological footprint as the greatest step forward (Chambers *et al.*, 2014). This method is beneficial because it is possible to estimate the fraction of land or ocean required to support a specific lifestyle within a specific geographic area such as a city, region, and nation. EF, as one of the methods used in environmental analyses, has many advantages, but it is claimed that it is not clear what is being measured and how resources and waste are being converted. Another limitation of the method is that the definition of nature is not well-defined in how much nature people use to sustain themselves and that it is not clear what is meant by carrying capacity (Van Kooten and Bulte, 2000). It can be suggested that ecological footprint is only a convenient means of organising globally available data on population, income, resources use and resource availability into a single measure (Van Kooten and Bulte, 2000).

See Table 2.1 for the environmental evaluation tools.

Table 2.1: Environmental evaluation methods

Method	Initiated year	Initiator	Conceptual root	Definitions	Unit	Scale
Input-Output Analysis (IOA)	1936	Leontief	Economic theory	An economic technique that uses sectorial monetary transaction data to account for the complex interdependencies of various economic sectors		Macro level, such as national and regional.
Life Cycle Analysis (LCA)	1960s			A method used to comprehensively assess environmental effects of product choices from the generation of raw materials to the ultimate disposal of wastes		Micro level, such as product and process
Ecological Footprint (EF)	1992	Wackernagel and Rees	Environmental carrying capacity	The biologically productive land and water a population requires to produce the resources it consumes and to absorb part of the waste generated by fossil and nuclear fuel consumption.	Global hectares (ha)	Multi levels, particularly regions and cities
Carbon Footprint (CF)	1997	Wiedmann and Minx	Climate change	The amount of CO_2-equivalent emissions caused directly and indirectly by an activity	tonnes	From micro to macro levels

Note: Details of environmental measuring tools adapted from (Dong *et al.*, 2016)

2.1.2 Material footprint

Material footprint is a tool to measure and optimise the resource consumption of both products and their ingredients and the production processes along the whole value chain (Lettenmeier *et al.*, 2012). This method covers the entire life cycle of products, from extraction of raw materials to the processing industry, distribution, recycling and disposal. The unit of measurement is kilogram per kilometre travelled (Lettenmeier *et al.*, 2009).

2.1.3 Nitrogen footprint

Nitrogen footprint (NF) is a measure of the reactive nitrogen (for example, nitrogen oxides, ammonia and others) associated with a population or activity through agriculture, energy use and resource consumption (Bontemps *et al.*, 2011; Leach *et al.*, 2012; Perming, 2012). Nitrogen footprints are typically expressed in terms of mass loading per time (i.e. kg/year) (Bontemps *et al.*, 2011; Leach *et al.*, 2012).

2.1.4 Water footprint

Water footprint (WF) is another method employed in environmental analysis, which measures the total volume of freshwater that is directly or indirectly consumed by a well-defined population, business or product. Water use is measured by the volume of water consumed (the amount evaporated and or polluted in a given period of time) and is indicative of the water volume required to sustain a given population (Chapagain *et al.*, 2006). The water footprint of a region is the total volume of water used, direct or indirect, to produce goods and services consumed by inhabitants of a region. An internal water footprint measures the consumption within a region for goods and services, while an external water footprint measures the embodied water used outside the region for goods and services. The water footprint is divided into three elements (Yeh *et al.*, 2011; Berger *et al.*, 2012; Ercin *et al.*, 2013): blue (freshwater consumed from surface and groundwater sources), green (freshwater consumed from rainwater stored in the soil), and grey (the amount of polluted water, which is calculated as the volume of water needed to dilute pollutant loads to meet water quality standards).

2.1.5 Carbon footprint

However, from all the environmental footprint analyses methods, carbon footprint is the most developed. It is a measure of the direct and indirect greenhouse gas emissions caused by a defined population, system or activity. Scholars define carbon footprint as a measure of an individual's contribution to climate change in terms of the amount of greenhouse gases produced by him/her or GHG produced from their activity or activities and is measured in units of carbon dioxide equivalent (Weidema *et al.*, 2008; Wiedmann and Minx, 2008; Hertwich and Peters, 2009). Carbon footprint is calculated by taking an inventory of six greenhouse gases identified in the Kyoto protocol: carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbons and hydrofluorocarbons (Kolk and Pinkse, 2005; Matthews *et al.*, 2008). Each of these greenhouse gases is expressed in terms of the single unit indicator: carbon dioxide equivalent (CO_2e) (Wiedmann and Minx, 2008). Carbon footprints are categorised into three scopes (Sinden, 2009; Benjaafar *et al.*, 2013): Scope 1 (direct greenhouse gas emissions from fuel combustion in vehicles and facilities), Scope 2 (indirect emissions from purchased electricity), and Scope 3 (other indirect greenhouse gas emissions, for example waste disposal). This Defra's scope or method will be used in this study to calculate the carbon footprint of both spectator and participant-dominated sport from waste and travel. It helps to identify climate impacts and lower them in a cost-effective manner; and the carbon footprint results can be used in strategic and operative planning, constructing a climate policy, environmental reporting, increasing awareness of an individual's behaviour or life style as a source of global carbon emissions, and planning of cost savings. The Defra's method of calculating carbon footprint was employed in this research to calculate travel GHG emissions using mode of travel to participant or spectator dominated sporting location and multiplying the distance travelled by 2012 DEFRA/DECC's GHG Conversion Factors. The GHG emission is expressed in kgCO_2e (DEFRA, 2012). The GHG emissions from waste sent to landfill and waste recycled at football clubs annually were calculated using Defra's conversion factors of year 2012 of 290kgCO_2e/1000kg landfill waste (municipal waste, average) and 21kgCO_2e/1000kg recycled waste (DEFRA, 2013). All the calculation of GHG emissions from both participant and spectator dominated sport was based upon the recommended conversion factors provided by Defra as part of its environmental reporting guidelines.

2.2 Measuring connectedness to nature

Several measures have been created which attempt to quantify the concept of connectedness to nature (Schultz, 2002; Mayer *et al.*, 2009; Nisbet *et al.*, 2009). For the purpose of this study, connectedness to nature can be defined as the extent to which an individual's view of nature is incorporated into their perception of their own sense of self (Schultz, 2002). This broad definition includes physical, cognitive and emotional elements of that relationship. Nature in this sense can be defined as spaces large or small consisting predominantly of flora and fauna.

Schultz (2000,2001) designed a measure to examine the extent to which people are connected to the natural environment. The inclusion of nature in self-scale, taps beliefs regarding one's feelings of connection to the natural world. This single item graphical measure was developed to assess the extent to which an individual includes nature within his or her cognitive representation of self. The modified measure contains a series of several overlapping circles labelled "self" and "nature", where the circle with the least overlap represents an individual who views him or herself as separate from nature. By contrast, the circle with complete overlap represents a person who views him or herself as the same as nature (Schultz, 2000; Schultz, 2001). This method of measuring connectedness to nature confers many advantages. Its visual, non-linguistic nature allows the subject to express their choice in a context free from the constructor's language. This could potentially create a less biased and more intuitive measurement and its simplicity and facility of administration make it a very accessible measure to administer. This measure is not suitable for this study because it offers no details or reasons as to why one may feel that sense of connection to nature, and as a single measure it is impossible to judge internal consistency.

This study will use a more recent scale to measure the concept of connectedness to nature, known as the Nature Relatedness (NR) Scale (Nisbet *et al.*, 2009), which is a trait measure. The nature relatedness scale is used to assess the value structure underlying environmental concerns (whether individuals care about themselves, other people, or all living things). The NR was designed to assess the affective, cognitive and physical relationships between humans and the natural world. In addition to functioning as a single, cohesive measure of connectedness, the NR is linked with 3 factors: NR Self, NR Perspective and NR Experience. The NR Self measures an internalised identification with nature reflecting feelings and thoughts about one's personal connection to nature; the NR perspective measures an external, nature-related worldview, a sense of agency concerning individual human actions and their impact on all living things; and the NR Experience measures a physical familiarity with the natural world and the level of comfort with and desire to be out in nature (Nisbet *et al.*, 2009). Also, statistically, the Nature Relatedness Scale is reliable (Weinstein *et al.*, 2009; Howell *et al.*, 2011). The NR scale measures an individual's intent to participate in environmental behaviours which does not translate into behaviour, it is also a trait measure which measures habitual pattern of behaviour, thought and emotions over the period of two weeks unlike the state version of connectedness to nature which can measure instantaneous changes.

Mayer and Frantz (2004) designed another measure known as the Connectedness to Nature Scale (CNS) to quantify the concept of connectedness to nature. This measure was based on the theory and writings of Aldo Leopold (Leopold, 1949), and its 14 items were designed to measure individuals' affective sense of connectedness to nature (Mayer and Frantz, 2004). CNS is an effective measure of environmental attitudes, a multi-item scale and a good predictor of environmental behaviour (Frantz *et al.*, 2005; Mayer *et al.*, 2009). It could be used as both a trait and state measure and this is the justification for the use of this measure in this study at the later stage after recognising the limitation of NR scale, which cannot be used as a state measure.

After a review of the measures developed to examine individuals' relationship with the natural world, the Nature Relatedness Scale (NR) and Connectedness to Nature Scale (CNS) best define the concept of connectedness to nature and will be used for this study. NR (trait measure) and CNS (state measure) have been found to be associated with measures of wellbeing, particularly in relation to exercise or sporting activities.

2.3 Measuring mental wellbeing

Existing instruments in the measurement of wellbeing take different conceptualisations, which will be reviewed below:

The positively worded five-item World Health Organisation (WHO) Wellbeing Index (WHO-5) (Bech, 2004) is used to measure overall wellbeing and covers aspects of physical as well as mental health.

Kammann and Flett developed the Affectometer 2 in New Zealand in the 1980s. The aim of the instrument according to literature was to measure wellbeing (Kammann and Flett, 1983) and it had an intuitive appeal to those working in mental health promotion in the UK, because it covered both eudemonic and hedonic aspects of mental health and had a good range of positive items . The scale comprises 20 statements and 20 adjectives relating to mental health in which positive and negative items are balanced. However, the Affectometer 2 scale has important limitations. For example, it has high levels of internal consistency (r = 0.94), which suggest redundancy; its susceptibility to social desirability bias is higher than that of comparable scales; and its length is a potential barrier to its uptake as a measure of population wellbeing.

Tennant and colleagues in 2007, as a result of the limitations of Affectometer 2, developed the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS). The scale aimed to capture a wide conception of wellbeing, including affective-emotional aspects, cognitive-evaluative dimensions and psychological functioning, in a form, which is short enough to be used in population level surveys. The advantages of this measure include: positively worded items; its intention to support mental health promotion initiatives; it appears to have good face validity, as it covers the majority of the range of concepts associated with positive mental health, including both hedonic and eudemonic aspects, positive affect, and satisfying interpersonal relationships and functioning (Tennant *et al.*, 2007). This measure will be used for this study because of its advantages.

Maheswaran *et al.* (2012) evaluated the responsiveness of WEMWBS at both individual and group levels using secondary analysis of twelve different international studies undertaken in different populations. The results of the studies claim that WEMWBS detected important improvements in at least 12.8% to 45.7% of participants. The studies concluded that WEMWBS is responsive to changes occurring in a wide range of mental health interventions undertaken by different populations. Thus, the findings from these studies confirm that WEMWBS is a valid, reliable and acceptable measure (Tennant *et al.*, 2007), making it suitable for use in evaluation of interventions at both group and individual levels (Maheswaran *et al.*, 2012).

In addition, Mitchell (2013) examined whether physical activity in a natural environment is better for mental health than physical activity in other environments by using data from the Scottish Health Survey 2008, describing all environments in which respondents were physically active. The Warwick Edinburgh Mental Wellbeing Scale (WEMWBS) was used to measure the level of wellbeing. Findings from the study showed that regular use of the natural environment was not clearly associated with greater wellbeing, whilst the regular use of non-natural environments was. The study concluded that physical activity in natural environments is associated with a reduction in the risk of poor mental health to a greater extent than physical activity in other environments, but also that activity in different types of environment may promote different kinds of positive psychological responses (Mitchell, 2013).

For almost 50 years, scholars have been using the Rosenberg self-esteem scale, which comprises of 10 items to measure global self-worth by measuring positive and negative feelings about self (Rosenberg, 1965). The scale is believed to be one-dimensional and will be used in this study to measure the emotional state of runners. Moreover, this study will use the Profile of Mood State (POMS) to assess the transient and fluctuating mood states of runners (McNair *et al.*, 1971). The sub-scales of the measure are tension, anger, fatigue, depression, vigour and confusion. A lot of studies have successfully used this measure. These measures (Rosenberg self-esteem scale and POMS) are used as proxy measures for wellbeing in the absence of measures for measuring it directly (Hine *et al.*, 2008; Barton and Pretty, 2010; Thompson Coon *et al.*, 2011).

3. Spectator-dominated sport: GHG emissions relating to travel and waste

3.1 Introduction

In 2012, UK GHG emissions from all sectors were 581 $MtCO_2e$ and the most common greenhouse gas (CO_2) resulted in 474.1$MtCO_2e$ (DECC, 2013). The GHG emissions for England in 2012 were 441.8 $MtCO_2e$ with 33% from the energy sector, 14% residential, 15% business, 4% waste management sector and 22% from transportation (DEFRA, 2014). Transport emissions in England in 2012 were 97 $MtCO_2e$. The GHG emissions were dominated by road transport emissions (93% of all transport emissions in 2012, with 54% of transport emissions from cars alone). The transport sector emissions also included 1.8% from national navigation and coastal shipping, 1.8% from rail, 0.9% from domestic aviation and 2.3% from military aviation and shipping (DEFRA, 2014).

Transportation is vital on a day-to-day basis because it facilitates travel to work, businesses, schools, and entertainment and to sports venues. In 2013, on average, each person in England travelled approximately 10,534km comprising 64% in cars or vans (either as a driver or as a passenger), 22% on foot, 3% by rail, 7% by bus and 4% from other modes of travel. The average time spent travelling per person in a year in England in 2013 was 354 hours (NTSE, 2014). Apart from walking and cycling, other modes of travel such as cars, van, buses and rail result in GHG emissions. Major sporting events result in GHG emissions, particularly from the travel of participants and spectators to the venues. Sport events experience mass transportation challenges due to wide variety of traffic and parking challenges on events days. Sporting events generate economic benefits, also spectators and participants enjoy the sport (Shipway and Fyall, 2013). Travel impact to sporting events depends on the nature of the event and location of the sporting events, the demographics of spectators and participants and types of trips involved. Sporting events organisers should focus their attention in traffic reduction, reduce peak period traffic wherever possible, shifts car travel to alternative modes, improve access to events, increase car sharing, encourage public transport, cycling, walking where possible to events, thereby reducing GHG emissions at sporting events. The recreational use of cars to sporting locations will interact and impact on almost all aspects of community life such as economic and social wellbeing and the quality of life of everyone. The recreational use of cars results in emissions that contribute to atmospheric pollution, including greenhouse effects. If the use of cars to sporting events is not controlled, it could have impact on individual's health. Promoting walking and cycling to sporting events could help to reduce the environmental impact of the recreational use of cars.

In the UK, cycling to football venue is very rare, while more than 50% of away spectators travel by train for some games particularly at premier and championship leagues and car sharing is also higher for away travel among season ticket holders. For home games 43% of spectators drive to games while 34% use trains, 16% use buses and about 7% walk to games (CFBT, 2013). For example, Colchester United FC now run shuttle bus services on match days and over 24% of spectators now travel to home games by bus (CTPC, 2012). The Carbon trust studied the carbon footprint of the FA community shield at Wembley stadium between Manchester United and Wigan FC in 2013. They estimated the GHG emissions to approximately 5,160 tonnes of CO_2e with 5,000 tCO_2e coming from travel to and from the game, but a spectator who drove on their own to and from the game created $152kgCO_2e$. In contrast, the spectator that travelled by bus generated just $4kgCO_2e$; the finding suggest that public transport such as buses and trains are the lowest carbon way to get to a football game unless the spectator can either walk or cycle (Carbon Trust, 2013).

Moreover, few premier league clubs notably Stoke City and Aston Villa football clubs offered free bus travel to away matches for the duration of 2012/13 season. This reduced the number of spectators travelling by car to these matches. This action reduced GHG emissions by avoiding car travel to matches and reduced congestion on roads particularly around stadiums (GJ, 2013).

There have been several studies on the GHG emissions from major sporting events unlike fewer researches at the minor sporting events that occur on a regular basis like the games at 11 football tiers in England. Travel to major spectator-dominated sporting events such as the Olympic Games, FIFA World Cup, and Commonwealth Games has been shown to be the most important source of GHG emissions (Laininen, 2007) and travel associated with participant-dominated events, such as running, also result in GHG emissions.

In order to understand the GHG contributions made by one spectator-dominated sport in England, specifically football - the most popular sport nationally, the GHG contribution made from football spectators at matches of various football tiers in England must be examined. GHG levels from the various modes of travel used to travel to games are particularly important. To evaluate the GHG emissions certain questions need to be answered. What are the common modes of travel among football spectators? What is the average distance travelled to and from games across the football tiers? Are there differences between the football tiers in terms of GHG emissions? What are the levels of GHG emissions by football spectators when extrapolated nationally?

It is estimated that since 2011, the world population has exceeded seven billion (Laurance *et al.*, 2014). Globally, this population generates significant quantities of waste with the potential of causing adverse impacts both on the environment and on public health (Lin *et al.*, 2014). Waste is defined as any item or materials which a person discards, or is required to discard, or intends to discard (European Commission, 2008) and the increase in waste generation is attributed to economic development, globalisation and industrialisation.

Solid waste generated globally in 2012 was over 2.5 billion tonnes and contributed 5% of global GHG emissions. 70% of this waste was sent to landfill, 19% recycled or recovered, and 11% was sent to energy recovery facilities (Taherzadeh and Rajendran, 2014). In 2014, the waste generation per capita in the UK was 420 kg/year. There is an urgent need for the safe disposal of waste from all sectors. Currently, waste management is reliant on the waste hierarchy which prioritises practices from waste prevention, to waste reuse, to waste recycle, to waste recovery down to waste disposal (Papargyropoulou *et al.*, 2014).

Sporting events, either large scale or small scale, regularly generate waste and as a result, waste sent to landfill releases GHG particularly methane (CH_4). For example, the FIFA World Cup in Brazil recorded an attendance of over 5.1 million people, resulting in waste GHG emissions of 32,098 tCO_2e (FIFA, 2014). Several studies that highlight the environmental impact of sport also include waste management practices (Collins *et al.*, 2009; Dolles and Söderman, 2010; Cornelissen *et al.*, 2011). On a club level, Forest Green Rovers FC has decreased their carbon footprint over the years. In 2011/12 season the club generated 222.8 tCO_2e, in 2012/13 season 210.0 tCO_2e and in 2013/14 season generated 205.6 tCO_2e. The decrease in the footprint was due to the reduction in gas usage due to milder winter over the years resulting in reduction in gas use for heating. Although total waste produced at the club has increased over the years from 98.1 tonnes in 2011/12 to 131 tonnes in 2013/14. However, the total wastes recycled have increased from 62.06 tonnes in 2011/12 to 119.40 tonnes in 2013/14 while the recycling rate has increased from 62.7% to 90.8%. The club aim to maintain waste sent to landfill to fall below 5% (FGR, 2016).

This chapter seeks to highlight football spectators in England's travel GHG emissions and the importance of reducing GHG emissions from waste generated at football games in England.

3.1.1 Aim of the study

The primary aim of this study is to evaluate the impact of one spectator-dominated sport (football) on the environment, through the calculation of travel and waste-related GHG emissions from football spectators and comparing emissions across the eight football tiers.

Key objectives:

1) To evaluate the impact of football on the environment through the calculation of GHG emissions from spectator travel and waste.

2) To extrapolate the impact to a national level**.**

3.2 Method

This research comprises of two components: study 1 on GHG emissions related to travel and study 2 on GHG emissions related to waste. For the study on GHG emissions from travel, a questionnaire-based approach was taken to examine travel GHG emissions of football spectators and socio aspect. For the study on the GHG emissions from waste, a survey method was adopted for this study to examine waste management practices and to quantify GHG emissions from eight football tiers (Tier 3 – Tier 10) in Essex in order to then extrapolate nationally. Questionnaires were administered to collect data from football clubs and their waste contractors in Essex (Table 3.1)[1].

[1] An adapted version of some of the materials in this chapter has been published by ACS: **Dosumu, A.**, Colbeck, I. and Bragg, R. (2014) Greenhouse Gas Emissions: Contributions Made by Football Clubs in England. *Atmospheric and Climate Sciences*, **4**, 642-652. doi: 10.4236/acs.2014.44057 (included in appendix E).

Table 3.1: Football tiers, representative clubs and their waste contractors

Football Tier	Football Club	Waste collector/contractor
Tier 3	Colchester United	Colchester Skip Hire Environmental Ltd
Tier 4	Southend United	Veolia Environmental Services
Tier 5	Braintree Town Dartford Cambridge United	Braintree District Council Veolia Environmental Services Mick George Limited
Tier 6	Chelmsford City	Chelmsford City Council
Tier 7	East Thurrock	Veolia Environmental Services
Tier 8	Aveley	Ahern Waste Limited
Tier 9	FC Clacton	Veolia Environmental Services
Tier 10	Barking	Veolia Environmental Services

3.2.1 Role of football spectators travel

Spectators GHG emissions from travel

Several million spectators travel long distances on a weekly basis to watch football across the 11 football tiers in England. They commonly travel using 3 modes of travel: active travel (walking and cycling), public travel (buses and trains) and private travel (cars). From these three categories of travel, the most environmentally friendly mode of travel is the active travel with zero GHG emissions, then public travel, and the least environmentally friendly mode is by private travel.

3.2.2 Participants

In order to quantify GHG emissions from football spectators, Essex was chosen as a subset to represent the whole of the football sector first in England. This was done in collaboration with Essex County Football Association, football clubs in Essex from tiers 3 to 10 were selected, chosen to reflect a wide representation of football spectators across the football tiers in England.

A total of 1,649 football spectators from 46 clubs from football tiers 3 to 10 took part in this research by completing a questionnaire. Tier 8 had the most number of clubs while tier 3 had the least number of clubs. All participants were given the option to take part in the research, and they were recruited using a convenience-sampling technique, which is a form of opportunity sampling commonly employed in field research (Lai and Chen, 2011; Saunders, 2012). Measures were taken from spectators of away and home spectators at games and the football clubs representing each football clubs are shown in Table 3.2. These chosen clubs have similar attributes compared to other clubs across the football tiers in various part of the country. The geographical locations of football clubs was mixed and ranged from rural, suburban and urban environment and this did not have significant difference on the findings. Tiers 1 and 2 were not included in the study because there were no representative clubs in Essex, which was used as subset to represent England before extrapolating the results to national level and the social and environmental responsibilities of these tiers have been studied before (Jenkins and James, 2012; Laurence Webb, 2013; Edie 2015). Preliminary studies with Tier 11, indicated that spectators were mainly substitutes and managers with odd passer-by who just stopped to watch the game for a few minutes.

Table 3.2: Football tiers and representative clubs location

Football Tier	**Games**	
	Home	**Away**
Tier 3	Colchester United FC	Walsall FC
Tier 4	Southend United FC	Oxford United FC
	Dagenham & Redbridge FC	Cheltenham Town FC
Tier 5	Braintree Town FC	Barrow AFC
Tier 6	AFC Hornchurch	Chelmsford City FC
	Billericay Town FC	Eastleigh FC
Tier 7	Canvey Island FC	Hendon FC
	Thamesmead Town FC	Enfield Town FC
	Thurrock FC	Wealdstone FC
	East Thurrock FC	Great Wakering Rovers FC
Tier 8	Witham Town FC	Waltham Forest FC
	Brentwood Town FC	Romford FC
	Maldon & Tiptree FC	Potters Bar Town FC
	Tilbury Town FC	Redbridge FC
	Ilford Town FC	Wroxham FC
	Grays FC	Redbridge FC
Tier 9	Stanway Rovers FC	Wivenhoe FC
	FC Clacton	Hadleigh United FC
	Wivenhoe FC	Cambridge United FC
Tier 10	Barking FC	Sawbridgesworth Town FC
	Takeley FC	Southend Manor FC
	Barkingside FC	Basildon United FC
	Stanstead FC	London APSA FC
	Halstead Town FC	Downham Town FC

3.2.3 Study procedure

Data were collected using both a pre-printed and online questionnaire, employing outcome measures specifically developed for this research and by applying approved DEFRA's conversion factors to determine the GHG emissions from spectator travel to games. The questionnaire was designed to be short and be appropriate for self-completion by participants over the age of 18 years. The University of Essex, Faculty of Science and Health Ethics committee approved the study and all aspects of the field study were risk assessed and complied with the Data Protection Act.

The paper copies of the questionnaire were administered at football games before, at interval and the end of the games. While, link to the online questionnaire was made available to participants through respective football club websites and also through email when requested from the researcher. The online questionnaire was hosted through the University by Questionmark perception at http://perception5.essex.ac.uk/perception5/open. Although the response on the online questionnaire was low, about 20 participants completed the online questionnaire through the link made available. All data was collected and entered into SPSS version 20.

Defra conversion factors which are annually updated was used to calculate emissions by multiplying the data on the distance travelled according to mode of travel to and from games by the appropriate conversion factor as shown in Table 3.3.

Table 3.3:Defra's carbon emission conversion factors 2012

Mode of transport	Defra's Conversion factor ($kgCO_2e$)	Remarks
Walking	0	No fuel
Cycling	0	No fuel
Car (unknown fuel)	0.19	$kgCO_2e$/km/car
Bus (Average local)	0.11	$kgCO_2e$/km/person
Train (National Rail)	0.06	$kgCO_2e$/km/person
Taxi (Regular)	0.23	$kgCO_2e$/km/person

Note: The distance travelled by participants was measured in mile but converted to kilometres (1 mile =1.61km). The emission per spectator was calculated by multiplying distance travelled according to mode of travel by appropriate conversion factor based on mode of travel and reported in $kgCO_2e$. For example 20 km travel to and from a football game by bus will result in 20*0.11= 2.2 $kgCO_2e$. (Source of Defra's conversion factors: DEFRA/DECC (2012).

To aggregate the greenhouse gases covered in this study, a weighting based on the relative global warming potential (GWP) of each of the following gases was applied, using the effect of CO_2 over 100 years period as a reference (Murrells *et al.*, 2014). This gives methane a weight of 21 relative to CO_2 and nitrous oxide a weight of 310 relative to CO_2 as shown in Table 3.4.

Table 3.4: Global warming potential of selected greenhouse gases

Greenhouse gas (GHG)	Global warming potential (GWP)
Carbon dioxide (CO_2)	1
Methane (CH_4)	21
Nitrous oxide (N_2O)	310

Note: A universal unit of measurement used to indicate the global warming potential of a greenhouse gas, expressed in terms of global warming potential of one unit of carbon dioxide.

The chairmen and secretaries of football clubs in Essex were contacted by e-mail and also through Essex County Football Association for their consent to administer the online questionnaire and to share the link with their members. All participants were informed of the purpose of the research and their decision to complete the questionnaire was solely voluntary. The importance, purpose, nature and duration of the study were explained to the participants and clarification was provided where the need arose. All participants gave their informed consent. Participants were advised that all information provided would be treated as anonymous and would not be passed on to a third party.

Participants were approached at games to participate in the research and the questionnaire was administered to participants before games, at intervals and at the end of the game, to both home and away spectators. All completed questionnaires were returned to the author after completion for collation and analysis. Data collection was conducted from mid-February 2012 until March 2013. No use of incentives was provided for participation.

3.2.4 Outcome measures

A range of outcome measures was included in the questionnaire to address: i) demographic information, ii) details on travel mode and distance; and a 3-item importance scale of different aspects of football.

i. *Demographics*

Participants' data included in the questionnaire were their age and gender.

ii. *Details on travel mode*

To quantify GHG emissions of participants from travel, questions were purposely developed for this study. The questions comprised of the mode of travel used to and from games with the distance travelled and car sharing details if participants drove to games. In order to simplify the GHG emission calculations and still retain a realistic estimate per participant, the following approach was taken:

- Mode of travel to and from games was confirmed
- The travel distance to and from games was calculated
- 2012 DEFRA/DECC's GHG conversion factors were applied to quantify participants' GHG emissions (CO_2, CH_4, N_2O) from travel (results expressed in $kgCO_2e$).
- National extrapolation was made by multiplying the mean GHG emissions at the football tier by annual number of spectators at the tier.

iii. Importance of different aspects of football

The questionnaire was designed to show 3 different importance scales of participants' different aspect of football. A 3-item importance scale was designed for this research to measure the importance of being outside in nature, the importance of being with people and the importance of watching the game. Each of the 3-item importance scale contained a visual analogue scale of 1-10, with 1 = not very important and 10 = very important.

A copy of the questionnaire is included in Appendix A.

3.2.5 Statistical analysis

The questionnaires were collated and stored electronically on IBM Statistical Package for the Social Sciences (SPSS) 20 database, to assist in manipulating data and statistically analysing the results (Aron, 2012; Graham, 2012; Newton and Rudestam, 2012).

For the study, descriptive statistics were obtained for each measure and statistical significance was set at $p < 0.05$. All data sets were initially subjected to preliminary analyses to assess normality. Univariate normality was assessed using the Shapiro Wilk test (Field, 2009, 2013; Pallant, 2013). Also, visual inspections of frequency histograms providing a pictorial representation of distribution and expected normal probability plot were also used. A variety of output data was also inspected for normality by examining skewness and kurtosis values of the dependent variables. However, where a set of data was not normally distributed (e.g. as with GHG emission-variable), the use of non-parametric tests on the data was employed (Field, 2013; Pallant, 2013).

A range of statistical analyses was undertaken: descriptive statistics of the variables, Kruskal-Wallis test, Mann-Whitney U test, comparing the median or mean rank score of the dependent variables and Spearman's correlation (Field, 2013). Where Kruskal-Wallis test was significant, to identify the differences between the groups, further pairwise comparison testing with adjusted *p*-values was applied. Where appropriate, effect sizes were reported using Cohen's (1988) effect size (.1 = small effect; .3 = moderate effect; .5 = large effect). For the correlation, the strength of relationships was also reported using Cohen's (1988) interpretation of 'r' values - r=.10 to .29 weak; r=.30 to .49 moderate; r=.50 to 1 strong.

Method on study of GHG emissions from waste

3.2.6 Study procedure

A survey technique was used to collect empirical data for this study. In collaboration with Essex FA, one club was selected from each football tier (tier 3 to tier 10) to be representative of clubs at each tier (see Table 3.1). In tier 6, however, a total of three clubs were selected to account for the variations in club composition within the tier. Structured interviews and an observational checklist were used at each survey site to record the findings and to examine waste management practices. A designated waste management official at each football club was asked questions to identify his/her level of knowledge and awareness of football waste management and to collect data on waste generation. Football club officials were asked questions on availability of a waste policy, waste contractor details, types of waste generated, types and size of waste containers, frequency of waste collection, quantity of waste generated, proportion of waste diverted from the landfill and proportion of landfill waste if known. The contact details of the waste contractor from each club were also collected and the clubs were informed that the waste contractors would be contacted to verify the quantity of waste managed and how the waste collected is treated.

The waste contractors were asked questions to verify that they managed waste from the clubs, the frequency of waste collection, the proportion of waste sent to landfill and the proportion of the waste diverted from landfill.

Observational checklist

Physical observations were made at each football club to verify the type of waste generated at the clubs, and the types and quantity of waste containers. The general behaviour on waste management of football spectators was also observed at games.

GHG conversion factor

The GHG emissions from waste sent to landfill and waste recycled were again calculated using Defra's conversion factors 2012 of 290kgCO_2e/1000kg waste for landfill (municipal waste, average) and 21kgCO_2e/1000kg waste recycled (DEFRA, 2013).

Extrapolating GHG emissions from waste at the national level

Waste per spectator was calculated by dividing the annual waste at the representative club by the annual number of spectators at that club. The mean waste (kg/spectator) was used to estimate annual waste generated at that football tier by multiplying mean waste per spectator by the annual number of spectators at that football tier, and the result was subsequently extrapolated to the national level.

The GHG emissions were determined by using extrapolated GHG emissions resulting from:

(i) GHG emissions from landfill waste at football tiers = Σ (Total mass of waste landfill (tonnes)) x emission factor of waste landfill (kg CO_2e/tonnes)).

(ii) GHG emissions from recycled waste at football tiers = Σ (Total mass of waste recycle (tonnes)) x emission factor of waste recycle (kg CO_2e/tonnes)).

3.2.7 Data processing and analysis

The quantitative data from the structured interviews was stored in Microsoft Excel for processing and analysis. Descriptive statistics were carried out to compare the waste at each club and at each football tier. Descriptive statistics of GHG emissions were compared between league and non-league levels and also between landfill waste and recycled waste.

3.3 Results of the study on GHG emissions from travel

3.3.1 Demographic information

A total of 1649 participants took part in the study across football tiers 3 to 10. 80% of the participants were male (n=1315) and 20% were female (n=334); and participants' ages ranged from 18-84, with a mean age of 42.63 (SD=17.01).

3.3.2 Details of travel

The most frequent mode of travel used by the participants was by car (67%, n=1,113), followed by walking (13%, *n*=221), then bus (10%, *n*=166), train (8%, *n*=127), cycling (0.8%, *n*=14) and taxi (0.4%, *n*=7) as shown in Figure 3.1.

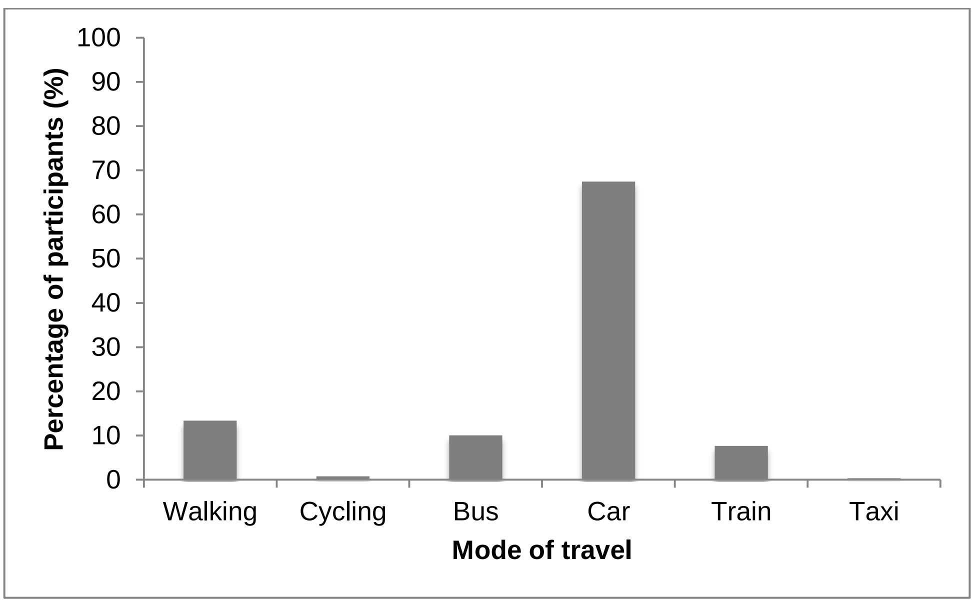

Figure 3.1: Participants' percentage mode of travel across all the football tiers

The mode of travel within the football tiers is shown in Figure 3.2 with participants travelling to games mostly by car and the least used mode of travel was cycling.

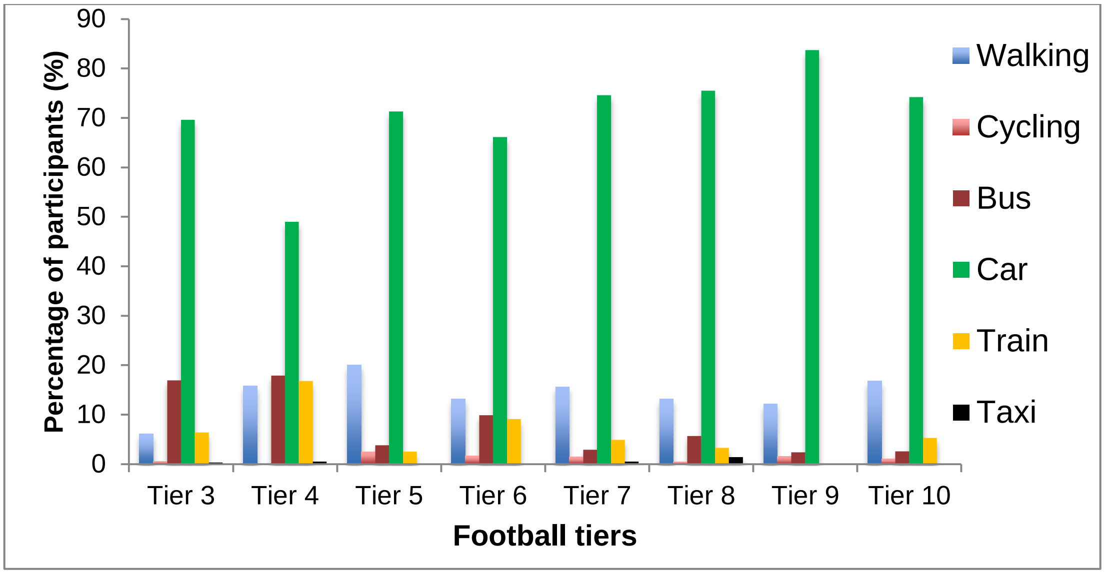

Figure 3.2: Participants' percentage mode of travel across all the football tiers

Distance travelled by participants

The mean distance travelled to and from games across the football tiers was 41.55km, SD=72.89.The distance travelled decreased from tier 3 (the highest e.g. Colchester United FC) down to the lowest tier 10 (Halstead Town FC). The mean distance travelled to and from football games is shown in Table 3.5.

Table 3.5: Mean distance travelled across the football tiers

Football Tier	Mean Distance Travelled (km)	Standard Deviation (SD)
Tier 3	66.92	101.65
Tier 4	59.40	85.01
Tier 5	51.34	110.23
Tier 6	27.12	39.33
Tier 7	26.48	34.62
Tier 8	22.41	37.86
Tier 9	19.12	31.42
Tier 10	18.40	23.36

3.3.3 Annual attendances at the football tiers and mean GHG emissions

The GHG emissions for each participant was calculated by multiplying the distance travelled to and from games depending on the mode of travel by Defra's conversion factors. From this data the mean GHG emissions at each football tier was applied to the annual attendance for each football tier during 2012/13 football season, the result was extrapolated to national level as shown in Table 3.6. Annual attendance varied across the football tiers during the 2012/13 season. Approximately 3.5 million people attended games at tier 3, almost 2.5 million people attended games at tier 4, about 1 million people at tier 5, roughly 540,000 at tier 6, nearly 420,000 at tier 7, around 464,000 at tier 8, approximately 540,000 at tier 9 and about 268,470 at tier 10. The mean GHG emission across the football tiers was 4.74kgCO_2e per participant per game.

Table 3.6 describes the mean GHG emissions from the football tiers in England during the 2012/13 season. Mean GHG emissions among football tiers are highest among tier 3 at 8.46 kgCO_2e and least at tier 9 at 2.04kgCO_2e.

Table 3.6: Annual attendance and mean GHG emissions at the football tiers during 2012/13 football season

Football tier	Annual Attendance	Mean GHG emissions per person (kgCO_2e)	Standard Deviation (SD)	Annual GHG emissions (tCO_2e)
Tier 3	3,473,154	8.46	14.31	29,382.88
Tier 4	2,422,218	6.23	10.16	15,090.42
Tier 5	1,041,886	5.97	14.69	6,220.06
Tier 6	539,217	2.69	3.73	1450.49
Tier 7	413,765	2.83	4.16	1170.95
Tier 8	463,398	2.69	4.94	1246.54
Tier 9	539,959	2.04	3.66	1101.52
Tier 10	268,470	2.14	3.53	574.53

NOTE: Extrapolated annual attendance at each football tier during 2012/13 season
Source: Annual attendance at football tiers (EMF, 2013; FA, 2013; NLM, 2013; Isthmian League, 2013).

Annual GHG emissions at each football tier were calculated by multiplying the mean GHG emissions at each football tier by the annual attendance at the football tier. For example, the GHG emission at tier 3, (8.46* 3473154 = 29,382.88 kgCO_2e).

Annual GHG emissions for football tiers

The annual GHG emissions at football tiers were calculated by multiplying the mean GHG emissions at each football tier by the annual extrapolated attendance at each football tier as shown in Figure 3.3. GHG emissions from travel by football spectators reduced down the football tiers. The highest emissions were at tier 3 with 29,382 tCO_2e and the least GHG emissions of 574 tCO_2e at tier 10.

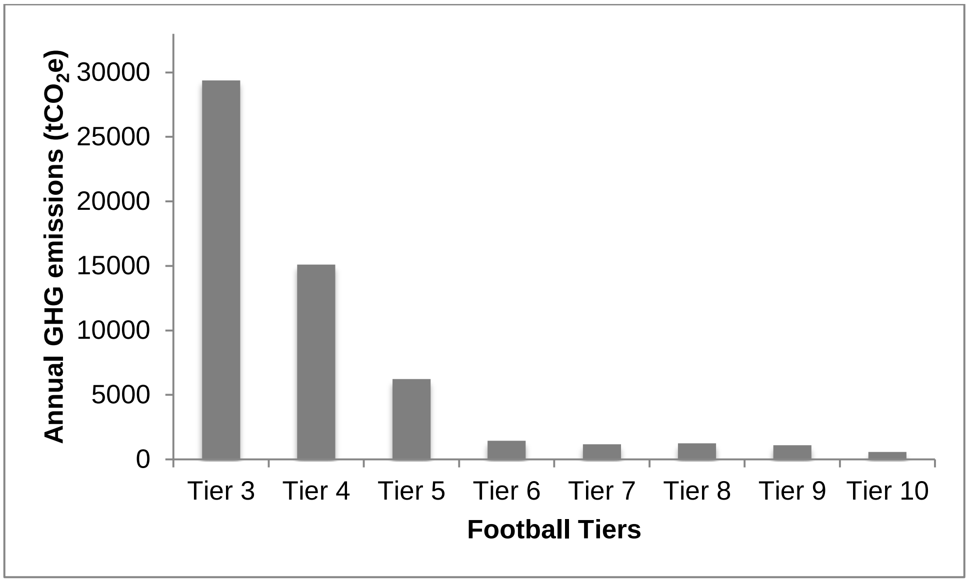

Figure 3.3: Annual extrapolated GHG emission during 2012/13 season
NOTE: Extrapolated annual GHG emissions were calculated by multiplying mean GHG emission at each tier by annual attendance at each football tier.

Extrapolating these results with a total of 9,162,067 participants that watched football games from tier 3 to tier 10 during the 2012/13 football season in England resulted in approximately 56,237 tCO_2e.

Comparing GHG emissions between the football tiers

A Kruskal-Wallis test was conducted to evaluate differences in GHG emissions among the eight football tiers (tier 3-tier 10) in England from travel during the 2012/13 football season. The results of the analysis indicate significant differences between football tiers' GHG emissions, [$H(7)=46.474$, $p < .001$].

Further pairwise comparison testing with adjusted *p*-values showed Tier 9 had significantly lower GHG emissions compared to tiers 4 and 5, while GHG emission was significantly higher in tier 3 than tiers 7, 8 and 10 (Table 3.7). The non-significant differences are shown in Appendix B.

Table 3.7: GHG pairwise comparisons between football tiers

Sample 1- Sample 2	Test statistics	Std. Error	Std. Test statistics	Sig (p-value)	Adj. sig (p-value)	Effect Size (EF)
Tier 9 – Tier 4	186.453	49.135	3.795	.000	**.004**	0.17
Tier 9 – Tier 3	287.090	50.309	5.707	.000	**.000**	0.27
Tier 10 – Tier 3	222.442	43.393	5.126	.000	**.000**	0.23
Tier 7 – Tier 3	150.482	42.378	3.551	.000	**.011**	0.15
Tier 8 – Tier 3	142.967	41.947	3.408	.001	**.018**	0.15

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and EF is the effect size (.1 small, .3 medium and .5 and above large).

GHG emissions between home and away spectators

A Mann Whitney U test was conducted to compare the GHG emissions between two groups of participants: home and away. The results revealed a statistically significant difference with higher GHG emissions for away participants (M=13.77,SD=15.03, n=435) than for home participants as expected (M=1.75,SD=3.00, n=1214), [U = 87371.50, z = -20.766, p <.001, r =.51-large effect size]. Note: The number of participants was represented by n.

GHG emissions between non-league and league

A Mann Whitney U test was conducted to compare the GHG emissions between non-league (tier 5 to tier 10) and league levels (tier 3 and tier 4) and found a statistically significant difference, with higher GHG emissions at the league level (M=7.24, SD=12.26, n=718) than the non-league level (M=2.81, SD=5.90, n=931); [U = 284845.00, z = -5.159, p <.001, r =.13-small effect size].

Relationship between GHG emission and distance travelled to games

The relationship between the two variables: GHG emission and distance was examined using a Spearman's correlation coefficient. A statistically significant strongly positive correlation was found between GHG emissions and distance [r=.94, n= 1649, p<.001]. This finding show that the two variables are related and both variables increase simultaneously.

3.3.4 Summary of key findings of study 1 on travel

- Participants mean distance travelled to and from games was 41.55km and the majority (67%) of participants travel by car.
- The mean GHG emission across the football tiers was 4.74kgCO_2e per participant per game.
- Extrapolating the results to national level with a total of 9,162,067 participants from tier 3 to tier 10 during the 2012/13 football season resulted in approximately 56,237 tCO_2e.
- GHG emissions significantly differ between the football tiers; Tier 9 had significantly lower GHG emissions compared to tiers 4 and 5, while GHG emission was significantly higher in tier 3 than tiers 7, 8 and 10
- There was a relationship between GHG emissions and distance travelled to and from games. Both variables were strongly and positively correlated.

3.4 Results of the study on GHG emissions from waste

3.4.1 GHG emissions from waste in Essex

The findings from the data collected from ten football clubs and their waste contractors are presented below. The results of the survey were designed to quantify waste at representative club and extrapolate to the rest of football tier and to calculate GHG emissions from waste sent to landfill and from waste recycled at each football tier; and to compare GHG emissions between the league and the non-league system in England during 2012/13 football season.

Waste from football clubs in Essex

Total waste generated at each football club representing a football tier in Essex during 2012/13 season ranged from 1.62 to 356.77 tonnes. The annual attendance for the football season also ranged from 931 at Barking FC representing tier 10 to 114,494 at Southend United FC representing tier 4. Therefore the waste generated per spectator ranged from 1.82kg per spectator at tier 10 to 6.81 kg per spectator at tier 6 (Table 3.8).

Table 3.8: Representative football clubs annual waste details and attendance during 2012/13 football season

Football tier	Representative club	Annual waste (tonnes)	Annual Attendance	Waste per spectator (kg)
Tier 3	Colchester United FC	281.69	81,179	3.47
Tier 4	Southend United FC	345.77	114,494	3.02
Tier 5	3 clubs*	97.50	38,376	2.54
Tier 6	Chelmsford City FC	37.90	5,566	6.81
Tier 7	East Thurrock FC	8.31	3,596	2.31
Tier 8	Aveley FC	9.39	2,241	4.19
Tier 9	FC Clacton	4.30	2,160	1.99
Tier 10	Barking FC	1.69	931	1.82

N*otes*: Waste per spectator = Annual waste divided by annual attendance at club level*; *average results from 3 clubs. (The 3 football clubs at Tier 5 are: Dartford FC, Cambridge United FC and Chelmsford City FC)*

Proportion of waste recycled and landfilled in Essex

Figure 3.4 shows the proportion of waste sent to landfill at the football tiers in Essex, which ranged from 11% at tier 3 to 53% at tier 6; and the percentage of waste recycled ranged from 47% at tier 6 to 89 % at tier 3.

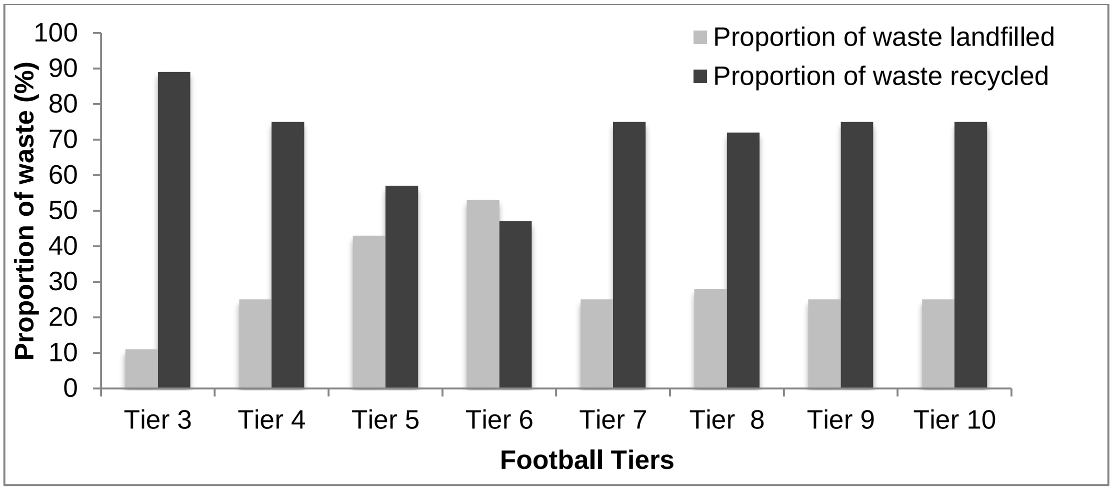

Figure 3.4: Percentage of waste recycled and landfilled at each football tier in Essex

3.4.2 Extrapolations from Essex county level to national level

Waste from football tiers in England

In order to extrapolate figures for the national picture, the GHG figures from the Essex clubs chosen to represent the football tiers were used to calculate the GHG emissions and also considering the annual attendance at the football tiers. The annual attendance across all football tiers 3 to 10 during 2012/13 football season was 9,162,067. The annual waste generated across the 8 football tiers was 30,147 tonnes, and the waste generated at the football tiers ranged from 489 tonnes at tier 10 to 12,052 tonnes at tier 3 (Table 3.9).

Table 3.9: Waste per spectator, annual attendance and extrapolated annual waste at the football tiers during 2012/13 football season

Football tier	Waste per spectator (kg)	Annual Attendance	Annual waste (tonnes)
Tier 3	3.47	3,473,154	12,052
Tier 4	3.02	2,422,218	7,315
Tier 5	2.54	1,041,886	2,646
Tier 6	6.81	539,217	3,672
Tier 7	2.31	413,765	956
Tier 8	4.19	463,398	1,942
Tier 9	1.99	539,959	1,075
Tier 10	1.82	268,470	489

NOTE: Annual waste= waste per spectator * annual attendance at each football tier
Source: Annual attendance at football tiers (EMF, 2013; FA, 2013; NLM, 2013; Isthmian League, 2013)

Extrapolated GHG emissions from landfill and recycled waste in England

The quantity of waste recycled across the eight football tiers during 2012/13 season was 13,334 tonnes and 16,813 tonnes of waste was sent to landfill. The variation in GHG emissions from recycled waste across the football tiers is illustrated in Table 3.10. The least GHG emissions from recycled waste were from tier 10 with 7.7 tCO_2e, while the highest GHG emissions were from Tier 4 resulting in 115.2 tCO_2e. The greatest GHG emission from waste sent to landfill was at tier 3 with 311 tCO_2e, while the least GHG emission was from Tier 10 with 35.4 tCO_2e, as shown in Table 3.10.

Table 3.10: Extrapolated GHG emissions from recycled and landfill waste in England

Football tier	GHG emissions from landfill waste (tCO_2e)	GHG emissions from recycle waste (tCO_2e)
Tier 3	3,110.6	27.8
Tier 4	530.3	115.2
Tier 5	329.9	31.7
Tier 6	564.4	36.2
Tier 7	69.3	15.1
Tier 8	157.7	29.4
Tier 9	77.9	16.9
Tier 10	35.5	7.7

Aggregated GHG emission in England

Figure 3.5 illustrates the aggregated GHG emissions (from waste sent to landfill and recycled waste). The highest emission (3,138 tCO_2e) was from football tier 3 which recorded the highest annual attendance while the least GHG emission was from tier 10 (43 tCO_2e). The aggregated GHG emission from recycled waste and landfill waste for tiers 3 to 10 for 2012/13 football season was about 5,155 tCO_2e.

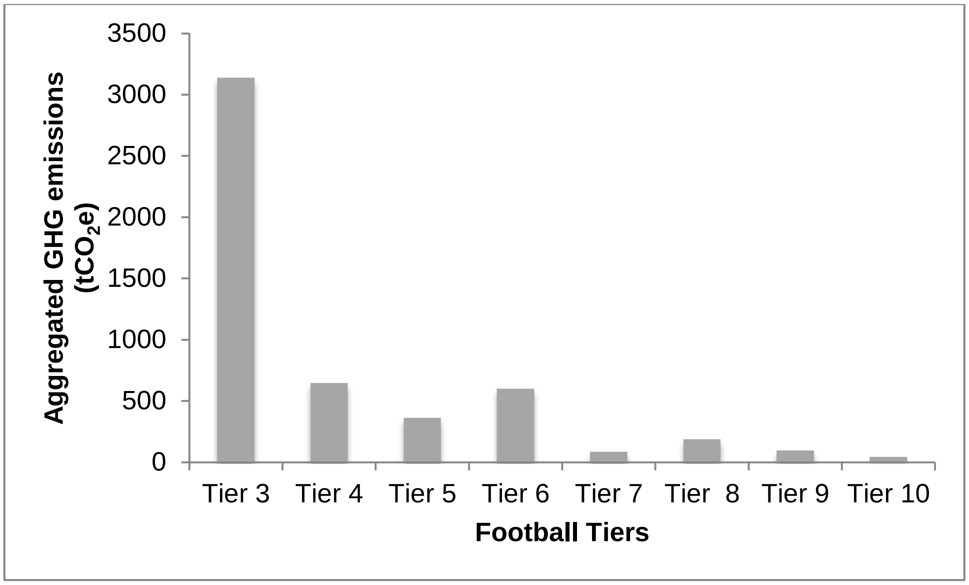

Figure 3.5: Aggregated GHG emissions across the football tiers

Comparing GHG emissions between non-league and the league system in England

Descriptive statistics was used to compare the GHG emissions from waste between the football tiers. The findings reveal that the GHG emission at the league system was over 2.5 times more than the GHG emission at the non-league. The non-league system generated 1,371tCO_2e, while the league system generated 3,784 tCO_2e, as shown in Figure 3.6. Findings from this study reveal the mean waste per spectator at the league level of 3.25 kg per spectator was similar to the non-league with 3.27 kg per spectator.

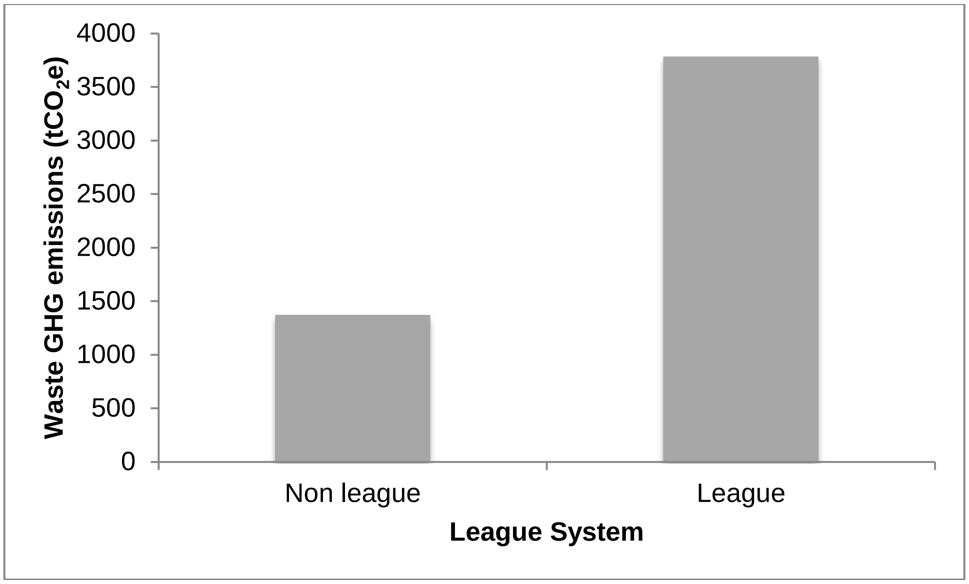

Figure 3.6: Comparing GHG emissions between the non-league and the league in England

3.4.3 Summary of key findings from study on GHG emissions from waste

- Football spectators from the eight football tiers in Essex generated an average waste of 3.27 kg per spectator.
- The average recycling rate at the football tiers in Essex was approximately 71% and the average proportion of waste sent to landfill across the football tiers in Essex was approximately 29%.
- Extrapolating the results to national level in England resulted in GHG emissions of 280 tCO_2e from recycled waste while GHG emissions from waste sent to landfill was 4,875tCO_2e.
- The aggregated GHG emissions (combining GHG emission from recycled waste and landfill waste) from the eight football tiers in England was 5,155 tCO_2e during 2012/13 football season in England.

3. 5 The importance of watching the game and watching with people

The importance of football spectators watching the game and watching with other people fits into this section because it is the same data set as that of spectators GHG emissions from travel.

3.5.1 Importance of the social aspects of watching football

Participants' perceptions of the importance of being with other people was assessed and being with other people scores ranged from 1 to 10, with a mean score of 7.90, SD = 1.99 and median of 8.00.

Importance of being with other people between the eight football tiers

When tested with a Kruskal-Wallis test no statistically significant differences between the importance of being with other people for spectators at different football tiers' was found [H (7) = 7.779, *p* = .352, r = .19-small effect].

Importance of being with other people between home and away groups

A Mann Whitney U test was conducted to compare the importance of being with other people between home and away groups. The result showed that there was a statistically significant difference between the home group (M=7.95,SD=2.00,n=1214) and away group (M=7.76,SD=1.94,n=435), [U = 243,295.000, *z* = -2.484, *p* = .013, r = -.06 - small effect]. The social aspects of watching football appear to be more important to participants at home games than for those at away games.

Importance of being with other people between non-league and league

A Mann Whitney U test was conducted to compare the importance of being with other people between non-league and league spectators. The result showed that there was no statistically significant difference between the non-league (M=7.92,SD=1.98, n=931) and the league (M=7.88,SD=2.01, n=718), [U = 329739.500, *z* = -.478, *p* =. 633, r =. 01-small effect].

Importance of being with other people and gender.

A Mann Whitney U test was conducted to compare the importance of being with other people between males and females. The result showed that there was a statistically significant difference between the males (M=7.82,SD=2.03) and females (M=8.21,SD=1.82), [U = 195174.500, *z* = -3.207, *p* = .001, r = .08 - small effect.] The importance of being with other people was preferred more in females than in males.

3.5.2 Importance of watching the game

Participants' importance of watching the game was assessed using an importance scale containing a visual analogue scale of 1-10, with 1 = not very important and 10 = very important. The importance of watching the game scores ranged from 1 to 10 with a mean score of 8.61, SD = 1.82, and median of 9.00. The mean score of importance of watching games was highest in Tier 7 and least in tier 6 (Table 3.11).

Table 3.11: Comparing the Importance of watching the game in England

Football Tier	Mean	Standard Deviation (SD)
Tier 3	8.41	1.73
Tier 4	8.85	1.81
Tier 5	8.77	1.19
Tier 6	8.38	2.01
Tier 7	8.91	1.43
Tier 8	8.42	2.03
Tier 9	8.40	1.89
Tier 10	8.54	2.06

Importance of watching the game between the eight football tiers

A Kruskal-Wallis test was conducted to evaluate differences in importance of watching the game between the eight football tiers (tier 3 - tier 10) in England during the 2012/13 football season. The results of the analysis indicate significant differences in the importance of watching the game for spectators in different football tiers, [H (7) = 31.783, *p*< .001, r = .78 - large effect]. The importance of watching the game was higher in tier 7 (M=8.91,SD=1.43) compared to tier 3 (M=8.41,SD=1.73). The non-significant differences are shown in Appendix D.

Importance of watching the game between home and away groups

A Mann Whitney U test was conducted to compare the importance of watching the game between home and away groups. The result showed that there was no statistically significant difference between the home (M=8.53,SD=1.91,n=1214) and away group (M=8.83, SD=1.52,n=435); [U = 250114.500, z = -1.699, p =. 089, r = .04 - small effect]. The result indicates that importance of watching the game was the same between the home and away groups.

Importance of watching the game between non-league and league

A Mann Whitney U test was conducted to compare the importance of watching the game between the non-league and the league. The result showed that there was no statistically significant difference between the non-league (M=8.57,SD=1.85,n=931) and the league (M=8.65,SD=1.79,n=718), [U = 327637, z = -.686, p = .493, r = .02 - small effect]. The importance of watching the game was the same between the non-league and the league.

Gender comparison

A Mann Whitney U test was conducted to compare the importance of watching the game between males and females. The result showed that there was a statistically significant difference between the males (M=8.68,SD=1.76,n=1314) and females (M=8.33,SD=2.01,n=334), [U = 199259.500, z = -2.740, p = .006, r = -.07 - small effect]. The importance of watching the game was preferred by males than females. The finding suggest that females go for the event and love to be with other people while men go for the game than the social bonding.

3.6 Discussion

3.6.1 Addressing the study aim and objectives

The primary aim of these two studies were to evaluate the impact of football on the environment through the calculation of GHG emissions from travel and waste by football spectators at eight football tiers in England and to extrapolate to national level.

Study 1 on GHG emissions from travel

The study revealed that the participants were not evenly distributed by gender: there were 80% males and 20% females. It is apparent from these findings that football spectators are predominantly males. This is not limited to this country but similar to other countries of the world according to past studies (Waddington *et al.*, 1998; Stone, 2007; Gencer, 2010), although there are more females watching football now than over two decades ago (Malcolm *et al.*, 2000; Ben - Porat, 2009). In terms of age, the results showed that the mean age of football spectators is 42 years and the majority are middle aged (31-50 years). This is similar to the mean age (41 years) of spectators reported attending football games in the premier league in 2011 (Premier League, 2014).

3.6.2 Effects of travel GHG on the environment

The findings of the GHG emissions from spectator-dominated sport (football) from eight football tiers were significant because of GHG emissions from travel to games during 2012/13 season. This is similar to previous studies on GHG emissions from travel at major sporting events, particularly events such as the FIFA World Cup and Olympic games. For example, the 2014 FIFA World Cup in Brazil recorded 2.7 million tonnes of CO_2e, with almost 2.3 million tonnes of CO_2e due to travel (www.carbonvisuals.com), while the FIFA World Cup in South Africa resulted in 1.65 million tonnes of CO_2e (EOLA, 2014). The Olympic Games in London in 2012 resulted in 3.3 million tonnes of CO_2e from construction work, transportation, staging the events and spectator impact. Travel emission from the games was 913 million tonnes of CO_2e (Reuters, 2015). The mean GHG emissions was calculated and when aggregated at football tiers was significant and also substantial when extrapolated nationally.

An examination of distance travelled by spectators' shows that, on average, a spectator travels 41.55 km to and from games and that the majority of spectators travel by car. Travelling to and from games across the eight football tiers during the 2012/13 season generated a mean GHG emission of 4.75kgCO_2e; and extrapolating this to a national level with over 9.1 million spectators resulted in approximately 56,237 tCO_2e.

Findings from this study also demonstrate that GHG emissions were significantly different across the football tiers, particularly tier 9 which had a significantly lower GHG emission compared to tiers 4 and 5. GHG emission was significantly higher in tier 3 than in tiers 7, 8 and 10. The away group emitted more GHG than the home spectators due to distance travelled and mode of travel, which is similar to the findings from another study (Chard and Mallen, 2012).

The GHG emission from the higher football tiers is due to the mode and distance travelled to games. For example, during 2014/15 football season an average premier league spectator travelled a total of 9,173 km to away games; 180 km was the lowest average trip made by Aston Villa FC while 350 km was the highest average trip made by Swansea FC spectator during the season (BBC, 2015). The league emitted more GHG than the non-league, which could be as a result of distance travelled, for there is bigger geographical coverage in the league than for the non-league.

The best approach to reducing GHG emissions of football spectators is to avoid travelling as much as possible in the first place. However, opting for a lower impact or zero emission mode of transport (such as walking and cycling) or choosing public transport could be the most realistic options. Studies have shown that better transport mode reduces GHG emissions; for example, in the premier league in 2013, Newcastle United, Arsenal and Fulham were laudable transport champions because they provided: season-long match day public transport that was cheap (as low as £10), good public transport links, good travel planning and reduction in car use to games, while Manchester United, Reading and QPR were at the bottom of the premier league travel table due to out of date travel plans, least accessible ground with poor public transport link (Girod *et al.*, 2014; Sanjust *et al.*, 2014; CfBT, 2015).

Transport is the fastest growing sector both nationally and internationally and contributes significantly to air pollution and other forms of environmental impacts. To minimise the impacts of transport on the environment, a more sustainable transport strategy should be in place such that it will integrate all modes of transport rather than being over reliant on cars.

There exist a number of solutions to solve the transport problems and the resultant GHG emissions. These are:

1. The use of public transport should be encouraged among football spectators with a fully developed and sustainable transport policy in place. A decrease in personal car use would have environmental benefits particularly on air quality.
2. Encouraging a number of technological solutions, which can help reduce pollutant emissions from road traffic. Alternate fuels to petrol and diesel should be developed and the use of electric cars should be encouraged which would all result in the release of less GHG emissions into the air.
3. Car sharing should be encouraged to sporting locations so as to reduce congestion on roads and pollution.
4. Although, travelling to games by car is popular as it is the most attractive form of transport, due to its convenience, football spectators should be encouraged to use other modes of transport and adopt more sustainable transport behaviour. The use of cars to sporting

locations should be made less attractive while, making parking charges more expensive than the cost of public transport should be encouraged. The use of active transport such as walking and cycling or the use of public transport should be encouraged.

The level of importance of being with other people was found to be high. The findings from this study show that the majority of people that came to watch games came as a group of 2 or more people, indicating the social benefits of watching football together. This indicate that spectators were more likely to watch games with friends and family members, which encourages bonding among family members and even friends according to past literature (Welford and Kay, 2007; Funk *et al.*, 2012; Bairner, 2014). The importance of being with other people in the study was affected by the location of the spectators and their gender (with higher levels for home and for female participants). However, football tiers and league system did not affect the importance of being with other people.

The level of importance of watching the game was found to be high, similar to other studies in literature (Robertson *et al.*, 2013; Alonso and O'Shea, 2014; Eguchi, 2014). Football tiers affected the level of importance of watching the game, with tier 3 levels lower than tiers 4 and 7. The level of importance of watching the game was affected by gender (with a higher level for males than females). However, age group, home and away, and the league system did not affect the importance of watching the game.

3.6.3 Limitations

Study on GHG emissions from travel

Although the current results have provided important evidence regarding levels of GHG emissions, importance of being with other people and the importance of watching football games, the study does have some limitations.

- While questionnaires were administered at tiers 3 to 10 across representative clubs in conjunction with Essex County Football Association, tiers 1 and 2 in the England football hierarchy could not be included in the data collection due to having no representative club present in Essex and tier 11 could not be included because of very low attendance at games.
- Official approval was sought before questionnaire administration at games, but when there were adverse weather conditions such as flood and snow resulting in match cancellations at a short notice, rescheduling of data collection was difficult.
- Participants were able to complete the questionnaire before the games and at intervals, but were not readily available to complete the questionnaire after the games because they were in a rush to leave. This necessitated uploading the questionnaire online, but the response rate for online submissions was low, possibly due to a lack of time or interest particularly after games.
- A standardised questionnaire to measure connection with nature of participants using connectedness to nature (CNS) or nature relatedness (NR) scale could not be included in the questionnaire because time would not make it practically possible to complete the questionnaire and a scale on the importance of being outside in nature was included as a proxy to be able to collect the data to evaluate the contact with nature of participants. This could not readily measure the level of contact with nature and the data was excluded from further analysis.
- Calculating GHG emissions data at the football tier was based on the assumption that a spectator travelled similar distances to and from games using the same mode of transport, which might vary and could result in a level of error calculating the GHG emissions from travel accurately.

Study on GHG emissions from waste

Although the current results have provided important evidence regarding waste GHG emissions across the eight football tiers in England, the study does have some limitations.

- Waste data collection was carried out at one football club per football tier, except tier 5 due to limited resources. Incorporating more clubs at each football tier could strengthen future research.
- Time constraints limited the number of football clubs included in this study.

3.7 Discussion on GHG emissions from waste

3.7.1 Addressing the study aim and objectives

The primary aim of this study was to evaluate the impact of spectator-dominated sport (football) on the environment through the calculation of GHG emissions from waste generated by football spectators at football tiers in Essex and to extrapolate to national level in England

3.7.2 Waste and GHG emissions

The findings from this study show that spectators at football games on a regular basis generate a large quantity of waste, and this is similar to studies carried out from major sporting events (Schmidt, 2006; Collins *et al.*, 2009; Cornelissen *et al.*, 2011). This study shows that the number of games played increases down the football tiers (Tier 5-10), but attendance decreases at games. However, when aggregated nationally the resultant numbers of spectators are equivalent to those of the Premier League. This means that waste and resultant GHG emissions have environmental impact even from lower football tiers in England.

The mean waste per spectator across the football tier was 3.27 kg and extrapolating the waste generated to national level resulted in approximately 30,000 tonnes of waste during 2012/13 season.

Previous studies that examined the FA Cup, which is the most prestigious competition for football clubs in England and possibly the biggest domestic football competition in the world, found that waste generated at past FA cup finals was significant. In 2004 waste generated per spectator at FA cup final was 0.78 kg per spectator; 2012 final was 0.27 kg per spectator and at 2013 final was 0.25 kg per spectator. However, the waste per spectator from this present study was more than 4 times the waste per spectator from past FA cup finals, possibly due to high waste generations across the football tiers through the season while the FA cup final is an event for a day with more environmental awareness to the spectators at the finals (Collins and Flynn, 2008; Veolia, 2012, 2013). Moreover, the aggregated GHG emission from total waste generated during the season by over 9 million spectators was 5,155 tCO_2e.

The waste sent to the landfill has the potential to generate GHG, particularly methane (CH_4) (Kumar *et al.*, 2004; Themelis and Ulloa, 2007; Xiang *et al.*, 2014). Reducing waste generated at football games will lead to less environmental impact by reducing GHG emissions from waste sent to landfill, less use of resources and will save money.

Similarly, this study has shown that the commitments of environmental professionals at the football tiers have boosted their recycling rate to 71% in 2012, which has exceeded England's household waste recycling rate of 40% in 2011 (Hou *et al.*, 2012). In addition, private contractors collected more waste than the local councils (Table 3.9). This finding suggests that the use of private contractors for waste collection at football games has increased and has encouraged recycling due to environmental reason (Gandy, 2014).

The quantity of waste sent to the landfill from the football clubs is still a concern. The mean waste generated was exceptionally high in tiers 6 with an average spectator generating 6.81kg of waste and this tier sent the highest proportion of 53% waste to landfill. The clubs in this tier should be concerned with better waste management particularly reducing the amount of waste generated and also increasing their recycling rate so as to reduce their overall GHG emissions from waste sent to landfill. Football clubs at the mid-tier clubs should have waste management policy that will limit or avoid growth in waste volumes which will further reduce GHG emissions from the waste sector and deliver other benefits to the club, the society and ultimately the environment. The use of landfill has been increasingly criticised as a viable disposal option because it produces toxic substances including landfill gas from anaerobic decomposition of putrescible waste.

This study is the first to evaluate waste management practices among 8 football tiers in England. The football clubs studied possibly acted at reducing their GHG emissions due to the rise in the landfill tax, which is the key policy driver employed under the 1999 EU Landfill Directive, which required a 65% reduction in biodegradable municipal waste landfilled in Europe by 2020 compared to 1995 levels (Ishii and Furuichi, 2013).The landfill tax has increased from its initial rate of £7/tonne in 1996 to £82.60/tonne in 2015 (CIWM, 2015). Reducing the amount of waste sent to land fill at football games should be of utmost importance to all the stakeholders so as to reduce their environmental impact.

For example, the London 2012 Olympics were the greenest games ever recorded because 100% of event operations waste was diverted from the landfill (www.greenwisebusiness.co.uk). Due to legislation worldwide, particularly in US and UK, the number of landfills is reported to have declined in number (Gandy, 2014).

The release of GHG emissions from waste recycled or landfill has great environmental implications. The findings from this study show that waste generation from spectator dominated sport made a significant contribution to England's emissions of GHG in 2012 football season. Football clubs should be encouraged to reduce, reuse or recycle their waste so that they can reduce their GHG emissions, because all waste have environmental impact. According to Defra, eliminating waste to landfill and diverting it to a waste-to-energy facility will reduce direct GHG emissions by almost 90% (www.defra.gov.uk).

There were differences in GHG emissions between the non-league and the league when aggregated although waste per spectator was not different. The league produces more than two and half times the quantity of emissions produced at the non-league, and the number of spectators at the league was approximately double the number of spectators at the non-league. The rate of waste generation per spectator was roughly the same. This is possibly the first time that waste GHG emissions have been compared between the non-league and the league in England.

Football Association, football clubs and spectators should be at the forefront to reduce their environmental impact. Since the globally popularity of football continues to grow, the football industry can contribute positively to environmental protection by ensuring proper waste management at the football clubs. For example, since 2013 the national stadium at Wembley has reduced GHG emissions associated with their waste. Moreover, in 2015 Wembley Stadium has become a 'zero waste to landfill venue’ because majority of the waste is diverted out of the general waste stream by way of mixed recycling and food waste management. The mixed recycling is transferred, sorted and recycled while food and liquid waste is sent to an anaerobic digestion plant to be broken down and energy and fertilizer are produced as a by-product. The remaining general waste is sent to a 'waste to energy' facility where energy is generated and returned to the National Grid. If all the football clubs adopted a similar waste management system to that at the national stadium, to ensure a zero waste to landfill at club level policy, they would ultimately have a much more positive impact on the environment. Forest Green FC have increased their recycling rate over the years to over 90%, other clubs should be encouraged to increase their recycling rate and also reduce their waste generation and should aim at sending below 5% waste to landfill if zero waste to landfill cannot be achieved (FGR, 2016).

3.8 Conclusions and rationale for next study

Study on GHG emissions from travel

This study evaluated the impact of one spectator-dominated sport, namely football, on the environment through the calculation of GHG emissions from travel by football spectators at football tiers in England, and assessed the importance of being with other people across the football tiers with 1649 respondents of mixed age and mainly male-dominated.

The findings from this study have added to the evidence relating to the GHG emissions from spectator-dominated sport (football). This study showed that majority (67%) of participants travel by car and GHG emissions from the eight football tiers (tier 3 to tier 10) were quite large when extrapolated to a national level.

The mean GHG emission across the football tiers was 4.74kgCO_2e per participant. Extrapolating these results with a total of 9,162,067 participants that watched football games from tier 3 to tier 10 during the 2012/13 football season resulted in approximately 56,237 tCO_2e which was higher than the 42,000 tonnes of GHG emissions generated from travelling to all matches at the FA cup matches during 2007/8 season (Rydin *et al.*, 2011). GHG emissions from travel to football games were much less than travel GHG emissions (3,250,000 tCO_2e) from travel to National Health Services (NHS) in England in 2012 (Pierce *et al.*, 2013). GHG emission was notably different between the football tiers; Tier 9 had significantly lower GHG emissions compared to tiers 4 and 5, while GHG emission was significantly higher in tier 3 than tiers 7, 8 and 10.

This finding signifies that spectators from all tiers should consider travelling where possible in a more environmentally friendly way to and from games to reduce their environmental impact. Where this is impossible, spectators travelling long distances to and from away games should be encouraged to use public transport such as buses and trains. On the positive side, this study showed that the importance of being with other people and watching the game were significantly important to spectators across the eight football tiers.

Since the GHG emissions from travel by football spectators were substantial from this study, assessing the health benefits arising from watching football across the football tiers should be examined. This will give a more accurate picture of the mental benefits of spectator-dominated sport (football).

Study on GHG emissions from waste

This study has highlighted football spectators GHG emissions from waste across eight football tiers in England. It has shown that waste GHG emissions from the eight football tiers (tier 3 to tier 10) were significant when extrapolated to a national level (5,155 tCO_2e). This finding indicates that football tiers in the league generated more waste and more GHG emissions than the non-league. The recycling rate across the football tiers was relatively high (71%), but more still needs to be done to further reduce the quantity of waste sent to landfill. The football tiers should properly apply waste hierarchy, which could lead to prevention of GHG emissions, reduce pollutants, conserve resources, and reduce the burden on landfills and other waste disposal methods. Football clubs should be dedicated to minimising the environmental impacts of all their activities including that of waste. They should be committed to reducing their impact by embracing initiatives and technologies that will reduce their environmental impact whenever possible. Football clubs should work towards improving efficiency and sustainability within their operations and should encourage fans, staff, suppliers and partners to do the same.

While the GHG emissions from waste at the eight football tiers had a significant environmental impact, the health benefits arising from watching football have not been examined. Watching football by spectators can have beneficial mental health implications; therefore evaluating the mental wellbeing of football spectators is appropriate. The next study will examine the mental benefits of spectator-dominated sport (football) across the eight football tiers.

4. Spectator-dominated sport: Effects of watching football on mental wellbeing

4.1 Introduction

Mental health presents one of the greatest challenges that current and future generations face. It is estimated that approximately 450 million people worldwide have a mental health problem (Cree *et al.*, 2015). Research suggests that mental health consists of two dimensions: mental health problems such as depression and anxiety, and positive mental health, which include life satisfaction, positive relationships with others and purpose in life (Huppert and Whittington, 2003; Keyes, 2007; Patel *et al.*, 2007; Huppert and So, 2013).

At an individual level, mental health problems affect an individuals' ability to function and their overall quality of life. When mental health problems are considered collectively, they have a great impact on society. Studies have shown that when people are free of anxiety, excessive stress, depression and worry, addictions and other psychological problems, they are more able to live their lives to the maximum. Good mental health strengthens and supports people's ability to have healthy relationships, maintain physical health and wellbeing, make good life choices, handle issues of life and discover and grow towards their full potentials (RIPA, 2016). The factors that promote mental health and support the recovery of people with mental health problems need to be encouraged (Wade *et al.*, 2013). These factors include good physical health, education, employment, reduced crime, anti-social behaviour and sport.

Studies have shown that there are five key elements to wellbeing of people namely: career wellbeing (that's the enjoyment of what you do on daily basis); social wellbeing (having strong relationships with other people); financial wellbeing (managing a person's economic life); physical wellbeing (having good health and enough energy to get things done on regular basis) and community wellbeing (about the sense of engagement you have with the area where you live) (Rath *et al.*, 2010).

There are scientific evidence that taking part in sport, and spectating have a positive impact on the mental wellbeing and happiness of individuals and also improve some mental illnesses (Barton and Pretty, 2010; Morgan and Goldston, 2013). Football is a popular sport in England and watching football at various football tiers could have major impact on mental health (Stieger *et al.*, 2015). Watching football affects emotions, identity, relationship and self-esteem. In a study, 25% of football spectators said football was one of the most important thing in their lives. When a football club does well, it promotes feelings of happiness, wellbeing and collective euphoria. A win of a football match makes the spectators bask in reflected glory, which improves their mood individually and in the communities. However, if a team loses a match, it does have negative impact on mental health and spectators have low self-esteem and other negative moods. Watching football may be cathartic, as the atmosphere of a match is socially inclusive and spectators would use languages that they will not usually use in their day-to-day life and the atmosphere encourage the cathartic release of tension by shouting, screaming and chanting at their teams depending on the state of the match. Young people under the age of 35 have the opportunity to externalise tension, which is important to maintain mental health while watching football and this might prevent suicidal thoughts. Football spectators feel a sense of pessimism before a match. But this can also have positive overall impact in that it can unite the spectators and having a shared moan after a loss of a match can be another way of bonding (MHF, 2016).

4.1.1 Aim of this study

The aim of this research is to examine whether watching football affect mental wellbeing.

<u>Key objectives:</u>

1) To determine if watching football affect mental wellbeing
2) To examine if football results affect mental wellbeing.

4.2 Method

This research adopts a composite questionnaire approach in order to assess mental wellbeing of football spectators across eight football tiers in England. These football clubs were chosen to reflect a wide representation of football spectators across the football tiers in England. This research is the first attempt in England to examine mental wellbeing of football spectators across eight football tiers.

4.2.1 Participants

In this study, the term ‘participant’ is used to describe football spectators at eight football tiers (tier 3 - tier 10) in England. A total of 470 participants took part in the research and all the participants were spectators at football games. Participation in the research was on a voluntary basis, and all participants were invited to take part in the study. Participants were recruited in collaboration with Essex Football Association among home and away spectators attending football games.

4.2.2 Study procedure

A short questionnaire was used to collect empirical data including: a standardised instrument to measure aspects of mental wellbeing; demographic data (such as age and gender); name of the club; period of the game; result of the game and location of the club. Questionnaires were administered to participants before the game or at the interval or at the end of the game to examine the wellbeing of participants watching football games. Administering questionnaires at interval was challenging due to time factor and participants were not willing to wait after the game too.

The questionnaire was designed for self-completion (but help was provided by the researcher if the participant requested). All details of ethical approval, consent, data protection, risk assessment and anonymity were addressed as outlined in chapter 3, Section 3.2.3. Participants were asked to complete the questionnaire individually and not to compare or discuss their answers with other participants and the researcher was present to administer and collate questionnaires.

4.2.3 Outcome measure

The questionnaire (Appendix F) was designed to incorporate: demographic data (such as age and gender); one standard instrument for measuring aspects of subjective wellbeing (Warwick Edinburgh Mental Wellbeing Scale); and details about the football game (name of the participant's football club; period of the game; result of the game and location of the club).

Mental Wellbeing measure

Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS)

Mental wellbeing was measured by using the Warwick Edinburgh Mental Wellbeing Scale (WEMWBS), which is a relatively new, standardised and validated measure developed by both the University of Warwick and the University of Edinburgh, to measure mental wellbeing of the adult population in the UK (Stewart-Brown and Janmohamed, 2008). The scale contained the 14-item self-report Warwick Edinburgh Mental Wellbeing Scale (WEMWBS) developed by Tennant et al., (2007) to measure positive mental health (mental wellbeing). WEMWBS has been used in both population-level surveys (Stewart-Brown and Janmohamed, 2008; Gale *et al.*, 2011) and at the individual level (Maheswaran *et al.*, 2012).

All 14 items are worded positively and address aspects of positive mental health. Items are scored along a 5-point Likert Scale, from 1 = none of the time, 2 = rarely, 3 = some of the time, 4 = often to 5 = all of the time. The scale has a single factor of wellbeing, focusing entirely on the positive aspects of mental health including affective-emotional aspects, cognitive evaluative dimensions and psychological functioning (Tennant *et al.*, 2007). For the WEMWBS, the minimum score was 14 and the maximum scale score was 70.

The 14-item scale has demonstrated good content and construct validity and excellent internal consistency, with Cronbach's alpha α = .89 in a student sample and α = .91 in a population sample.

It had high correlations with other mental health and wellbeing scales and a lower correlation with scales measuring overall health (Tennant *et al.*, 2007; Stewart-Brown *et al.*, 2009; Gale *et al.*, 2011; Lloyd and Devine, 2012). The 14-item instrument has been validated for the UK population and adopted by the England and Scottish health survey (Powell *et al.*, 2013).

The WEMWBS is not designed to identify individuals with exceptionally low or high levels of mental health, and so cut off points have not been developed (Health Scotland, 2014). However, a three-fold classification for WEMWBS scores has been used in research, where ‘poor’, ‘average’ and ‘good’ mental wellbeing scores are determined by the mean and standard deviation (SD) of the data (Maheswaran *et al.*, 2012). A ‘poor mental wellbeing’ is classified as more than one SD below the mean, ‘average’ as within one SD of the mean and ‘good mental wellbeing’ as one SD or more above the mean. Although the normative population mean score at the Scottish health survey over the years was 50.7 (Stewart-Brown and Janmohamed, 2008).

WEMWBS was used to assess the mental wellbeing of people attending football matches.

4.2.4 Statistical analysis

The questionnaires were collated and stored electronically on an IBM SPSS version 20 database to assist in manipulating data and statistically analysing the results. Descriptive statistics were obtained for the outcome measure and statistical significance was set at p = .05. The statistical tests employed in this study were: descriptive statistics, one-way ANOVA, independent samples t-tests, Pearson correlation and Factorial ANOVA.

The parametric assumption of normality was tested using skewness and kurtosis, a visual examination of histograms and boxplots, and a rigorous Shapiro Wilk test of normality. Skewness of mental wellbeing was below the threshold of 1 (skewness -.52), which is consistent with a normal distribution; kurtosis was below 3, as recommended (kurtosis 1.91). The Shapiro Wilk test confirmed wellbeing was normally distributed ($D(470) = 1.25$, $p = .087$) for parametric tests. For all statistics, the effect size was reported (eta-square and partial eta-squared) and strength of relationship, which indicated the magnitude of the difference between the variables.

A power analysis was performed using G Power 3.1 software to calculate the recommended sample size for this study; based on differences between eight independent means of eight groups, medium effect size, and 95% power, a total sample size of 360 participants was recommended. The achieved sample size of 470 has 100% statistical power to detect all significant effects that may exist in the study data. The mental wellbeing scales demonstrated excellent internal consistency with Cronbach alpha values of .89; this indicates that each of the 14 items of the Warwick Edinburgh Mental Wellbeing scale accurately measured their intended construct.

Analyses used parametric techniques including:

- A series of one-way between-subjects ANOVA on parametric data to identify any significant differences in participants' outcome measure scores between eight football tiers, three periods of the match and three age groups.
- Independent sample t-tests on the outcome measure to see if there were any differences between the data and gender, football game result and game location.
- A Pearson correlation analysis to examine if mental wellbeing varies significantly with age.
- A series of Factorial ANOVA to measure whether a combination of independent variables (age group, gender, game location and location of the game) predict the value of dependent variable (mental wellbeing) scores.

4.3 Results

4.3.1 Demographics

In total, 470 participants took part in the study from eight football tiers in England (Table 4.1). 77.2% of the participants were male and 22.8% were female. 306 participants were at home games and 164 at away games. Participants' age ranged from 18-85, with a mean age of 41.27, SD=17.57.

Table 4.1:Number of participants at 8 football tiers

No	Football tiers	No of Participants
1	Tier 3	90
2	Tier 4	93
3	Tier 5	67
4	Tier 6	70
5	Tier 7	47
6	Tier 8	36
7	Tier 9	39
8	Tier 10	28
Total		470

4.3.2 Mental wellbeing

Mental wellbeing was assessed using the WEMWBS and was administered at the beginning or interval or end of football games. The mental wellbeing scores of 470 participants ranged from 14-70, with a good average mental wellbeing score of 51.52, SD = 8.23.

Mental wellbeing and age

In order to evaluate the relationship between mental wellbeing and age, a Pearson product-moment correlation coefficient was conducted. A Pearson correlation analysis found that mental wellbeing does not vary significantly with age (r = .008, *p* = .869).

Mental wellbeing and gender

An independent samples t-test was conducted to compare the mental wellbeing between male and female participants. The independent samples t-test found that mental wellbeing did not vary between males (M= 51.32, SD = 8.26,n=363) and females (M=52.20, SD=8.11,n=107), [t(468) = -.966, *p*=.335, small effect size: d=.04].

Mental wellbeing between the eight football tiers

A one-way ANOVA was conducted to examine the differences in the mental wellbeing scores between spectators at the eight different football tiers. A one-way between groups ANOVA found that mental wellbeing did not vary between spectators of different football tiers [F(7, 462) = .847, *p*=.549, small effect size: d=.008].

Mental wellbeing with period of watching the game

A one-way ANOVA was conducted to examine the differences in the mental wellbeing scores between periods of watching the game (before, half time and after the game). A one-way between groups ANOVA found that mental wellbeing does not vary with the level of watching the game [F(2, 467) = 2.065, *p*=.128, small effect size: d=.003].

Mental wellbeing and results of the game (lost, draw or won)

A one-way ANOVA was conducted to examine the differences in the mental wellbeing scores between results of the game (lost, draw or won). A one-way between groups ANOVA found that mental wellbeing does not vary with results of the game [F(2, 467) = .730, *p*=.482, small effect size: d=.003].

Mental wellbeing and location of the football club

An independent samples t-test was conducted to assess whether mental wellbeing was dependant on whether spectators are watching their team play ‘at home’ or ‘away’. An independent samples t-test found that mental wellbeing does not vary with location of the club, home (M= 51.65, SD = 7.84,n=306) and away (M=51.29, SD=8.92,n=164), [t(468) = .452, *p*=.610, small effect size: d=.009].

Effect of Independent Variables on Mental Wellbeing

There was no significant effect of gender, age, football tiers, levels of watching the game, results of the game, or location of the football club on the levels of mental wellbeing among participants (Table 4.2).

Table 4.2. Descriptive and statistical test of mental wellbeing of participants

Variable	Category	Sample number	Mean	SD	Median	Test Statistic	Test of difference	*p*-value	Effect Size
Total Sample	**Mental Wellbeing**	470	51.52	8.23	52.00	N/A	N/A	N/A	N/A
Gender	**Male**	363	51.32	8.26	51.00	-.996	Independent t-test	.335	.04
	Female	107	52.20	8.11	53.00				
Age Group	**Age**	470	N/A	N/A	N/A	.008	Pearson	.869	.008
Football location	**Home**	306	51.65	7.84	52.00	.452	Independent t-test	.651	.02
	Away	164	51.29	8.92	52.00				
Football tiers	**Tier 3**	90	51.51	9.12	51.00	.847	One-way ANOVA	.549	.013
	Tier 4	93	50.77	9.11	52.00				
	Tier 5	67	51.66	6.59	52.00				
	Tier 6	70	50.40	7.10	51.00				
	Tier 7	47	51.17	8.75	52.00				
	Tier 8	36	53.25	9.38	54.50				
	Tier 9	39	53.33	6.67	53.00				
	Tier 10	28	52.36	7.88	50.50				
Period of watching game	**Before the game**	287	51.47	7.58	52.00	*.206*	One-way ANOVA	.128	.009
	After 1st Half	121	50.73	9.93	51.00				
	After the game	62	53.32	7.25	53.00				
Results of the game	**Won**	174	51.36	8.21	51.50	*.730*	One-way ANOVA	.482	.003
	Drawn	94	50.80	9.06	52.00				
	Lost	202	52.00	7.84	52.00				

4.3.3 Factorial ANOVA analysis

Measuring whether age groups, gender and game venue predicts mental wellbeing.

A three way factorial ANOVA was employed to evaluate the effect of age, gender and venue of football games on mental wellbeing. There was no main effect of gender (F (1, 458) = .001, *p* = .973, np^2=.000) or age group (F (2, 422) = .205, *p* = .815, np^2=.001) or football venue (F (1, 458) = 1.41, *p* = .235, np^2=.003) on wellbeing, indicating that wellbeing was similar among respondents regardless of their gender, age group, or venue of the football game. There was a significant interaction effect between gender and football game venue (F (1, 458) = 5.48, *p*=.020, np^2=.012). Females at the home games had significantly higher wellbeing score than males, whereas males at the away games had significantly higher wellbeing score than females. Thus, gender moderates the effect of football venue on mental wellbeing (Figure 4.1). However, there was no age group x football venue interaction effect (F (2, 458) = 1.41, *p* = .246, np^2=.006), and no gender x age x football venue interaction effect (F (2, 458) = .256, *p* = .774, np^2=.001).

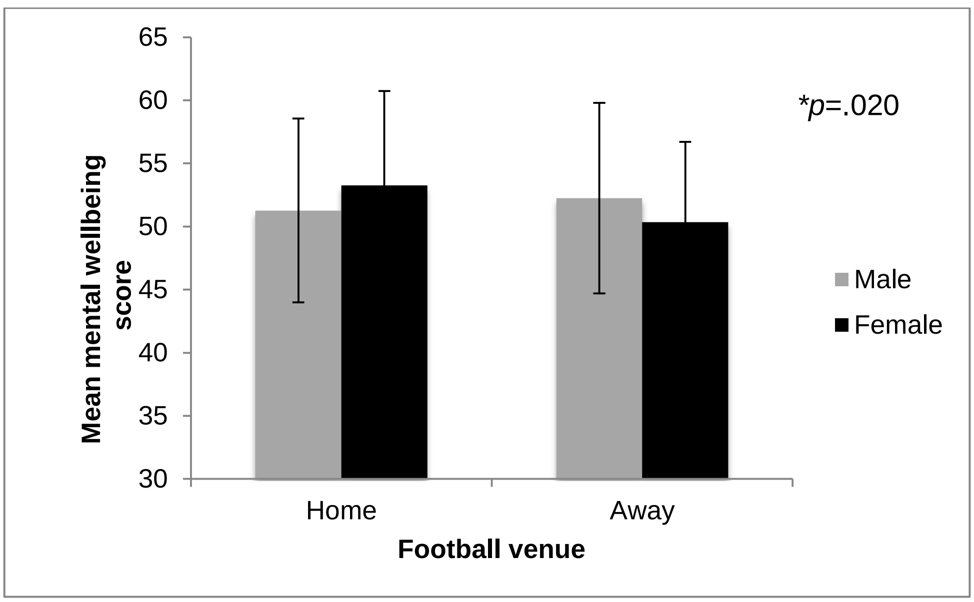

Figure 4.1: Effect of gender and venue of football game on mental wellbeing.
Note: WEMWBS scored from 14-70, with a larger score indicating greater level of wellbeing (WEMWBS Scottish population norm of 50.0 in 2014).

Measuring whether age groups, gender and football game result predict mental wellbeing.

A three way factorial ANOVA was employed to evaluate the effect of age, gender and result of football game on mental wellbeing. There was no main effect of gender ($F (1, 50) = 1.85$, $p = .180$, $np^2=.036$) or age group ($F (2, 50) = .025$, $p = .975$, $np^2=.001$). There was a significant main effect of result of the game on mental wellbeing ($F (1, 50) = 5.48$, $p = .023$, $np^2=.099$). The respondents whose club won the game had significantly higher wellbeing than respondents whose club lost the game (Table 4.3). There was no significant interaction effect of gender x result of the game ($F (1, 50) = 2.22$, $p = .143$, $np^2=.042$); age group x result of the game ($F (2, 50) = .514$, $p = .601$, $np^2=.020$); or gender x age x result of the game ($F (2, 50) = 1.90$, $p = .161$, $np^2= .070$). These results indicate that gender and age do not moderate respondents' mental wellbeing but depends on the result of the game.

Table 4.3: Estimated marginal means, standard deviation for mean wellbeing by gender and venue of football game.

Result of the Game	Mental Wellbeing Mean score	Standard Deviation (SD)
Won	55.91	5.49
Lost	50.31	4.40

4.3.4 Summary of key findings

This study examined the mental wellbeing of 470 participants from eight football tiers in England. The participants were predominately male and were of mixed ages. There are four key findings:

1) There were no significant differences of gender, age, football tiers, levels of watching the game, results of the game, or location of the football club on the levels of mental wellbeing among participants. The mean mental wellbeing score of 51.52 indicated that participants had good mental wellbeing.
2) The findings from this study indicate that gender and age do not moderate the level of total mental wellbeing based on the participants' level of watching the game.

3) There was a significant interaction effect between gender and football game venue. Females at the home games had significantly higher total wellbeing than males, whereas males at the away games had significantly higher total wellbeing than females; thus, gender moderates the effect of venue on total wellbeing.

4) Findings from examining whether gender or age moderate the impact of results of the game on mental wellbeing found there was no main effect of gender or age group. There was a significant main effect of the result of the game on total wellbeing. Respondents whose club won the game had significantly higher total wellbeing than respondents whose club lost the game.

4.4 Discussion

4.4.1 Addressing the study aim and objectives

The primary aim of this study was to use a spectator-dominated sport (football) to examine whether watching football affect mental wellbeing (objective 1), in this case using spectators from eight football tiers (tier 3 – tier 10) in England and to examine whether the results of the game affect mental wellbeing (objective 2). Mental wellbeing of participants was determined using a composite questionnaire comprising of WEMWBS.

4.4.2 Effects of spectator-dominated sport (football) on mental wellbeing

<u>Mental wellbeing</u>

The findings from this study show that mental wellbeing of spectator-dominated sport (football) from eight football tiers in England was not different between the tiers. Mental wellbeing did not vary with age and gender, although WEMWBS was not designed to identify individuals with exceptionally high or low levels of positive mental health. The mean mental wellbeing score of the participants from eight football tiers was 51.52, which was within one standard deviation from the mean mental wellbeing value of the Scottish Population Survey 2012 (Gray and Leyland, 2013) of mean = 49.9, SD = 8.50, which is used as the benchmark for categorising levels of wellbeing (Braunholtz *et al.*, 2007; Davoren *et al.*, 2013).

There are no other examples in the published literature that have used WEMWBS to examine mental wellbeing with spectator-dominated sport, and no direct comparisons can therefore be made with other studies involving football spectators. There is a general consensus in the empirical literature that, regardless of the type of exercise or sport that the individual is involved in as a participant or spectator, it does not result in poor wellbeing (Terry, 2003; Pringle, 2004; Darongkamas *et al.*, 2011; Kim and Walker, 2012). This study suggests that mental wellbeing did not differ significantly by participants' gender, age, football tier, location of the club and time of the match or results of the game.

The WEMWBS is used to monitor the national indicator "improve mental wellbeing" (Parkinson, 2012), and the findings from this study suggest that football spectators in England tend to be generally optimistic, cheerful, and relaxed, to have satisfying interpersonal relationships, and positive functioning, including energy, clear thinking, self-acceptance, personal development, mastery and autonomy (Smith-Merry *et al.*, 2010; Mason and Kearns, 2013). Contrary to previous studies, the findings from this study did not report any age difference in mental wellbeing of participants. Rickwood *et al.* (2014) recently found that younger people aged 16-24 have the highest wellbeing score as do ages 65-71, whilst those aged 45-54 and 75+ have the lowest average mental wellbeing (Rickwood *et al.*, 2014). This pattern of low self-reported wellbeing among middle aged and older age groups was also found by the earlier Scottish health survey in 2012 (Smith-Merry *et al.*, 2010; The Scottish Health Survey, 2013).

Contrary to previous studies, no gender difference in mental wellbeing was found, although there was a significant interaction effect between gender and football game venue, where females at the home games had significantly higher total wellbeing than males, while males at the away games had significantly higher total wellbeing than females. Thus, gender moderates the effect of football game venue on total wellbeing. Previous studies suggest that men have a significantly higher wellbeing than women (Kawachi and Berkman, 2001; Tennant *et al.*, 2007; The Scottish Health Survey, 2013). Women are more likely to face mental wellbeing issues because of the position they play in their family and in society, including social factors such as caring for children and other dependent relatives, doing more tasks than men like being mothers, working for a paid job, running the household, etc. Women may also find it difficult to talk about their problems and feelings which might make them more susceptible to having lower mental wellbeing (Newton, 2013). Although the percentage of women in this study was low (23%), as watching football is more popular among men, this study shows that even watching away football games by females resulted in a lower mental wellbeing score compared to males in away games but not in home games.

Previous research by Frey and Stutzer (2010) found that winning a game of sport resulted in higher wellbeing, whereas losing a game resulted in lower wellbeing. Findings from this study show that there was a significant main effect of the result of the game on wellbeing: i.e. a more positive wellbeing score when games are won than when a game was lost (Frey and Stutzer, 2010). This suggests that winning football games can have a major positive impact on mental health of football spectators by increasing their positive emotions, relationships, identity and self-esteem. Previous study found that watching football was one of the most important things in the lives of football spectators (Spaaij and Anderson, 2010). The difference in score between the mental wellbeing score of teams that lose and win was 5.60, this reflects a clinical benefits and watching football could be used particularly when the team wins to improve mental wellbeing. Time point did not seem to change outcomes but winning or losing a game did, this is due to the reason that the measure used to measure mental wellbeing WEMWBS was a trait measure and could not be used as a state measure and this could affect the outcome at the different time points. This is one of the limitations of this study.

4.4.3 Limitations

The study on examining mental wellbeing across the eight football tiers in England has added to the evidence-base by providing quantitative analysis of the effects of various aspects of football on mental wellbeing. However, the study does have some limitations:

- Although the study was found to be successful in examining the mental wellbeing of the participants, the participation in the study was limited to a short questionnaire; and other outcome measures such as the connection to nature could not be added to the questionnaire because of the short time frame that the football spectators could devote to complete the questionnaire.
- The response from the online question was very low, possibly because the football spectators were not interested after watching the game, and the data collection was done mainly at the football games where the spectators could not be distracted while watching football and they left the games immediately after they had finished.
- The lack of representative football club in tiers 1 and tier 2 in Essex could not allow data to be collected from these tiers. Future research will benefit from data collection from the top two football tiers. Also, tier 11 had very limited attendance at games, thereby excluding the tier from the study.
- WEMWBS was not able to measure mental wellbeing differences at different time point because it’s a trait measure and not a state measure and suitable state measure could be used in future research, such as Profile of Mood States (POMS).
- WEMWBS was used to assess the mental wellbeing of people attending football matches and there is need for a longitudinal data on individual’s overtime to be able to measure mental wellbeing better.

4.5 Conclusions and rationale for next study

The study did not find significant differences in mental wellbeing across the eight football tiers, game location, age, gender and game result. There was, however, a significant interaction effect between gender and football game venue, where females at the home games had significantly higher total wellbeing than males, while males at the away games had significantly higher total wellbeing than females. Thus, gender moderates the effect of football game venue on total wellbeing. This study shows that there was a significant main effect of the result of the game on total wellbeing; this suggests that winning football games can result in improved mental wellbeing.

The GHG emissions, connection to nature and mental wellbeing of participants engaged in sports such as running is not known due to lack of research. This suggests that a rationale next step in this research would be for the first time to explore travel GHG emissions from participant-dominated sport (running) and their mental wellbeing in details with regards to running conditions. There are mounting evidences demonstrating the benefits of physical exercise outdoor (i.e. green exercise) can make to mental, physical health and wellbeing. Green exercise can reduce symptoms of poor mental health and stress and can improve mental wellbeing across all ages.

5. Participant-dominated sport: GHG emissions from travel, and effect of running in nature and mental wellbeing

5.1 Introduction

Scientific evidence has confirmed that participating in sports including running can bring extensive health benefits (Thorpe *et al.*, 2014; Vella *et al.*, 2014; Lee *et al.*, 2015). Participation in sport as a child or adult provides well-documented positive benefits, it could bring communities together, improves social cohesion, as well as mental and physical health (Khan *et al.*, 2012; Stafford *et al.*, 2013; Meyer and Surujlal, 2014).

The national guidelines on physical activity suggest that to promote and maintain good health, adults' aged 18-65 should maintain a physically active lifestyle. They should perform moderate-intensity aerobic (endurance) physical activity for a minimum of 30 minutes five times a week or vigorous-intensity aerobic activity for a minimum of 20 minutes three times a week. Moreover, combinations of moderate-and-vigorous-intensity activity can be performed to meet this recommendation (Donaire-Gonzalez *et al.*, 2013; Granacher and Hortobágyi, 2015). It is estimated that over 1.6 billion people participate in running every year worldwide. In 2014, the number of people that participated in running weekly in England was over 2.2 million (www.sportengland.org).
When a person participates in sport, there is an impact on the environment from the venue, equipment, energy consumption at the venue, waste generation and from their travel, to running location which can contribute to greenhouse gas emissions (Schmidt, 2006; Dawson *et al.*, 2009; Guo, 2013).

Many studies have documented that there is a link between climate change and travel to sporting venues (Landauer *et al.*, 2012; Becken, 2013; Dolf and Teehan, 2014). Running is one of the most popular sports in England and participants GHG emissions from travel is currently not known.

There is link between physical activity, transport and GHG emissions particularly with people that are less physically active. A UK study suggested that there are associations between less physically active people that are obese and levels of GHG emissions from transportation. These associations seem mostly to reflect the fact that obese people tend to travel longer distances by car. They also travel less on active transport such as cycling and walking (Goodman *et al.*, 2012). Approximately, a quarter (23%) of UK GHG emissions come from energy use. The use of motorised travel also have negative health impacts resulting in air and noise pollution and this might contribute to obesity levels, because driving may displace more active forms of transport, such as walking and cycling. As such promoting active travel can reduce GHG emissions and produce health co-benefits (Goodman *et al.*, 2012).

The first study to investigate the GHG implications of engaging in active travel and physical activities in Cardiff, Kenilworth and Southampton used questionnaire with 3,643 adults, calculated GHG emissions from transport and statistically analysed the factors responsible for the emissions. The study found that car driving was the largest source of emissions (89.9%), then train travel (4.4%), bus travel (3.8%) and other private or public transport (1.9%). From the study there was strong evidence that weight status was statistically associated with greater GHG emissions, the possible reason could be because obese people tend to travel longer distances by car and participate less in cycling and walking (active travel). Another factor could be that obese people were more likely to own vehicles with bigger engines. The study found that physical activity, as a means of transport, such as cycling and walking was associated with low GHG emissions. However, recreational walking and physical activity was associated with more motorised travel and higher GHG transport emissions because cars are often used as transport to the location of leisure activity like the walking route. The study demonstrated some links between health, physical activity and GHG emissions from transport. These support that active travel can provide benefits to both the environment and health (Goodman *et al.*, 2012).

People who engage in physical activity outdoors in nature could enjoy health benefit such as reducing their risk of chronic diseases such as diabetes and coronary heart diseases. Walking and cycling outdoors for recreational purposes or to travel from place to place offer an ideal opportunity for people to incorporate more moderate-intensity physical activity into their daily lives. Running outdoors also results in mental wellbeing benefits and using active transport to running location could reduce GHG emission. Without any doubt, active transport to running location could yield greater environmental, physical and mental benefits (Haines *et al.*, 2010).

5.1.1 Aims of this study

The primary aim of this study is to evaluate the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions from travel by runners across England to their running location and to extrapolate this to a national level. The secondary aim is to assess mental wellbeing and perceptions of the importance of the nature, outdoor environment when participating in running in England.

Key objectives:

1) To evaluate the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions from travel.

2) To extrapolate the impact to a national level.

3) To assess the effect of running on connection with nature and mental wellbeing and to compare these across runners in England.

5.2 Methods

The study employed a questionnaire-based method, GHG emissions of participants was calculated by multiplying Defra's greenhouse gas conversion factors based on fuel consumption from various modes of travel with distance travelled to and from running location (DEFRA, 2013). Standardised measure on nature and mental wellbeing was included in the questionnaire. The participants were runners at events and those training from across England and opportunity sampling were used with the aim of providing a broadly representative sample of the adult population nationally with respect to age and gender. The data collected from the participants was used to extrapolate the GHG emissions from travel to national level assuming that the sampled population is similar to the population of runners nationally. The distance travelled was measured in mile and converted to kilometres for better calculation (1 mile represent 1.61km).

5.2.1 Participants

Prior to the main study, a pilot study was conducted using 50 participants from the University of Essex Evolve gymnasium on the 9th of February 2012 to verify their understanding and average completion time of the questionnaire. As a follow up to the pilot study, 673 participants from across England running in gymnasia, running clubs, those training and runners from home took part in this research by completing the questionnaire after their running session.

Participants engage in running at the following places: University of Essex Evolve gym, L A Fitness Colchester, West London Hash House Harriers, City Hash House Harriers, Bannatyne Health Club Colchester, Essex Stragglers Orienteering Society, Colchester Harriers Athletics Club, Bexley Athletics Club, Croog Log Leisure Centre Bexleyheath, Dartford Harriers Athletics Club, Serpentine Running Club Battersea, One Triathlon RDS Battersea Park, Springfield Striders Chelmsford, Hadleigh Leisure Centre, East Berghort Sport Centre, Parkrun (Colchester, Guildford and Bushy Park). The link was sent to participants through e-mail, facebook and twitter (@outdoorrunning) created for the research. 33 participants completed the questionnaire online at (www.questionpro.com), but could not be placed to any environment because the details on the online questionnaire could not reflect the environment where they engage in their running session, but the researcher could infer from the details of other running sites the type of environment other participants engage in their running session such as rural, suburban and urban environment by refereeing to Defra's website (Lookup for 2011 rural-urban classification of local authorities), Defra classified local authorities from rural-urban (DEFRA, 2016). All participants were given the option to take part in the research and they were recruited using a convenience-sampling technique employed in Chapter 3, section 3.2.2.

5.2.2 Study procedure

Data were collected using both a pre-printed and an online questionnaire, using outcome measures specifically developed for this study and by applying approved Defra's conversion factors. The questionnaire was designed for self-completion by participants over the age of 18 years. Similar to previous studies, the University of Essex, Faculty of Science and Engineering Ethics committee approved the study and all aspects of the field study were risk assessed and complied with the Data Protection Act 1998.

The questionnaire was administered to participants after their running session, they were asked to complete a paper or an online questionnaire. This ensured that the findings were representative of participants in England. Moreover, the online questionnaire or the online link was emailed to participants requesting them to complete it after their running session.

All participants were informed of the purpose of the research and their decision to complete the questionnaire was purely voluntary. The importance, purpose, nature and duration of the study were explained to the participants (in order to control for potential bias) and clarification was provided where need arose. All participants gave their informed consent by ticking the consent box in the questionnaire. The officials of running clubs and managers of gymnasia were contacted by e-mail to approve the questionnaire administration at their venues. Participants were advised that all information provided would be treated as anonymous and not passed on to a third party. All completed questionnaires were returned to the author, or submitted through the online link or emailed to the author after completion for collation and analysis.

5.2.3 Outcome measures

Ranges of outcome measures were included in the questionnaire to address: i) demographic information, ii) details on travel mode and distance; iii) 4-item importance scale; iv) mental wellbeing; v) nature relatedness scale; iv) running details; and vii) emotions felt during and after running session.

I. Demographics

Participants' data included in the questionnaire were their age and gender.

II. Details on travel mode

To quantify GHG emissions of participants from travel, questions were purposely developed for this study. To calculate the GHG emissions of each participant before storing on SPSS data file, the emissions was calculated by multiplying distance travelled by each participants to and from running location, in kilometres by appropriate GHG emission factors similar to section 3.2.3. The questions comprised of the mode of travel used to and from running locations, with the distance travelled and car sharing details if participants drove to running locations. In order to simplify the GHG emission calculations and still retain a realistic estimate per participant, the following approach was taken:

- Mode of travel to and from running location was confirmed
- The travel distance to and from running location was calculated
- 2012 Defra/DECC's GHG Conversion Factors were applied to quantify participants' GHG emissions (CO_2, CH_4, N_2O) from travel and the unit expressed in kgCO_2e. Walking and cycling does not burn any fossil fuel hence the emission factor was zero.

- National extrapolation was made by multiplying the mean GHG emissions of runners by the annual number of runners in 2012 of over 104 million runners in England (Sport England, 2012).

III. Importance of different aspect of running

The questionnaire was designed to examine different aspect of running. A 4-item importance scale was designed for this research to measure participants' importance of 'being outside in nature', 'being with other people', 'being on one's own' and 'the feeling of release and freedom'. Each of the 4-item importance scales contained a visual analogue scale of 1-10, with 1 = not very important and 10 = very important. A copy of the questionnaire is included in Appendix G.

iv) Mental wellbeing

Warwick-Edinburgh mental wellbeing scale (WEMWBS)

Mental wellbeing was measured using the 'trait' version of the Warwick Edinburgh Mental Wellbeing Scale (WEMWBS), as already discussed in section 4.2.3.

v) Nature relatedness scale (NR)

Nature relatedness scale was used to assess participants' level of connectedness with the natural world through the cognitive, affective and physical connection (Nisbet *et al.*, 2008, 2011). The scale consisted of 21 items rated on a 5-point Likert scale, from 1 (disagree strongly) to 5 (agree strongly). Items 2, 3, 10, 11, 13, 14, 15, and 18 were reverse scored. Adding the total score and dividing by 21 created a total nature relatedness score. Scores range from 1 to 5, with a high score endorsing a cognitive, affective, and physical connection with nature. The nature relatedness scale also had three subscales (Self, Perspective, and Experience). A subscale score was created for each subscale by averaging the items within that subscale. Scores again ranged from 1 to 5, with high scores endorsing the subscale. The Self subscale measures *"an internalized identification with nature, reflecting feelings and thoughts about one's personal connection to nature"*; the Perspective subscale measures *"an external, nature-related worldview, a sense of agency concerning individual human actions and their impact on all living things"*; and the Experience subscale measures *"a physical familiarity with the natural world and the level of comfort with and desire to be out in nature"* (Nisbet *et al.*, 2008).

The internal reliability of the NR scale using Cronbach's alpha was reported as .87 and the subscales: Self =.82 ; Perspective = .67; and Experience = .70. The reliability of this scale was similar to past studies (Cervinka *et al.*, 2011; Howell *et al.*, 2011; Zelenski and Nisbet, 2014). While the NR scale was initially tested on students it has been used successfully in a number of other studies with different cohorts (Bartholomew *et al.*, 2011; Nisbet *et al.*, 2011; Howell *et al.*, 2013; Tam, 2013).

vi) <u>Running details</u>

The questionnaire was designed to ask participants questions about their running details on how long their running session lasted, if they did other exercise, if they ran alone or in a group.

vii) <u>Emotions felt during and after running session</u>

The questionnaire included open questions on participants' emotions felt during and after their running session.

5.2.4 Statistical analysis

The data collected was organised and analysed by Statistical Package for the Social Sciences (SPSS) version 20. A bar chart was used to represent the findings of the data where the statistical analysis showed significant differences, using a non-parametric test between the variables. For all statistics, the effect size was reported, which indicated the magnitude of the difference between independent variables, using Cohen's (1988) conventions for small, medium and large effect sizes (Cohen, 1988). Where variables are non-normally distributed, the Mann Whitney U test was performed, instead of a parametric independent samples t-test. In terms of interpreting the significance levels for each analysis, a *p*-value of <.05 is significant. The Kolmogorov–Smirnov test confirmed GHG emissions, nature relatedness scores (NR), Nature relatedness Self (NR Self), Nature relatedness Perspective (NR Perspective), Nature relatedness Experience data (NR Experience) and mental wellbeing scores were not normally distributed with *p*<.001 thereby using non-parametric tests.

To know the adequate sample size for this study, a power analysis was performed using G Power 3.1 software to calculate the recommended sample size based on the difference between two independent means of 2 groups, medium effect size, 95% power: a total sample size of 210 participants was recommended. The achieved sample size of 673 has 100% statistical power to detect all significant effects that may exist in the study data.

In order to statistically analyse GHG emission differences between runners in rural, suburban and urban environments, 33 participants were excluded from the data because they completed the questionnaire online and they could not be categorised to any form of environment, the non-parametric statistics of Kruskal Wallis (the equivalent of one-way ANOVA) was used and the Mann Whitney U test (the equivalent of an independent samples *t*-test) were used to compare the GHG emissions between indoor and outdoor runners and between male and female runners. This was due to the lack of normality in the GHG emission data that was positively skewed.

A significant alpha level of *p*<.05 was used for all statistical tests. Prior to performing multiple regression analyses, the relevant statistical assumptions of sample size, normality, linearity, multicollinearity and singularity were assessed, as violation of these assumptions may reduce the accuracy of results (Field, 2013). Firstly, the sample size of 673 is large enough to provide 95% statistical power for two to four independent variables to be entered in the regression models. Secondly, the assumption of singularity was met, as the independent variables are independent of one another. Third, there was no problem with multicollinearity as the variance inflation factor (VIF) was below the recommended threshold of 10 in each model (Field, 2009).

5.3 Results

5.3.1 Demographical information

A total of 673 participants took part in the study across England. 54.7% of the participants were male (n=368) and 45.3% were female (n=305); and participants' age ranged from 18-84, with a mean age of 38.76 (SD=13.39). 16.3% of participants ran in rural environment, nearly half (50.3 %) ran in suburban environment and 33.4% ran in urban environment.

5.3.2 Details of travel

The most frequent mode of travel by the participants to the start of their run was by car (49.5%), followed by foot (25%), train (13.5%), cycling (8%) then bus (2.5%) and taxi (1.5%). The mean distance travelled to the running location by participants was 7.40km, SD=10.16. The mean running distance of participants was 6.13km (SD=3.88). The mean running time of participants was 43.27 minutes (SD=19.33). Participants run approximately 3 times a week.

5.3.3 Greenhouse Gas (GHG) emissions

The GHG of 673 runners ranged from 0-11.95 kgCO_2e. (M = 0.62, SD = 1.43). The national annual estimate of GHG emission produced by runners was 64,480 tonnes of CO_2e (based on approximately 2 million runners per week in England).

Emissions by different mode of transport

Travel emissions vary according to mode of transport. There was no GHG emission from the active mode of transport (walking and cycling), while the majority of the emissions came from private transport, with the use of car to running location accounting for 84.70% of the total emissions. The use of public transport also accounted for the remaining source of GHG emissions with the use of trains resulting in 12% of the total GHG emissions. The use of buses accounted for 2.90%, and taxis resulted in 0.40% of the total emissions. The mean GHG emissions from the mode of transport also varied, with no emissions from walking and cycling, 1.43 kgCO_2e from buses, 1.80 kgCO_2e from cars, 0.93 kgCO_2e from trains, and 0.30 kgCO_2e from taxis.

Relationship between distance travelled and GHG emissions

A Spearman rank-order correlation found a significant, strongly positive relationship between distance travelled and GHG emission, (rho (671) = .759, p<.001). The results suggest that GHG emission really does increase as people travel further to running locations.

GHG emissions of runners at indoor and outdoor running locations

A Mann Whitney U test compared GHG emissions between indoor and outdoor running locations and found that GHG emission differed significantly, [U(671) = 363363.50, Z = -3.55, p<.001, r = .14, small effect size]. GHG emission from travelling to indoor locations produced significantly higher GHG emissions (M=0.86, SD=1.77,n=174) than outdoor (M=0.54, SD=1.28,n=466).

GHG emission and running environment

When tested with a Kruskal-Wallis test statistically significant differences between GHG emissions from participants' travel to various environment was found, [$\chi^2(2, N = 639) = 52.80, p < .001$]. The

GHG emissions from travelling to various environments were: rural (M=0.07, SD=0.28, n=103), suburban (M=0.70, SD=1.64,n=322) and urban (M=0.58, SD=0.90,n=214). The least GHG emissions was from travelling to the rural environment, because the participants travelled more with active transport (walking and cycling) while the most GHG emissions was from the suburban and then the urban environment because of the dependency on cars to running location.

Further pairwise comparison testing with adjusted *p*-values showed that there was a statistically significant difference in GHG emissions between rural and suburban environments, as well as between rural and urban environment as shown in Table 5.1.

Table 5.1: GHG emissions pairwise comparisons between three environments

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Rural - Suburban	-100.578	18.202	-5.526	.000	**.000**	0.28
Rural - Urban	-139.778	19.284	-7.249	.000	**.000**	0.40
Suburban - Urban	-39.200	14.237	-2.753	.006	.018	0.09

NOTE: Test statistic is the difference between the mean ranks between three environments, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above = large).

<u>GHG emissions between lone and group participants</u>

A Mann Whitney U test compared GHG emissions between lone and group runners and found a significant difference, [U(671) = 30558.50, Z = -9.24, p<.001, r = .36 - indicating medium effect size]. The result therefore indicates that GHG emission from the group participants (M=0.90, SD=1.27,n=212) was higher than the lone participants (M=0.51, SD=1.49,n=420), because most lone runners started their running from home.

5.3.4 Relative influence of independent factors on outcome variable: GHG emissions

In section 5.3.3, the effect of various independent factors on GHG emissions was considered. However, in order to establish which of these independent factors are the most influential in determining or explaining the outcome variable (GHG emissions), a multiple regression was conducted, putting into the models the independent factors that were shown in section 5.3.3 to affect the outcome variable. Assumptions for the models were first analysed including: linear relationship where appropriate, independence of residuals, presence of two or more independent variables, outcome measure is in continuous scale, homoscedasticity, multicollinearity, no significant outliers, high leverage point, highly influential point and normality, as outlined in 5.2.4 None of the assumptions were violated unless stated otherwise. In order to conduct the multiple linear regression, the independent variable (environment) with three levels (rural, suburban and urban) was dummy coded to reflect two dummy variables.

A multiple linear regression (Enter method) was performed to examine the variance in the GHG scores of participants loading five predictors (age, gender, distance travelled, running location and running environment) into the model. Table 5.2 shows that the model was able to explain 70.6% of the sample outcome variance (Adj. R^2 = .701), and was found to significantly explain outcome [$F(6,392)$ = 153.795, p = <.001]. Two of the predictor variables significantly contributed to the model. Travelling distance to running location was related to higher GHG emissions [β = .114, t = 29.258, p<.001], and running in an urban environment was also related to higher GHG emissions [β = .647, t = 6.327, p<.001]. Distance travelled to running location was more highly important in the regression model than the running environment in explaining GHG emissions. The other predictor variables (age, gender, running location (indoor or outdoor), and running environment (rural vs urban) did not significantly contribute to variance (p = .92, p = .25, p = .33 and p = .12 respectively).

Table 5.2: Multiple linear regression of GHG emission

Predictor variable	B	SE_B	*B*	*t*	*p*
Model	-.484	.178		-2.722	.007
Age	.000	.004	-.003	-.095	.924
Running location	.104	.106	.030	.981	.327
Distance travelled	.144	.005	.843	29.258	.000
Rural vs urban	.365	.234	.046	1.560	.120
Suburban vs Urban	.647	.102	.184	6.327	.000
Gender	.112	.097	.032	1.148	.252

Notes: B= Unstandardized regression Coefficients; SE_B= Standard Error of coefficient; β= Standardized Coefficients; *t*= *t* score; *p*=statistical significance

5.3.5 Mental wellbeing

Mental wellbeing was assessed using the WEMWBS and was administered after the running session. The mental wellbeing scores of 673 participants ranged from 14-70, with a mean mental wellbeing score of 51.19, SD = 8.23 and median 52.00.

Gender comparison

A Mann Whitney U test compared mental wellbeing between male and female runners, and found they did not differ significantly, [U(672) = 55, 801.00, *Z* = -.054, *p*=.957, r = .00-small effect size]. The result indicates that mental wellbeing was similar between males (M=51.08, SD=8.13,n=368) and females (M=51.32, SD=7.57,n=304).

Age comparison

A Kruskal-Wallis test was conducted to evaluate differences in mental wellbeing scores between participants in three age groups: 18-30 years, 31-50 years and 51+ years and found no statistically significant difference between the three age groups, [H(2) = 2.365, *p* = .307, r =0.11- small effect size]. Participants had similar scores; 18-30 years (M=51.51, SD=8.89,n=205); 31-50 years (M=51.77, SD=6.53,n=164) and 51+ (M=50.55, SD=7.97,n=131).

Mental wellbeing of runners at indoor and outdoor locations

A Mann Whitney U test compared mental wellbeing scores between indoor and outdoor running locations, and found no statistically significant difference, [U(672) = 45,413.50, *Z* = 1.024, *p*=.306, r = .04, small effect size]. Participants at both running locations had similar scores; indoors (M=51.74, SD=8.30,n=173) and outdoors (M=51.00. SD=7.72,n=499).

Mental wellbeing differences between running environment

A Kruskal-Wallis test was conducted to evaluate differences in mental wellbeing scores between participants in three environments: rural, suburban and urban and found no statistically significant difference between the three environments [H (2) = 3.705, *p* = .157, r =0.16- small effect size]; Participants at the three environments had similar scores; rural (M=52.72, SD=8.07,n=103); suburban (M=51.05, SD=3.59,n=322) and urban (M=51.12, SD=3.65,n=214).

Mental wellbeing between lone and group participants

A Mann Whitney U test compared mental wellbeing between lone and group runners and found a significant difference between lone and group runners, [U (664) = 54,609.00, *Z* = 2.046, *p*=.041, r = .08- indicating medium effect size] (Figure 5.1). The result therefore indicates that mental wellbeing was higher in lone runners (M=51.57, SD=8.02,n-435) than group runners (M=50.31, SD=7.56,n=229).

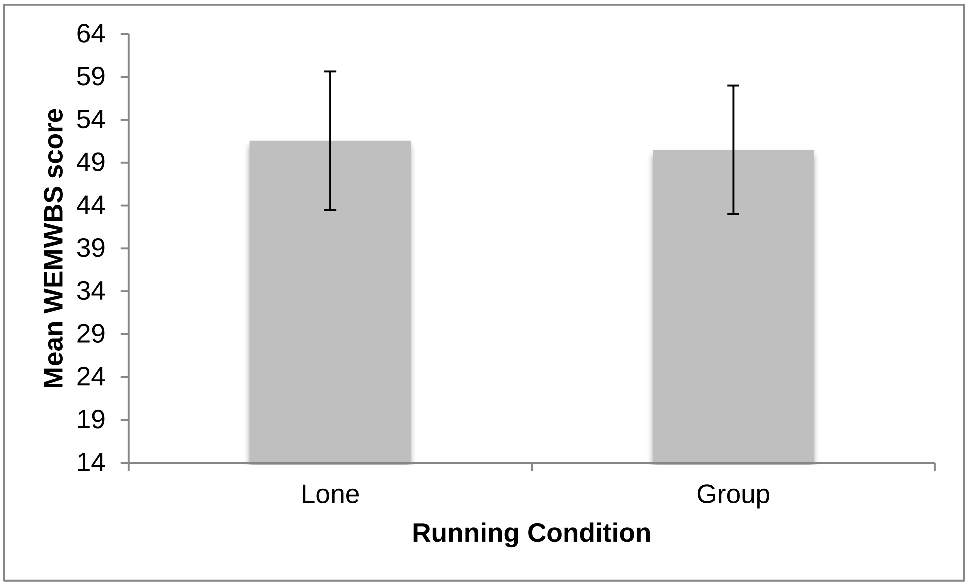

Figure 5.1: Mean Mental Wellbeing scores of lone and group runners
Note: WEMWBS scored from 14-70, with a larger score indicating greater level of mental wellbeing

5.3.6 Connection to nature

Level of connection with the natural world was assessed using the nature relatedness (NR) Scale and was administered after running sessions. The nature relatedness scores of 673 participants ranged from 1-5, with a mean (NR) score of 3.68, SD = .58 and median 3.67.

Gender comparison

A Mann Whitney U test compared nature relatedness scores between male and female runners, and found they did not differ significantly, [U(673) = 60,353.50, Z = 1.686, p=.092, r = .06-small effect size]. The result indicates that level of connectedness with the natural world was similar between males (M=3.66, SD=.55,n=368) and females (M=3.71, SD=.60,n=305).

Age comparison

A Kruskal-Wallis test was conducted to evaluate differences in nature relatedness scores between three age groups: 18-30 years, 31-50 years and 51+ years and found statistically significant differences between the three age groups, [χ^2 (2) =72.780, *p*<.001]. Participants had different scores; 18-30 years (M=3.40, SD=.51, n=205); 31-50 years (M=3.86, SD=.57,n=165) and 51+ (M=3.81, SD=.52,n=131). Further pairwise comparison testing with adjusted *p*-values is shown in Table 5.3.

Table 5.3: NR scores pairwise comparisons between three age groups

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
(18 – 30) – (51+)	-105.419	16.191	-6.511	.000	**.000**	0.36
(18-30) – (31-50)	-116.956	15.139	-7.725	.000	**.000**	0.40
(51+) – (31-50)	11.537	16.939	.681	.496	1.000	0.04

NOTE: Test statistic is the difference between the mean ranks between three age groups, std is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Nature relatedness scores of runners at indoor and outdoor locations

A Mann Whitney U test compared NR scores between participants indoors and outdoors, and found statistically significantly difference, [U(673) = 32,428.500 Z = -4.975, p<.001, r = .19, small effect size]. The result indicated that level of connectedness with the natural world was higher among participants outdoor (M=3.74, SD=.5, n=174) than indoor (M=3.51, SD=.57,n=499) location.

Nature relatedness scores and running environment

A Kruskal-Wallis test was conducted to evaluate differences in nature relatedness scores between three environments: rural, suburban and urban environment and found statistically significant differences between the three environments, [H(2) = 32.825, *p* <.001].Participants had different scores; rural (M=3.98, SD=.55,n=104); suburban(M=3.59, SD=.56,n=322) and urban (M=3.63, SD=.59,n=214). Further pairwise comparison testing with adjusted *p*-values (see Table 5.4).

Table 5.4: NR scores pairwise comparisons between three environments

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Suburban - Urban	-26.855	16.305	-1.647	.100	.299	0.04
Suburban - Rural	124.712	20.851	5.981	.000	**.000**	0.26
Urban - Rural	97.857	22.099	4.428	.000	**.000**	0.25

NOTE: Test statistic is the difference between the mean ranks between three environments, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Nature relatedness between lone and group participants

A Mann Whitney U test compared nature relatedness scores between lone and group runners and found no significant difference between lone (M=3.67, SD=.59, n=436) and group runners (M=3.69, SD=.54,n=229), [U(665) = 49,492.000, Z = -.183, p=.855, r = .01- indicating small effect size]. The result indicates that level of connectedness with the natural world was similar between lone and group runners.

Nature relatedness subscale

The nature relatedness self-scores of 673 participants ranged from 1-5, with a mean (NR Self) score of 3.68, SD = .70 and median 3.63.

Gender differences in nature relatedness self scores

A Mann Whitney U test compared nature relatedness self scores between male and female runners, and found no significant difference, [U (673) = 60,721.000, Z = 1.834, p=.067, r = .07-small effect size]. The result indicates that nature relatedness self score was similar between males (M=3.66, SD=.55, n=368) and females (M=3.71, SD=.60,n=305).

Differences in nature relatedness self scores between age groups.

A Kruskal-Wallis test was conducted to evaluate differences in nature relatedness self scores between three age groups: 18-30 years, 31–50 years and 51+ years and found a statistically significant difference in nature relatedness self scores between the different age groups [χ^2 (2) =75.640, *p*<.001]. Participants at the three age groups had different scores; 18-30 years (M=3.34, SD=.63,n=205); 31-50 years (M=3.85, SD=.69,n=165) and 51+ (M=3.91, SD=.62,n=131).

Further pairwise comparison testing with adjusted *p*-values (Table 5.5) showed that there was lower NR self scores in ages 18-30 years than 31-50 years; there was lower NR self scores in ages 18-30 years compared to ages 51+; but between 31-50 years and 51+ years there was no significant difference.

Table 5.5: NR self scores pairwise comparisons between three age groups

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
(18 – 30) – (31-50)	-105.450	15.123	-6.973	.000	**.000**	0.36
(18-30) – (51+)	-123.446	16.174	-7.632	.000	**.000**	0.42
(31-50) – (51+)	-17.997	16.921	-1.064	.288	.863	0.06

NOTE: Test statistic is the difference between the mean ranks between three age groups, std is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Nature relatedness self scores of runners at indoor and outdoor locations

A Mann Whitney U test compared NR self scores between indoor and outdoor running locations, and found statistically significant difference, [U (673) = 36,401.500, *Z* = -3.178, *p*=.001, r = .12-small effect size]. The result indicated that NR self was higher in outdoor participants (M=3.73, SD=.69,n=499) than indoors (M=3.53, SD=.71,n=174) (Figure 5.2).

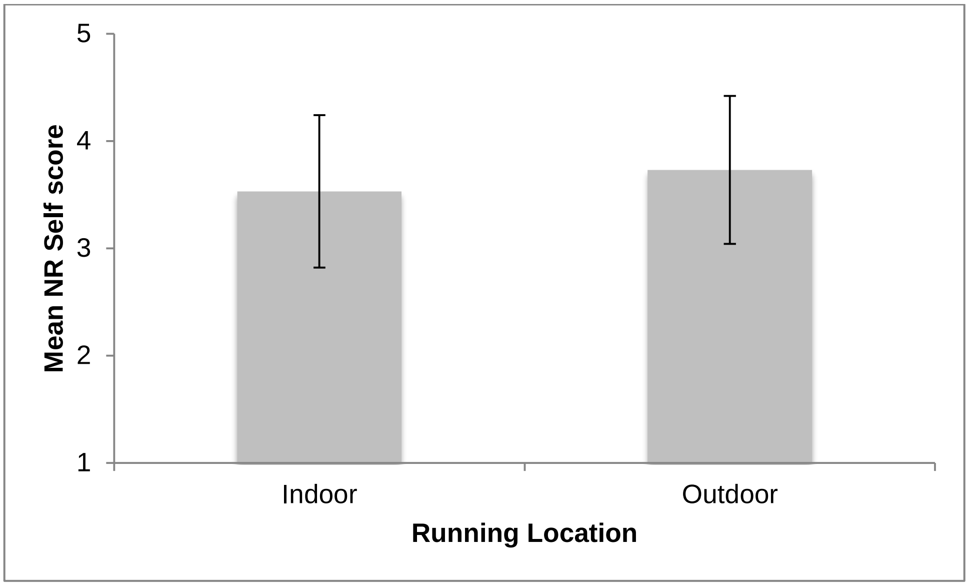

Figure 5.2: Mean NR self-scores between two running locations
Note: Error bars represent 1SD

Nature relatedness self scores between running environments

A Kruskal-Wallis test was conducted to evaluate differences in NR self scores between three environments: rural, suburban and urban environment and found statistically significant differences between the three environments, $H(2) = 23.526$, $p < .001$. Participants had different scores; rural (M=3.98, SD=.72,n=104); suburban(M=3.59, SD=.67,n=322) and urban (M=3.64, SD=.72,n=214).

Further pairwise comparison testing with adjusted *p*-values (Table 5.6) showed that there was a higher NR self-scores in rural environment than suburban environment; there was higher NR self-scores in rural environment than urban environment; but between suburban and urban there was no significant difference. The result indicates that nature relatedness self was different between the environments.

Table 5.6: NR self-scores pairwise comparisons between three environments

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Suburban - Urban	-21.860	16.290	-1.342	.180	.539	0.04
Suburban - Rural	100.972	20.832	4.847	.000	**.000**	0.24
Urban - Rural	79.112	22.078	3.583	.000	**.001**	0.19

NOTE: Test statistic is the difference between the mean ranks between three environments, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Differences in nature relatedness self-scores between lone and group participants

A Mann Whitney U test compared nature relatedness self-scores between lone and group runners and found no significant difference between lone (Mdn=3.63,n=436) and group runners (Mdn=3.75,n=229), U (665) = 49,616.000, Z = -.130, p=.855, r = .01- indicating small effect size. The result indicates that nature relatedness self-scores was the same between lone and group runners.

Nature relatedness perspective subscale

The nature relatedness perspective-scores of 673 participants ranged from 1-5, with a mean (NR Perspective) score of 3.68, SD = .64 and median 3.71.

Gender comparison

A Mann Whitney U test compared NR perspective scores between male and female runners, and found statistically significant difference, [U (673) = 66,452.000, Z = 4.118, p <.001, r = .16-small effect size]. The result indicates that nature relatedness perspective score was higher in females (M=3.80, SD=.63,n=305) than in males (M=3.59, SD=.64,n=368) as shown in Figure 5.3.

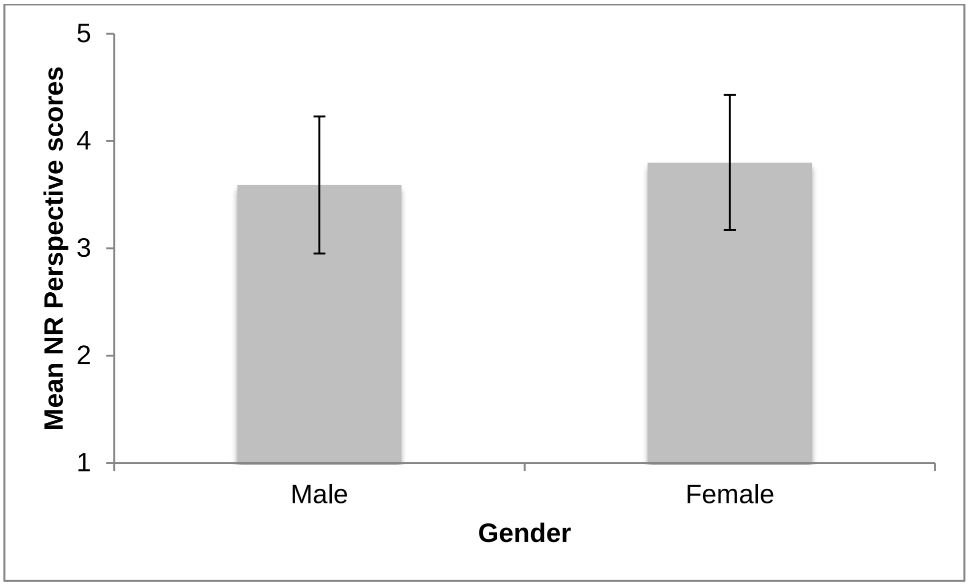

Figure 5.3: Mean NR perspective-scores and gender
Note: Error bars represent 1SD

Age comparison

A Kruskal-Wallis test was conducted to evaluate differences in nature relatedness perspective scores among three age groups: 18-30 years, 31-50 years and 51+ years. The result showed a statistically significant difference in nature relatedness perspective scores between the different age groups [χ^2 (2) =29.351, p<.001]. Participants NR perspective score was different between the three age groups: 18-30 years (M=3.47, SD=.61,n=205); 31-50 years (M=3.81, SD=.62,n=165) and 51+ (M=3.74, SD=.66,n=131).

Further pairwise comparison testing with adjusted *p*-values (Table 5.7) showed that there was a lower NR perspective scores in ages 18-30 than ages 51+; there was lower NR perspective scores between ages 18-30 years than 31-50 years; but between 31-50 years and 51+ years there was no difference. The result indicates that NR Perspective score was higher in ages 51+ than 18-30 years and also higher in 31-50 years than 18-30 years.

Table 5.7: NR perspective scores pairwise comparisons between three age groups

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
(18 – 30) – (51+)	-65.011	16.180	-4.018	.000	**.000**	0.22
(18-30) – (31-50)	-75.320	15.129	-4.979	.000	**.000**	0.26
(51+) – (31-50)	10.309	16.928	.609	.543	1.000	0.04

NOTE: Test statistic is the difference between the mean ranks between three age groups, std is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

<u>Nature relatedness perspective scores of runners at indoor and outdoor locations</u>

A Mann Whitney U test compared NR perspective scores between indoor and outdoor running locations, and found statistically significant difference, [U (673) = 36,729.000, Z = -3.029, p=.002, r = .12- small effect size]. The result indicated that NR perspective score was higher in participants outdoor (M=3.73, SD=.63,n=499) than indoor (M=3.56, SD=.65,n=174) locations (Figure 5.4).

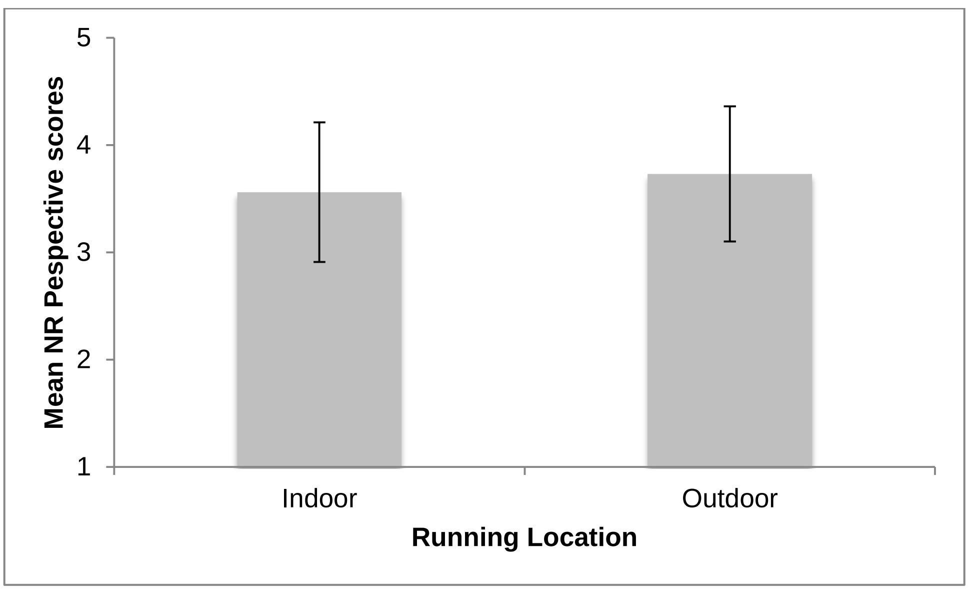

Figure 5.4: Mean NR perspective scores between two running conditions
Note: Error bars represent 1SD

<u>Nature relatedness perspective scores between running environments</u>

A Kruskal-Wallis test was conducted to evaluate differences in NR perspective scores between three environments: rural, suburban and urban environment and found statistically significant differences between the three environments, H(2) = 14.729, *p* =.001.. Participants had different scores; rural (M=3.90, SD=.59,=104); suburban (M=3.63, SD=.62,n=322) and urban (M=3.63, SD=.68,n=214).

Further pairwise comparison testing with adjusted *p*-values (Table 5.8) showed that there was higher NR perspective scores in rural than suburban environment; there was higher NR perspective scores in rural than urban environment; but between suburban and urban there was no significant difference The result indicates that nature relatedness perspective was higher in rural environments than either suburban or urban environments.

Table 5.8: NR perspective scores pairwise comparisons between three environments

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Urban - Suburban	-5.383	16.293	-.330	.741	1.000	0.01
Urban - Rural	77.838	20.836	3.736	.000	**.001**	0.19
Suburban - Rural	72.455	22.083	3.281	.001	**.003**	0.18

NOTE: Test statistic is the difference between the mean ranks between three environments, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Differences in nature relatedness perspective scores between lone and group participants

A Mann Whitney U test compared nature relatedness perspective scores between lone and group runners and found no statistically significant difference between lone and group runners, [U (665) = 49,186.500, *Z* = -.313, *p*=.855, r = .01- indicating small effect size]. The results indicate that nature relatedness perspective scores were the same between lone (M=3.68, SD=.65,n=436) and group (M=3.69, SD=.63,n=229) runners.

Nature relatedness experience subscale

The nature relatedness experience scores of 673 participants ranged from 1-5, with a mean (NR Experience) score of 3.69, SD = .73 and median 3.67.

Gender comparison

A Mann Whitney U test compared nature relatedness experience scores between male and female runners, and found no statistically significant difference, [U (673) = 51,418.500, *Z* = -1.875, *p*=.061, r = .07-small effect size]. The result indicates that nature relatedness experience score was not different between males (M=3.75, SD=.64,n=368) and females (M=3.80, SD=.63,n=305).

Age comparison

A Kruskal-Wallis test was conducted to evaluate differences in nature relatedness experience scores among three age groups and found a statistically significant difference in Nature relatedness experience scores between the different age groups [χ^2 (2) =51.559, *p*<.001]. 18-30 years (M=3.39, SD=.72,n=205); 31-50 (M=3.93, SD=.67,n=165) and 51+ (M=3.75, SD=.69,n=131).

Further pairwise comparison testing with adjusted *p*-values (Table 5.9) showed that there was a lower NR experience scores in ages 18-30 years than ages 51+; there was lower NR experience scores in 18-30 years than 31-50 years; but between 31-50 years and 51+ years there was no significant difference. The result indicates that NR experience score was lower in ages 18-30 years compared to ages 30-31 years and 51+.

Table 5.9: NR experience scores pairwise comparisons between three age groups

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
(18 – 30) – (51+)	-69.539	16.177	-4.299	.000	**.000**	0.23
(18-30) – (31-50)	-106.184	15.126	-7.020	.000	**.000**	0.37
(51+) – (31-50)	36.645	16.924	2.165	.031	.091	0.13

NOTE: Test statistic is the difference between the mean ranks between three age groups, std is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Nature relatedness experience scores of runners at indoors and outdoors locations

A Mann Whitney U test compared NR Experience scores between participants in indoor and outdoor running locations, and found statistically significant difference, [U (673) = 30,511.500, $Z = -5.849$, $p<.001$, r = .23- small effect size]. The result indicated that NR experience score was higher in participants outdoors (M=3.79, SD=.69,n=499) than indoor (M=3.41, SD=.76,n=174) locations (Figure 5.5)

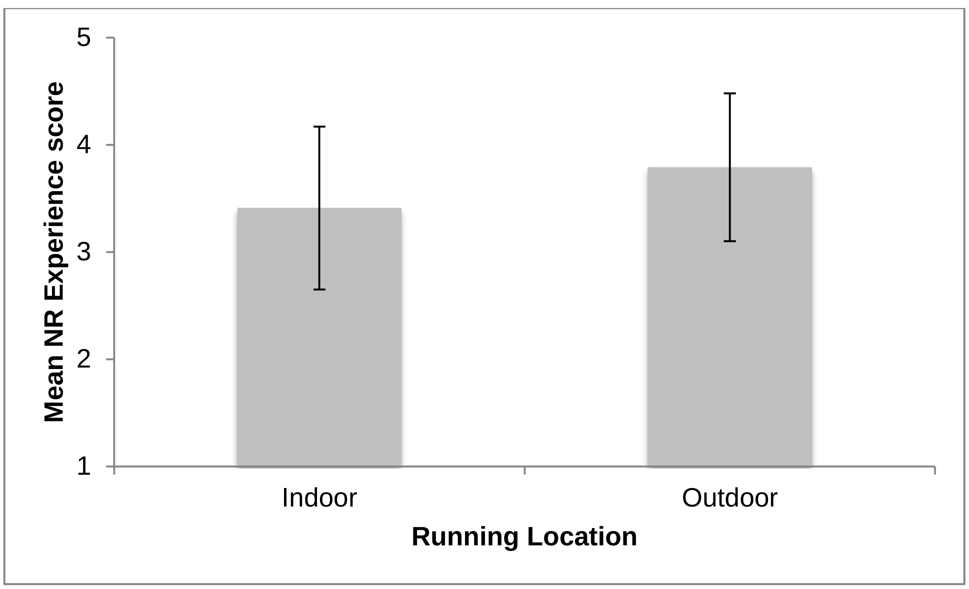

Figure 5.5: Mean NR Experience scores between two running conditions
Note: Error bars represent 1SD

Nature relatedness experience scores between running environments

A Kruskal-Wallis test was conducted to evaluate differences in NR experience scores between three environments: rural, suburban and urban environment and found statistically significant differences between the three environments, [H(2) = 36.665, *p* <.001]. Participants had different scores; rural (M=4.05, SD=.63,n=104); suburban (M=3.57, SD=.74,n=322) and urban (M=3.67, SD=.70,n=214).

Further pairwise comparison testing with adjusted *p*-values (Table 5.10) showed that there was higher NR experience scores in rural than suburban environment; there was higher NR experience scores in rural than urban environment but between suburban and urban there was no significant difference. The result indicates that nature relatedness experience was higher in rural environments than either suburban or urban environments.

Table 5.10: NR experience scores pairwise comparisons between three environments

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Suburban - Urban	-28.925	16.288	-1.776	.076	.227	0.03
Suburban - Rural	126.101	20.830	6.054	.000	**.000**	0.27
Urban - Rural	97.176	22.075	4.402	.000	**.000**	0.25

NOTE: Test statistic is the difference between the mean ranks between three environments, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Differences in nature relatedness experience scores between lone and group participants

A Mann Whitney U test compared nature relatedness experience scores between lone and group runners and found no statistically significant difference between lone and group runners, [U(665) = 47,960.500, *Z* = -.834, *p*=.404, r = .03- indicating small effect size]. The result indicates that nature relatedness experience score was the same between lone (M=3.67, SD=.75, n=436) and group runners (M=3.75, SD=.66,n=229).

5.3.7 Relationships between outcome variables

Nature relatedness

NR and subfactors all correlated either strongly or moderately positively with each other when tested with a Spearman's rho correlation coefficient. NR correlated well with its subfactors with a strong positive correlation with Self (76% shared variance), Perspective (62% shared variance) and Experience (61% shared variance); shared variance is the amount that the variations of 2 variables tend to overlap (Table 5.11).

Table 5.11: Correlation matrixes for Nature relatedness and subfactors

	NR	NR Self	NR Perspective	NR Experience
NR	1			
NR Self	.872**	1		
NR Perspective	.786**	.577**	1	
NR Experience	.781**	.583**	.436**	1

Notes: r values are reported; ** Correlation is significant at the .01 level (2-tailed); *Correlation is significant at the .05 level (2-tailed); ns Correlation non-significant

Wellbeing

There was no significant correlation between mental wellbeing and NR with subfactors (*p*>.05) as shown in Tables 5.12

Table 5.12: Correlation matrix for outcome variables

	WEMWBS	NR	NR Self	NR Perspective	NR Experience
WEMWBS	1				
NR	-.043	1			
NR Self	.043	.872**	1		
NR Perspective	-.038	.786**	.577**	1	
NR Experience	-.042	.781**	.583**	.436**	1

Notes: r values are reported; ** Correlation is significant at the .01 level (2-tailed); *Correlation is significant at the .05 level (2-tailed); ns Correlation non-significant.

5.3.8 Importance of being outside in nature running

Participants' perceptions of the importance of being outside in nature was assessed and being outside in nature scores ranged from 1 to 10; (mean = 7.93, SD = 1.78, median = 8.00).

Importance of being outside in nature between age groups

A Kruskal-Wallis test was conducted to evaluate differences in importance of being outside in nature among three age groups: 18-30 years, 31-50 years and 51+ years. The results of the analysis indicated that there was a statistically significant difference in importance of being outside in nature between the three different age groups,[H(2) = 26.593, *p* <.001]. 18-30 years (M=7.36, SD=2.04,n=205), 31-50 years (M=8.34, SD=1.51,n=165) and 51+ (M=7.90, SD=1.38,n=131).

Further pairwise comparison testing with adjusted *p*-values showed that there was statistically significant difference in participants' perceptions of the importance of being outside in nature between the age groups as shown in Table 5.13. Participants between the ages of 31-50 had higher importance score than participants that were 51+ and between 18-30 years.

Table 5.13: Importance of being outside in nature score pairwise comparisons between three age groups

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
(18 – 30) – (51+)	-54.101	15.838	-3.416	.001	**.002**	0.19
(18-30) – (31-50)	--73.095	14.809	-4.936	.000	**.000**	0.26
(51+) – (31-50)	18.994	16.570	1.146	.252	.755	0.07

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above = large).

Importance of being outside in nature between indoor and outdoor runners

A Mann Whitney U test compared the importance of being outside in nature between indoor and outdoor participants and found that it differed significantly, [U(671) = 34 128.00, *Z* = -4.31, *p*<.001, r

= .17, small effect size]. The importance of being outside in nature score was higher in outdoor participants (M=8.11, SD=1.67,n=499) than indoor (M=7.41, SD1.96,n=174).

Importance of being outside in nature between participants in rural, suburban and urban environments

A Kruskal-Wallis test was conducted to evaluate differences in the importance of being outside in nature among three running environments (rural, suburban and urban environments). The importance of being outside in nature varied significantly between these environments, [$\chi^2(2, N = 640) = 23.90$, $p < .001$]. Rural (M=8.68,SD=1.37,n=104), suburban (M=7.78,SD=1.77,n=322) and urban (M=7.81,SD=1.88,n=214).

Further pairwise comparison testing with adjusted *p*-values showed that there was a statistically significant difference in importance of being outside in nature scores between the running environments as shown in Table 5.14. Participants at rural environment preferred to be outside in nature due to availability of green space compared to the suburban and urban environment. Statistical analyses for the importance of being outside in nature with gender and running condition were insignificant (see Appendix H).

Table 5.14: Importance of being outside in nature pairwise comparisons between three environments with adjusted significance and effect size

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Suburban - Urban	-7.844	16.435	-.477	.633	1.000	0.02
Suburban - Rural	101.479	21.172	4.793	.000	**.000**	0.23
Urban - Rural	93.635	22.697	4.125	.000	**.000**	0.23

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above = large).

5.3.9 Importance of the social aspect of participating in running

Participants' perceptions of the importance of being with other people was assessed and being with other people scores ranged from 1 to 10, (mean = 7.51, SD = 1.91, median = 8.00).

Importance of being with other people with gender

A Mann Whitney U test compared the importance of being with other people between male and female participants and found statistically significant difference between males (M=7.31, SD=1.91,n=368) and females (M=7.76, SD=1.89,n=305). [U(672) = 64 146.000, *Z* = 3.33, *p* = .001, r = .13 - small effect size]. The result indicates that the importance of being with other people was higher in females than males.

Importance of being with other people and age groups

A Kruskal-Wallis test was conducted to evaluate differences in importance of being with other people among three age groups: 18-30 years, 31-50 years and 51+ years. The results of the analysis indicated that there was a statistically significant difference in importance of being with other people between these three age groups, [H(2) = 25.965, *p* <.001], with (M=7.07, SD=1.81,n=205) for 18-30 years, (M=7.31, SD=1.93,n=165) for age group 31-50 years and (M=7.07, SD=1.88,n=131) for 51+ years.

Further pairwise comparison testing with adjusted *p*-values showed that there was statistically significant difference in importance of being with other people between the age groups as shown in Table 5.15. Younger participants 31-50 years prefer to run with other people because more of them participate in sports and are also encouraged by their age mate.

Table 5.15: Importance of being with other people pairwise comparisons between three age groups

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
(51+) – (31-50)	19.680	16.631	1.183	.237	.710	0.07
(51+) – (18-30)	75.068	15.912	4.718	.000	**.000**	0.26
(31-50) – (18-30)	55.389	14.881	3.722	.000	**.001**	0.19

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted *p*-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above = large).

Importance of being with other people between indoor and outdoor runners

A Mann Whitney U test compared the importance of being with other people between indoor and outdoor participants and found statistically significant difference, [U(673) = 49982.50, *Z* = 3.07, *p* = .002, r = .12 - small effect size]. The importance of being with other people was higher in indoor participants (M=7.88, SD=1.84,n=174) than outdoor (M=7.39, SD=1.67,n=499). Statistical analyses for the importance of being with other people with environment and running condition were insignificant (see Appendix I).

5.3.10 Importance of being on one's own

The importance of being on one's own was measured using a visual analogue scale of 1-10. Their importance score ranged from 1-10, (mean = 6.54, SD = 1.99, median = 7.00).

Importance of being on one's own and gender

A Mann Whitney U test compared the importance of being on one's own with gender and found a significant difference between males (M=6.36, SD=2.01,n=365) and females (M=6.75, SD=1.96,n=305). [U(670) = 62231.50, *Z* = 2.67, *p* = .008, r = .10 - small effect size]. The result indicates that the importance of being on one's own was higher in females than males.

Importance of being on one's own between participants in rural, suburban and urban environments

A Kruskal-Wallis test was conducted to evaluate differences in importance of being on one's own between participants in rural, suburban and urban participants and found statistically significant difference between the three running environments, [$\chi^2(2, N = 640) = 12.45, p = .002$]. Participants at the rural environment had the highest importance score (M=7.02, SD=2.02,n=104), suburban (M=6.53, SD=1.99,n=322) and urban (M=6.32, SD=1.91,n=214).

Further pairwise comparison testing with adjusted *p*-values showed that there was statistically significant difference in the importance of being on one's own between the environments as shown in Table 5.16. Statistical analyses for the importance of being on one's own with age, running location and running condition were insignificant (see Appendix J).

Table 5.16: Importance of being on one's own pairwise comparisons between three environments

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Urban - Suburban	22.451	16.562	1.356	.175	.526	0.06
Urban - Rural	80.678	22.925	3.519	.000	.020	0.20
Suburban - Rural	58.227	21.408	2.720	.007	.000	0.13

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and ES is the effect size r (.1 = small, .3 = medium and .5 and above = large).

5.3.11 Importance of the feeling of release and freedom

The importance of the feeling of release and freedom of participants was measured using a visual analogue scale of 1-10. The importance scores after running ranged from 2-10; (mean = 8.17, SD = 1.65, median = 8.00). Analyses for gender, age, running location, environment and running condition were insignificant with the importance of the feeling of release and freedom (see Appendix K).

5.3.12 Summary of key findings

This study evaluated the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions from travel by runners across England and extrapolated the GHG emissions to the national level. The secondary aim was to assess nature relatedness and mental wellbeing in England among 673 respondent of mixed age and approximately equal gender proportion among runners' in England. There are 15 key findings:

1. The mean distance travelled to and from the running location by participants was 7.40km and nearly half of the participants travel by car while a quarter travel on foot. The mean GHG emission from travel of the participants was 0.62 $kgCO_{2.}$
2. Extrapolating GHG emissions from travel in England with approximately 104 million running sessions in 2012 resulted in approximately 64,480 tCO_2e.
3. GHG emission from travelling to indoor locations produced significantly higher GHG emissions than to outdoor locations due to dependence on cars.
4. A multiple linear regression examined the variance in the GHG scores of participants loading five predictors into the model. The model was able to explain 70.6% of the sample outcome variance; travelling distance to running location was related to higher GHG emissions and running in an urban environment was also related to higher GHG emissions
5. The study shows that the mean importance score of being outside in nature of participants was high: 7.93. The importance of being outside in nature was higher in outdoor participants than indoor. The importance of being outside in nature was higher in rural than suburban environments, but no significant difference between suburban and urban environments.
6. The importance of being with other people was higher among the participants with a mean score of 7.51.The result indicates that the importance of being with other people was higher in females than males. The importance of being with other people was higher in indoor than outdoor participants.

7. The mean score of the importance of being on one's own among the participants was slightly above average: 6.54. The result indicates that this importance was higher in females than males.
8. There was less importance of being on one's own between participants in urban than rural environments and also in suburban than rural environments.
9. The importance of the feeling of release and freedom after participating in a running session was high among the participants with a mean of 8.17, regardless of other independent variable.
10. Mean mental wellbeing score of the participants was 51.19, SD=8.23. Mental wellbeing did not significantly differ with gender, age, location, and environment, but was significantly higher in lone runners compared to group runners.
11. Mean nature relatedness score of participants was 3.68, SD=0.58. NR was significantly different with age; participants of 31-50 years had higher NR score than 18-30 years, and 51+ had higher NR score compared with 18-30 years. However, there was no difference between 31-50 years and 51+. NR was significantly higher in participants outdoors compared with indoors and was higher in participants in the rural environment compared to urban, and higher in rural participants compared with suburban.
12. NR sub factor of 'self' measured how much individuals identify with nature. NR 'self' was significantly higher in 31-50 years and also 51+ than 18-30 years. NR Self was higher in participants in rural environments compared to suburban and urban environment. NR self was higher in participants outdoors compared with indoor.
13. NR subfactor of perspective measured how concerned individuals may feel about the effect of human actions on the environment. NR perspective was higher in female than male, NR perspective was significantly higher in 51+ than 18-30 years and higher with 31-50 years than 18-30 years, but was not different between 31-50 years and 51+. NR perspective was higher outdoors than indoors and was higher in rural than urban and suburban environment.

14. NR subfactor of experience measured how comfortable individuals are in nature and their desire to be involved with nature. NR experience was significantly higher between 51+ than 18-30, higher between 31-50 compared to 18-30, was higher outdoors than indoor.
15. NR and all subfactors correlated positively well together and there was no significant correlation between mental wellbeing and NR and all subfactors.

5.4 Discussion

5.4.1 Addressing the study aims and objectives

The primary aim of this study was to evaluate the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions from travel by runners across England and to extrapolate to a national level. The secondary aim was to measure mental wellbeing, nature relatedness, the importance of 'being outside in nature', 'being with other people', 'being on one's own' and 'the feeling of release and freedom' among runners in England. In this study, the outcomes were determined using a questionnaire.

5.4.2 Implications of GHG emissions

Studies have shown that every mode of transport, comprising of walking, cycling, car, bus, train and taxi, each has its advantages. Active transport (walking and cycling) results in zero GHG emissions, public transport results in less GHG emissions due to a high number of passengers on buses and trains, while private transport (particularly by car) provides door to door transportation but also results in much higher GHG emissions due to more fuel consumption (Walsh *et al.*, 2008; Pan *et al.*, 2013; Pongthanaisawan and Sorapipatana, 2013).

The evidence base does not currently include travel GHG emissions from participants- dominated sport (running). Several studies have examined transport GHG emissions from mega sporting events such as the Commonwealth Games and Olympic games, although both participants and spectators were responsible for the GHG emissions (Roper, 2006; Shaw *et al.*, 2007; Collins *et al.*, 2009; Shaw *et al.*, 2010; Sahu *et al.*, 2011). Moreover, there is well-documented evidence that travel to marathon races by spectators; organisers, volunteers and participants contribute to GHG emissions (Bullard *et al.*, 2007; Robbins *et al.*, 2007; Krugell and Saayman, 2013).

This study found that car travel dominated overall emissions (84.70% of total GHG emissions), followed by train (12%), bus (2.90%) and taxi (0.40%). Participants that use active transport such as walking and cycling to running locations emitted zero GHG emissions. This research suggest that increase in active transport will not just help to reduce traffic congestion on the roads but ultimately reduce GHG emissions, a finding similar to a previous study (Simons *et al.*, 2013).

The mean GHG emissions of participants from their travel to running location was 0.62 $kgCO_2e$, which was far less than the mean GHG emissions from travel from spectator dominated sports (football) of 4.74$kgCO_2e$ in Chapter 3.The extrapolations of travel GHG emission of runners in England for 2012 included all forms of athletes: track and field, road running and other running such as recreational running alone or with a running group. This amounted to about 2 million runners per week and, with a mean GHG emission of 0.62 $kgCO_2e$ to and from running locations for a running session, resulted in 64,480 tCO_2e. The GHG emissions from indoor running location (0.86$kgCO_2e$,n=174) was higher than the outdoor (0.54 $kgCO_2e$,n=466), a change in the way runners travel to running location such as gym could reduce their environmental impact, and the findings can be used for policy changes. Participants travel average distance of 7.4km and their running session last for averagely 6.1km. If participants had started their run from home or the office, their travel GHG emissions could have reduced because they travel more distance than their running distance.

The findings show that the behavioural choice of participants going to a gymnasium produced higher GHG emissions than to other outdoor running locations. Participants in rural environments produced less GHG emissions compared to suburban and urban environments, which can be compared to a previous study on residential CO_2 emissions in suburban and urban China (Donglan *et al.*, 2010). This is possibly due to less open space to engage in physical activities in suburban and urban settings, unlike the rural environment, and also the population density is higher in urban than rural environments.

The result of multiple regression analysis on the outcome variable showed that, to varying degrees, the independent variables of distance travelled and urban environment affected levels of GHG emissions and explained 70.6% of the variance, leaving just 29.4% unexplained. The outcome variable also positively correlated with the independent variable (distance travelled). These influencing factors are in line with the evidence base (Goodman *et al.*, 2012; Rentziou *et al.*, 2012; Gately *et al.*, 2013). As with the present findings, the evidence in published literature regarding GHG emissions used the carbon footprint method, comprising of recording, analysing, reporting and managing GHG emissions. More importantly, behavioural changes by people to use more environmentally friendly modes of travel are vital to reduce and manage GHG emissions (Ramaswami *et al.*, 2011; Wright *et al.*, 2011; Andrews *et al.*, 2013; Cadarso *et al.*, 2015; Li *et al.*, 2015).

5.4.3 Mental wellbeing

The findings of this study show that taking part in running has a beneficial effect on mental wellbeing among participants of varying gender and ages; this is similar to past studies (Thompson Coon *et al.*, 2011; Gaudlitz *et al.*, 2015). The average (mean) WEMWBS scores of the participants was 51.19, SD=8.23; this is within the ‘average wellbeing’ range reported in chapter 4; This is similar to the average mental wellbeing found in Scottish Survey 2012 and at the study of spectator dominated sport (football) in chapter 4 of mean wellbeing score of 51.52.

In terms of how mental wellbeing trait was affected by independent variables: gender and age, had no effect on mental wellbeing measures similar to findings in chapter 4. Mental wellbeing was not affected by running location (indoor or outdoor) and running environment. However, mental wellbeing was higher in lone runners compared to group runners. However, mental wellbeing did not correlate with nature connectedness. This is contrary to findings from past studies that showed positive correlation between mental wellbeing and connection with nature (Newton, 2007; Nisbet *et al.*, 2011; Bragg, 2014).

5.4.4 Nature relatedness

The findings show that taking part in running affects the connectedness to nature of participants in the study. The mean NR score was 3.68, (SD = 0.58), this was within the normative value of 3.2 to 3.7 as found by (Nisbet, 2013), but lower than the norm of 4.5 for environmental educators, as would be expected.

Nature relatedness was affected by independent variables of age, running condition and running environment but not by gender and running condition (lone or group). Older participants (31 years and above) had significantly higher nature relatedness scores than the younger participants (18-30 years). This suggests that increase in age results in increase in nature connection. Overall, nature relatedness was higher in outdoor participants than indoor participants, this corresponds with past studies which reported higher nature relatedness score in outdoor participants than indoor (Nisbet and Zelenski, 2011). Participants in rural environments had higher nature connection compared to suburban and urban environments; this suggests that increase in connection to nature could be linked to the environment.

The NR self subfactor, which represents the degree to which an individual feels personally connected to nature, was not affected with gender or running condition. However, NR self was affected by age which was significantly higher between the ages of 31-50 years than between 18-30 years, it was also higher in 51+ than between 18-30 years. NR self was higher in outdoor participants compared to indoor and was significantly higher in participants in rural environments compared to suburban and urban environments. This suggests that older participants running outdoors in rural environments feel personally connected to nature.

The NR perspective, which represents a more external, nature-related worldview of an individual, was not affected with running condition. However, it was affected with gender, age, running location and running environment. NR perspective was significantly higher in females compared to males, higher in older age groups (31-50 years and 51+) compared to 18-30 years; higher outdoors than indoor and higher in rural environments compared to suburban and urban environment respectively. This suggests that females were more connected to nature; participant's that are older, outdoors and in rural environments are all more personally connected to nature (Capaldi *et al.*, 2014).

The NR experience subscale, which represents the level of an individual's comfort or familiarity with being outside in nature, was not significantly affected with gender and running condition. But was significantly higher in 31-50 years and 51+ compared to 18-30 years; was higher outdoor than indoors and was higher in rural environment compared to suburban and urban environments. This suggests that older participants that run outdoors and in rural environments tend to be more familiar with being outside in nature. This finding is in line with previous studies that supports the theory that the level of individuals' familiarity with being outdoors increases and also increases participants' vitality (Ryan *et al.*, 2010).

5.4.5 Implications of the importance scales

This study examined the importance of being outside in nature among participant-dominated sport (runners in England). The findings suggest that the importance of being outside in nature was generally very important to participants. This study therefore confirms the findings of other studies on green exercise on the importance of being outside in nature and exercise and the beneficial effects (Krenichyn, 2006; Peacock *et al.*, 2007; Thompson Coon *et al.*, 2011). Moreover, it was more important to the middle aged than the younger and older age groups; in particular, being outside in nature was more important to ages 31-50 years than those younger (18-30 years) or older (51+years). Participants outdoor felt it was more important to be outside in nature than those indoor. The findings from this study also found that it was more important to people in rural environments to be outside in nature than those in suburban or urban environments. However, the findings from this study did not show any gender difference in the importance of being outside in nature and there was no difference between individual and groups.

This study shows that the importance of being with other people was very high in participants. Female participants found it more important than their male counterparts. The findings from this study also found that, as people get older, their importance of being with other people reduces. Participants who are 18-30 years found it more important than 31-50 years, and 31-50 years found it more important than 51+years. Moreover, participants indoors found it was more important than those outdoors. However, contrary to one of the initial hypotheses of this research, there was no difference between participants in rural, suburban and urban environments and also no difference between individual and group participants.

The findings from this study found the importance of being alone to be above average among the participants. This importance was higher among females than males and higher among participants in rural environments than suburban or urban environments. Longitudinal survey should be carried out to further examine these findings, because this finding is contrary to literature (Cohen *et al.*, 2007; Jordan, 2013). However, this study found no difference in the importance of being alone among the other independent variables: age groups 18-30, 31-50 and 51+), running location (indoor or outdoor) and running condition (alone or group).

Findings from this study found that the importance of the feeling of release and freedom was very high among the participants. It was higher in the participants in the rural environment than the urban, a finding similar to other studies (Thompson *et al.*, 2007; Swanwick, 2009; Henderson, 2013); but there were no differences between the three age groups (18-30, 31-50 and 51+), running location (indoor or outdoor) and running condition (lone or group). Physical activities have many benefits on both physical and mental health, particularly when undertaken outdoors. When participants start their running session from home or travel in an environmentally friendly way to their running location, it results in less environmental impact through their GHG emissions from travel.

5.4.6 Limitations

In interpreting findings from this study regarding levels of GHG emissions, mental wellbeing, nature relatedness, the importance of being outside in nature, being with other people, being on one's own and the feeling of release and freedom among runners in England, it is important to bear in mind this study's limitations.

- Although GHG emissions from participants' travel was measured using their travel details and applying Defra's GHG emission conversion factors, examining participants' levels of contact with nature, social aspects of importance and feelings after participation in running sessions used scales on the importance of these measures instead of standardised instruments (such as connectedness to nature scale and profile of mood state) due to time constraints.
- With the calculation of GHG emissions, particularly from participants that travelled by car, GHG conversion factors for average engine size with unknown fuel was applied; there may have been greater accuracy if the participants' actual car engine size had been used.

- Some of the participants engage in running as events or training or for fitness purpose and this might affect the research outcome because they may concentrate on the event or their fitness than enjoying the benefits of running.
- Although the study was successful in examining if sporting location and type affects mental wellbeing and nature relatedness, the changes could be better measured using standardised questionnaires that measure state versions of mental wellbeing (using RSES and POMS) and connection to nature scale (using CNS) over time and comparing the differences with running condition (alone and group).
- The response rate from the online questionnaire was very low (33 participants) and the responses from online could be questionable due to the fact that the actual time in which the questionnaire was completed could not be confirmed and this could have impacted on the data collected. Although the online response rate was low and this may not have had any significant effect on the results and the study altogether, these participants were excluded from some statistical analysis when comparing outcome with various running environment.

5.4.7 Conclusions and rationale for next study

For the first time, this study has examined the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions from travel to running location in England and assessed mental wellbeing, connection with nature of runners in England. The analysis of a sample of 673 adults across England confirms that travelling to running locations resulted in GHG emissions depending on travel behaviour. The findings from this study show that nearly half of the participants used cars to their running location, implying that the largest GHG emissions was as a result of car use and the other emissions were attributed to public transport such as taxis, buses and trains. GHG emission was positively correlated to distance travelled to running location.

The average GHG emissions of participants as a result of their travel to and from running location was 0.62 $kgCO_2$ and when extrapolated to a national level with approximately 2 million participants who run for about 30 minutes per week, resulted in approximately 64,480 tCO_2e.

Travelling distance to running location was related to higher GHG emissions and running in an urban environment was importantly related to higher GHG emissions. Participant-dominated sport (running) travel behaviour remains car-dependent and resulted in high GHG emissions. Thus, national behavioural change encouraging the use of active transport or the use of other environmentally friendly modes of travel apart from cars could have a considerable reduction on GHG emissions and ultimately on climate change.

The study showed that older participants (31 years and above) had significantly higher nature relatedness scores than the younger participants (18-30 years). This suggests that increase in age results in increased levels of connectedness with the natural environment. Overall, nature relatedness was higher in participants outdoors than indoors. Participants in rural environments had higher levels of connectedness to nature compared to suburban and urban environments; this suggests that increase in connection to nature could be linked to the environment. There was also a significant positive correlation between nature relatedness and all subfactors.

Findings from this study found that the importance of being outside in nature, being with other people, and the feeling of release and freedom was very high among the participants, while the importance of being on one’s own was of average importance to participants. Further research will benefit from using standardised instruments to measure connection with nature, plus the mental and emotional benefits of engaging in participant-dominated sport such as running to show the benefits of green exercise.

6. Participant dominated sport-Effects of running on mental wellbeing and connection to nature

6.1 Introduction

Evidence has shown that physical activities also support and enhance wellbeing and psychological health (Biddle and Asare, 2011; Khalsa *et al.*, 2012; Caddick *et al.*, 2015). Researchers have started to explore the psychological effects of physical activity in natural environments such as rural, suburban, urban, parks, countryside and coastal regions (Mitchell and Popham, 2008; Barton and Pretty, 2010; Brown *et al.*, 2014). Without any doubt, the combination of physical activity and contact with nature yields wellbeing and psychological benefits. For example, studies have shown that contact with nature can replenish depleted cognitive attention (Hartig and Staats, 2006) and help to cultivate general feelings of vitality and wellbeing (Cervinka *et al.*, 2011).

While there is potential evidence that physical activity influences wellbeing (Biddle and Mutrie, 2007), there is still need for more empirical evidence concerning the additional effects of physical activity undertaken in the natural environment. It is important to examine the resultant effects of participating in sport such as running outdoors, on mental and physical wellbeing.

The literature (Pretty *et al.*, 2005; Barton and Pretty, 2010; Thompson Coon *et al.*, 2011; Barton *et al.*, 2012; Wood *et al.*, 2014) has evaluated the health benefits of participating in physical activities whilst outdoors and compared changes in self-esteem (SE) and overall mood both pre and post exercise. The results have shown significant improvements in self-esteem and mood after participation in physical activities. Moreover, comparing levels of self-esteem, mood and connection to nature between individuals and groups who engage in physical activities, particularly outdoor ones will further add to the evidence base. Physical activity such as a workout in the gym or a brisk walk for half an hour can improve the participant's mood because physical activity stimulates various brain chemicals that may leave the person feeling happier and more relaxed. Physical activities can help improve or boost confidence and improve self-esteem (Haugen *et al.*, 2013). Moreover, exercising in the outdoors increases self-esteem even more.

Studies that have used pre to post design to examine levels of connection to nature using physical activities or exercise, particularly outdoors, have reported an increase in levels of connection to nature after participating in physical activities compared to before (Allen and Balfour, 2014; Frampton *et al.*, 2014; Thomson *et al.*, 2015). The next stage of this research is to examine self-esteem; mood and levels of connection with nature among runners outdoors.

6.1.1 Aim of the study

The aim of this study is to examine mental wellbeing and connection to nature of participant-dominated sport (running) outdoors.

<u>Key objectives:</u>

1) To examine changes in self-esteem of participants over time (pre-post) under two conditions (alone and group) and to examine any interaction effects between time, running conditions and other independent variables.
2) To examine changes in mood of participants over time (pre-post) under two conditions (alone and group) and to examine any interaction effects between time, running conditions and other independent variables.
3) To examine changes in connection to nature of participants over time (pre-post) under two conditions (alone and group) and to examine any interaction effects between time, running conditions and other independent variables

6.2 Methods

A pre and post session study used a questionnaire methodology to measure changes in participant's self-esteem, connection to nature and mood changes pre and post running session, and employed a counterbalanced, randomised crossover design.

6.2.1 Participants

The study had 42 participants that were recruited from undergraduates, postgraduates and employees at the University of Essex. Other participants were drawn from the local community in Colchester using electronic means and posters. However, 2 participants dropped out.

6.2.2 Study procedure

Before the commencement of the pre-post study, participants completed and signed an informed consent form and the PAR-Q General Health Questionnaire. Ambient temperature at the time of run was measured using a KTJ Portable Digital Thermometer and the result recorded in degree Celsius. Running time was recorded after the running session using Apple iPhone 4S digital stopwatch. Twenty-one participants were randomly assigned to run alone and twenty-one participants were also randomly assigned to run in a group. Each participant was then asked to undertake their first running session outdoors; either alone or in a group over a standard distance (3km) natural environment within University of Essex, Colchester campus, with at least a day between the first and the second run. All the participants were told to run the 3km at their own chosen pace, they were not forced to stick to a certain speed because it has shown that an acute response to high intensity exercise could lead to an increase in anxiety and other negative feelings (Parfitt *et al.*, 2000). Therefore, the participants choose a comfortable pace to minimise induced mood states through speed. The running distance was chosen so that the running activity duration would take between 10 and 20 minutes or more. This exercise duration is effective in promoting positive changes in a person's mental state (Demark‐Wahnefried *et al.*, 2012).

The experiments took place between March and April 2014. Running conditions were randomised and counterbalanced. Twenty-one participants completed their first session running alone and 21 people completed their first session running in a group condition. A total of 42 participants completed their first running condition; however only 40 participants completed their second running condition and also completed all questionnaires. Two participants dropped out from the second running session.

The outdoor running environment was a three-kilometre run around the University of Essex Campus with directions positioned at 100 metres interval. Participants completed the questionnaires before and after each running condition.

6.2.3 Outcome measures

The study questionnaires (Appendix L and M) were designed to incorporate: i) demographic data (such as gender and age); three standardised instruments for measuring aspects of ii) subjective wellbeing (Rosenberg self-esteem scale (RSES), iii) profile of Mood States (POMS) and iv) connection with nature (CNS).

I. Demographics

Participants' data included in the questionnaire were their age and gender.

II. Rosenberg Self Esteem (RSES)

The 10-item Rosenberg Self-esteem Scale (RSES) is considered to be the most widely used and popular self-esteem measure in health psychology, psychotherapy, social science and other evaluated research (Rosenberg, 1965; Barton, 2009; Campbell and Hemsley, 2009). The scale's reliability and validity has been demonstrated with many different sample groups, including adults, adolescents and older populations (Chen *et al.*, 2001; Martín-Albo *et al.*, 2007; Westaway *et al.*, 2015). The RSES consists of 10 statements relating to overall feelings of self-worth or self-acceptance and each item has four-response choices ranging from 0 (strongly agree) to 3 (strongly disagree). Items 3, 5, 8, 9 and 10 were reverse scored. An overall self-esteem score between 0 and 30 was generated.

The scale generally has high reliability: test-retest correlations are typically in the range of .82 to .88, and Cronbach's alpha for various samples are in the range of .77 to .88 (Tomaka *et al.*, 1993; Robins *et al.*, 2001; Hubbs *et al.*, 2012). The scale's superior reliability and validity has been demonstrated with many different sample groups and its use has been validated for adolescents, adult, elderly populations and also for those with mental illness. There are also no recommended discrete cut-off points representing high and low self-esteem although some review resources suggest that scores between 0-14 indicate low self esteem, 15 and 25 are within normal threshold and scores above 25 indicate high self esteem (Rosenberg, 1965).

III. <u>Profile of mood states</u>

The 30-item short form standardised Profile of Mood States (POMS) questionnaire was used (McNair *et al.*, 1971). The scale is widely used in research examining the relationship between exercise and mood (Barton *et al.*, 2012; Bragg *et al.*, 2013). The POMS contains a list of 30 adjectives describing the particular mood state using a five point Likert scale, where 0 indicates "not at all" and 4 represents "extremely" (Marczinski *et al.*, 2014). The adjectives collectively measure six mood factors or affective states: tension, depression, anger, vigour, fatigue and confusion. In addition, a Total Mood Disturbance (TMD) score was calculated to denote an overall assessment of emotional state (McNair *et al.*, 1992). This was calculated by summing the scores for the scales of tension, depression, anger, fatigue and confusion and subtracting vigour. Cronbach's alpha from a previous study ranged from 0.84 to 0.92 for the mood subscale and was 0.91 for the TMD score (Yeun and Shin - Park, 2006).

IV. <u>Connectedness to nature</u>

The connectedness to nature scale (CNS) was used to measure the extent to which participants felt a part of the natural world and emotionally connected to it (Mayer and Frantz, 2004). Although CNS is considered primarily a trait measure, a state version has been created in order to assess the acute state of nature affiliation. This version has been proven to have good internal stability = 0.01 and validity using three samples of undergraduate psychology students (Mayer *et al.*, 2009).

A simplified version of the CNS was adapted for this study. This measure consisted of 13 items rated on a 5-point Likert scale, with a rating ranging from 1 (strongly disagree) to 5 (strongly agree). Respondents were asked to answer each of the questions on the scale in terms of the way each person felt at that moment. Items 4 and 12 were reversed scored. Scores were summed and the total score ranged from 13 to 65. Higher scores reflect a higher degree of affective connectedness to nature. Previous studies have successfully used CNS as a state measure (Frantz *et al.*, 2005; Mayer *et al.*, 2009; Weinstein *et al.*, 2009; Bragg *et al.*, 2013).

6.2.4 Statistical analysis

The study data were analysed with the SPSS statistical package (20.0 Version). Descriptive statistics were expressed as mean, standard deviation (SD). The Kolmogorov–Smirnov test was used to analyse the normal distribution of the variables; self esteem, profile of mood and connectedness to nature ($P > 0.05$) (Field, 2013; Pallant, 2013).

A post hoc power analysis using GPower 3.1 software, indicated that the actual sample size in this study (N=40) achieved 86% statistical power, with a medium effect size, and alpha (probability) level of 0.05, which indicates that the sample of 40 participants provided sufficient statistical power (between 80-95% power) to detect all significant effects (Ellis *et al.*, 2009).

Series of repeated measure ANOVA were conducted with condition and time as the two within-subjects factors, while age and gender were the between subject factors. MANOVA test was conducted to determine whether there were any differences between the independent groups on more than one continuous dependent variable. All the assumptions for both the repeated measure ANOVA and the MANOVA were considered before running the tests (Field, 2013).

6.3 Results-pre and post running outdoor

42 participants took part in the study, however 2 participants dropped out and the remaining 40 completed the CNS, self esteem and mood measures at both time points (pre and post) and both running conditions (alone and group). All data sets were subjected to a series of preliminary analyses to identify any potential outliers, assess normality and ensure assumptions of the individual tests were not violated as stated in section 3.2.5.

6.3.1 Demographical information

Participants comprised of 20 male and 20 females. Their ages ranged from 21 to 68 years, Mean age = 36.43, SD = 11.33. Generally, the air temperature at the running sessions ranged from 6 ^{0}C (mostly cloudy) to 20 ^{0}C (mostly sunny), Mean = 11.40^{0}C, SD = 4.43. The time taken among the group runners to complete the run ranged from 11.50 to 19.17 minutes, mean = 15.48 minutes, SD = 2.70; while lone running session ranged from 12.01 to 21 minutes, mean = 15.59 minutes, SD = 2.38.

6.3.2 Mental wellbeing

Participants completed the Rosenberg Self-Esteem Scale (RSES) and the Profile of Mood States (POMS) questionnaire both before and immediately after running sessions in the two conditions to enable any changes in their mental wellbeing to be evaluated.

Self-Esteem

RSES was used to examine levels of self-esteem in participant dominated sport (running).

A mixed between-within group repeated measure ANOVA was conducted to assess the main effect of running condition (lone, group) and Time (pre-post) as within factor, the main effect of gender and age group on self-esteem and to examine any interaction between the within and between factors. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance matrices and multicollinearity, with no serious violation noted.

Time

- There was a main effect for time [*F* (1, 34) = 23.93, *p* =<.001, Wilks' ^= .601, ηp^2 = .399 (large effect size)]. A significant increase was found in self-esteem scores after running (M=21.80, SD=5.60) compared to before running outdoors (M=20.49, SD=5.42) (Figure 6.1). The mean difference in self-esteem index was 1.31, with a percentage increase in self-esteem of 6.39% after running (Table 6.1).

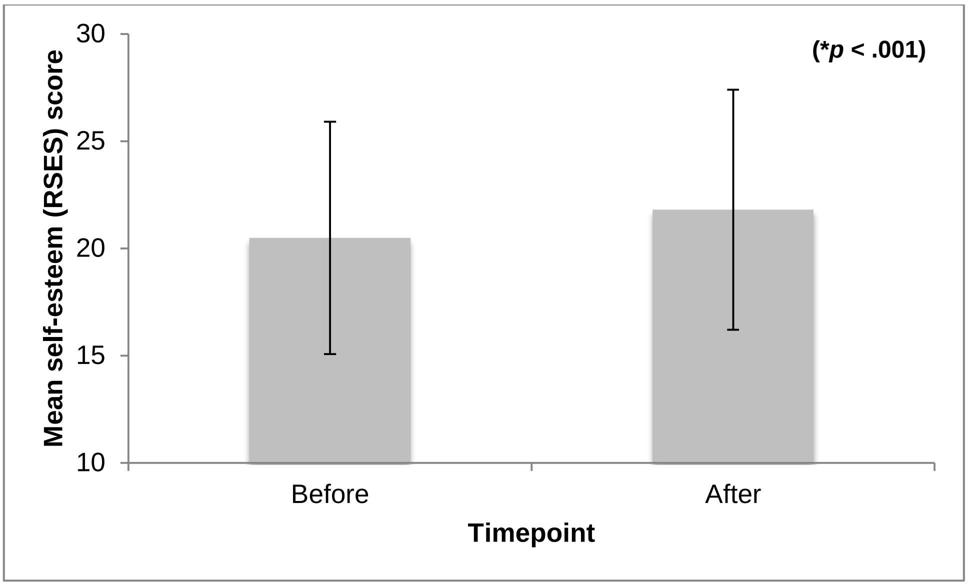

Figure 6.1: Changes in participants' self-esteem scores after running
Note: RSES scored 0-30, with a larger score indicating higher self-esteem. Error bars represent 1SD

- There was no interaction between time and age [*F* (2, 34) = 2.927, *p* =.096, Wilks' ^= .925, ηp^2 = .075 (medium effect size)].
- There was no interaction between time and gender [*F* (1, 34) = 1.157, *p* =.290, Wilks' ^= .967, ηp^2 = .033 (small effect size)].
- There was no interaction between time, age and gender [*F* (2, 34) =.599, *p* =.444, Wilks' ^= .984, ηp^2 = .040 (medium effect size)].

Condition

- There was a main effect for running condition [*F* (1, 34) = 5.932, *p* =.020, Wilks' ^= .851, ηp^2 = .147 (large effect size)]. A significant increase was found in self-esteem scores in participants that ran alone (M=21.61, SD=5.72) compared to group runners (M=20.68, SD=3.54) (Figure 6.2). The mean difference in self-esteem index was 0.93, with a percentage increase in self-esteem of 4.50% between lone and group running.

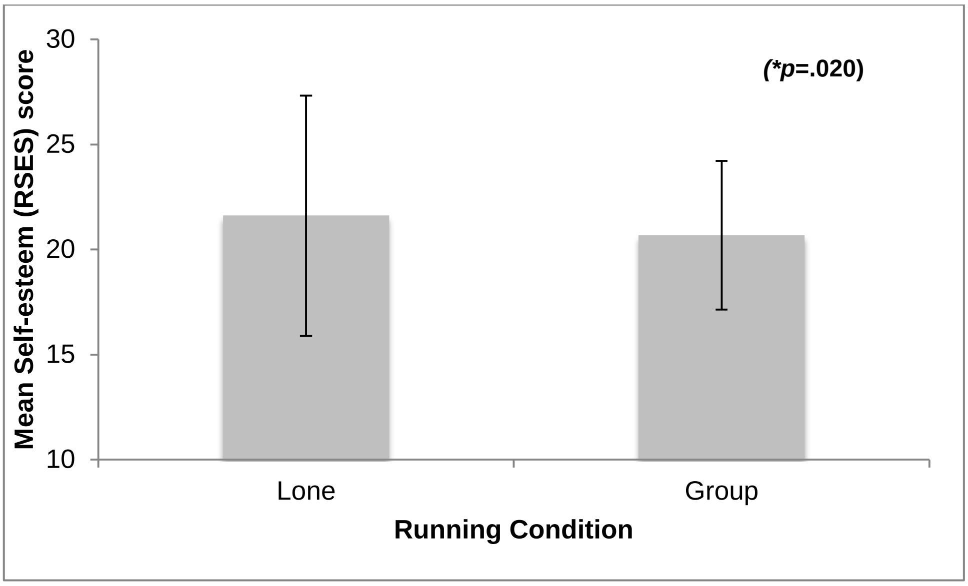

Figure 6.2: Changes in self-esteem scores between lone and group participants
Note: RSES scored 0-30, with a larger score indicating higher self-esteem. Error bars represent 1SD

There was no interaction between running condition and other variables (see Appendix N). The results of analyses examining effect of running condition on outcome measures (see Table 6.1).

Table: 6.1: Results of the mixed ANOVA, mean RSES score and mean difference for participants pre and post run.

Variables	Independent variable	Pre Mean	SD	Post Mean	SD	Mean Difference	Main (Effect)	Interaction
Time		20.49	5.42	21.80	5.60	1.31	Yes	
Condition	Alone (n=20)	20.93	4.19	22.28	4.39	1.35	Yes	No
	Group (n=20)	20.05	3.78	21.31	4.03	1.26		
Gender	Male (n=20)	20.59	4.11	22.38	4.25	1.79	No	No
	Female (n=20)	20.39	6.46	21.22	6.68	1.16		
Age	18-30 (n=15)	20.42	3.97	21.51	4.10	1.09	No	No
	31 and above (n=25)	20.36	4.11	22.64	4.01	2.28		
Time x Gender x Condition	Male Lone (n=20)	21.08	4.50	23.28	4.72	2.20	No	No
	Male Group (n=20)	20.10	4.06	21.48	4.32	1.38		
	Female Lone (n=20)	20.78	7.07	21.29	7.41	0.51		
	Female Group (n=20)	20.00	6.37	21.15	6.79	1.15		

Note: SD= 1 standard deviation; IV = independent variable; n = number of participants in analysis**. *Note: % change = ((Post run mean- Pre run mean) / Pre run mean) * 100***

Table 6.2: Results of analyses examining effect of running alone and in group on outcome measures

Outcome measure		Alone M	SD	Group M	SD	Interaction Main or condition effect	Sig.	Test statistics (Wilks' ∧ & *F*	*P* value	Effect size (partial ηp^2)	N
RSES						Interaction	No	Wilks' ∧= 1.00 *F*(1,34) =.011	.916	Partial ηp^2= .00 (no effect)	l=20;g=20
	Pre	20.93	4.19	20.05	3.78	Main (time)	Yes	Wilks' ∧= .799 *F*(1,34) = 8.53	.006	partial ηp^2 = .20 (large)	
	Post	22.28	4.39	21.31	4.03	Main (Condition)	Yes	Wilks' ∧= .851 *F* (1,34) = 5.93	.020	partial ηp^2 = .15 (large)	
TMD						Interaction	No	Wilks' ∧= .985 *F*(1,34) =.529	.472	partial ηp^2 = .015(small)	l=20;g=20
	Pre	152.17	20.08	151.90	17.66	Main (time)	No	Wilks' ∧= .900 *F* (1, 34) = 3.789	.060	partial ηp^2 = .10 (moderate)	
	Post	146.50	14.71	143.01	13.46	Condition	No	Wilks' ∧= .988 *F*(1,34) = .429	.517	partial ηp^2=.01 (small)	
CNS						Interaction	No	Wilks' ∧= 1.00 *F* (1,34) =.008	.929	Partial ηp^2 = .00 (no effect)	l=20;g=20
	Pre	42.92	7.11	41.12	5.99	Main (time)	Yes	Wilks' ∧= .622 *F*(1,34) = 20.02	<.001	partial ηp^2=.38 (large)	
	Post	47.88	6.71	46.20	6.26	Condition	No	Wilks' ∧= .919 *F* (1, 34) = 2.98	.094	partial ηp^2=.08 (medium)	

Notes: M=mean; SD=1 standard deviation; Sig = significant or not; ∧= Wilks' Lambda; *F*= F statistics, with degrees of freedom in brackets; *p* value= significance; partial ηp^2= partial eta squared; N= number of participants in analysis; l=number of lone participants; g= number of group participant.

Mood

Mood was measured using the profile of Mood States. A Total Mood Disturbance (TMD) score was calculated to denote an overall assessment of emotional state. This method is used to provide an indicator of overall mood. It involves summing the POMS subscales T-scores of confusion, anger, fatigue, depression and tension and then subtracting the T-score for vigour (McNair *et al.*, 1992; Barton *et al.*, 2009).

A mixed between-within group repeated ANOVA was conducted to assess the main effect of running condition (lone, group) and time (pre-post) as within factor, the main effect of gender and age group on mood (TMD) and to examine any interaction between the within and between factors. Preliminary assumption testing was conducted as reported before, with no serious violation noted.

Time

- There was main effect for time [F (1, 34) = 3.789, p =.001, Wilks' $\wedge$= .900, ηp^2 = .258 (medium effect size)]. However, a reduction in TMD (representing an improvement in overall mood) was found after running outdoors (M=144.28, SD=16.99) compared to before running outdoors (M=154.28, SD=16.22). The mean difference in TMD index was 10 and the percentage mean improvement of 6.48%.
- There was no interaction between time and age [F (2, 34) = .073, p =.789, Wilks' $\wedge$= .998, ηp^2 = .003 (small effect size)].
- There was no interaction between time and gender [F (1, 34) = .122, p =.729, Wilks' $\wedge$= .997, ηp^2 = .003 (small effect size)].
- There was no interaction between time, age and gender [F (2, 34) =.682, p =.519, Wilks' $\wedge$= .981, ηp^2 = .019 (small effect size)]. Results of analyses examining interaction effect between gender and time on outcome measures is shown in Appendix O.

Condition

- There was no main effect for running condition [*F* (1, 34) = .429, *p* =.517, Wilks' ∧= .988, ηp^2 = .012 (small effect size)].
- There was no interaction between condition and age [*F* (2, 34) = .264, *p* =.661, Wilks' ∧= .993, ηp^2 = .007 (small effect size)].
- There was no interaction between condition and gender [*F* (1, 34) = .472, *p* =.497, Wilks' ∧= .986, ηp^2 = .014 (small effect size)].
- There was no interaction between running condition, age and gender [*F* (2, 34) =.358, *p* =.554, Wilks' ∧= .990, ηp^2 = .010 (small effect size)].
- There was no interaction between time and running condition [*F* (1, 34) =.529, *p* =.472, Wilks' ∧= .985, ηp^2 = .015 (small effect size)].
- There were significant interactions between time, running condition and age [*F* (2, 34) =7.467, *p* =.010, Wilks' ∧= .828, ηp^2 = .172 (large effect size)].

The 3-way interaction is presented in Figure 6.3 and Figure 6.4, reflecting the age by running condition by time interactions as follows:

(a) TMD of participants between 18-30 years improved substantially after running both alone and in group (M=145.67,SD=13.08,M=148.28,SD=15.02) compared to before (M=161.61,SD=25.29, M=153.86, SD=15.98)

(b) TMD of participants of 31 years and above improved substantially after running both alone and in group (M=143.73,SD=14.36,M=139.43, SD= 13.64) compared to before (M=149.09,SD=17.17, M=152.56, SD=19.81)

The results of the analyses examining interaction effect between age and time on outcome measures (see Appendix P)

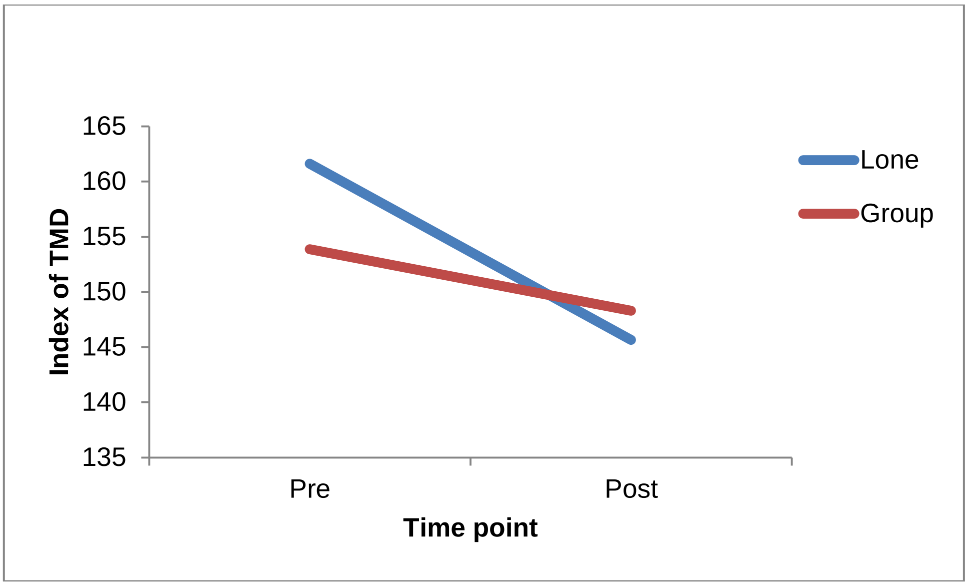

Figure 6.3: Time point change in TMD by age (18-30 years) and running condition (a drop in TMD indicates an improvement of overall mood)

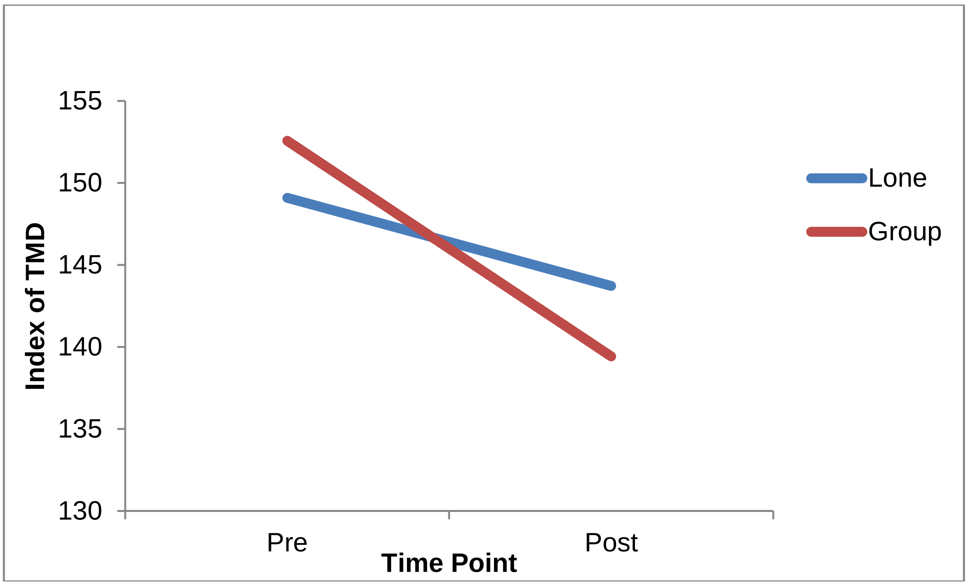

Figure 6.4: Time point change in TMD by age (31 years and above) and running condition (a drop in TMD indicates an improvement of overall mood)

- There was no interaction between time, running condition and gender [F (1, 34) =.371, p =.068, Wilks' ⋀= .905, ηp^2 = .095 (small effect size)].
- There was no interaction between time, running condition, age and gender [F (2, 34) =.834, p =.367, Wilks' ⋀= .997, ηp^2 = .023 (small effect size)].

Effects of other independent variables on mood

A series of mixed between-within subjects analysis of variance (ANOVA) were conducted to assess the impacts of categorical independent variables (participants gender and age) on mood.

- There was a significant main effect for time [F (1, 39) = 12.53, p =.001, ηp^2 = .258 (large effect size)]. There was however no significant main effect for gender [F (1, 39) = .324, p =.573, ηp^2 = .008 (small effect size)] nor significant interaction between gender and time [F (1, 39) = .012, p = .914, ηp^2 = .001 (small effect size)].
- Age was grouped into the following categories: 18-30 and over 31 years. There was main effect for time [F (1, 39) = 7.467, p =.010, ηp^2 = .172 (large effect size)]. There was however no significant main effect for age [F (1, 39) = .818, p =.449, ηp^2 = .042 (small effect size)] nor significant interaction between age and time [F (1, 39) = .853, p = .435, ηp^2 = .044 (small effect size)] as shown in Table 6.3.

Table: 6.3: Results of the mixed within ANOVA with TMD effects over time.

Independent variable		Pre		Post				
		Mean	SD	Mean	SD	Effect	Sig.	Interaction
Condition	Alone	152.17	20.08	146.50	14.71	Decrease	No	No
	Group	151.90	17.66	143.01	13.46	Decrease		
Gender	Male (n=20)	151.48	17.25	142.30	12.93	Decrease	No	No
	Female (n=20)	153.98	17.14	144,23	11.24	Decrease		
Age	18-30 (15)	157.74	18.76	146.97	10.77	Decrease	No	No
	31 and above (n=25)	150.82	15.77	141.58	9.24	Decrease		

Note: SD= 1 standard deviation; IV = independent variable; n = number of participants in analysis, a decrease in TMD represents an improvement in overall mood.

Sub-scales mood factors

A mixed between-within group MANOVA was conducted to assess the main effect of running condition (lone, group) and Time (pre-post) as within factor and the main effect of gender and age group on the 6 mood subscale and to examine any interaction between the within and between factors. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance matrices and multicollinearity, with no serious violation noted. The six related dependent mood variables were tension, depression, anger, vigour, fatigue and confusion. All of the mood factors represent negative moods, with the exception of vigour, which is positive. Therefore, a decrease in a negative mood variable is a desired outcome, whereas an increase in vigour is a favourable result.

Time

- There was a significant main effect for time [F (6, 29) = 3.640, p =.008, Wilks' $\wedge$= .570, ηp^2 = .430 (large effect size)]. When the results of the six dependent variables were analysed individually, statistically significant differences were found in tension [F (1,34) = 15.634, p <.001, ηp^2 = .315)] , vigour [F (1,34) = 4.356, p =.044, ηp^2 = .114)], confusion [F (1,34) = 5.172, *p* =.029, ηp^2 = .132)]. However, there were no statistically significant differences before and after running outdoors on depression [F (1,34) = .208, *p* =.651, ηp^2 = .006)], anger [F (1,34) = 3.414, *p* =.073, ηp^2 = .091)] and fatigue [F (1,34) = 1.031, *p* =.317, ηp^2 = .029)] (Table 6.4 and Table 6.5)

- The mean scores showed that the feelings of tension were significantly less for participants after running (M = 32.02, SD=2.60) compared with participants before running (M=35.02, SD = 4.27). Similarly, confusion levels were lower after running (M = 34.97, SD = 4.04) in comparison with participants before running (M = 36.72, SD = 5.70). Moreover, vigour levels improved after running (M = 39.54, SD=7.81) compared to before running (M=36.60,SD =8.35). However, depression levels were not different after running (M=37.84, SD=2.13) compared to before (M=37.95, SD=1.64). Anger levels were not different after running (M=37.83, SD=2.21) compared to before (M= 38.92, SD=3.77) and fatigue levels were not different after running (M=41.27,SD=7.15) compared to before (M=39.78,SD=7.91)(Figure 6.5).

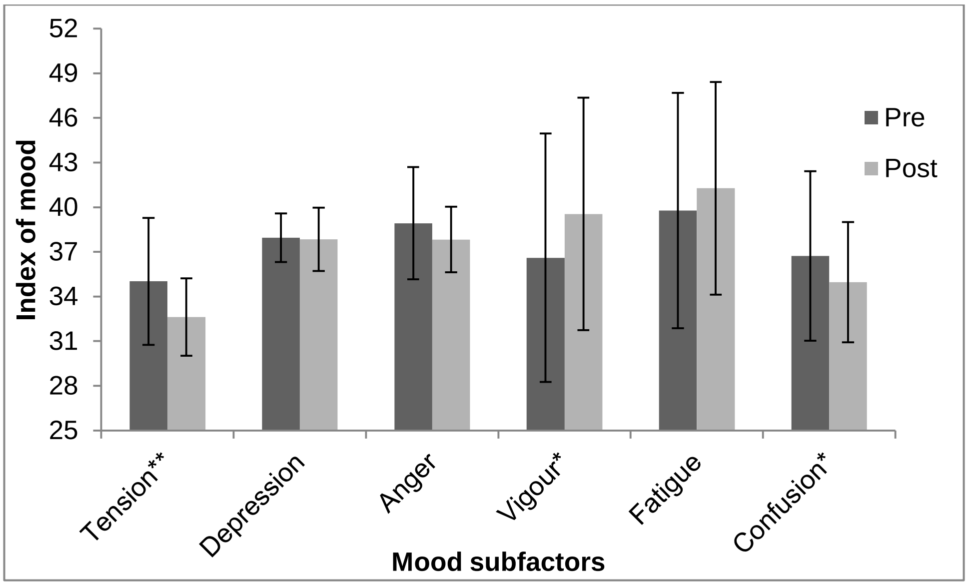

Figure 6.5: Changes in mood sub factors over time. Significance tested with MANOVA (*p<0.05;p<0.001).**Note: Error bars represent 1SD

- There was no significant interaction between time and age [*F* (12, 58) = 1.105, *p* = .374,Wilks' $\wedge$= .663, ηp^2 = .186 (medium effect size)].

- There was no significant interaction between time and gender [F (6, 29) = .835, p = .553,Wilks' ⋀= .853, ηp^2 = .147 (medium effect size)].
- There was no significant interaction between time, age and gender [F (12, 58) = .697, p = .747,Wilks' ⋀= .764, ηp^2 = .126 (medium effect size)]. The main effect of running condition on 6 mood subfactors and interaction with other variables is shown in Appendix Q.

Table 6.4: Mean of pre and post POMS subfactor scores, percentage change and significance

POMS Subfactor	Pre Mean	Pre SD	Post Mean	Post SD	Mean Change	Effect	Significance (p)	P value
Tension	35.02	4.27	32.63	2.60	-2.40	Decrease	Yes	<.001
Depression	37.95	1.64	37.84	2.13	-0.12	Decrease	No	.651
Anger	38.92	3.77	37.83	2.21	-1.08	Decrease	No	.073
Vigour	36.60	8.35	39.54	7.81	2.94	Increase	Yes	.044
Fatigue	39.78	7.91	41.27	7.15	-1.48	Increase	No	.317
Confusion	36.72	5.70	34.97	4.04	-1.75	Decrease	Yes	.029

Note: SD= 1 standard deviation. For negative factors tension, depression, anger, fatigue and confusion, a decrease represents an improvement; for the positive sub factor vigour, an increase is desirable.

Table 6.5: Mean of lone and group participants POMS subfactor scores, percentage change and significance

POMS Subfactor	Alone Mean	Alone SD	Group Mean	Group SD	Mean Change	Effect	Significance (p)
Tension	33.83	3.95	33.82	3.05	-0.01	Decrease	No
Depression	38.20	2.28	37.60	1.64	-0.60	Decrease	No
Anger	38.18	2.78	38.57	3.10	0.39	Increase	No
Vigour	37.82	7.59	38.32	7.65	0.50	Increase	No
Fatigue	41.31	7.21	39.74	6.64	-1.57	Decrease	No
Confusion	35.88	4.74	35.82	4.74	-0.06	Decrease	No

Note: SD= 1 standard deviation. For negative factors tension, depression, anger, fatigue and confusion, a decrease represents an improvement; for the positive sub factor vigour, an increase is desirable.

6.3.3 Connection to nature

Participants completed the state form of the connectedness to nature scale (CNS) before and immediately after running sessions in two conditions (alone and group) to enable any changes in their connection to nature to be evaluated.

A mixed between-within group repeated measure ANOVA was conducted to assess the main effect of running condition (lone, group) and time (pre-post) as within factor, the main effect of gender and age group on CNS and to examine any interaction between the within and between factors.

Time

- There was a main effect for time [*F* (1, 34) = 20.020, *p* <.001, Wilks' $\wedge$= .622, ηp^2 = .378 (large effect size)] (Table 6.6). A significant increase was found in CNS scores after running (M=47.04, SD=1.30) compared to before running outdoors (M=42.02, SD=1.35) (Figure 6.6). The mean difference in CNS score was 5.02, with a percentage increase in CNS of 11.95% after running.

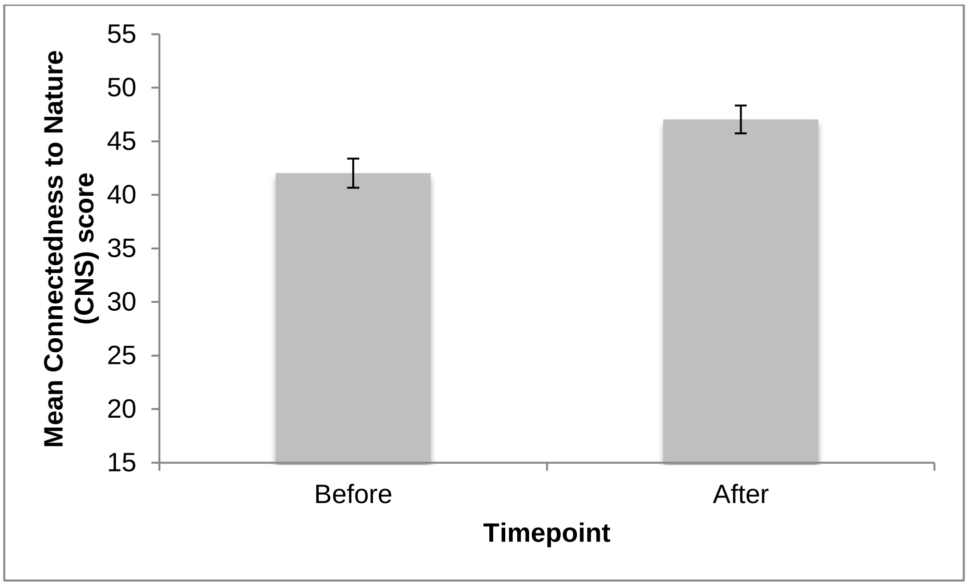

Figure 6.6: Changes in participants CNS scores after running which rrepresents an increase of 5.02, p<001 and % mean increase of 11.95% post running. Note: Error bars represent 1SD

- There was no interaction between time and age [F (2, 34) = 2.061, p =.164, Wilks' $\wedge$= .947, ηp^2 = .053 (small effect size)].
- There was no interaction between time and gender [F (1, 34) = .005, p =.945, Wilks' $\wedge$= 1.000, ηp^2 = .000 (no effect)].
- There was no interaction between time, age and gender [F (2, 34) =1.152, p =.290, Wilks' $\wedge$= .969, ηp^2 = .031 (small effect size)].

There was no main effect for running condition [F (1, 34) = 2.977, p =.094, Wilks' $\wedge$= .919, ηp^2 = .081 (small effect size)] . There was no interaction between running condition and other variable (see Appendix R).

Table: 6.6: Results of the mixed within ANOVA, mean CNS and mean percentage change for participants pre and post CNS.

Independent variable		CNS score					Significant effect (Mixed between-within ANOVA)		
		Pre		Post		Mean %			
		Mean	SD	Mean	SD	Change	Main (Time)	IV	Interaction
Condition	Alone	42.92	7.11	47.88	6.71	11.56			
	Group	41.12	5.99	46.20	6.26	12.35			
Gender	Male (n=20)	43.28	5.42	47.98	6.74	10.86	Yes	No	No
	Female (n=20)	42.23	6.92	47.83	5.16	13.26			
Age	18-30 (n=15)	43.10	7.75	46.83	7.85	8.65	Yes	No	No
	31+ (n=25)	42.33	4.66	48.25	3.84	13.99			

6.3.4 Summary of findings

This study examined mood and connection to nature of 40 participants over time spent outdoors. The participants were of mixed age and equal gender proportion. There are 4 key findings:

1. Self-esteem levels significantly improved after running outdoors among the participants and there was a significant increase in self-esteem of participants who ran alone compared with those that ran in a group. However, there was no interaction between time, running condition, gender and age.
2. TMD was significantly different over time, there was an improvement in TMD after running sessions. There was no main effect of running condition, (running alone or in a group does not affect TMD). However, there was an interaction between time, running condition and age, such that TMD improves over time in participants 18-30 years and 31 years and above who ran alone and in group.

3. There was significant improvement in 3 mood subfactors over time (tension, vigour and confusion) but no significant difference in other three subfactors (depression, anger and fatigue). There was no interaction between time, running condition, gender and age.
4. There was a significant increase in CNS after running session. However, there was no main effect for running condition (CNS is not affected by running alone or in a group) and no interaction between time, running condition, gender and age (which implies that the combination of time, running condition, gender and age does not influence CNS)

6.4 Discussion

6.4.1 Addressing the study aim and objectives

Pre and post running effect study used a suitable methodology to determine if running outdoors over time (before and after) under two conditions (alone and group) affects self-esteem (Objective 1). Also to determine if running outdoors over time (before and after) under two conditions (alone and group) affects mood (Objective 2) and if running outdoors over time (before and after) under two conditions (alone and group) affects connection to nature (objective 3). These objectives were achieved by using composite questionnaires containing standardised measures, namely Rosenberg Self esteem Scale (RSES), Profile of Mood Scale (POMS) and Connectedness to Nature Scale (CNS).

6.4.2 Effects on participants' self esteem, mood and connection to nature pre and post session study

Self-esteem

The finding of this study shows that self-esteem of participants significantly improved over time and both scores (before and after) were within the normal threshold scores of 15-25 (Rosenberg, 1965).This finding suggests that participating in running results in positively enhancing self-esteem. Similar increases in self-esteem as a result of participating in exercise in nature that provides additive benefits for self-esteem have been reported (Barton *et al.*, 2012; García-Martínez *et al.*, 2012; Randall *et al.*, 2014; Wood *et al.*, 2014; Júnior *et al.*, 2015) and highlighted in chapter 1. Self-esteem was significantly higher in lone participants than group participants; there are no other examples in the published literature to compare self-esteem scores of runners between lone and group participants.

Mood

Overall mood was significantly different over time, the TMD scores (mood) improved over the running session with an overall improvement after the session. Significant overall improvement in mood after participating in exercise has been reported in past studies (Barton *et al.*, 2012; Annesi *et al.*, 2015; Guimaraes *et al.*, 2015; Vancini *et al.*, 2015). The findings from this study show significant interaction between time (pre and post), running condition (lone and group) and age. Overall mood improves over time in participants who run alone between 18-30 years compared to participants who run in a group. Participants who ran alone started with poorer moods but experienced a larger improvement in overall mood after their running session. However, overall mood improved over time in participants who ran in group in ages 31 years and above compared to participants who ran alone. Participants who ran in group started with a poorer mood but experienced a larger improvement in overall mood after their running session, this findings is similar to past research (Ensari *et al.*, 2016). Tension, vigour and confusion improved significantly after running session, comparable to other studies (Lofrano-Prado *et al.*, 2012; Annesi *et al.*, 2015) but improvement in depression, anger and fatigue levels were not significant.

Connectedness to nature

The finding of this study shows that connection to nature significantly improved over time. It suggests that higher scores after running sessions indicate higher degrees of connection to nature. This finding is in line with other studies (Cervinka and Corraliza, 2011; Terry *et al.*, 2012). Reports have shown that increase in physical activities in natural environments improves physical health, improves mood and self-esteem (Gladwell *et al.*, 2013; Bratman *et al.*, 2015). However, the findings show that connection to nature was not affected by other independent variables. CNS was not affected by running condition, indicating that there was no difference between lone and group participants. CNS was not affected by gender; there was no difference between male and female participants. CNS was not different with age, indicating that participants across the two age groups had similar CNS scores. This study shows no interaction effect between time, running condition, gender and age.

6.4.3 Limitations

The pre and post study was designed to examine changes in self-esteem, mood and connection to nature of participants in outdoor running environments over time (pre-post) under two conditions (alone and group) and to examine any interaction effects between time, running conditions and other independent variables. The results of this study gave some quantitative analysis to the importance of physical activities such as running in natural environments resulting in improved physical health, mood and self-esteem of participants. However, there are limitations to the study:

- Whilst around forty-two participants started the study, for a variety of different reasons, not all completed the sessions. This could have adversely affected the analysis if not for the large completion rate of participants who completed all the sessions.
- Although the weather condition was favourable for most of the sessions, a running session scheduled for group participants was rescheduled due to unfavourable weather conditions and getting the participants to run in a group was difficult but was later achieved, this delayed data collection and analysis.

6.4.4 Conclusions

The pre and post effect study showed that outdoor running has a positive impact on self-esteem, there was a significant increase in self-esteem after running sessions and self-esteem was higher in lone runners than in group runners. There was an overall improvement in the mood of the participants, which was significant; there were significant improvements in three-mood subscale post run (tension, vigour and confusion) and no significant difference for the other mood subscales post run (depression, anger and fatigue). Connection to nature increased post run regardless of running condition (i.e. lone or group run) and no interaction effects were significant. This study show that green exercise particularly running outdoors led to significant improvement in self-esteem, total mood disturbance and connectedness to nature all improving post exercise. Thus running outdoors generated mental health benefits, indicating the potential for a wider health and wellbeing dividend from green exercise. Exercise or physical activities such as running thus have important implications for public and environmental health and for a wide range of policy sectors.

7. General discussion

Table 7.1 Thesis map outlining individual study objectives and key findings

Chapter	Type of study	Objectives	Key Findings
3	Spectator-dominated sport: GHG emissions relating to travel and waste.	1) To evaluate the impact of spectator-dominated sport (football) on the environment through the calculation of GHG emissions from travel and waste. 2) To extrapolate the impact to a national level	• Participants mean distance travelled to and from games was 41.55km and the majority (67%) of participants travel by car. • The mean GHG emission across the football tiers was 4.74kgCO_2e per participant. • Extrapolating the results to national level with a total of 9,162,067 participants from tier 3 to tier 10 during the 2012/13 football season resulted in approximately 56,237 tCO_2e. • GHG emissions significantly differ between the football tiers; GHG emission was significantly higher in tier 3 than tiers 7, 8 and 10 • Football spectators from the eight football tiers generated an average waste of 3.27 kg per spectator. • The average recycling rate at the football tiers was approximately 71% and the average proportion of waste sent to landfill across the football tiers was approximately 29%. • The total GHG emissions from recycled waste from the eight football tiers were 280 tCO_2e while GHG emissions from waste sent to landfill from the eight football tiers was 4,875 tCO_2e in 2012/13 football season. • The aggregated GHG emissions (combining GHG emission from recycled waste and landfill waste) from the eight football tiers was 5,155 tCO_2e during 2012/13 football season in England.
4	Spectator-dominated sport: Effects of watching football on mental wellbeing	1) To determine if watching football affect mental wellbeing	• Mental wellbeing of participants was not significantly different with gender, age, football tiers, levels of watching the game, results of the game, or location of the football club. • Participants had a good average mental wellbeing score of 51.52 indicating average mental wellbeing. • There was a significant interaction effect between gender and football game venue. Females at the home games had significantly higher total wellbeing than males, whereas males at the away games had significantly higher total wellbeing than females. • There was a significant main effect of the result of the game on total wellbeing. Respondents whose club won the game had significantly higher total wellbeing than respondents whose club lost the game.

5	Participant-dominated sport: GHG emissions from travel and effect of running on mental wellbeing and connection to nature.	1) To evaluate the impact of participant-dominated sport (running) on the environment through the calculation of GHG emissions from travel. 2) To extrapolate the impact to national level 3) To examine the effect of running on mental wellbeing and connection to nature.	• Participants mean distance travelled to and from the running location was 7.40km. • Nearly half of the participants travelled by car while a quarter travel on foot. • The mean GHG emission from travel of the participants was 0.62 $kgCO_2$.e • Extrapolating these results with approximately 104 million runners in 2012 resulted in approximately 64,480 tCO_2e. • Participants had a good average mental wellbeing score of 51.19 indicating good average mental wellbeing. • Mental wellbeing was significantly higher in lone runners compared to group runners. • Participants mean nature relatedness score was 3.68, (within normative value of 3.2-3.7). • NR was significantly higher in participants outdoors compared with indoors and was higher in participants in the rural environment compared to urban, and higher in rural participants compared with suburban.
6	Participant-dominated sport: Effects of running outdoors on mental wellbeing and connection to nature	1) To examine changes in self-esteem, mood and connection to nature of participants over time (pre-post) under two conditions (alone and group) and to examine any interaction effects between independent variables.	**Pre and post session study:** • Participant self-esteem was significantly improved after running outdoors and there was a significant increase in self-esteem of participants who ran alone compared with those that ran in a group. • TMD was significantly different over time, there was a reported improvement in mood after running and there was an interaction between time, running condition and age. • There was significant improvement in 3 mood subfactors over time (tension, vigour and confusion) • Participants CNS significantly increased after running session.

7.1 Summary of findings

The key findings have already been highlighted and discussed in relation to the existing literature in each of the preceding chapters and are summarised along with specific objectives in Table 7.1. A summary of the overall findings of this thesis is outlined in this section, under the following categories: i) greenhouse gas emissions; ii) mental wellbeing and iii) connection to nature.

7.1.1 GHG emissions

In chapters 3 and 5 the environmental impact of sport was assessed using spectator and participant sports in England. In these studies the GHG emissions from travel to sporting location was significant. Most football spectators (67%) travelled by car to watch football games and the mean GHG emission across all the eight football tiers was 4.74kgCO_2e per participant; extrapolating this to national level with 9,162, 067 spectators resulted in approximately 56,237 tCO_2e during 2012/13 football season in England (chapter 3). GHG emissions were significantly high in tiers 3, 4 and 5 compared to other lower football tiers. GHG emissions and distance travelled to games were strongly and positively correlated.

Approximately half of the participants in chapter 5 drove to their running location; while the average GHG emissions of 0.62 kgCO_2e was reported from their travel to their sporting location, this was lower than the average GHG emission of 4.74 kgCO_2e associated with spectator dominated sport (chapter 3). Extrapolating the GHG emissions to national level resulted in approximately 64,480 tCO_2e in 2012.

The quantity of GHG emissions from waste generated by spectator-dominated sport (football) was significant (chapter 3). Each spectator generated an average waste of 3.27 kg per spectator; while 3,798 tonnes of waste was generated averagely at football tiers. The average recycling rate at the football tiers was approximately 71% while the average proportion of waste sent to landfill across the football tiers was approximately 29%. The mean GHG emission from waste was 0.56 kgCO_2e and extrapolating the impact to national level with over 9 million spectators (combining GHG emission from recycled waste and landfill waste) from the eight football tiers was about 5,155 tCO_2e during 2012/13 football season in England.

7.1.2 Connection to nature

In Chapter 5, connection to nature in the cross sectional study resulted in a mean nature relatedness score of 3.68. Those participants who engaged in running outdoors had significantly higher connection to nature than participants indoors. Higher connection to nature was reported in participants at the rural environment compared to participants at both suburban and urban environment. NR and all subfactors correlated positively well together.

Findings in Chapter 6 (pre and post running session study) also suggested that participants had a significant increase in nature connection after taking part in running outdoors. Running outdoors has been found in this research to be effective in increasing participant's connection to nature over a period of time.

7.1.3 Mental wellbeing

In Chapter 4, football spectators' mean mental wellbeing score (using Warwick Edinburgh Mental Wellbeing Scale) was 51.52, indicating decent mental wellbeing. Although, football spectators' mental wellbeing was not significantly different with gender, age, football tiers, levels of watching the game, results of the game or the location of watching the game. There was a significant interaction effect between gender and football game venue. Females at the home games had significantly higher mental wellbeing than the males, whereas males at the away games had significantly higher mental wellbeing compared to females. Moreover, there was a significant main effect of the result of the game on mental wellbeing. Football spectators whose club won the game had significantly higher mental wellbeing than spectators whose club lost the game.

In Chapter 5, the mean mental wellbeing score (using Warwick Edinburgh Mental Wellbeing Scale) at the cross sectional study was 51.19, indicating normal mental wellbeing. Mental wellbeing was significantly higher in participants that ran alone compared to participants who ran in a group. In the pre and post running session study (Chapter 6), improvements in mental wellbeing (self-esteem and mood) were experienced as a result of taking part in running sessions outdoors. Participants' self esteem significantly improved after running sessions and participants that ran alone had a significant increase in self-esteem compared with group runners. Participants' mood improved after running sessions and there was an interaction between time, running condition and age, such that mood improves over time in participants 18-30 years and 31 years and over. There was significant improvement in 3 mood subfactors over time (tension, vigour and confusion) but no significant difference in other three subfactors (depression, anger and fatigue). There was no interaction between time, running condition, gender and age.

7.1.4 Summary

In this research, both spectator and participant dominated sport results in environmental impacts by generating GHG emissions from travel and waste. Although, engaging in either or both spectator (football) and participant (running) dominated sport also resulted in wellbeing benefits.

7.2 Study implications

This section addresses the study implications in relation to: the aims and objectives of the thesis; the environmental impacts, connection to nature and wellbeing benefits of sport covered in the introduction and literature review, and the method of measuring environmental impacts and wellbeing in chapters 3 to chapter 6.

7.2.1 Addressing the thesis aims

The overall aims of this thesis were to examine the environmental impacts and wellbeing benefits of sport: assessing spectator and participant dominated sports in England. The specific aims and objectives for each chapter have been addressed and are detailed in Table 7.1. The summary of findings in Table 7.1 gives an insight to the environmental impacts and wellbeing benefits of sports in England.

7.2.2 Addressing GHG emissions

Although mega sporting events have vital social, political and economic benefits, the resultant environmental impact such as traffic congestion, noise pollution and particularly GHG emissions from energy use, waste generation and travel cannot be overlooked. GHG emissions from mega sporting events have significant effects on the environment and also on climate change (Prayag *et al.*, 2013). Moreover, activities associated with football and running in England, result in GHG emissions. Millions of people travel to watch football weekly across the eleven football tiers in England and millions of people often travel to their running locations. Transport is one of the most important sources of GHG emissions globally (Bakas, 2008). Particular focus should be given to this sector since, despite all efforts (technological improvement and regulations); there is clear increase in the GHG emissions from transport. The EU's target is to reduce GHG emissions by 20% by the year 2020. The GHG emissions from sports should likewise be reduced to reflect these measures to reduce negative environmental impact.

Overall, this research showed that approximately 67% of spectators travelled to football games by car, while nearly half of participants travelled to their respective running locations by car. Several strategies should be directed to reduce the generation of GHG emissions particularly the GHG emissions associated with sports. Both sport spectators and participants should change their travel behaviour by shifting to more efficient modes of travel and improving the efficiency of their existing travel patterns (Porter *et al.*, 2013). Although the mean GHG emissions from travel of participant dominated sport was much lower than that of spectator dominated sports, but not when extrapolated nationally and efforts should be made to reduce GHG emissions overall. Where it is not practical to travel by foot, increase in vehicle occupancy rate and encouraging low emission travel mode choices should be made (Dolf and Teehan, 2015).

Findings from chapter 3 quantify the GHG emissions from waste generated at football games by spectators and extrapolated to national level. The recycling rate at football games should be increased so that the quantity of waste and resultant GHG emissions from waste sent to landfill is reduced. Also, efforts should be made to improve the treatment of waste such as reducing the amount of waste sent to landfill and converting waste to energy could be encouraged so as to reduce GHG emissions. A shift from waste landfilling to generating energy from waste usually results in GHG emission benefits over time (Monni, 2012).

7.2.3 Addressing connection to nature

This research supports that interaction with nature is important to human development and wellbeing, although access to natural environment to engage in sport is diminishing due to urbanisation and other human needs. Through deliberate design this connection can be repaired and restored if all stakeholders play their part. Urbanisation has resulted in the consumption of enormous amounts of resources and materials and generating large quantities of waste and pollutants. Consequently, the modern urban environment consumes 40% of energy resources and 30% of natural resources (Kellert, 2012). Nonetheless, most people understand that the health and diversity of the environment are primarily related to their own physical, mental and even spiritual wellbeing.

Participating in sporting activities like running, particularly outdoors, has been shown to increase the connection with nature and also improve social cohesion among participants directly or indirectly. This research suggests that participating in sports can initiate a positive change in a participant’s relationship with the natural world and contact with nature can replenish depleted cognitive attention and help to cultivate general feelings of vitality and wellbeing. Participating in sport can lead to the development of feelings of connection to the natural world (Brymer *et al.*, 2009).

Sports participants (runners) such as those mentioned in Chapter 5 had significantly higher connection to nature than participants indoors. Participants in rural environments had a higher connection to nature compared to participants in both suburban and urban environments. It is unknown which characteristics of natural settings (e.g., level of disturbance, proximity, accessibility and biodiversity) are most important for triggering a beneficial interaction with nature (Keniger *et al.*, 2013). The findings from Chapter 5 suggest the NR and all subfactors correlated positively well together. Results from study in chapter 6 suggest that participants had significant increase in nature connection after taking part in running outdoors.

7.2.4 Addressing mental wellbeing

Wellbeing is a multi-dimensional state comprising both objective and subjective components. Consequently, any attempts to explore the wellbeing benefits of the natural environment need to capture both dimensions. Objective wellbeing captures the material and social attributes (recognised as important for fostering wellbeing) that contribute or detract from an individual's or a community's wellbeing. Broadly, they include factors deemed important for society's welfare and are easily measured at the population level. On the other hand, subjective wellbeing refers to an individual assessment of their own circumstances: what they think and feel (Newton, 2007). This research has focused more on subjective wellbeing. This research examined subjective wellbeing (WEMWBS trait) of both spectator and participant dominated sports in England and found that engaging in sports has mental wellbeing benefits. Significant increases in self-esteem (RSES state) after running outdoors were found and improvements to overall mood and decrease in negative affects (specifically to tension and confusion) were found after an individual finished a running session. These findings imply that running outdoors increases subjective wellbeing or helps individuals to flourish. Flourish refers to individuals' experience of life going well, it is a combination of feeling good and functioning effectively and is linked to high levels of mental wellbeing (Huppert and So, 2013).

Studies have shown that the natural environment provides synergistic physical, social and mental benefits. This research (Chapters 5 and 6) has shown that running helps people feel better, improves mood, and self-esteem. Other studies have reported decreased physiological reactions to stress (Newton, 2007). Most of the research exploring the wellbeing benefits of engaging in sports or physical activities in natural environment have originated from the US, Scandinavia, Holland and Japan. Although, the green exercise group at the University of Essex has contributed appreciably to the wealth of knowledge in this field, this research too has contributed to knowledge in this field but much more research is still required to explore wellbeing benefits in England.

7.3 Trade-offs between GHG emissions, wellbeing and connection to nature

Although sport have economical, social and health benefits, the activities of spectators and participant dominated sport in England also result in GHG emissions through travel and waste. Where a sustainable use of resources proves difficult to attain particularly in sports, trade-off could occur between the GHG emitted and the wellbeing of people. The trade-offs that may occur between the environmental impact and wellbeing benefits should be evaluated in terms of environmental behaviour of people involved, ensuring reductions in GHG emissions and increasing wellbeing benefits. This research (spectator-dominated sport) has shown that GHG emissions decreased down the football tier because less distance is travelled at the lower football tiers despite the increase in the number of games. However, if individuals could change their environmental behaviour to favour more efficient and environmentally friendly way of travelling, the GHG emissions could further reduce.

Participant dominated sport should also encourage behavioural change, which should be purposeful, and consciously taken to ensure a change from previous actions and it should lead to a reduction in GHG emissions. Participant dominated sport reported significant reduction in GHG emission in lone runners because they tended not to drive to their running location and participants mostly ran outdoor which made them more connected to nature, particularly in the rural environment compared to suburban and urban environment. The GHG emission from travel of participants at the rural environment was also lower than suburban and urban environment. Participants at the rural environment were more connected to nature than their urban counterparts. This research shows that after running outdoors self-esteem and mood improves significantly. This suggests that environmental behaviour, such as changes in lifestyle and behavioural patterns of people in sport are the major contributing factors to reducing GHG emissions and also could lead to a higher yield in wellbeing benefits particularly in a natural environment.

To reduce the negative environmental impact of sporting activities spectators, participants and those managing sporting events should encourage sustainable means of managing resources so as to make sport sustainable. Clearly, a central issue in achieving sustainability is reducing fossil fuel dependency. Sports organiser, spectators and participants can travel in more efficient transport modes such as rail and public buses. They can also promote cycling and walking. Spots organisers should be sourcing energy for their events from renewable sources so as to tackle the issue of reducing fossil fuel consumption.

To achieve truly sustainable sport in England, the government should therefore consider separate areas of policy delivery, like waste, transport, energy and decide whether public behaviour, institutional or legislative change would be the most appropriate and effective route for advancing a given sustainability goal. Where public behaviour change is considered the most fruitful way forward, a step-by-step approach is needed, in which external barriers are removed before psychological or attitudinal factors are addressed. Research has shown that it is easier to influence behaviour in terms of stimulating automatic responses to changes in opportunity than it is to challenge deep-rooted attitudes and perceptions.

7.4 Future research priorities

While the findings from this thesis contribute to the growing evidence base by assessing the environmental impact and wellbeing benefits of both participant and spectator dominated sport in England, this research is still incomplete and identifies avenues for further research.

- There is the need to extend the research on GHG emissions from travel of spectator-dominated sport nationwide to cover more clubs from tier 1 to tier 11 so as to examine their environmental impact.
- Future studies could examine the GHG emissions from waste from spectator-dominated sport (football) in more depth; this could strengthen the research by incorporating more clubs at each football tier with more available resources.
- It is suggested that improvement in mood and connection to nature was reported in studies of participant dominated sport, these standardised measures to measure mood and connection to nature should be extended to spectator dominated sport to cover all the 11 football tiers in England. Comparison could be made to examine mood and connection to nature between the top football tiers (league) and the lower football tiers (non-league).
- There is also a need for research to examine GHG emissions from travel and connection to nature between football spectators between rural and urban environment.
- Whilst this research suggests that running outdoors has more wellbeing benefits and this is also supported by literature; there is a need to examine if running season variations (autumn, spring, summer and winter) affects connection to nature and wellbeing.
- Finally, future research on the environmental impact and wellbeing benefits of spectator sport could be extended to two other spectator-dominated sports such as rugby and golf, and the GHG emission results could also be extrapolated to a national level.

7.5 Recommendations

This research adds to the growing evidence base that highlights the environmental impacts and wellbeing benefits of spectator and participant dominated sport in England. These have important policy implications for a wide range of sectors including individuals, the health sector, government, sporting organisations, football associations, running club and gym management, park management, and the transport sector. The following 18 recommendations are made.

7.5.1 Individual

1) Although travelling to sporting locations cannot be avoided due to distance involved, carefully selecting which modes of transport to use by individuals will be effective in the reduction of GHG emissions. Certain modes of transport generally have a lower associated GHG emission. For example travelling on foot and by cycling does not result in any GHG emissions and the use of public transport also has a lower environmental impact. However, the use of private transport (car) should be reduced the most; Where this cannot be avoided, car sharing should be encouraged to sporting location to reduce GHG emissions from travel.

2) If the only option to travel to a sporting location is by private transport (car), individuals should drive during off-peak times which could be beneficial to the environment because fuel consumption rates of vehicles can double on congested roads as fuel economy rapidly declines at lower speeds and from frequent braking and acceleration. Studies have shown that traffic jams are bad for health because of inhalation of more car fumes whilst driving during the rush hour is associated with stress levels and high blood pressure.

3) Individuals should change their behavioural patterns to reduce their environmental impact.

7.5.2 Sport management

4) Waste generated at sporting locations should not be sent to the landfill, the waste should be recycled and reuse. Recycling services for plastics, metals and paper should be readily available at sporting venues. Sports managers should encourage better waste management.

5) Avoiding GHG emissions is by far the best and most direct way or reducing climate change impact. However, some emissions are unavoidable. For those, offsetting is a

worthwhile option. Sports managers purchasing 'carbon credit' from accredited companies, which offer this service, who will then invest the money into renewable energy projects or planting of trees, could do this.

7.5.3 Government and policy makers

6) The Department for transport could take the lead in setting up a national 'Kombi Ticket' system to enable football match tickets to be used consistently and universally for local and or regional travel to matches, as is the case in Germany.

7) A national source of football match day travel information and travel planning for football spectators, plus a central booking point that includes the ability to book door to turnstiles travel in one go, including scheme such as bus plus when tickets are purchased with train ticket should be set up by the government.

8) Government and private sector should invest in research to explore the link between sporting activity, environment, wellbeing and mental health.

9) Policy makers and local authorities should create physical environments which motivate people to build physical or sporting activity into their daily lives by improving street lighting and street safety and providing safe cycling routes and open spaces. They should also promote social environments in town centres, residential homes, work places and schools where physical activity is perceived as a normal and valued part of peoples' daily lives.

10) Policy makers and local authorities should tackle the monetary obstacles many people face by promoting types of sporting activities that are free or cheap to access. They should also provide accessible information to raise awareness of opportunities for sporting activities, in particular to capture the attention of those who currently undertake minimal sporting or physical activity.

7.5.4 Transport services

11) A national railcard for football spectators should be introduced to make public transport easier and more affordable for football spectators.

12) Football stadiums are clearly not well served at present by trains, spectators face the problem of high ticket prices, inflexible booking arrangements, engineering works on match days and timetables that often fail to match the particular needs of football spectators. Although football authorities are also at fault on this point for scheduling matches without reference to timetable. There should be positive dialogue between football clubs, leagues, spectator representatives and rail companies to solve these problems.

13) There should be bus shuttles, park and ride schemes and dedicated match day buses to reduce car dependency.

14) Planning policies and decisions should avoid supporting large stadium developments located outside town from population centres that are not well served by existing public transport networks.

15) All football clubs should have a travel plan that includes plans for new facilities to improve access by walking and cycling, improve public transport services, promotion of different ways to travel and clear targets to reduce the number of cars driven to football games. Ideally, this plan should be produced in collaboration with local authorities and transport providers.

7.5.5 Public health

16) Individuals should recognise that participating in sporting activities including running can promote psychological wellbeing. Individuals should see running as a fundamental and desirable part of daily life.

17) Employers should develop a workplace culture and environment that supports and motivates employees to be physically active.

18) Health practitioners should be fully informed about the benefits of physical activity such as green exercise for both physical and psychological wellbeing. People working in the field of mental health in particular need to understand and act on the benefits that

physical activity such as green exercise can bring to people with mental health problems, and support them in undertaking physical activity.

7.6 Concluding comments

Greenhouse gas (GHG) emissions from waste and transportation are of environmental concern. Globally, every year, waste contributes an estimated 5% and transport approximately 23% of the total anthropogenic GHG emissions. Sport contributes to GHG emissions by spectators and participants travelling to/from sporting venues and generating waste. Whilst a small reduction in an individual's travel and waste may be perceived as having negligible impact, if these are aggregated over a population, the resultant GHG emissions can be significant.

Currently, over 15.6 million people currently play sport at least once a week in England. This research has examined the environmental impacts and wellbeing benefits of sport. The research found that both spectators and participants' that travel to sport location significantly generated GHG emissions from travel. When the GHG emissions were extrapolated to a national level they were significant. It is recommended that football clubs should promote the use of public transport and awareness campaign should be undertaken to educate spectators on their options.

Despite the environmental impact of sports in England, both spectator and participant dominated sport reported significant wellbeing benefits. Participant dominated sport in particular had improved wellbeing, self-esteem and mood after running sessions. These significant improvements in wellbeing and mood, as a result of participating in running sessions and spectator dominated sport, have many positive implications for individuals, private sectors, sporting organisations, policy makers and government authorities. The huge environmental benefits from reduced emissions from travel and waste are also of paramount importance, while considering engaging in sporting activities outdoor that will results in several wellbeing benefits.

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Appendix A: Key questionnaire outcome measure used in Chapter 3.

University of Essex

Research into Sport and Environment

Please spare 5 minutes to take part in my research?

I am looking at the effect of sport on the environment and am asking spectators at football games to complete a questionnaire. I value your comments and would be most grateful if you could spare the time to complete this questionnaire.

All the information given to me will be treated as anonymous and will not be passed on to a third party. You do not have to answer the questions if you do not want to. If you can't answer a question just leave it and go onto the next question.

When you have completed the questionnaire please hand it back to the person who gave it to you.

Thank You!

1. I agree to taking part in this questionnaire *(please tick)* ☐

2. Name of your football club ☐

3. Your gender? Male ☐ Female ☐

4. Your age? ☐

5. How far did you travel to the football ground (in miles)**?** ☐

6. How did you get here today? *(Please tick)*

Walking	Cycling	Bus	Car	Train	Taxi	Other *(please specify)*
☐	☐	☐	☐	☐	☐	☐

7. If you drove here, how many people were in the car? ☐

8. How often do you watch home games?

Weekly	Fortnightly	Monthly	Once a year	Twice a year	Other (please specify)
☐	☐	☐	☐	☐	☐

9. How often do you watch away games?

Weekly	Fortnightly	Monthly	Once a year	Twice a year	Other (please specify)

10. Do you play football yourself? **Yes** ☐ **No** ☐

11. If no, please tell us why not? ☐

Please tell us about your session today...

12. How long will you spend watching the match today (in minutes)? ☐

13. Did you come with friends / family to watch the match? **Yes** ☐ **No** ☐

14. Below is our importance scale. *(Please tell us how important each is to you when watching football by circling the appropriate number on our scale.)*

Not very important ***Very important***

Being outside in nature	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Being with other people	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Watching the game	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

That's all!

Thank you very much for sparing the time to fill out this questionnaire.

Please hand the questionnaire back to the person that gave it to you.

If you would like to know more about this research then please contact Ade Dosumu by email at aadosu@essex.ac.uk

Appendix B: Non-significant GHG pairwise comparisons between football tiers

Sample 1- Sample 2	Test statistics	Std. Error	Std. Test statistics	Sig (p-value)	Adj. sig (p-value)	Effect Size (EF)
Tier 9 -Tier 10	-64.647	55.021	-1.175	.240	1.000	0.07
Tier 9 – Tier 7	136.607	54.887	2.519	.012	.329	0.14
Tier 9 –Tier 8	144.123	53.887	2.675	.007	.210	0.15
Tier 9 – Tier 6	155.581	60.874	2.556	.011	.297	0.16
Tier 9 – Tier 5	163.035	68.286	2.388	.017	.475	0.18
Tier 10 – Tier 7	71.960	47.877	1.503	.133	1.000	0.08
Tier 10 – Tier 8	79.475	47.495	1.673	.094	1.000	0.08
Tier 10 – Tier 6	90.933	55.296	1.644	.100	1.000	0.09
Tier 10 – Tier 5	98.387	63.364	1.553	.120	1.000	0.10
Tier 10 – Tier 4	121.805	42.027	2.898	.004	.105	0.12
Tier 7 – Tier 8	-7.516	46.570	-.161	.872	1.000	0.01
Tier 7 – Tier 6	18.973	54.503	.348	.728	1.000	0.02
Tier 7 – Tier 5	26.427	62.673	.422	.673	1.000	0.03
Tier 7 – Tier 4	49.845	40.978	1.216	.224	1.000	0.05
Tier 8 – Tier 6	11.458	54.168	.212	.832	1.000	0.01
Tier 8 – Tier 5	18.912	62.382	.303	.762	1.000	0.02
Tier 8 – Tier 4	42.330	40.531	1.044	.296	1.000	0.04
Tier 6 – Tier 5	7.454	68.508	.109	.913	1.000	0.01
Tier 6 – Tier 4	30.872	49.443	.624	.532	1.000	0.03
Tier 6 – Tier 3	131.509	50.610	2.598	.009	.262	0.12
Tier 5 – Tier 4	23.418	58.326	.401	.688	1.000	0.02
Tier 5 – Tier 3	124.055	59.319	2.091	.036	1.000	0.10
Tier 4 – Tier 3	100.637	35.636	2.824	.005	.133	0.11

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and EF is the effect size (.1 small, .3 medium and .5 and above large).

Appendix C: Non-significant pairwise comparisons of Importance of being outside in nature between football tiers

Sample 1 – Sample 2	Test Statistics	Std. Error	Std. Test Statistics	Sig	Adj. Sig	Effect Size (ES)
Tier 3 – Tier 7	-71.277	41.928	-1.700	.089	1.000	0.07
Tier 3 – Tier 8	-90.008	41.501	-2.169	.030	.843	0.10
Tier 3 – Tier 6	-106.856	50.072	-2.134	.033	.919	0.10
Tier 3 – Tier 9	-116.951	49.774	-2.350	.019	.526	0.11
Tier 3 – Tier 5	-155.918	58.688	-2.657	.009	.221	0.13
Tier 7 – Tier 8	-18.731	46.075	-.407	.684	1.000	0.02
Tier 7 – Tier 6	35.579	53.924	.660	.509	1.000	0.04
Tier 7 – Tier 9	-45.674	53.647	-.851	.395	1.000	0.05
Tier 7 – Tier 5	84.641	62.007	1.365	.172	1.000	0.08
Tier 7 – Tier 10	-90.748	47.368	-1.916	.055	1.000	0.10
Tier 8 – Tier 6	16.848	53.592	.314	.753	1.000	0.02
Tier 8 – Tier 9	-26.943	53.314	-.505	.613	1.000	0.03
Tier 8 – Tier 5	65.910	61.719	1.068	.283	1.000	0.06
Tier 8 – Tier 10	-72.017	46.990	-1.533	.125	1.000	0.08
Tier 6 – Tier 9	-10.095	60.227	-.168	.867	1.000	0.01
Tier 6 – Tier 5	49.062	67.780	.724	.469	1.000	0.05
Tier 6 – Tier 10	-55.169	54.708	-1.008	.313	1.000	0.06
Tier 9 – Tier 5	38.967	67.560	.577	.564	1.000	0.04
Tier 9 – Tier 10	-45.074	54.435	-.828	.408	1.000	0.02
Tier 5 – Tier 10	-6.108	62.690	-.097	.922	1.000	0.06

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and EF is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Appendix D: Non-significant pairwise comparisons of Importance of watching the game between football tiers

Sample 1- Sample 2	Test Statistics	Std. Error	Std.Test Statistics	Sig.	Adj. Sig.	Effect Size (E.S)
Tier 3 – Tier 9	-24.867	47.745	-.521	.602	1.000	.03
Tier 3 – Tier 6	-40.944	48.031	-.852	.394	1.000	.04
Tier 3 – Tier 5	-47.509	56.296	-.844	.399	1.000	.04
Tier 3 – Tier 8	-50.418	39.809	-1.266	.205	1.000	.05
Tier 3 – Tier 10	-97.655	41.183	-2.371	.018	.496	.10
Tier 3 – Tier 4	-164.599	33.820	-4.867	.000	.000	.18
Tier 9 - Tier 6	16.077	57.772	.278	.781	1.000	.02
Tier 9- Tier 5	22.642	64.807	.349	.727	1.000	.02
Tier 9- Tier 8	25.551	51.141	.500	.617	1.000	.03
Tier 9- Tier 10	-72.788	52.217	-1.394	.163	1.000	.08
Tier 9- Tier 7	113.427	51.508	2.202	.028	.774	.12
Tier 9- Tier 4	139.732	46.631	2.997	.003	.076	.13
Tier 6- Tier 5	6.565	65.017	.101	.920	1.000	.01
Tier 6- Tier 8	-9.473	51.408	-.184	.854	1.000	.01
Tier 6- Tier 10	-56.711	52.478	-1.081	.280	1.000	.06
Tier 6- Tier 7	-97.350	51.773	-1.880	.060	1.000	.10
Tier 6- Tier 4	123.654	46.924	2.635	.008	.235	.12
Tier 5- Tier 8	-2.908	59.204	-.049	.961	1.000	.01
Tier 5- Tier 10	-50.146	60.135	-.834	.404	1.000	.05
Tier 5- Tier 7	-90.785	59.521	-1.525	.127	1.000	.09
Tier 5- Tier 4	117.090	55.354	2.115	.034	.963	.10
Tier 8- Tier 10	-47.238	45.075	-1.048	.295	1.000	.05
Tier 8- Tier 7	87.877	44.252	1.986	.047	1.000	.10
Tier 8- Tier 4	114.181	38.466	2.986	.003	.084	.12
Tier 10- Tier 7	40.639	45.491	.893	.372	1.000	.05
Tier 10- Tier 4	66.943	39.885	1.678	.093	1.000	.07
Tier 7- Tier 4	26.304	38.952	.675	.499	1.000	.03

NOTE: Test statistic is the difference between the mean ranks between two football tiers, std error is the standard error, standard test statistic is the z-score, sig is the significant p-value, adj. sig is the adjusted p-value and EF is the effect size r (.1 = small, .3 = medium and .5 and above= large).

Appendix E: Paper published: Greenhouse Gas Emissions: Contributions Made by Football Clubs in England. *Atmospheric and Climate Sciences*, 4, 642-652

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Scientific Research

Greenhouse Gas Emissions: Contributions Made by Football Clubs in England

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Abstract

Greenhouse gas (GHG) emission from waste is a major environmental problem. Globally, the waste management sector contributes an estimated 5% of the total anthropogenic GHG emissions. This paper estimates GHG emissions from football clubs in the England, where football is the highest profile and most popular sport, with large numbers of spectators and significant quantities of waste being produced. Football clubs should be more committed to reducing their GHG emissions by improving their waste management. The amount of GHG emitted from eight football tiers in England is assessed through methods including interviews, observations and questionnaires. The results reveal that in the 2012/13-football season, over 9 million spectators watched football in the lower leagues, with mean waste per spectator of 3.27 kg. 30,146,000 kg of waste was generated at the 8 football tiers, and the amount of waste sent to the landfill was about 74,000,000 kg, which resulted in GHG emissions of approximately 2,100,000 kg CO_2e. The implications for better waste management at football leagues are outlined.

Keywords

Football, Spectators, Waste, Emissions

1. Introduction

The world's population has already exceeded seven billion and is still growing [1]. Waste generation, is directly related to population density, and is responsible for greenhouse gas (GHG) emissions at landfill, which has negative environmental impact. Directive 2008/98/EC Article 3 (1) defined waste as any object or substance which a person discards or is required to discard or intends to discard [2]. Increased solid waste generation is attributed to industrialisation, globalization and rapid economic development. At a global level, the waste management

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sector contributed an estimated 5% of the total anthropogenic emissions in 2012 [3]. In light of this development, the waste sector can now be an emission saver instead of an emission generator by implementing sustainable waste management plans. Sport is now part of the society because millions of spectators watch games on a regular basis [4]. But as one of many human activities, wastes produce GHG emissions at landfills, which has become a global concern that needs to be addressed.

1.1. Waste Management

The collection, recycling, treatment and disposal of increasing quantities of solid waste remain a major challenge. UNEP reported that in 2012, around 11.2 billion tonnes of waste was collected globally [5]; emissions from commercial and industrial waste landfill generated 2.3 Mt CO_2e and the decomposition of organic materials at the landfill contributes around 5% of all global greenhouse gas emissions [6]. In the UK, the waste sector is responsible for 17 million tonnes of carbon emissions a year [6] [7]. During 2013, in England alone, approximately 177 million tonnes of waste could be attributed to poor use of resources, having huge economic impacts to both individuals and businesses [8]. The issue of reducing, reusing and recycling waste rather than dumping it in landfill therefore, reduces these environmental impacts.

A holistic approach to waste management has positive consequences for greenhouse gas emissions from various sources [4]. Waste can be classified by its source and by its properties as shown in **Figure 1** [9]. Waste generated from sport is classified under commercial waste, which according to Chartered Institute of Waste Management is defined as waste from premises used exclusively or primarily for the purposes of a business or for the purpose of entertainment, education, recreation or sport [10].

To effectively manage waste, the waste hierarchy should be applied. This is the classification of waste management options in order of their environmental impact, such as: reduction, reuse, recycle and recovery [11]-[14]. The waste hierarchy has five stages: prevention, preparing for re-use; recycling; other recovery e.g. energy recovery; and disposal [2] [14]-[17].

The main purpose of the waste hierarchy is to extract the maximum practical benefits from products and to generate the least amount of waste as revealed in **Figure 2**. However, there are some wastes for which the management options are limited and the best environmental option with the least impact lies towards the bottom of the hierarchy [18] [19]. In deciding the most appropriate waste disposal route, both economic and environmental benefits need to be considered.

1.2. Waste and Sport

When considering materials used by spectators and participants engaging in sport, it is evident that resources from water, energy and other consumables are required. Inevitably, sport leads to the generation of waste and pollution, which releases emissions of greenhouse gases [20] [21]. There is now a growing recognition that waste is one of the major environmental problems associated with mega sporting events such as the World Cup, the Olympic Games, and Football Association (FA) Cup final. For example, the 2004 FA Cup Final held at Millennium Stadiumin Cardiff resulted in 59 tonnes of waste, which is equivalent to 0.81 kg/spectator [22]. The 2012 FA Cup Final held in Wembley Stadium resulted in 24 tonnes of waste (of which 25% was sent to the landfill), reflecting 0.27 kg/spectator [23]. The 2013 FA Cup Final resulted in slightly less waste (21.5 tonnes with 18% sent to landfill) with the equivalent of 0.25 kg/spectator [24].

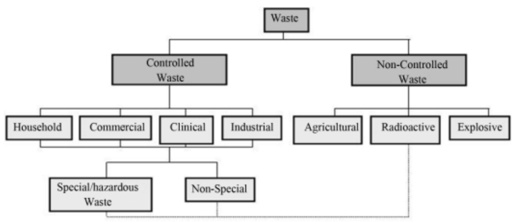

Figure 1. Waste classification framework. Source: (DEFRA 2011).

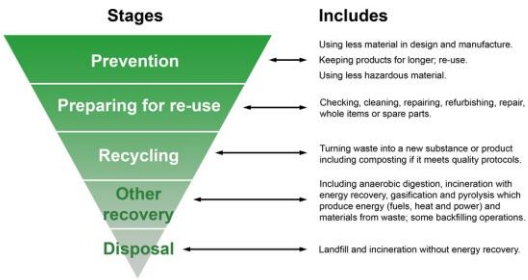

Figure 2. Waste hierarchy in UK. Source: (DEFRA 2007).

In regards to World Cups, the South African World Cup in 2010 generated waste of 1.8 kg/spectator [25] which is 5 times more than the waste generated at the 2006 World Cup, due to the quantity of waste generated and lack of proper waste management practice. The Olympics in Beijing 2008 produced about 48,000,000 kg of waste [26] with 6.8 million spectators resulting in 7.06 kg/spectator. However, the London 2012 Olympic games recorded about 10,000,000 kg of waste [27] with 11 million spectators, resulting in 0.91 kg/spectator [28]. This shows that sports generate a tremendous amount of waste but in different proportion depending on the sporting event.

Therefore, the sports sector has a major part to play both in cutting waste resulting from events and also in emission reduction from waste sent to landfill. Moreover, the overall climatic impact of the waste management system depends on proper accounting for waste generated, recycled and landfilled. At football league levels, the magnitude of these emissions are difficult to determine due to poor data collection on the proportions of waste generated, recycled and landfilled. The aim of this study is to estimate the amount of waste and greenhouse gas emitted from landfill waste over a range of football league tiers in England.

Within England, football is played at different levels, with eleven tiers making up the English pyramid system. The Premier League is the top tier followed by the Championship and Football Leagues One and Two. Below these is the National League System, which stretches from the Football Conference Premier Division through to County Leagues [29]. A total of 59 leagues incorporating 84 divisions across the country provide a feeder system through to the Football League. The lower leagues, consisting of more than 900 clubs, cover smaller geographical areas. Going down through the levels in the National League System the number of spectators at each game drops but the number of games increases, and when aggregated nationally are on par with numbers for the Premier League [29] [30].

Football clubs are slower than other industries to adopt environmental management practices and develop Corporate Social Responsibility (CSR) strategies. Although they are addressing Environmental sustainability, most do so in a non-strategic way with no formalized management systems. At higher football levels (Tiers 1 and 2) environmental considerations are sometimes packaged with a club's corporate social responsibility programme. For example Arsenal FC has a Waste Recycling Center, which recycles 10 tonnes of cardboard and plastic, and 1.5 tons of glass every month [31]. Manchester City FC has significantly improved their waste disposal over the past seven years, to the extent that none of their waste goes to landfill [32]. Similarly Manchester United FC has achieved 100% diversion of waste from landfill and has reduced waste generated yearly [33].

Previous studies on mega sporting events encourage actions that promote environmental sustainability to be taken [34], and in England, the contribution of football clubs to climate change are increasingly a focus of discussion and debate [35]. Although, clubs at the Premier League and Championship have started to reduce their environmental impact, but limited step is taken by the clubs in the non-league levels to reduce their environmental impacts [36]. Currently there is scarcity of studies in the literature on the environmental impact of lower level football clubs on day-to-day basis. As such, this paper will focus on waste generation and GHG emissions from waste sent to landfill among football clubs within eight leagues, from tier 3 to tier 10 in England. The quantity of waste and GHG emissions from these levels will also be extrapolated to the National level.

2. Methodology

A survey research method was adopted for this study in order to examine waste management practices and then to calculate the estimated landfill waste GHG emissions from eight football tiers in England (Tier 3 - Tier 10) as shown in **Table 1**. In addition to interviews and physical observations, structured questionnaires were also used to collect data from football clubs and waste contractors. The football tiers, clubs, leagues and waste contractors selected are shown in **Table 2**.

In collaboration with Essex FA one club was selected from each tier from 3 to 10 to be representative of clubs at that tier. Due to variations in the clubs at tier 5 another 2 clubs were selected to account for the variation in tier composition. Site surveys were carried out at the study locations as to observe and examine the current practices of waste management. An observational checklist was used to record the findings from the surveys and questionnaires were used to identify the level of knowledge and awareness on football waste management among respondents.

The questionnaire was designed such that data could be collected on not only annual waste generated by football clubs at each level, but also on waste policy, waste contractor, types of waste generated, types and size of waste containers, frequency of waste collection, percentage waste diverted from the landfill and percentage

Table 1. The football tier in England.

Football Tier	League/Non-League Name	Number of Clubs
1	Premier League	20
2	Football League Championship	24
3	Football League One	24
4	Football League Two	24
5	Conference Premier	24
6	Conference North & South	44
7	Northern, Southern & Isthmian League Premier Division	66
8	Northern, Southern & Isthmian League Lower Division	123
9	Top tier of 14 regionally based leagues	291
10	15 divisions in 2nd tier of regionally based feeder leagues	285
11	46 largely county-based feeder leagues	Over 327

Note. Football tiers was adapted from Football Insights 2007 [37] and Football Pyramid 2012 [30].

Table 2. Football tiers, leagues, clubs and their waste contractors.

Football Tier	League	Football Club	Waste Collector/Contractor
Tier 3	League 1	Colchester United	Colchester Skip Hire Environmental Ltd
Tier 4	League 2	Southend United	Veolia Environmental Services
Tier 5	Conference Premier Conference Premier Conference Premier	Braintree Town Dartford Cambridge United	Braintree District Council Veolia Environmental Services Mick George Limited
Tier 6	Conference South	Chelmsford City	Chelmsford City Council
Tier 7	Isthmian Premier	East Thurrock	Veolia Environmental Services
Tier 8	Isthmian Division One North	Aveley	Ahern Waste Limited
Tier 9	Thurlow Nunn Premier Division	FC Clacton	Veolia Environmental Services
Tier 10	Essex Senior League	Barking	Veolia Environmental Services

landfill waste. Face to face interviews were conducted with respective football clubs waste contractors to verify the information given by each club regarding their waste management. Structured interviews were conducted to obtain information on waste management. Information obtained included amount of waste collected, the type and size of waste container used, frequency of collections and proportion of waste recycled.

Waste per spectator was calculated by dividing the annual waste at the representative club at the league level by the annual number of spectators at that club. Then the resulting wastes per spectator figures were used to estimate annual waste generated at that football tier by multiplying waste per spectator by annual spectators at that football tier and the result extrapolated to national level. The GHG emissions were calculated by multiplying the annual waste landfilled at each football tier, by using DEFRA's conversion factors of 290 kg CO_2/1000 kg (commonly used in calculating emissions from municipal waste) [38].

Greenhouse gas emissions are categorized into three scopes by the most widely used international accounting tool, the GHG Protocol [3] [38]. Scopes 1 and 2 cover direct emissions sources while scope 3 emissions cover all indirect emissions due to the activities of an organization such as waste disposal [39]-[41]. The CO_2e emissions were determined by using extrapolated annual waste at each football tier using the following formula:

$$\begin{aligned}&\text{CO}_2\text{e emissions from waste from football tiers}\\&=\sum\left(\text{Total mass of waste landfill }(\text{tonnes})\right)\times\text{emission factor of waste landfill}\left(\text{kg CO}_2\text{e}/\text{tonnes}\right).\end{aligned}$$

3. Results

A total of ten questionnaires were completed by football club representatives as well as ten waste contractors (**Table 2**). Additionally, interviews and observations took place at each club. Total waste generated at football clubs during 2012/13 season ranged from about 2 tonnes to 345 tonnes. Annual number of spectators at the club level ranged from 931 spectators to 114,494. The waste per spectator ranged from 1.82 kg/spectator to 6.81 kg/spectator; mean waste per spectator was 3.27 kg. The total number of spectators during 2012/13 season was 9,162,067.

3.1. Waste and Emissions from Football League Level

The result of waste per spectator, annual waste, and annual attendance at football clubs and tiers for 2012/13 football season is given in **Table 3**.

3.2. Percentage Landfill and Diverted Waste from Football Tier

The percentage of waste landfilled and diverted from landfill between the football tiers during 2012/13 season is shown in **Figure 3**. Tier 3 sent the least proportion of waste to the landfill (11%), while tier 6 sent the highest proportion of waste to landfill (53%).

3.3. Extrapolated Result

Table 4 shows the waste per spectator, annual attendance and extrapolated annual waste at the football tiers. Number of spectators ranged from 268,470 to 3,473,154. This resulted in total annual waste of approximately 30,146 tonnes. At the league level (tiers 3 and 4) the annual waste was 19,367 tonnes, the mean was 9,683 tonnes compared to non-league (tiers 5 to 10) with annual waste of 10,779 tonnes and a mean of 1,797 tonnes. The waste generated at the league level was almost double the waste generated at the non-league levels as shown in **Table 4**.

3.4. Extrapolated Greenhouse Gas Emissions at Football Tiers

The extrapolated greenhouse gas emissions from waste sent to landfill for tiers 3 to 10 was 2,149,529 (kg CO_2e). The GHG emissions ranged from 35,453 (kg CO_2e) to 564,386 (kg CO_2e). The highest GHG emission was from Tier 6 as shown in **Figure 4**. The league level (Tier 3 & 4) emitted 914,796 (kg CO_2e) while the non-league emitted 1,234,733 (kg CO_2e) as shown in **Figure 5**. The result shows that GHG emissions varied across the football tier.

Comparing, the greenhouse gas emission between the league and non-league levels, this study revealed that

Table 3. Annual attendance, annual waste and waste per spectator during 2012/13-football season.

Football Tier	Selected Football Club (representative of Football Tier)	Annual Waste (tonnes)	Annual Attendance	Waste per Spectator (kg)
Tier 3	Colchester United	281.69	81,179	3.47
Tier 4	Southend United	345.77	114,494	3.02
Tier 5	3 clubs*	97.50	38,376	2.54
Tier 6	Chelmsford City	37.90	5,566	6.81
Tier 7	East Thurrock	8.31	3,596	2.31
Tier 8	Aveley	9.39	2,241	4.19
Tier 9	FC Clacton	4.30	2,160	1.99
Tier 10	Barking	1.69	931	1.82

Waste per spectator = Annual club waste divided by annual attendance at the club. *Braintree Town FC, Dartford FC and Cambridge United FC with average annual waste, annual attendance and waste per spectator.

Table 4. Football Tier, waste per spectator, total annual attendance and total annual waste 2012/13 season.

Football Tier	Waste per Spectator (kg)	Annual Attendance	Annual Waste (tonnes)
*Tier 3	3.47	3,473,154	12,052
*Tier 4	3.02	2,422,218	7,315
**Tier 5	2.54	1,041,886	2,646
**Tier 6	6.81	539,217	3,672
**Tier 7	2.31	413,765	956
**Tier 8	4.19	463,398	1,942
**Tier 9	1.99	539,959	1,075
**Tier 10	1.82	268,470	489

Source. Annual league attendance for 2012/13 football season for tier 3 to tier 10 [42]-[44]. *League level and **Non League level.
Football Tier Annual waste = waste per spectator × annual attendance .

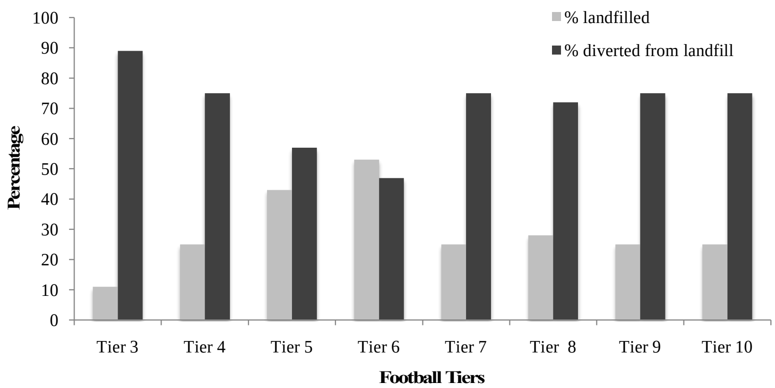

Figure 3. Proportion of waste sent to and diverted from landfill at football tiers.

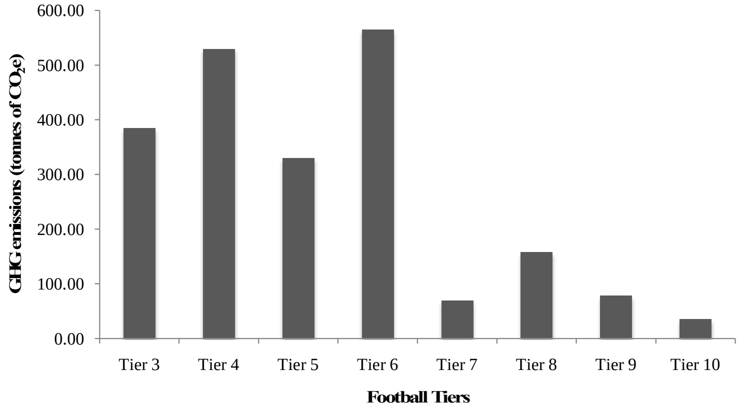

Figure 4. GHG Emissions from waste sent to landfill at Football Tiers.

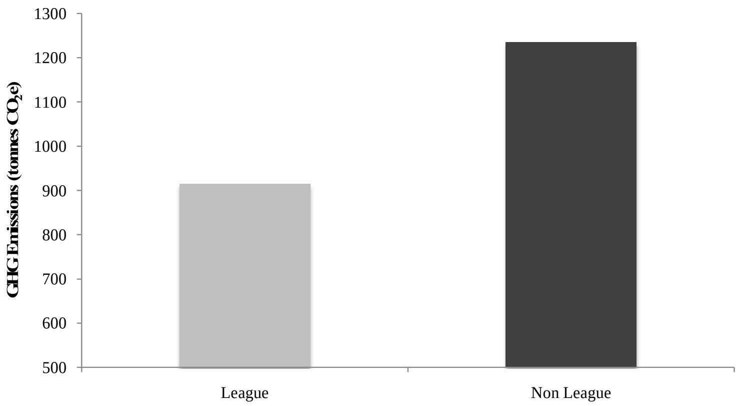

Figure 5. GHG Emissions from waste sent to landfill at football league and non-League.

GHG emissions from the non-league level was higher than that of the league level. This suggests that the GHG contribution of non-league is also significant as shown in **Figure 5**.

4. Discussion

This study shows that football spectators generated large quantities of waste over a season. **Table 1** shows that the number of spectators at each game drops down as you descend the football tiers. This drop in spectator numbers is particularly evident at non-league level where the number of clubs and games is much more than in the upper tiers. Nonetheless when aggregated nationally the resultant figures are on par with that of the Premier League [30]. **Table 3** reveals; the mean waste per spectator at the league level was 3.24 kg per spectator, which was similar to 3.27 kg per spectator at the non-league level. The mean waste generated by each spectator for all the football tiers was 3.27 kg per spectator, which is more than 10 times the waste produced by each spectator at

2012 and 2013 FA cup final of 0.27 kg per spectator and 0.25 kg per spectator respectively [23] [24]. **Table 3** also shows the annual waste generated at Tiers 3 to 10 of the Football League. The resultant figure of over 30,146,000 kg is about times 3 the waste generated at the 2012 London Olympic games [27]. **Figure 3**, shows that almost 30% of the waste generated at the 8 football tiers was sent to landfill, thereby resulting in GHG emissions of 2,149,529 kg CO_2e. The percentage of waste sent to landfill (29%) as shown in **Figure 3** was higher than the waste sent to landfill at FA Cup Final in 2012 (25%) and in 2013 (18%). The recycling rate from this study is about the same as household waste recycling rate in England [45]. The extrapolated GHG emissions of 8 football tiers represented less than 1% of UK GHG emissions. The GHG emission from the non-league level was higher than the league level as compared in **Figure 5**.

This study is the first to evaluate waste management practices among 8 football tiers in England. One of the factors that made the football clubs to act at reducing their GHG emissions was due to the increase in the landfill tax, which is the key policy driver employed under the 1999 EU Landfill Directive, which required a 50% reduction in biodegradable municipal waste landfilled in the UK by 2013 [46] [47]. The landfill tax has increased from its initial rate of £7/tonne in 1996 to £80/tonne in 2014 [48]. To further complement the impact of the landfill tax, football clubs and other sectors should encourage waste reduction, reusing and recycling, in order to reduce waste sent to landfill. Football clubs should encourage composting their organic waste to reduce GHG emissions.

League and non-league football clubs need to start using better data collection methods. A good example would be the Pay-By Weight system to manage their waste effectively and monitor their performance [49]. Moreover, this study shows that there is an obvious desire among football clubs at various league levels to improve their performance, with many now employing professional services to oversee their waste operations. In this study 70% of football clubs sampled employ the services of private waste contractor to manage their waste.

Sports organizers in general and football clubs in particular should be at the forefront of better waste management with the result that GHG emissions are reduced. Since the worldwide popularity of football continues to grow, the industry can contribute positively to the environment by being responsible for the environmental management of all aspects of the game [50]. Corporate Social Responsibility is relatively a new concept in sports management. As a result of the industrialisation of football, clubs, national federations and continental confederations have four responsibilities under CSR. These are economic responsibility, legal responsibility, ethical responsibility and lastly discretionary responsibility [51]-[57] Sport, including football, has greater effects than other businesses in providing support and inspiration in such areas as education, health and wellness, environment, art and culture [58].

Football clubs do face issues of sustainability due to their operations [59]. Akansel reported that Besiktas football club through the "Be Green initiative" enlightened and encouraged their supporters to be more environmentally friendly. The club started with their immediate environment, Inonu Stadium by installing recycling bins around the stadium and used energy efficient light bulbs and recycled napkins [50]. Football clubs are slower than other industries to adopt environmental management practices and develop CSR strategies because of their lack of positive attitude. Although they are addressing environmental sustainability, most do so in a non-strategic way with no formalized management systems. Although many corporate organizations have moved to a wider social audit of their performance that includes triple bottom line reporting of their economic, environmental and social performance. Football clubs have not yet moved in this direction [59].

5. Limitations of the Study

One of the key limitations of the study was the fact that waste data collection was carried out at one football club per football tier. Future research could be strengthened by incorporating more clubs at each football tier and with more available resources.

6. Conclusions

The main aim of this study was to estimate the amount of waste produced at the various football tiers in England. This study has presented, for the first time, using waste generation data and GHG emissions at football tiers to extrapolate to national level the quantity of waste and GHG emissions from football in England. During the 2012/13 football season, approximately 9 million spectators watched football, with average waste per spectator of 3.27 kg. The amount of waste generated at the 8 football tiers was approximately 30,146 tonnes. Waste sent to landfill was about 7,412 tonnes, which resulted in GHG emissions of 2,149,529 kg CO_2e, accounting for less than 1% of UK GHG emissions. The GHG emission at the league level was 914,796 (kg CO_2e) which was less than emissions at the non-league level 1,234,733 (kg CO_2e).

Diverting waste from landfill appears to be the best option to adopt across football tiers to reduce GHG emissions. Hence, football clubs have a lot to do to reduce their environmental impact. They have great opportunity to educate spectators to practice waste reduction and maximize waste recycling.

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Appendix F: Key questionnaire outcome measure used in Chapter 4.

University of Essex

RESEARCH INTO SPORT AND THE ENVIRONMENT

Please spare a few minutes to take part in my research

I am researching how watching football affects people and therefore am asking football spectators to complete a short wellbeing questionnaire. I value your comments and would be most grateful if you could spare the time to complete my questionnaire. All the information given to me will be treated as anonymous and will not be passed on to a third party. When you have completed the questionnaire please hand it back to the person who gave it to you.

Thank You!

1. I agree to taking part in this research by completing this questionnaire ☐

2. Name of football club ☐

3. Your gender? **Male** ☐ **Female** ☐

4. Your age? ☐

5. What is your present level of watching the game? *(Please tick one answer)*

About to watch a game ☐ **In the middle of watching** ☐ **At end of game** ☐

6. Below are some statements about feelings and thoughts.

(Please tick the box that best describes your experience of each over the last 2 weeks)

STATEMENTS	None of the time	Rarely	Some of the time	Often	All of the time
I've been feeling optimistic about the future					
I've been feeling useful					
I've been feeling relaxed					
I've been feeling interested in other people					
I've had energy to spare					
I've been dealing with problems well					
I've been thinking clearly					
I've been feeling good about myself					
I've been feeling close to other people					
I've been feeling confident					
I've been able to make up my own mind about things					
I've been feeling loved					
I've been interested in new things					
I've been feeling cheerful					

Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)

Thank you very much for sparing the time to fill out this questionnaire.

If you would like to know more about this research then please contact Ade Dosumu by email at aadosu@essex.ac.uk

Appendix G: **Key questionnaire outcome measure used in Chapter 5.**

University of Essex

RESEARCH INTO SPORT AND THE ENVIRONMENT

Please spare a few minutes to take part in my research

I would like to evaluate the benefits of sports on the environment. I would be asking participants to complete a questionnaire at the end of their gym/running club exercise. I value your comments and would be most grateful if you could spare the time to complete my questionnaire. All the information given to me will be treated as anonymous and will not be passed on to a third party. You do not have to answer the questions if you do not want to. If you can't answer a question just leave it and go onto the next question. When you have completed the questionnaire please hand it back to the person who gave it to you.

Thank You!

1. I agree to taking part in this research by completing this questionnaire ☐

2. Name of gym/running club ☐

3. Your gender? **Male** ☐ **Female** ☐

4. Your age? ☐

5. How far do you travel to the running club/gym (in miles)? ☐

6. How do you get to your gym/running club? *(Please tick)*

(a)Walking	(b)Cycling	(c) Bus	(d) Car	(e) Train	f) Taxi	**(g) Other** *(please specify)*
☐	☐	☐	☐	☐	☐	☐

7. How many days a week do you run? ☐

8. How long do you run for on average (in minutes)? ☐

9. Do you usually run on your own? Yes ☐ No ☐

10. Do you usually run with others? Yes ☐ No ☐

11. What percentage of your running is indoor/ outdoor? Indoor ☐ % Outdoor ☐ %

12. How far do you run? ☐ In miles ☐ or in km

13. Below are some statements about individual level of connectedness to the natural world. *(Please tick the box that best describe your experience.)*

Statements:	Disagree strongly	Disagree a little	Neither agree or disagree	Agree a little	Agree strongly
I enjoy being outdoors, even in unpleasant weather					
Some species are just meant to die out or become extinct.					
Humans have the right to use natural resources any way we want.					
My ideal vacation spot would be a remote, wilderness area.					
I always think about how my actions affect the environment.					
I enjoy digging in the earth and getting dirt on my hands.					
My connection to nature and the environment is a part of my spirituality.					
I am very aware of environmental issues.					
I take notice of wildlife wherever I am.					
I don't often go out in nature					
Nothing I do will change problems in other places on the planet					
I am not separate from nature, but a part of nature.					
The thought of being deep in the woods, away from civilization, is frightening.					
My feelings about nature do not affect how I live my life.					
Animals, birds and plants should have fewer rights than humans.					
Even in the middle of the city, I notice nature around me.					
My relationship to nature is an important part of who I am.					
Conservation is unnecessary because nature is strong enough to recover from any					
The state of non-human species is an indicator of the future for humans.					
I think a lot about the suffering of animals.					
I feel very connected to all living things and the earth					

Nisbet et al 2009

14. Below is our importance scale. *(Please tell us how important each aspect is to you by circling the appropriate number on our scale.)*

Not very important → ***Very Important***

Being outside in Nature	1	2	3	4	5	6	7	8	9	10
Being with other people	1	2	3	4	5	6	7	8	9	10
Being on my own	1	2	3	4	5	6	7	8	9	10
The feeling of release and freedom	1	2	3	4	5	6	7	8	9	10

Please tell us about your session today...

15. How long have you spent running today (in minutes)? ________

16. Have you done any other exercise during your session today? If so please tell us

Other exercise:	For how long?

17. Did you run on your own? Yes ☐ No ☐

18. Did you run with other people? Yes ☐ No ☐

19. What emotions were you feeling while you were running today?

20. Now that you have finished your session how do you now feel?

21. Below are some statements about feelings and thoughts.

(Please tick the box that best describes your experience of each over the last 2 weeks)

STATEMENTS	None of the time	Rarely	Some of the time	Often	All of the time
I've been feeling optimistic about the future					
I've been feeling useful					
I've been feeling relaxed					
I've been feeling interested in other people					
I've had energy to spare					
I've been dealing with problems well					
I've been thinking clearly					
I've been feeling good about myself					
I've been feeling close to other people					
I've been feeling confident					
I've been able to make up my own mind about things					
I've been feeling loved					
I've been interested in new things					
I've been feeling cheerful					

That's all!

Thank you very much for sparing the time to fill out this questionnaire.

Please hand the questionnaire back to the person that gave it to you If you would like to know more about this research then please contact Ade Dosumu by email at aadosu@essex.ac.uk

Appendix H: Non-significant analyses of the importance of being outside in nature with gender and running condition

Independent Variable	Category	M	SD	Sig.	Test statistics (U or H)	P value	Effect Size (r)	N
Gender	Male	7.88	1.71	No	5559341.59	.19	r=.05 (small)	368
	Female							305
Condition	Alone	7.86	1.86	No	48,608.00	.568	r=.02 (small)	461
	Group	8.09	1.48					204

Notes: M=mean; SD= 1 standard deviation; Sig= significant or not; U= Mann-Whitney U statistics; H= Kruskal-Wallis statistic; P value=significance; r=effect size; N= number of samples.

Appendix I: Non-significant analyses of the importance of being with other people with environment and running condition

Independent Variable	Category	M	SD	Sig.	Test statistics (U or H)	P value	Effect Size (r)	N
Environment	Rural	7.35	1.98	No	1.06	.59	r=.001 (small)	104
	Suburban	7.51	1.91					355
	Urban	7.61	1.87					213
Condition	Alone	7.43	2.00	No	45528.00	.070	r=.07 (small)	461
	Group							203

Notes: M=mean; SD= 1 standard deviation; Sig= significant or not; U= Mann-Whitney U statistics; H= Kruskal-Wallis statistic; P value=significance; r=effect size; ηp^2=Eta squared; N= number of samples

Appendix J: Non-significant analyses of the importance of one's own with age, running location and running condition

Independent Variable	Category	M	SD	Sig.	Test statistics (U or H)	P value	Effect Size (r)	N
Age group	18-30	6.61	2.00	No	H=.983	.612	.04 (small)	203
	31-50	6.51	1.99					164
	51+	6.33	2.09					131
Location	Indoor	6.33	2.07	No	U=39781.50	.120	.06 (small)	174
	Outdoor	6.61	1.96					496
Condition	Alone							
	Group							

Notes: M=mean; SD= 1 standard deviation; Sig= significant or not; U= Mann-Whitney U statistics; H= Kruskal-Wallis statistic; P value=significance; r=effect size; ηp^2=Eta squared; N= number of samples

Appendix K: Non-significant analyses of the Importance of the feeling of release and freedom with gender ,age, location, environment and running condition

Independent Variable	Category	M	SD	Sig.	Test statistics (U or H)	P value	Effect Size (r)	N
Gender	Male	8.11	1.63	No	U=59273.00	.199	r=.05 (small)	368
	Female	8.24	1.66					305
Age group	18-30	8.17	1.74	No	H=3.41	.182	ηp^2=.01 (small)	205
	31-50	8.30	1.59					165
	51+	8.00	1.56					131
Location	Indoor	8.20	1.66	No	U=44,268	.692	r=.02 (small)	174
	Outdoor	8.16	1.64					499
Environment	Rural	8.54	1.45	No	H=6.00	.050	ηp^2=.001 (small)	104
	Suburban	8.16	1.57					355
	Urban	8.00	1.84					214
Condition	Alone	8.18	1.64	No	U=51186	.583	r=.02 (small)	461
	Group	8.13	1.67					204

Notes: M=mean; SD= 1 standard deviation; Sig= significant or not; U= Mann-Whitney U statistics; H= Kruskal-Wallis statistic; P value=significance; r=effect size; ηp^2=Eta squared; N= number of samples

Appendix L: Key questionnaire used among group runners in Chapter 6.

University of Essex

QUESTIONNAIRE 1: PRE AND POST GROUP RUN

Please spare a few minutes to take part in my research

I would be asking participants to complete questionnaires before and after their group running exercise. I value your comments and would be most grateful if you could spare the time to complete my questionnaire. All the information given to me will be used for my research and will not be passed on to a third party. When you have completed the questionnaire please hand it back to the person who gave it to you. Thanks. **Enjoy your run!**

So that I can match up your responses before and after your running session, please tell me your date of birth and initials of your first name and surname in the boxes below:

Date of birth ☐ **First name initials** ☐ **Surname initial** ☐

1. I agree to taking part in this research by completing this questionnaire ☐

2. Number ☐

3. Your gender? **Male** ☐ **Female** ☐

4.Below is a list of words that describe feelings people have. Please read each one carefully. Then fill ONE circle under the answer to the right, which best describes how you feel <u>NOW.</u> The numbers refer to these phrases.

	Not at all	A Little	Moderately	Quite a bit	Extremely		Not at all	A Little	Moderately	Quite a bit	Extremely		Not at all	A Little	Moderately	Quite a bit	Extremely
1. Tense	⓪	①	②	③	④	11. Unworthy. . .	⓪	①	②	③	④	21. Gloomy . . .	⓪	①	②	③	④
2. Angry	⓪	①	②	③	④	12. Uneasy. . . .	⓪	①	②	③	④	22. Sluggish . . .	⓪	①	②	③	④
3. Worn out . . .	⓪	①	②	③	④	13. Fatigued . . .	⓪	①	②	③	④	23. Weary	⓪	①	②	③	④
4. Lively	⓪	①	②	③	④	14. Annoyed . . .	⓪	①	②	③	④	24. Bewildered .	⓪	①	②	③	④
5. Confused. . .	⓪	①	②	③	④	15. Discouraged	⓪	①	②	③	④	25. Furious . . .	⓪	①	②	③	④
6. Shaky	⓪	①	②	③	④	16. Nervous . . .	⓪	①	②	③	④	26. Efficient	⓪	①	②	③	④
7. Sad	⓪	①	②	③	④	17. Lonely.	⓪	①	②	③	④	27. Full of pep .	⓪	①	②	③	④
8. Active	⓪	①	②	③	④	18. Muddled . . .	⓪	①	②	③	④	28. Bad tempered	⓪	①	②	③	④
9. Grouchy . . .	⓪	①	②	③	④	19. Exhausted. .	⓪	①	②	③	④	29. Forgetful. . .	⓪	①	②	③	④
10. Energetic. . .	⓪	①	②	③	④	20. Anxious . . .	⓪	①	②	③	④	30. Vigorous . .	⓪	①	②	③	④

Lorr *et al.*, (1984)

5. Below is a list of statements dealing with your general feelings about yourself.
(Please tick the box that best describe you.)

Statements:	Strongly agree	Agree	Disagree	Strongly disagree
I feel that I am a person of worth, at least on an equal plane with others.				
I feel that I have a number of good qualities.				
All in all, I am inclined to feel that I am a failure.				
I am able to do things as well as most other people.				
I feel I do not have much to be proud of.				
I take a positive attitude toward myself.				
On the whole, I am satisfied with myself.				
I wish I could have more respect for myself.				
I certainly feel useless at times.				
At times I think I am no good at all.				

Rosenberg, (1965)

8. Please answer each of these questions in terms of the way you feel at the present moment. There are no right or wrong answers. Using the following scale please tick what you are presently experiencing.

Strongly disagree ***Neutral*** ***Strongly agree***

→

Right now I'm feeling a sense of oneness with the natural world around me.	1	2	3	4	5	6	7
At the moment, I'm feeling that the natural world is a community to which I belong.	1	2	3	4	5	6	7
I presently recognize and appreciate the intelligence of other living organisms.	1	2	3	4	5	6	7
At the present moment I don't feel connected to nature.	1	2	3	4	5	6	7
At the moment, I can imagine myself as part of the larger cyclical process of living.	1	2	3	4	5	6	7
At this moment I'm feeling a kinship with animals and plants.	1	2	3	4	5	6	7
Right now I feel as though I belong to the Earth just as much as it belongs to me.	1	2	3	4	5	6	7
Right now I am feeling deeply aware of how my actions affect the natural world.	1	2	3	4	5	6	7
Presently, I feel like I am part of the web of life.	1	2	3	4	5	6	7
Right now I feel that all inhabitants of Earth, human and non-human, share a common "life force."	1	2	3	4	5	6	7
At the moment I am feeling embedded within the broader natural world, like a tree in a forest.	1	2	3	4	5	6	7
When I think of humans' place on Earth right now, I consider them to be the most valuable species in nature.	1	2	3	4	5	6	7
At this moment, I am feeling like I am only a part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.	1	2	3	4	5	6	7

Connectedness to Nature Scale, (CNS) Mayer, S. F., & Frantz, C. M. (2004)

Thanks! See you for the next session

Appendix M: Key questionnaire used among lone runners in Chapter 6.

University of Essex

QUESTIONNAIRE 2: PRE AND POST LONE RUN

Please spare a few minutes to take part in my research

I would be asking participants to complete questionnaires before and after their lone running exercise. I value your comments and would be most grateful if you could spare the time to complete my questionnaire. All the information given to me will be used for my research and will not be passed on to a third party. When you have completed the questionnaire please hand it back to the person who gave it to you. Thank You!

So that I can match up your responses before and after your running session, please tell me your date of birth and initials of your first name and surname in the boxes below:

Date of birth ☐ **First name initials** ☐ **Surname initial** ☐

1. I agree to taking part in this research by completing this questionnaire ☐

2. Number ☐

3. Your gender? **Male** ☐ **Female** ☐

4.Below is a list of words that describe feelings people have. Please read each one carefully. Then fill ONE circle under the answer to the right, which best describes how you feel NOW. The numbers refer to these phrases.

	Not at all	A Little	Moderately	Quite a bit	Extremely
1. Tense	⓪	①	②	③	④
2. Angry	⓪	①	②	③	④
3. Worn out . . .	⓪	①	②	③	④
4. Lively	⓪	①	②	③	④
5. Confused. . .	⓪	①	②	③	④
6. Shaky	⓪	①	②	③	④
7. Sad	⓪	①	②	③	④
8. Active	⓪	①	②	③	④
9. Grouchy . . .	⓪	①	②	③	④
10. Energetic. . .	⓪	①	②	③	④
11. Unworthy. . .	⓪	①	②	③	④
12. Uneasy. . . .	⓪	①	②	③	④
13. Fatigued . . .	⓪	①	②	③	④
14. Annoyed . . .	⓪	①	②	③	④
15. Discouraged	⓪	①	②	③	④
16. Nervous . . .	⓪	①	②	③	④
17. Lonely.	⓪	①	②	③	④
18. Muddled . . .	⓪	①	②	③	④
19. Exhausted. .	⓪	①	②	③	④
20. Anxious . . .	⓪	①	②	③	④
21. Gloomy . . .	⓪	①	②	③	④
22. Sluggish . . .	⓪	①	②	③	④
23. Weary	⓪	①	②	③	④
24. Bewildered .	⓪	①	②	③	④
25. Furious . . .	⓪	①	②	③	④
26. Efficient	⓪	①	②	③	④
27. Full of pep .	⓪	①	②	③	④
28. Bad tempered	⓪	①	②	③	④
29. Forgetful. . .	⓪	①	②	③	④
30. Vigorous . .	⓪	①	②	③	④

Lorr *et al.*, (1984)

5. Below is a list of statements dealing with your general feelings about yourself.
(Please tick the box that best describe you.)

Statements:	Strongly agree	Agree	Disagree	Strongly disagree
I feel that I am a person of worth, at least on an equal plane with others.				
I feel that I have a number of good qualities.				
All in all, I am inclined to feel that I am a failure.				
I am able to do things as well as most other people.				
I feel I do not have much to be proud of.				
I take a positive attitude toward myself.				
On the whole, I am satisfied with myself.				
I wish I could have more respect for myself.				
I certainly feel useless at times.				
At times I think I am no good at all.				

Rosenberg, (1965)

8. Please answer each of these questions in terms of the way you feel at the present moment. There are no right or wrong answers. Using the following scale please tick what you are presently experiencing.

Strongly disagree ***Neutral*** ***Strongly agree*** →

Right now I'm feeling a sense of oneness with the natural world around me.	1	2	3	4	5	6	7
At the moment, I'm feeling that the natural world is a community to which I belong.	1	2	3	4	5	6	7
I presently recognize and appreciate the intelligence of other living organisms.	1	2	3	4	5	6	7
At the present moment I don't feel connected to nature.	1	2	3	4	5	6	7
At the moment, I can imagine myself as part of the larger cyclical process of living.	1	2	3	4	5	6	7
At this moment I'm feeling a kinship with animals and plants.	1	2	3	4	5	6	7
Right now I feel as though I belong to the Earth just as much as it belongs to me.	1	2	3	4	5	6	7
Right now I am feeling deeply aware of how my actions affect the natural world.	1	2	3	4	5	6	7
Presently, I feel like I am part of the web of life.	1	2	3	4	5	6	7
Right now I feel that all inhabitants of Earth, human and non-human, share a common "life force."	1	2	3	4	5	6	7
At the moment I am feeling embedded within the broader natural world, like a tree in a forest.	1	2	3	4	5	6	7
When I think of humans' place on Earth right now, I consider them to be the most valuable species in nature.	1	2	3	4	5	6	7
At this moment, I am feeling like I am only a part of the natural world around me, and that I am no more important than the grass on the ground or the birds in the trees.	1	2	3	4	5	6	7

Connectedness to Nature Scale, (CNS) Mayer, S. F., & Frantz, C. M. (2004)

Thanks! That's all! Please hand the questionnaire back to the person that gave it to you.

Appendix N: Results of mixed ANOVA on self-esteem

Interaction	Sig.	Test statistics	P value	Effect size
Running condition and age	No	$F(2, 34) = .972$, Wilks' $\wedge = .974$,	$p = .331$,	$\eta p^2 = .026$ (moderate)
Running condition and gender	No	$F(1,34) = 2.302$, Wilks' $\wedge = .940$	$p = .138$	$\eta p^2 = .060$(moderate)
Running condition, age and gender	No	F (2, 34) =2.77, Wilks' $\wedge = .928$	$p = .104$,	$\eta p^2 = .072$ (moderate)
Running condition and time	No	F (1, 34) =.487, Wilks' $\wedge = .998$,	$p = .767$,	$\eta p^2 = .002$(small)
Time, running condition and age	No	F (2, 34) =.089, Wilks' $\wedge = .998$,	$p = .852$,	$\eta p^2 = .009$ (small)
Time, running condition and gender	No	F (1, 34) =.541, Wilks' $\wedge = .985$,	$p = .467$,	$\eta p^2 = .015$ (small)
time, running condition, age and gender	No	F (2, 34) =.000, Wilks' $\wedge = 1.000$,	$p = .999$,	$\eta p^2 = .000$ (none)

Notes: Sig= significant or not, Wilks' $\wedge$=Wilks Lambda; F= F statistics, with degree of freedom in bracket; p value=significance; ηp^2 =partial eta squared

Appendix O: Results of analyses examining interaction effect between gender and time on outcome measures

Outcome measure		Male M	SD	Female M	SD	Interaction Main or gender effect	Sig.	Test statistics (Wilks' ^= & *F*	*P* value	Effect size (partial ηp^2)	N
RSES						Interaction	No	Wilks' ^= .967 *F*(1,34) = 1.157	.290	Partial ηp^2=.03(small)	m=20;f=20
	Pre	20.59	4.11	22.39	4.25	Main (time)					
	Post	20.39	6.48	21.22	6.66	Gender					
TMD						Interaction	No	Wilks' ^= .998 *F*(1,34) = .069	.794	Partial ηp^2=.02(small)	m=20;f=20
	Pre	150.83	18.02	153.24	28.31	Main (time)					
	Post	142.57	12.88	146.94	20.26	Gender					
CNS						Interaction	No	Wilks' ^= 1.000 *F*(1,34) = .001	.975	Partial ηp^2=.00(none)	m=20;f=20
	Pre	43.79	6.48	40.25	10.20	Main (time)					
	Post	48.77	6.26	45.31	9.84	Gender					

Notes: M=mean; SD=1 standard deviation; Sig = significant or not; ^= Wilks' Lambda; *F*= F statistics, with degrees of freedom in brackets; *p* value= significance; partial ηp^2= partial eta squared; N= number of participants in analysis; m= number of male participants; f= number of female participants.

Appendix P: Results of analyses examining interaction effect between age and time on outcome measures

Outcome Measures		Age 18-30 (1st)	SD	Age 31+ (2nd)	SD	Interaction Main or condition effect	Sig.	Test statistics (Wilks' ∧= & *F*	*P* value	Effect size (partial ηp^2)	N
RSES						Interaction	No	Wilks' ∧= .845 *F*(2,34) = 3.124	.057	Partial ηp^2=.16 (large)	1st=15; 2nd =25
	Pre	20.42	3.99	21.97	4.07	Main (time)					
	Post	21.51	4.10	21.04	4.20	Age					
TMD						Interaction	No	Wilks' ∧= .952 *F*(2,34) = .858	.433	Partial ηp^2=.05 (small)	1st=15; 2nd =25
	Pre	153.64	17.38	151.07	17.84	Main (time)					
	Post	146.41	12.42	145.99	12.79	Age					
CNS						Interaction	No	Wilks' ∧= .960 *F*(2,34) = .70	.504	Partial ηp^2=.40 (small)	1st=15; 2nd =25
	Pre	43.47	6.27	42.71	6.44	Main (time)					
	Post	47.04	5.60	48.21	6.22	Age					

Notes: M=mean; SD=1 standard deviation; Sig = significant or not; ∧= Wilks' Lambda; *F*= F statistics, with degrees of freedom in brackets; *p* value= significance; partial eta squared ηp^2=; N= number of participants in analysis; 1st= number of participant 18-30 years; 2nd= number of participants 31-50 years; 3rd= number of participants

Appendix Q: Results of mixed ANOVA on 6 mood subfactors

Interaction	Sig.	Test statistics	P value	Effect size
Running condition and age	No	*F*(12, 58) = .940, Wilks' ∧= .701	*p* =.515,	ηp^2=.163 (moderate)
Running condition and gender	No	*F*(6,29) = .735, Wilks' ∧= .868	*p* =.625	ηp^2 =.132 (moderate)
Running condition, age and gender	No	*F* (12, 58) =.1.305, Wilks' ∧= .620	*p* =.241	ηp^2= .213 (large)
Running condition and time	No	*F* (6, 29) =.917, Wilks' ∧= .841,	*p* =.497	ηp^2=.159 (moderate)
Time, running condition and age	No	*F* (12, 58) =.910, Wilks' ∧= .708	*p* =543,	ηp^2= .158 (moderate)
Time, running condition and gender	No	*F* (6, 29) =.435, Wilks' ∧= .913,	*p* =.849	ηp^2 = .083 (small)
Time, running condition, age and gender	No	*F* (12, 58) =1.727, Wilks' ∧= .543	*p* =.084	ηp^2 = .263 (large)

Notes: Sig= significant or not, Wilks' ∧=Wilks Lambda; *F*= F statistics, with degree of freedom in bracket; *p* value=significance; ηp^2 =partial eta squared

Appendix R: Results of mixed ANOVA on (CNS)

Interaction	Sig.	Test statistics	P value	Effect size
Running condition and age	No	$F(2, 34) = .311$, Wilks' $\wedge = .971$	$p = .308$	$\eta p^2 = .018$ (small)
Running condition and gender	No	$F(1,34) = 2.323$, Wilks' $\wedge = .939$	$p = .136$	$\eta p^2 = .061$(small)
Running condition, age and gender	No	F (2, 34 =.1.068, Wilks' $\wedge = .971$	$p = .308$	$\eta p^2 = .029$(medium)
Running condition and time	No	$F(1, 34) = .008$, Wilks' $\wedge = 1.00$	$p = .929$	$\eta p^2 = .000$ (none)
Time, running condition and age	No	$F(2, 34) = .265$, Wilks' $\wedge = .993$	$p = .610$	$\eta p^2 = .007$ (small)
Time, running condition and gender	No	$F(1, 34) = .006$, Wilks' $\wedge = 1.00$	$p = .940$	$\eta p^2 = .000$ (none)
Time, running condition, age and gender	No	$F(2, 34) = .081$, Wilks' $\wedge = .998$	$p = .777$	$\eta p^2 = .002$(small)

Notes: Sig= significant or not, Wilks' $\wedge$=Wilks Lambda; *F*= F statistics, with degree of freedom in bracket; *p* value=significance; ηp^2 =partial eta square