Non-Probabilistic Sampling in Quantitative Clinical Research: A Typology and Highlights for Students and Early Career Researchers

Nestor Asiamah, Ph.D.

Africa Centre for Epidemiology

Department of Gerontology and Geriatrics

Accra Ghana

E-mail: nestor.asiamah@ace-gh.org

Henry Kofi Mensah, Ph.D.

Senior Lecturer, Kwame Nkrumah University of Science and Technology

Department of Human Resources and Development

Kumasi, Ashanti Region

E-mail: hkmensah@knust.edu.gh

Eric Fosu Oteng-Abayie, Ph.D

Associate Professor, Kwame Nkrumah University of Science and Technology

Department of Economics

Kumasi, Ashanti Region

E-mail: oteng_abayie@yahoo.com

Abstract

Quantitative researchers need a probabilistic sample to generalise their findings, but research constraints often compel them to use non-probabilistic samples. The use of non-probability sampling methods in quantitative studies has therefore become a norm. Interestingly, even studies published in top-quality journals compromise best practices that the use of non-probabilistic samples requires. Based on a narrative review of relevant studies, we developed a typology of non-probability sampling methods used in quantitative health studies. An attempt was made to

discuss the limit of inference under each type of non-probability sampling method. Non-probability sampling in quantitative research was also delineated as a way to maximise response rate. This study is expected to guide students and early career epidemiologists to understand how to apply non-probabilistic sampling methods in quantitative approaches and plausibly document or report their chosen methods.

Keywords: Study population, response rate, generalisability, quantitative designs, non-probability sampling, epidemiology, healthcare

Introduction

Systematic reviews continue to show that the quantitative research approach is the most frequently used technique in the world [1,2]. Quantitative studies we encounter in the literature in daily research activities enormously outnumber qualitative ones. As academics, we have seen most student researchers under our supervision opt for the quantitative design in their research work on the grounds that it was the most suitable approach for addressing their research problems. A few college students are also honest to link their choice of the quantitative approach to their interest and capabilities.

A large number of studies [3-10] have used criteria-based selection (i.e. using a set of relevant criteria to select participants) to determine their accessible population or sample. In some other quantitative studies, researchers were constrained by research conditions to use an available population or predetermined sample, which researchers consider a 'convenient' population or sample [3,8]. In fact, a careful analysis of top-tier quantitative papers [3,8,9,11] revealed to us that quantitative researchers frequently use at least five different non-probability sampling methods. Obviously, the use of non-probability sampling methods in quantitative studies is a growing norm. Considering the fine reputation of many of the studies championing this tradition, it can be said that using non-probability sampling in quantitative

designs is acceptable and unavoidable. We have nonetheless observed that the non-probability techniques used by quantitative researchers are either not well documented or portrayed as absolute probability sampling methods. We would want to ascribe this problem to non-availability of a formal typology for these non-probability selection procedures in the literature. That is, there is no acceptable standard for documenting these methods. The primary goal of this study is thus to develop a typology of these techniques to enable researchers to scientifically or plausibly document them, guide journal editors and reviewers to assess manuscripts and provide a standard for research critique.

A basic goal in quantitative research is to generalise sample statistics to the general population. The idea that qualitative studies can also generalise findings from a sample to the population is undeniable, but the quantitative design is renowned for applying more rigorous procedures that make its findings more generalizable [12,13]. Central to these procedures is determining and using a *representative sample*, which is a sample that is large enough to give rise to findings that the population would have produced if entirely surveyed [14,15]. Sampling theory suggests that representativeness of the sample is necessary if findings are to be inferred to the population [13,16]. A sampling frame is required to determine a representative sample [13,16,17], but this list is often not available when the general population is very large. Similarly, the researcher needs a list that details characteristics of members of the general population to be able to determine the target and accessible populations.

In many cases nevertheless, the researcher would come across an 'anonymous' population, which we refer to as a general population whose members are not individually known. We have on many occasions met college students and researchers who struggled to make sampling decisions and document their sampling approaches in the face of this type of

population. Working with an anonymous population can indeed be a problem, particularly because this experience can make sampling or participants selection stressful and unscientific. Therefore, the final objective of this study is drawing on trending practices in the literature to identify decisions that could be made by inexperienced quantitative researchers to select – without a sampling frame – participants using acceptable and justifiable non-probability methods. This study develops a framework of novel recommendations based on what is already being done by experienced quantitative researchers and is directed to college students and early-career researchers. Even so, we think this study can guide experienced quantitative researchers to document and justify their sampling techniques as it throws light on current acceptable practices. This study is expected to guide college students to understand how to apply non-probabilistic sampling methods in quantitative approaches and plausibly document or report their chosen methods. To make our thoughts understandable enough, we expound them with a scenario and recall basic concepts on sampling and population specification.

A Clinical Research Scenario

Emotional intelligence (EI) as a concept has earned the interest of many researchers and produced a wealth of studies and pieces of evidence in the last few decades. EI has been consistently confirmed to predict several performance indicators, including leadership behaviour, job satisfaction, health care quality delivery, and job performance [18-21]. The concept is however relatively new in the literature, and its research is yet to be grounded in many jurisdictions [18,19]. This notwithstanding, many health care planners and administrators are buying into the growing rhetoric about the relevance of EI to quality health care delivery. Hence, EI is the primary variable of interest in this study. We assume in this

paper that the Regional Health Services Directorate (RHSD) in Christchurch, New Zealand, is interested in taking key steps to enhance the quality of health care delivered, and one of these steps is to introduce a culture of EI specialised training in line with some studies [22,23]. One of the primary elements of the adoption of an EI specialised training culture is knowing the average EI of health workers and using this estimate as a baseline to which future estimates that result from the specialised training program is compared to know what progress is being made over time. The RHSD in Christchurch needs a baseline estimate to put the adoption process in motion. This being so, the objective of the research is to estimate the level of EI of health workers in public hospitals in Christchurch.

The assumed study area is health care institutions in Christchurch, New Zealand. The study also assumes that Christchurch has a total of five public healthcare facilities. Goleman's [24] theoretical argument that every human is born with some level of EI is pivotal to our assumed research goal, which has much to do with precise estimation of EI in terms of the five theoretical dimensions developed by Goleman [24]. A self-reported questionnaire is chosen as the appropriate data collection instrument. This study also assumes the application of a quantitative research approach to better make discussions for quantitative research. Health care personnel's daily communication with customers (i.e. patients) and other stakeholders (e.g. relatives of patients, co-workers) has been the basic context in which the relevance of EI to health care delivery has been argued in the literature [20,21,24]. Any assessment of emotional intelligence in a health care setting must as a result focus on individuals who engage in daily communication with patients, relatives, and other co-workers. Our scenario also assumes that the study must be completed in twenty-four working days in harmony with the schedule of the adoption program. Finally, the RHSD in Christchurch can spend a maximum of $NZ 20,000.00 on the study.

What is Already Known about the Study Population

The general population is what is often specified and defined by researchers in their effort to document their research work and is better understood when defined alongside the target and accessible population. The general population is the largest group of potential participants in a study that has been defined as "… an entire group about which some information is required to be ascertained" [25, p. 151]. Participants in the general population must share at least one characteristic since they are required to provide the same data or information.

The general population, with respect to our scenario, constitutes health workers in the five health care institutions in Christchurch. Members of this population share at least one basic characteristic, being a health worker (see Table 1). Job or personal variables such as education, tenure and gender can be other attributes shared by population members but being a health worker in any of the five health care organisations in Christchurch is the fundamental requirement (for being a member of the general population) implied by the research goal. The basis of specifying the general population in a quantitative study should therefore be the researcher's knowledge of the cardinal attribute that unifies all population members from the point of view of the research goal and qualifies them as people who can provide access to relevant data. If so, the quantitative researcher must be able to name this attribute by answering this or similar questions: *who is implied to be eligible to participate in the study by the research objective(s)?* The right answer to this question should unfold potential participants, not specific participants, of the study and their geographical location. The right response to this question is 'health workers of health facilities in Christchurch'. It can thus be deduced that the general population is an outcome of trying to know people who can provide data to address the research objective(s).

One may be wondering why the general population is health workers in the five health care institutions in Christchurch but not workers in other health and non-health institutions. Of course, the research goal is to estimate the emotional intelligence of exclusively health workers in hospitals in Christchurch; hence it is necessary to limit the study setting to these hospitals. If the researcher includes employees of non-health organisations in Christchurch, the resulting estimate cannot be attributed to health workers in the chosen five hospitals. That is, the resulting EI estimate will be adulterated with the EI of those who are not workers in the five hospitals in Christchurch. Undoubtedly, decision makers may be misled if they depend on this result. These concerns can better be appreciated if this principle of representative sampling is borne in mind: representative sampling is necessary for inferring findings to the population, but inference or generalisation is only valid when it covers exactly those recognised by the research goal [25].

One may also be right to ask why the general population is not a specific group of employees such as physicians or midwives in the five hospitals. It is easy to address this concern with reference to our research goal and assumptions, which call for an EI estimate of all health workers who substantially communicate with patients, relatives of patients, hospital administrators, and co-workers in health care situations. The researcher is, therefore, bound to reach an EI estimate that cannot be generalised to health workers if he/she specifies and works with a general population that excludes any relevant participants. Moreover, it is instructive for the general population to be made as broad as dictated by the research objective(s) to set the basis for reaching the specific population through a scientific and systemic process that is the focus of this paper. The reasoning behind this argument is that an oversight may compel researchers not to include eligible participants in the accessible population if they decide to define the specific or accessible population without first

describing the composition of the general and target populations. The general population is the largest when compared to the target and accessible population. It contains the largest number of participants who share at least a single characteristic and as a result comprises the target and accessible population. With respect to our scenario, it is simply all health workers in the five health care organisations in Christchurch, regardless of their demographic attributes and conditions such as being ill or absent at work. It could be seen that our definition of the general population in this study squares with that of Asiamah et al. [26] because qualitative and quantitative researchers need similar geographical settings (i.e. a general population that includes all potential participants suggested by the research goal) to ensure that no participant is overlooked prior to sampling.

It has been opined elsewhere [12,17,27] that typical qualitative research objectives are structured to focus on few people with specific experiences and knowledge. This is the case because qualitative studies focus on analysing, in sufficient detail, opinions from people who can share experiences and knowledge about a phenomenon [27-29]. Even so, considerations mentioned above for specifying the general population of a quantitative study also apply to the qualitative design since qualitative and quantitative researchers both need similar geographical settings – as revealed above – to ensure that the target and accessible populations as well as the sample are holistic. What however may make quantitative and qualitative designs different in terms of participant selection is the set of criteria and procedural rigour that inform transition from the general population to the target and accessible populations [17].

To understand what the primary composition of the target population is, it must be borne in mind that the general population is the largest group of subjects a researcher can make a sample from [27,28,30,31]. Considering our scenario, members of the general

population are ‘health workers’ in all healthcare institutions in Christchurch. That is, every employee in these institutions who directly or indirectly contributes to healthcare delivery is a health worker and is as a result a member of the general population. Based on our research context and assumptions nevertheless, not every health worker can participate in the study. An assumption that would need to be recalled is the need for EI to be measured as a competence applied by health workers when interacting with patients, co-workers, bosses, and other stakeholders – this is the ideal context of EI assessment in health care [21,23]. Alternatively speaking, EI assessment is best done by focusing on health care professionals who are constantly involved in traditional health care activities, particularly communication with patients, co-workers, and relatives of patients.

Within a hospital setting nonetheless, not all workers can engage in this network of communication. Cleaners, security personnel, database administrators, and some administrative workers (who hardly communicate with patients and other workers) are typical examples. Though they work in the hospital environment, their inclusion in the study population (i.e. accessible population) violates our main research context and assumption and may as a result badly affect data integrity and research outcomes. In this situation, the need to refine the general population by eliminating individual employees belonging to such categories is evident. The part of the general population left after refinement is the target population, which Asiamah et al. [17] defined as individuals of the general population who possess the specific attributes of interest. These attributes are used to determine the criteria for selecting members of the target population (see Table 1). As implied by the foregoing definition, the target population is more refined compared to the general population because it contains no attribute that undermines a research assumption, context, or goal.

Table 1. An Illustration of the General, Target and Accessible Population Sizes based on the Scenario

Population type	Stage	Condition	Hospital	Population size (N)	NIE	NINE
General population	1	Being a worker in the study area or the five hospitals	Hospital 1	543	---	---
			Hospital 2	687	---	---
			Hospital 3	509	---	---
			Hospital 4	432	---	---
			Hospital 5	588	---	---
			Total	**2,759**	**---**	**---**
Target population	2	Meeting the selection criteria implied by the research goal and context	Hospital 1	543	521	22
			Hospital 2	687	668	19
			Hospital 3	509	491	18
			Hospital 4	432	412	20
			Hospital 5	588	561	27
			Total	**2,759**	**2,653**	**106**
Accessible population (1)	3	Willingness to participate in the study	Hospital 1	521	514	7
			Hospital 2	668	658	10
			Hospital 3	491	485	6
			Hospital 4	412	407	5
			Hospital 5	561	549	12
			Total	**2,653**	**2,613**	**40**
Accessible population (2)	4	Availability at the time of data collection to respond	Hospital 1	514	501	13
			Hospital 2	658	658	0
			Hospital 3	485	478	7
			Hospital 4	407	394	13
			Hospital 5	549	538	11
			Total	**2,613**	**2,569**	**44**

Note: NIE = number of individuals eligible (included); NINE = number of individuals not eligible (included)

It is common knowledge that any study that makes use of primary data must apply some ethical principles in recognition of the rights of participants. A principal way to respect the right of participants is to ensure that they participate in the study voluntarily. Suffice to say, no person should be coerced to participate or respond in a study. This idea makes it mandatory for every researcher to specify the accessible population and work with and gather data from only those who are willing to participate in the study. The accessible population, also referred to as the specific population, are all individuals of the target population who are willing to participate in the study and will be available to respond during data collection

[17,32]. It is reached by taking out from the target population those who are not willing to participate for personal reasons and/or will not be available to respond (see Table 1). The accessible population is smaller than the target population unless every individual (of the target population) is willing to participate in the study and will be available to respond. Table 1 shows the target and accessible populations for the Christchurch study and the selection criteria used to reach them. A total of 2,569 health workers make up the accessible population and are the ultimate participants of the study. The total number of health workers under each population is those who met the relevant condition or criteria implied by the research objectives.

Refusal of some subjects in the target population to participate in the study is indeed a significant loss for the quantitative researcher apparently because it contributes to missing data, acts as a threat to internal validity and can as a result increase the risk of generalising findings. Yet, the adverse impact of losing participants this way on findings is not as serious as coercing people to participate in the study, particularly from a legal and human right perspective [12,17,25]. Even so, coherently explaining the purpose, benefits, and risks of the study to members of the target population, preferably through the informed consent form, can convince them to participate in the study and is an acceptable conduct. Similarly, members of the target population can make sacrifices to participate in the study when they are made to know the study's benefits to them and society. The next section discusses how and when the accessible and target populations become non-probability samples and/or serve as a foundation for various non-probability sampling variants.

A Typology of Non-Probability Sampling Methods Used by Quantitative Researchers

To recall, quantitative researchers, at best, require a random sample that is representative of the general population, but research constraints often make it impossible for them to reach this sample. A common constraint is non-availability of the sampling frame, but this impediment should not stop the research – there should be a way out. Often, using a non-probability sampling method is a way to improvise and ensure continuity of the study. With respect to our scenario, the sampling frame is available, so we would want to explain in this section various non-probability sampling methods that are increasingly dominating representative samples in quantitative research as a precursor to delineating strategies for sampling without a sampling frame.

Purposive sampling has been simply defined as "a type of sampling procedure that selects members of the sample to meet a specific purpose" [27, p.2]. This definition is unfortunately not only superficial but is also potentially unacceptable because every study is conducted to address a specific purpose, and the right sampling method is the one that generates the ultimate sample to address this purpose or a set of objectives. Purposive sampling, also referred to as judgemental sampling, has been more satisfactorily defined as a non-probability sampling method that selects members of the general population based on qualities or attributes (required by the researcher) that these members possess [27,33]. A purposive sample is made up of elements or individuals who have some pre-determined characteristics. The qualitative researcher sees these characteristics as indicators of the ability of individuals in the general population to provide detailed responses and therefore connote the specialised knowledge, experience, and skills of members of the ideal sample [17].

Because qualitative studies use relatively small samples [26,28], the stepwise and rigorous process propounded elsewhere [17] is potentially the best way to reach the purposive sample. In a quantitative design however, the researcher needs a relatively large sample to detect statistical significance of estimates and/or maximise statistical power [27,28,31]. Hence, quantitative researchers tend to use relevant selection criteria once (as explained above) to reach the target population (if some eligible individuals selected from the general population do not agree to participate or will not be available to respond to questionnaires) or sample (if every eligible individual selected from the general population agrees to participate and will be available to respond to questionnaires). Justifiably, researchers [27,34-36] have identified this process as a typical purposive sampling method but admitted that the process (as discussed by Asiamah and colleagues [17]) is repeated several times in a qualitative study to further refine the target population for a smaller sample.

As indicated earlier, the target population is equal to the accessible population if all its members are willing to participate in the study and will be available to respond to questionnaires. In any case, if the researcher realises that the accessible population is not too large, he/she could avoid sampling. We would want to refer to the accessible population reached this way as a *pure purposive sample*, primarily because it results from the use of the theoretical purposive sampling determination process [17]. It is worth reporting some of reputable studies that have used this method in healthcare and public health research. In the United States, Jang and associates [37] used some selection criteria once to select 444 volunteers out of a general population of 808 people. They then gathered data on all 444 volunteers who were available at the time of data collection. In Australia, Curtis et al. [38] also gathered data on all members of the accessible population selected using criteria applied in a single phase. Many studies in Africa [39-41] have also used this method to produce

important findings. Regarding the Christchurch scenario, the accessible population becomes a pure purposive sample if all its members are made to participate in the study. Unarguably, the pure purposive sample is a dominant non-probability sampling method in the literature that quantitative researchers cannot avoid.

In some cases, it is impossible to gather data on the entire accessible population simply because it is too large. If, for example, financial resources available for the study in Christchurch are not sufficient to support data collection on all 2,569 professionals who make up the accessible population, sampling is inevitable. In making a sample in this situation, the researchers would have to determine and select a representative sample from each hospital in Table 1 based on an acceptable sample size determination formula such as Krejcie and Morgan [13]. Samples from the five hospitals added up results in the ultimate sample for the study. We would want to refer to this sample as a *representative purposive sample* owing to its reliance on the use of a purposive sampling process (i.e., using some selection criteria in a single stage to select eligible study participants). It is worth revealing that this type of sample is already in use by quantitative researchers [18,19,42-44] and is thus not a new creation of ours.

Another non-probability sampling method that quantitative researchers cannot avoid is convenience sampling, which is a process that selects participants simply because they are easily accessible to the researcher in situations where other participants or settings of interest cannot be reached [27]. If, for example, researchers in the Christchurch study did not have enough time and funds to collect data from all the five hospitals in Christchurch, they could use employees in a single hospital as study participants. We would want to refer to this approach in this discussion as *pure convenience sampling*, which assumes that all health workers in the hospital of interest are eligible to participate in the study [27,33,35,36,45].

Interestingly, this method is also highly used among quantitative researchers. In their study, Rezai et al. [46] in Canada used all members of a research registry in Saskatchewan rather than a national population of individuals who could provide insights into a national phenomenon. In Nigeria, Edomwonyi and Ogbue [47] also used a pre-determined group of participants in a teaching hospital in Irruna, Edo State, rather than a preferred national or State sample. Nelson et al. [48] in the United States also applied this procedure by using all 26,000 individuals making up a research registry in a defined region.

Also in use among quantitative researchers is what we would refer to as a *representative convenience sample* that is the outcome of using a random sampling method to select a representative number of participants from a convenience population i.e. a group that is used because it is accessible or available when other settings or groups of interest cannot be used owing to research constraints [28,49]. If, for instance, the number of employees in the hospital chosen at the convenience of the researchers in the Christchurch study is too large, a representative sample would have to be drawn from it and used as study participants. Like the other sampling methods discussed above, this procedure is increasingly used by quantitative researchers, including those publishing their findings in highly rated journals like the Lancet, Journal of Health Organisation and Management, and International Journal of Healthcare Management [3-9]. The final non-probability sampling method we have found to be frequently used by quantitative researchers is what we call *nested purposive sampling*, which is a purposive sampling (selecting participants using relevant criteria) conducted on a convenience group or sample. In this respect, the researcher does not draw a representative sample directly from the convenience population or group but rather applies some selection criteria to determine a target or accessible population from it. If, in this regard, the researcher draws a random sample from the target or accessible population reached because it is too

large, nested purposive sampling becomes *representative nested purposive sampling*. This method has been used in a large array of studies [29,43], including those conducted in the healthcare sector [40,44].

We would want to use this opportunity to explain the only *absolute representative sample* that is ideal for quantitative designs [17,26,43]. This sample is unbiased as it is determined directly as a facet of the general population but not as a subset of the target or accessible population. Let us assume that the aim of the study in Christchurch was estimating the weight of all employees in the five hospitals. If so, all employees can participate in the study because their weights can be measured objectively using an appropriate device or instrument. Similarly, data gathering using a device is independent of participants' skills and knowledge. In many cases however, the representativeness of this sample reduces for each participant who opts out of the study or refuses to participate. Of course, no researcher – in view of Helsinki guidelines and declaration on research ethics – can coerce a person to participate in a study. Thus, individuals can only participate in a study voluntarily, which implies that the so-called absolute representative sample is vulnerable to attrition. Nonetheless, it offers the best chance for generalising findings to the general population.

To reiterate, the use of the above non-probability samples in quantitative research has become a norm, but there are dos and don'ts associated with it that researchers must never overlook. The next section identifies due diligence that must follow the use of non-probability samples for quantitative designs.

The Dos and Don'ts of Using Non-Probability Samples in Quantitative Designs

The priority of quantitative researchers is an absolute representative sample that gives them the opportunity to generalise findings to the general population. Research conditions faced by

quantitative researchers however mostly make it impossible for this type of sample to be reached and applied. A purposive sample or any of the other non-probability samples mentioned above becomes unavoidable in the absence of an absolute representative sample – determining and using this sample is a way to improvise when research conditions become an impediment to a perfect random sample. Even so, researchers who use non-probability samples must always admit and acknowledge that their findings have no or limited generalisability [28,30]. In this section, we proffer what should be done when each of the non-probability samples discussed above is used.

A pure purposive sample (i.e. all members of the accessible or target population used as study participants) is not representative of the general population owing to the fact that a criteria-based selection process does not give every member of the general population a known chance of being included in the target or accessible population [27,43]. Therefore, a quantitative study that uses only a pure purposive sample cannot generalise findings to the general population. If the researchers in Christchurch decided to use a pure purposive sample (i.e. all members of the accessible population), their resulting estimate of the emotional intelligence of health workers cannot be generalised to all employees of the five hospitals in Christchurch. Concluding that the resulting average estimate represents all workers in the five hospitals accompanies a high risk and could mislead decision makers. Such conclusions and generalisation should be avoided in a healthcare setting where decisions have a direct impact on human lives. However, some researchers [29,34,42] have reported or at least implied that results from pure purposive samples can be generalised or applied to populations that are homogenous with these samples. We would want to nevertheless stick to our opinion that generalising findings based on a purposive sample to a broader population is associated with a high risk.

Pure convenience samples are as good as *pure purposive samples* because they are non-probabilistic in nature and are therefore not representative of the general population from which they are drawn. Results based on them can, therefore, not be generalised to their respective general populations. Etikan et al. [27], however, candidly reported that generalisation of findings is possible with a pure convenience sample drawn entirely from a homogeneous population. Their view justifies inferring findings (based on a purposive or convenience sample) to all other groups or settings that share characteristics with the general population. In any case, quantitative researchers must admit the weaknesses of their non-probability sampling methods and consider these weaknesses when discussing findings, making conclusions and suggesting policy actions. At their discretion, decision makers in healthcare or public health settings may assess the homogeneity of other populations they would want to apply (findings from a non-probability sample) to.

Representative purposive samples and *representative convenience samples* are random and representative of their respective accessible or target populations. Their findings can therefore be generalised to their target or accessible populations but not their respective general populations. At a significant level of risk however, findings can be generalised to populations that are homogeneous with these samples [27,49]. For a *nested purposive sample*, no generalisation to the general population (which is the convenience sample or group chosen) is possible, and results from this sample only estimate attributes of participants. Inferring findings from this sample to related populations is permissible [27], but we fear researchers and decision makers may be bias in appraising the homogeneity of other populations they may be interested in applying their findings to. We therefore recommend in agreement with other studies [28,29,31,49] that generalisation with non-probability samples

should be avoided, and researchers must treat the use of non-representative samples as a study limitation that decision makers must always keep in mind.

The specification of the target population, as seen earlier, is only possible when the sampling frame is available. In many cases however, the sampling frame is not available. In the next section, we explain how study participants can be selected using relevant non-probability methods in the absence of the sampling frame.

Working with an Anonymous General Population

Some characteristics (e.g. having a certain level of education, work experience, language skills, etc.) form the basis of selecting members of the target population. With respect to our scenario, a list of those who possess these attributes can easily be obtained from the host organisations (i.e. the five hospitals in Christchurch) that keep up-to-date records on all employees. In many other situations nevertheless, this list cannot be accessed or created by the researcher. This problem is frequently encountered by quantitative researchers in large epidemiological studies, opinion polls and market surveys involving unregistered participants or populations (i.e., groups on which no public or private organisation keeps socio-demographic data on). A solution to this problem is conducting a reconnaissance study focused on identifying the right participants of the study [3-10]. In an opinion poll undertaken in a community, the general population is ideally all community dwellers whose opinions are needed, but these individuals are not known, and there is nowhere to source information about them from. So, how does the researcher determine the target and accessible population? Well, in the face of this problem, the researcher must have in mind what makes a person in the community eligible to participate. This is to say he/she needs a list of selection criteria to screen the community for eligible participants. After obtaining this list, the researcher could choose one or more points (e.g., social centres, shopping malls, churches,

etc.) in the community where all target individuals are likely to go frequently. A single point like a supermarket is unlikely to be a place where all potential participants would commute at a given time. Hence, the researcher must choose two or more social centres to provide a basis for easily contacting all potential participants of the study. At the various centres chosen, the researcher (supported by some research assistants) should use a questionnaire or appropriate instrument to know individuals who have met all the selection criteria and are willing and will be available to participate in the study. This exercise should not be rushed to ensure that every prospective participant is included in the study.

This approach is not new but has been used in many studies across the world. Newton et al. [50], for example, used this technique to select participants for a trial in a community in Australia, but these researchers maximised access to their study's participants by using contact information from a public service provider to select participants via telephone. An alternative way to complement the list of participants selected at the social centres and maximise access to respondents is moving from house to house to select people (from households) using a questionnaire or any other appropriate instrument. Brand et al. [51] in Germany and Krueger et al. [52] in the United States employed a similar procedure to reach their accessible population. What is noteworthy about this approach is that it results in the accessible population rather than the target population since it identifies those who are eligible and willing and will be available to participate. In many instances [50,51], individuals selected were all made to participate in the main study. If the resulting set of individuals is too large however, a representative sample (i.e. *representative purposive sample* or *representative convenience sample*) should be made out of it. With this procedure however, the researcher is likely to overlook some eligible participants, and a way to avoid this oversight is using multiple social centres and complementary approaches (e.g. moving

from house to house and contacting community members via telephone based on an exhaustive telephone directory). The procedure can also be expensive and time-consuming but expending a high amount in this situation is a necessary price for quality and reliable findings. Of course, funders of trials and surveys are often aware of how expensive this approach can be. Yet, appropriate techniques should be applied by the researcher to optimise cost. Newton and colleagues [50], for instance, cut back on the cost of data collection by administering the main study questionnaires instantly after identifying participants at the social centres. By so doing, they avoided the cost of returning to participants to administer questionnaires and maximised response rate.

The initial survey through which participants or members of the accessible population are selected cannot be equated with a pilot study, which has completely different goals. In addition, a pilot study can follow such a survey to, for example, verify the validity of the main data collection instrument. Finally, the researcher is free to infer his/her findings to the study setting if the participants selected are exhaustive of this geographical area [35,53]. Nevertheless, findings should be generalised to the accessible population (or pure purposive sample) rather than the community if many eligible participants dropout of the study owing to their unavailability or unwillingness to be part of the study. The determination of the accessible population using the above procedure can therefore maximise generalisability of results if multiple social centres and supplementary methods are well executed to reach a group of participants that is representative of the study area. Yet, the next section highlights better opportunities for maximising response rate in non-probabilistic population specification.

Determining the Accessible Population to Maximise Response Rate

We have taken a critical look at the literature and realised that many researchers experience high attrition, discard many completed questionnaires owing to response errors, and therefore end up incorporating into their data analysis a number of questionnaires far less than their representative sample sizes. Therefore, these researchers increase the risk of generalising their findings to the population or/and fail to detect weak associations or effects. These repercussions are explained by the theory that small samples are unlikely to detect weak effects and associations and an excessive level of attrition decreases external validity or increases the risk of generalising findings to the population [13,50]. We argue that a high attrition rate is likely to result in a study when the researcher does not take any measures (at the stage of population specification) to guard against excessive non-response and response errors. We have observed that researchers whose studies have suffered from high attrition are those who took no actions against possible response and non-response errors at the stages of population specification [6,7,9,46,].

Often, researchers in the field of biomedical sciences and health try to solve this problem by estimating the study's acceptable attrition rate by determining (using appropriate formulae) the sample size that corresponds to a pre-determined statistical power, which is estimated based on an expected effect size and a level of confidence of often 95% [13,50]. While this effort is a good way to estimate a representative sample size that adjusts for attrition, it does not have any influence on the behaviour of participants in data collection and can therefore not pre-empt response and non-response errors. Furthermore, computation of the attrition rate is often based on subjective judgements of the researcher and some prior experiences in similar studies and can as a result be misleading. Apparently, the computation of attrition rates to determine the appropriate sample size of a study does not in any way

serve as an antidote to the risk of non-response. The question then is *how can the researcher take steps against too many non-responses and response errors to maximise generalisability?* The answer to this question is not farfetched and represents the procedure explained earlier for specifying the accessible population. First of all, let us recall that the general population is crude in nature and contains individuals whose inclusion in the study can undermine data integrity. To illustrate, some individuals in the five hospitals in Christchurch may lack good English skills and the ability to respond to questionnaires. If the researcher fails to take such persons out of the study, many questionnaires could be wrongly or partially completed, an outcome that can lead to a large number of response and non-response errors. In many cases, questionnaires with these errors are discarded to safeguard data integrity. The specification of the target population as illustrated earlier is thus an opportunity for the researcher to avoid losing too many questionnaires and data, but there is even a bigger opportunity for reducing response and non-response errors and maximising response rate.

We see many researchers draw their samples from the general or target population rather than the accessible population. Their choice is a serious flaw that is very likely to increase response and non-response errors to an astonishingly high level. Why so? Potential participants of a study would not be necessarily available at the time of data collection to respond to questionnaires. This is the case because people cannot make unreasonable or extreme sacrifices to participate in a study. To illustrate, a manager of one of the five hospitals being studied cannot call off an appointment simply because he/she wants to respond to a questionnaire. What if many participants who are supposed to respond to questionnaires in one of the hospitals proceed on annual leave and can as a result not be reached at the time of data collection? Participants may also be caught up in a training program within the data collection period. Clearly, the researcher cannot expect the training

session to be called off to make way for his/her research activity. Agreeably therefore, a study can result in an extremely low response rate if provisions are not made against these or similar eventualities. By specifying the accessible population therefore, the researcher sets the foundation for maximising response rate.

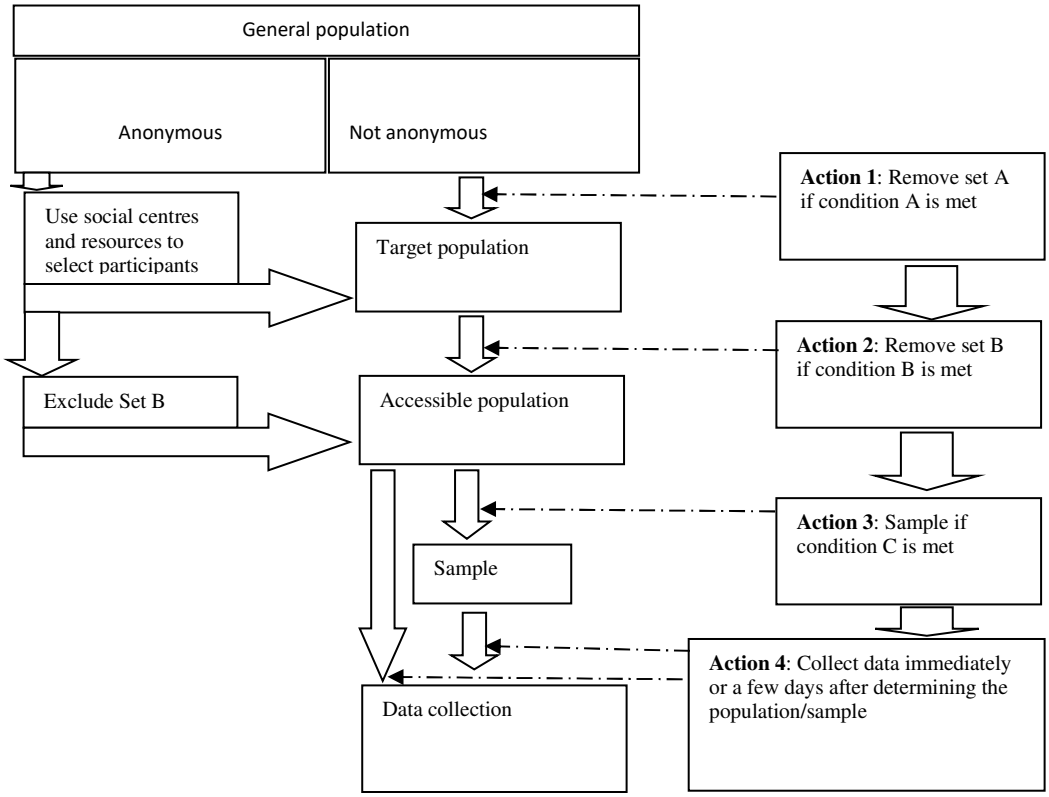
In determining the accessible population to reduce response and non-response errors, the researcher would have to strictly mention the time set for data collection and select into the accessible population only those who will be available to participate in the study at this time. This stage is also an opportunity for the researcher to avoid those who, for personal reasons, are not willing to participate in the study. If people are compelled to participate in a study, they are likely to refuse to complete questionnaires. The refusal of people to participate in a study or their unavailability during data collection is a factor that can limit external validity, but the researcher is very likely to pay a higher price (i.e. a large number of non-response and response errors and a high risk of generalising findings) if he/she fails to screen the target population for only individuals who are willing to participate in the study and will be available to respond to questionnaires. It is irrefutable that members of the accessible population can still be absent at the time of data collection or may fail to complete questionnaires, but the risk of non-response from them is relatively low and is unlikely to curtail generalisability of findings. Moreover, the researcher can take additional steps to avoid non-response or at least reduce it. For instance, he/she could administer questionnaires immediately or a few days after determining the accessible population. This strategy reduces the probability of an unforeseen circumstance (e.g., a change in the participant's schedule, sickness, death, etc.) being encountered and leading to non-response. If the researcher delays data collection after determining the accessible population, eventualities will increase attrition.

In the light of the foregoing considerations, there is no doubt that specification of the accessible population is a good opportunity for maximising response rate and reducing the risk of inference. Yet, the researcher should be mindful of the limit placed on the study's external validity by the removal of individuals who are not willing to participate in the study or will not be available to respond to questionnaires. The number of such eligible participants removed from the target population to form the accessible population should be acknowledged in the study. Doing so does not discredit the study since there is nothing ethically acceptable that the researcher can do to avoid losing some members of the target population apart from coherently and tactfully explaining the importance of the study to prospective participants (i.e. members of the target population). If the researcher does not want to acknowledge the number of subjects taken out of the target population to reach the accessible population, he/she should generalise findings to only the accessible population and report the study's attrition rate.

Conclusions

The general population is crude and would need to be refined by drawing from it the target and accessible populations. Failure to do so can lead to a large number of response and non-response errors, an outcome that has dire implications for data integrity and generalisability of findings. Similarly, the specification or determination of the target and accessible populations as explained in this paper is an opportunity to maximise response rate, data quality, and external validity. If the refinement process leads to a relatively small accessible population, sampling is not necessary. We have seen studies in which researchers went ahead to determine and use a sample even when the accessible population was small and could have been entirely surveyed. It must be borne in mind that sampling is not mandatory in

quantitative research and is only carried out when collecting data on the entire accessible population cannot be supported by resources (i.e. funds and time) available to the researcher.



***Note*:** *Set A* = individuals who have not met the selection criteria; *set B* = those who are not willing or will not be available to participate; *condition A* = if there are individuals in the general population who do not meet the selection criteria; *condition B* = if there are individuals in the target population who are not willing to participate or will not be available to participate; and *condition C* = if the accessible population is too large to support the study's resources and timelines.

Figure 1. A bi-focal conceptual lens for identifying the accessible population to maximise response rate.

Figure 1 depicts the process and stages through which the accessible population is reached. The starting point of the process is the general population, which is determined at stage 1 (see Table 1). The general population has two parts (i.e. conceptual lenses), namely the 'anonymous' (i.e. nothing is known about population members) and 'not anonymous' (i.e. this shows members and their relevant characteristics) divisions. Beyond the 'not

anonymous' facet is the first action that results in the accessible population. That is, the accessible population is formed out of 'not anonymous' by selecting into the target population individuals who have met the selection criteria. If the general population is 'anonymous', the first action is to use social centres (e.g. shopping malls, churches, recreation centres, etc.) and other platforms mentioned earlier to select participants, who become members of the target population. If people who do not meet the selection criteria (set B) are excluded through this channel, the resulting group is the accessible population, which is formed after taking action 2 through the 'anonymous' side of the framework. As mirrored in the figure, the accessible population is the point of convergence of the two conceptual lenses. If the accessible population is too large in view of the study's resources, action 3 is taken to draw a sample; otherwise, the researcher goes to the stage of data collection (i.e. action 4).

Our illustrations suggest that decisions made towards selecting members of the target population are subject to the research objective and context. This viewpoint explains why researchers should apply criteria dictated by the study objective and context to determine the target population. Failure to do so can result in an inappropriate group of participants or sample and as a result reduce internal validity. To add, population refinement is necessary in both qualitative and quantitative approaches, but while this process is repeated several times in qualitative research (or the said step-wise process), it constitutes a single stage criteria-based selection process in quantitative research. The use of selection and exclusion criteria to select study participants is therefore common to the qualitative and quantitative designs, but the protocol applied to the administration of these criteria in qualitative research is more stringent and strongly considers the relevant knowledge and experience of general population members.

Limitations and Future Research Directions

The removal of individuals from the general and target populations in line with our theory can result in an unfavourably small group of participants and sample. This is true of small general populations that have a relatively small number of eligible participants and can act as a buffer against statistical power and the significance of small effects and associations. A possible way to curb this problem is to plan to use a sufficiently large study area and general population. Secondly, the generation of the accessible population by removing from the target population some eligible participants (i.e. those who are not willing and will not be available to respond to questionnaires) limits generalisability of findings, even if inference is made to the accessible population. This is so because estimates (results) of the research are better off if every member of the target population responds to questionnaires accurately. For this reason, the researcher must see removal of some eligible participants from the target population as a study limitation. It is thus incumbent on the researcher to document this limitation.

Reference

1. Hanlon P, Yeoman L, Gibson L et al. (2018). A systematic review of interventions by healthcare professionals to improve management of non-communicable diseases and communicable diseases requiring long-term care in adults who are homeless. *BMJ Open. 2018,* 1-15.
2. Limaye D, Limaye V, Krause G et al. (2017). A Systematic Review of the Literature to Assess Self-medication Practices. *Annals of Medical and Health Sciences Research,* 7, 1-15.

3. Chappell LC, Bell JL, Smith A et al. (2019). Ursodeoxycholic acid versus placebo in women with intrahepatic cholestasis of pregnancy (PITCHES): a randomised controlled trial. *The Lancet,* 394(10196), 1-12.
4. Guo R, Berkshire SD, Fulton LV et al. Predicting intention to use evidence-based management among U.S. healthcare administrators: Application of the theory of planned behaviour and structural equation modelling. *International Journal of Healthcare Management*, 12(1), 1–8.
5. Özer Ö, Uğurluoğlu Ö, Saygılı M et al. (2017). The impact of work alienation on organizational health: A field study in health sector. *International Journal of Healthcare Management*, 12(1): 1–7.
6. Sibiya MN, Ngxongo TSP & Beepat SP. (2018). The influence of peer mentoring on critical care nursing students' learning outcomes. *International Journal of Workplace Health Management,* 11(3), 130-142.
7. Yağar F. & Dökme S. (2017). The relationship between organizational commitment and demographic variables of physicians in public institutions. *International Journal of Healthcare Management,* 12(1): 1–6.
8. Herrett E, Gadd S, Jackson R et al. (2019). Eligibility and subsequent burden of cardiovascular disease of four strategies for blood pressure-lowering treatment: a retrospective cohort study. *The Lancet*, 394 (10199), 663-671.
9. Sandoval GA, Brown AD, Wodchis WP et al. (2019). The relationship between hospital adoption and use of high technology medical imaging and in-patient mortality and length of stay. *Journal of Health Organization and Management,* 33(3), 286-303.

10. Medhekar A, Wong HY &Hall JE. (2019). Factors influencing inbound medical travel to India. *Journal of Health Organization and Management,* 33(2), 155-172.
11. Cuéllar-Molina D, García-Cabrera AM, & Déniz-Déniz MC. (2019). Emotional intelligence of the HR decision-maker and high-performance HR practices in SMEs. *European Journal of Management and Business Economics,* 28(1): 52-89
12. Creswell JW. (2003). *Research Design Qualitative, Quantitative and Mixed Methods Approaches*. Second Education, SAGE Publications, International Educational and Professional Publisher, pp. 3-15.
13. Krejcie RV & Morgan DW (1970). Determining sample size for research activities. *Educational and Psychological Measurement*, 30(1): 232-256.
14. Black K. (2010). *Business Statistics: Contemporary Decision Making*. 6th edition, John Wiley and Sons, 2010.
15. Saunders M, Lewis P & Thornhill, A. (2012). *Research Methods for Business Students.* 6th edition, Pearson Education Limited.
16. Williams C. (2007). Research Methods. *Journal of Business & Economic Research. 5(3),* 65-72.
17. Asiamah N, Mensah HK & Ateng-Abayie EF. (2017). General, Target and Accessible Population: Demystifying the Concepts for Effective Sampling. *The Qualitative Report*, 22(1), 1-14.
18. Asiamah N. (2017). Enhancing nurses' emotional intelligence: are tenure prolongation, education, and in-service training applicable methods even when not specialised? *Cogent Business and Management, 4,* 1–16.

19. Asiamah N. (2017). The nexus between health workers' emotional intelligence and job performance controlling for gender, education, tenure and in-service training. *Journal of Global Responsibility.* 8(1), 1–16.
20. Brackett MA, Mayer JD, & Warner RM. (2004). Emotional intelligence and its relation to everyday behaviour. *Personality and Individual Differences*, 36, 1387–1402.
21. Freshman B & Rubino L. Emotional intelligence: A core competency for health care administrators. *Health Care Manager.* 20(4), 1-9.
22. Hen M & Sharabi-Nov A. Teaching the teachers: emotional intelligence training for teachers. *Teaching Education,* 25(4): 75-390.
23. Jaafar J, Hassan S, Kadir HA, & Yusof HM (2017). The effect of training towards Emotional Intelligence (EQ) and Entrepreneur Culture: An Analysis. *Procedure Economics and Finance*, 31, 730-735.
24. Goleman D. *Emotional Intelligence*. New York, NY: Bantam Books, Inc. 1975.
25. Banerjee A, Chaudhury S, Singh DK et al. (2007). Statistics without tears: Inputs for sample size calculations. *Industrial Psychiatry Journal*, 16, 150-152.
26. Asiamah N, Mensah HK & Oteng-Abayie EF. (2017). Do larger samples really lead to more precise estimates? A simulation study. *American Journal of Educational Research*. 5(1), 9–17.
27. Etikan I, Musa SA & Alkassim RS. (2015). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, (5)1, 1-4.*

28. Majid U. (2018). Research Fundamentals: Study Design, Population, and Sample Size, *Undergraduate Research in Natural and Clinical Science and Technology (URNCST) Journal*. (2)1, 1-7.
29. Rahi S. (2017). Research Design and Methods: A Systematic Review of Research Paradigms, Sampling Issues and Instruments Development, *International Journal of Economic and Management Science*, (6)2: 1-5.
30. Kelley K, Clark B, Brown V et al. (2005). Good Practice in The Conduct and Reporting of Survey Research. *International Journal for Quality in Health Care*. (15)3, 261-266.
31. Ponto J. (2015). Understanding and Evaluating Survey Research, *J Adv Pract Oncol*. 6(2),168–171.
32. Pernecky T. (2016). *Epistemology and metaphysics for qualitative research*. London, UK: Sage Publications.
33. Ames H, Glenton C, & Lewin S. (2019). Purposive sampling in a qualitative evidence synthesis: a worked example from a synthesis on parental perceptions of vaccination communication, *BMC Medical Research Methodology,* (19)26, 1-9.
34. Omair A. (2014). Sample size estimation and sampling techniques for selecting a representative sample, *Journal of Health Specialties*. (2)4, 142-147.
35. Gentles SJ, Charles C, Ploeg J et al. (2015). Sampling in Qualitative Research: Insights from an Overview of the Methods Literature, *The Qualitative Report*. 20(11), 1772-1789.
36. Palinkas LA, Horwitz SM, Green CA, et al. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. Adm. *Policy Ment Health*. (42)5, 533–544.

37. Jang Y, Mortimer JA, Haley WE et al. (2004). The Role of Social Engagement in Life Satisfaction: Its Significance Among Older Individuals with Disease and Disability. *Journal of Applied Gerontology*. 23(3), 266-278.
38. Curtis RG, Windsor TD, & Luszcz MA. (2017). Perceived Control Moderates the Effects of Functional Limitation on Older Adults' Social Activity: Findings from the Australian Longitudinal Study of Ageing. *Journal of Gerontology: Psychological Sciences.* 72(4), 571-581.
39. Mends-Brew E & Asiamah N. (2018). Improving health workers' organisational commitment: Drawing lessons from the interaction between internal marketing and key job characteristics. *International Journal of Healthcare Management*, 11(4), 1-12.
40. Asiamah N, Opuni FF, & Frimpong FKS. (2019). Leveraging word-of-mouth as a payback from patients of private hospitals: the role of healthcare quality delivery. *Int. J. Behavioural and Healthcare Research.* 6(3/4), 251–267.
41. Asiamah N, Opuni FF, & Mensah HK. (2018). The nexus between internal marketing in hospitals and organizational commitment: Incorporating the mediation roles of key job characteristics. *International Journal of Healthcare Management.* 11(4), 1-16.
42. Teddlie C & Yu F. (2007). Mixed Methods Sampling a Typology with Examples. *Journal of Mixed Methods Research*. 1(1), 77-100.
43. Vance DE, Talley M, Azuero A et al. (2017). Conducting an article critique for a quantitative research study: perspectives for doctoral students and other novice readers. *Nursing: Research and Reviews*, 3, 67–75.
44. Azinga SA, Asiamah N & Mensah HK. (2019). Eschewing love of money and materialism: a potential step towards avoiding nurses' intention to quit. *Int. J. Behavioural and Healthcare Research.* 6(3/4), 225–236.

45. van Rijnsoever FJ. (2017). (I Can't Get No) Saturation: A simulation and guidelines for sample sizes in qualitative research. *PLoS ONE*. 12(7), 1-17.
46. Rezai M, Côté P, Cassidy JD et al. (2008). The association between prevalent neck pain and health-related quality of life: a cross-sectional analysis. *European Spine Journal*. 18(3), 371-381.
47. Edomwonyi EO & Ogbue IA. (2017). Epidemiology of Low Back Pain in a Suburban Nigerian Tertiary Centre. *Nigerian Journal of Surgical Science*. 27, 20-25.
48. Nelson LA, Noonan CJ, Goldberg J et al. (2013). Social Engagement and Physical Activity and Cognitive Health Among American Indian Participants in the Health and Retirement Study. *Journal of Cross-Cultural Gerontology*. 28, 453-463.
49. Martinez-Mesa J, González-Chica DA, Duquia RP et al. (2016). Sampling: how to select participants in my research study? *An Bras Dermatol*. (91)3, 326-30.
50. Newton JD, Klein R, Bauman A et al. (2015). The MOVE study: a study protocol for a randomised controlled trial assessing an intervention to maximise attendance at physical activity facilities. *BMC Public Health*. 15, 1-9.
51. Brand T, Gansefort D, Rothgang H et al. (2016). Promoting community readiness for physical activity among older adults in Germany – protocol of the ready to change interventional trial. *BMC Public Health*. 16, 1-6.
52. Krueger KR, Wilson RS, Kamenetsky JM et al. (2009). Social engagement and cognitive function in old age. *Experimental Ageing Research*. 35(1), 45-60.
53. Benoot C, Hannes K & Bilsen J. (2016). The use of purposeful sampling in a qualitative evidence synthesis: A worked example on sexual adjustment to a cancer trajectory. *BMC Medical Research Methodology*. (16)21, 1-12.