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COMPARISON OF HOUSEHOLD MEASURES TO FOOD PHOTOGRAPHS IN PORTION SIZE ESTIMATION OF PROTEIN FOOD SOURCES AMONG ADULTS IN SPINTEX-ACCRA, GHANA

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MSC. IN DIETETICS DEGREE.

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DECLARATION

I, Blessing Ama Ijenkeri Norgbe hereby affirm that this thesis is entirely my own original work and has not been partially or entirely submitted to the University of Ghana or any other institution with the purpose of receiving a different degree. The works of others have been appropriately recognized both within the text of the work and/or in the references list in those parts where it was appropriate to do so.

31/01/2023

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DEDICATION

I dedicate this thesis to God almighty for his sufficient grace, for seeing me through, and to my family.

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ABSTRACT

Background: Accurate estimation of portion size remains a challenge in dietary assessment. The Photographic Food Atlas (PFA) has been identified to be a more convenient tool compared to other portion size estimation tools. While an atlas has been developed and validated for carbohydrate and protein source Ghanaian foods, the accuracy of estimations made with the photographic atlas is yet to be tested against that of household measures (HHM) commonly used by dietitians and other nutrition professionals.

Aim: This study aimed to assess the accuracy of portion size estimates of commonly consumed protein-source foods using a Photographic Food Atlas in comparison with household measures.

Method: This was a cross-sectional study with participants from churches selected in the Spintex area in Accra, Ghana. Data was collected in September 2022 with a structured questionnaire and analyzed with STATA 16.0 software. Simple random sampling was employed during the first two stages of the study. First, a community within Spintex Accra was selected. A list of all the churches within the selected community (Nungua) was compiled to form a sampling frame for the second stage. Following that, study participants were selected by systematic random sampling, using the calculated sampling interval specific to the selected church using a structured questionnaire.

Logistic regression analysis was conducted to assess the association between participants' characteristics and the accuracy of portion size estimations using the PFA. Also, a one-sample t-test was conducted to determine differences in the portion size estimation by the assessment methods with the true weights of the food items at a statistical significance of $p \leq 0.05$.

Results: A total of 70 participants (mean age = 32.66 ± 11.4 years) were recruited. Altogether, 560 portion size estimations were recorded for the boiled egg, chicken, Atlantic mackerel, and

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groundnut soup samples, using the Photographic Food Atlas and the Household Measure (i.e., 280 estimations per portion size estimation aid). These estimations showed an overall accuracy rate of 30% and 35.7% respectively for PFA and HHM. Portion Size Estimation Aids (PSEA) significantly influenced the weight of the food item predicted by the participants. All the mean estimates showed that for all food items, portion size estimations that participants made using either of the PSEAs differed significantly (p=0.001) from the actual weights of the foods. Use of the PFA resulted in more overestimation of portion size than that of the HHM, for example, the percentage deviation for fried chicken thigh with the use of the PFA was 107% above the true weight (45g), compared to 35.7% for HHM. Lastly, participants' characteristics such as age, sex, BMI, and educational background were independent of how participants estimated the food samples presented to them.

Conclusion: Although most food samples in the study were estimated accurately using the photographic food atlas, the smoked fish sample (Atlantic Mackerel), a major protein source in the Ghanaian diet, had a higher proportion of accurate estimation when HHM was used, which makes the household measure (matchbox) a more suitable PSEA in estimating fish in dietary surveys and assessment in Ghana. Participants' factors such as age, sex, BMI, and educational background were not significantly associated with participants ability to accurately estimate portion sizes of food samples presented to them.

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LIST OF ACRONYMS

BMI	Body Mass Index
EPC-CHS	Ethical and Protocol Committee of the College of Health Science
FAO	Food and Agricultural Organization
HHM	Household measures
NCDs	Non-Communicable Diseases
PFA	Photographic food atlas
PSEA	Portion size estimation aids
SD	Standard Deviation
WHO	World Health Organization
GAMA	Greater Accra Metropolitan Area

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DEFINITION OF TERMS

Photographic Food Atlas (PFA): A set of photographs bound together in a single volume to depict different sizes of food items for the purposes of assessing dietary intake.

Household Measures (HHM): Items within the household used to assist in the estimation or description of the amounts of food consumed.

Portion size: The actual amount of food served on a plate at a time, or the amount of food eaten (Benton, 2015).

Protein food sources: These are food groups consisting of amino acids as their basic units. They come from both animal and plant sources.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Obtaining accurate information about individual and population dietary patterns is a challenging task (Gibson *et al*., 2016). There are two broad approaches for the collection of data for dietary assessment, namely; the direct and indirect methods (FAO, 2018). Depending on the purpose for which the data is intended; an appropriate method is chosen (Ali *et. al*, 2018). Indirect methods are employed at both household and national levels, and some examples include a food balance sheet and household expenditure survey, etc. At the individual level, direct methods such as 24-hour recall, the weighing method, and food frequency questionnaire are used. Direct methods of dietary assessment are further classified into prospective and retrospective methods (FAO, 2018).

Each of these methods have some inherent limitations, ranging from recall bias to under or overestimations of nutrient and dietary intake (McClung *et al*., 2018). A study conducted by McClung *et al*., (2018) reported that self-recall methods, such as the 24-hour recall, was shown to underestimate energy intake (McClung *et al*., 2018). The weighed food method, although considered the gold standard, tends to be tedious and cumbersome, and in some cases not practical (Sambell, Wallace, Costello, Lo, & Devine, 2019).

Portion size estimation of food is an important aspect of dietary assessment and a key determinant of the accuracy of food and nutrient quantification. It also plays a key role in individualized nutrition intervention, assessing dietary intake at population level, in diet-related research, and in informing nutrition policies and guidelines (Gibson *et.al* 2017). Direct weighing of food is the

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most accurate way to determine the exact amount of food consumed. However, this approach is burdensome to respondents and often not feasible. As a result, various portion size estimation aids (PSEA) such as household measures, hand measurements, food photographs (Photographic Food Atlas), food models, etc. are instead used (Vu *et. al.*, 2017). In Ghana, dietitians and nutritionists often use household measures such as cooking ladles, spoons, cups, etc. for portion size estimation (McClung *et al.*, 2018, Boateng, 2014). Although useful, household measures can be bulky and difficult to transport especially when fieldwork is involved. Furthermore, there is an increased likelihood of incorrect estimation because respondents may find it difficult to relate some of the objects to food (Kuevi, 2020).

Employing the best dietary assessment methods and portion size estimation aids which are both accurate and effective in measuring diet quality is necessary to manage health conditions and improve the general wellbeing of individuals. To achieve this, the Photographic Food Atlas was developed to serve as a portion size estimation aid (Wong & Wong, 2020). The PFA has been identified as a useful and effective tool for measuring food consumed (Villena-Esponera *et al.*, 2019). By definition, a photographic food atlas is a set of photographs depicting different quantities of food and usually bound together in a single volume (Nelson and Haraldsdottir, 1998). In view of the differences in dietary patterns, photographic food atlases must be appropriate and relevant for the context in which they will be used. Also, due to differences in food habits and ethnicity, a photographic food atlas cannot be assumed to have the same level of validity throughout populations (Ding *et al.*, 2021).

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The development and validation of photographic food atlases from different parts of the world are widely reported in literature (Korkalo *et al*., 2012; Nikolić *et al*., 2018; Ding *et al*., 2021). A PFA of commonly consumed carbohydrate-based Ghanaian foods was first developed and validated in 2014 (Boateng, 2014) and more recently for plant and animal protein source foods (Kuevi, 2020). Since household measures currently remain the most popular PSEA in Ghana, this current research seeks to compare their accuracy with that of the photographic food atlas of commonly consumed protein source foods.

1.2 Problem Statement

The need for accurate dietary assessment tools, including user-friendly portion size estimation aids, is important for delivery of the best and most individualized care to clients and the population at large (Höchsmann & Martin, 2020; Downer *et al.*, 2020). The photographic food atlas presents a potential in this regard (Villena – esponera et al. 2019). In a study conducted by Amoutzoupoulus *et. al* 2020, an estimated error of 10.76% to 39% was reported when food photographs were used as compared to 53.1% to 87.7% with the use of household measures. The validation studies conducted in connection with the photographic food atlases developed for Ghanaian foods reported accuracy rates of 52% and 47% for carbohydrate and protein source foods respectively (Boateng, 2014; Kuevi, 2020). However, in both studies, accuracy with the use of household measures commonly used in Ghana was not assessed for comparison with those obtained when the food photographs were used.

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Also, three elements determine individuals' ability to accurately estimate portion size using the food photographs, namely, perception, memory, and conceptualization. Perception is a person's

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ability to relate a food photograph that depicts a specific amount of food to a quantity of food that is present within their sight, while conceptualization is the ability to 'develop a mental picture of an amount of food and relate that to a photograph' (Naska *et al.*, 2016). The third element of memory is the ability to accurately recall an amount of food that was previously consumed (Naska *et al.*, 2016) (and therefore is no longer within sight), such as is required of respondents for instance during a 24-hour dietary recall. The studies by Boateng *et al*. (2014) and Kuevi (2020) made use of the visual perception method where respondents used the atlas to estimate food portions within sight. This approach is not fully representative of a typical dietary assessment session, where the food is not in sight and a respondent rather must create a mental picture of what has been previously consumed and relate it to the appropriate portion picture in the atlas (Naska *et al.*, 2016). This current study, therefore, seeks to explore the use of the photographic food atlas in portion size estimation of protein source foods in comparison to household measures, within a setting that closely mimics the usual conditions under which retrospective dietary assessment is carried out.

1.3 Significance of the Study

Accurate portion size estimation is important for evaluation of dietary intake. Therefore, a portion size estimation tool that is both accurate and user-friendly is imperative. Although not as accurate as the gold standard i.e., the weighing method, photographic food atlases are more practical and less burdensome. This study will provide evidence regarding the accuracy of the photographic food atlas for portion size estimation in comparison with household measures commonly used in our local context. The study will also contribute to literature about the use of the photographic food atlas in a more realistic setting i.e., when the food to be estimated is not within sight. These

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findings will together provide evidence regarding the appropriateness of using this tool for dietary assessment in our local context.

1.4 Hypothesis

There is no difference in the accuracy of portion size estimation of commonly consumed protein-source foods when household measures or the photographic food atlas are used.

1.5 Aim and Specific Objectives

1.5.1 Aim

To assess the accuracy of portion size estimates of commonly consumed protein-source foods using photographic food atlas in comparison with household measures.

1.5.2 Specific Objectives

1. To assess the proportion of the participants who are able to estimate the selected portion sizes accurately using the household measures and the photographic food atlas.
2. To assess and compare portion size estimations obtained with the atlas to that derived from the use of household measures.
3. To evaluate the factors associated with accurate portion size estimation with the photographic food atlas.

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CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Dietary Assessment Methods

In the nutrition care process and model, dietary assessment is one of four domains of nutrition assessment, the others being anthropometric, biochemical, and clinical examination (Gibson, 2005). Dietary assessment identifies nutrient deficits in people and the foods they eat (Sharma and Chadha, 2017). The accuracy of dietary assessment is critical not just for quantifying what people consume and how it affects their health, but also for monitoring, and evaluating suitable dietary interventions. Application of nutritional assessment methods might be direct or indirect (Fig 2.1), depending on the necessity for use (FAO, 2018). For most methods that assess dietary intake in retrospect, Portion Size Estimation Aids (PSEA), such as household measures and photographic food atlases, etc. are useful in determining the amount of food consumed by the respondent. Accurate portion size estimation is therefore important in achieving desired dietary interventions and managing Non-Communicable Diseases (NCDs) among individuals or in the population.

Accurate dietary assessment can explain the relationship between nutrition and health outcomes, as well as the effectiveness of public health programs and treatments. To acquire dietary information, dietary assessment methods such as food frequency questionnaires and 24-hour dietary recall can be employed. However, because of the intrinsic drawbacks of some of those methods, they are likely to induce respondent fatigue and poor-quality reported data, both at the individual and population levels (Kang *et al.*, 2018, Hooson Jzh *et al*., 2020; Shinozaki et al., 2021). The inability to accurately assess an individual's nutritional status could result in the misinterpretation of the relationship between dietary intake and diseases (Shinozaki et al., 2021).

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Archundia *et al* carried out a narrative review of new methods for assessing food and energy intake and found out that although dietary assessment methods such as the 24-hour recall, food frequency questionnaire and food record were a more useful tool in assessing food intake, they presented a major challenge of recall bias (Archundia *et al.*, 2018). The narrative study also reported that although the food record does not depend on individuals' ability to recall, it had a limitation of being a tedious process for participants to carry out, which can lead to changes in individuals' food pattern, thereby leading to inaccurate reports of food consumed (Archundia *et al.*, 2018).

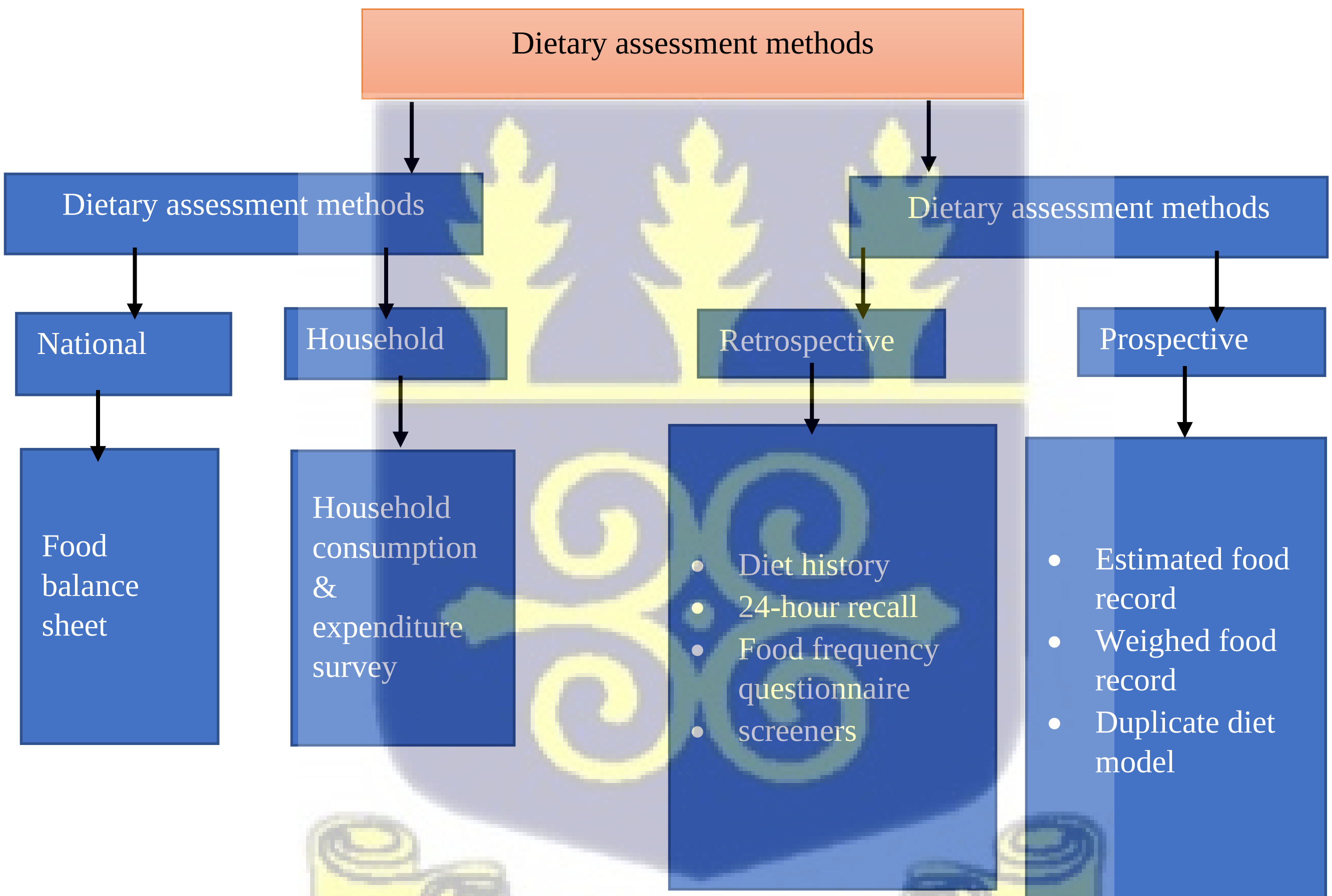

Figure 2.1: Overview of dietary assessment methods commonly used to estimate food and nutrient consumption at national, household, and individual level.

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2.2 Portion Size Estimation Aids

Portion size is defined as the actual amount of food served on a plate at a time, or the amount of food eaten (Benton, 2015) without leftovers (Sharma and Chadha, 2017). Often there is usually a mix-up between portion size and serving size, but they are completely different terms that translate into different meanings. Portion size is the amount of food consumed by an individual, while serving size is the amount of food recommended for an individual to consume (Faulkner *et al.*, 2017). Accurate estimation of food portion size is critical in dietary assessment, in determining the amount of nutrient taken for the best delivery of nutritional intervention. When portion sizes are not accurately estimated, this can result in errors in determining nutrient intake (Gibson *et al*, 2017). Portion Size Estimation Aids (PSEAs) are tools that help in obtaining accurate portion sizes of food consumed, and they have been in use since the early 1980s (de Vlieger *et al.*, 2020). These tools come in various formats such as food images, food replicas, household measures, and food models that assist individuals with estimating their portion sizes (de Vlieger *et al.*, 2020). Ideally, weighing food to get the exact quantity consumed, is considered the gold standard, but due to associated challenges such as participant burden and it being expensive, it is often not feasible for use in most circumstances (Foster *et al.*, 2009). Other portion size estimation aids require participants to estimate food quantities using tools, such as food images, food replicas, etc. subjectively, which are more often prone to errors of over and underestimation (Gibson *et al.*, 2016). There are two main classifications of portion size estimation aids, and they include two-dimensional and three-dimensional tools. However, some literature classifies portion size estimation aids such as food labels, till receipts and portion guides as one-dimensional portion size estimation aids (Byrd-Bredbenner and Schwartz, 2004, Amoutzopoulos *et al.,* 2020). Examples of one, two and three-dimensional portion size estimation aids are shown below in Table 2.1.

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Table 2.1: Examples of Portion Size Estimation Aids Based on Their Dimensions

Category	Examples
One dimensional	Till receipts Food guides Portion lists Labels/food packaging
Two dimensional	Images of utensils Images of Hand Food photo (i.e., Photographic atlas) Electronic image
Three dimensional	Hands Ruler Household utensils Food weighing scales Food models and replicas such as plastic meat, fruits etc.

Source: adopted and modified from Amoutzopoulos *et al.*, 2020; Bucher *et al.*, 2017; SharmaChadha 2017; Vu et., 2017.

2.2.1 Portion size estimation using Photographic Food Atlas.

A photographic food atlas is "a set of photograph series of food in portion sizes, usually bound together in a single volume" (Nelson & Haraldsdóttir, 1998). Usually, the foods listed in the atlas as well as the portions captured, are representative of what is consumed by the population in which it is administered (Ding *et al.*, 2021). Compared to PSEA's such as food models with a limited number of food types and portion sizes, photographic food atlases can capture a broad range of foods and in varying portions (Amoutzopoulos *et al.*, 2020). During the use of photographic atlases, a respondent is requested to show the clinician or researcher the quantity of food they (respondent) consumed by choosing a particular picture or a combination of pictures (Amoutzopoulos *et al.*, 2020).

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Three elements determine an individual's ability to accurately estimate portion size using the food photograph: perception, memory, and conceptualization. Perception is the ability of an individual to quantify portion size when food is in sight, in relation to photographic food atlas. While with memory and conceptualization, the individual is required to create a mental picture of food and recall the portion size in relation to the photographic food atlas, when the food is not in sight (Naska *et. al* 2016). The use of perception was employed in a couple of studies carried out in Ghana in validating generated photographic food atlas for both carbohydrate and protein food (Boateng, 2014; Kuevi, 2020). Another study conducted by Korkalo *et al*. (2012) among Mozambican adolescent girls employed the element of memory and conceptualization in estimating portion sizes using the photographic food atlas (Korkalo *et al*., 2012). Food photographs have been demonstrated to be valuable for field dietary assessment across different settings, including rural areas (Huybregts, *et al*., 2007; Lazarte *et al*., 2012). This has demonstrated minor errors over different population subgroups and in some instances, over 98% accuracy (Harris-Fry *et al*., 2016; Nikolic *et al*., 2018).

The development of photographic food atlases for use among the general population have been reported by the following: Al Marzooqi *et al*., 2015, for Dubai, Harris-fry *et al*., 2016 for Nepal, Ding *et al*., 2021 for China, Shinozaki *et al* 2021 for Japan, and Kuevi 2020 for protein foods in Ghana. Other photographic food atlases have been developed for special use; for example the PFA developed for use in rural Eastern Cape Province, South Africa, where a high incidence of esophageal cancer had been reported. In the PFA reported for the Eastern Cape Province, food consistency was considered in their nutrition intervention (Lombard *et al*., 2013). Similarly, PFA's

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were also developed for Spanish food consistency in assessing the nutritional status of patients with dysphagia (Ruiz Brunner *et al*., 2019).

2.2.2 Portion size estimation using Household Measures.

Household food models come with limited number of food types and portion sizes (Amoutzopoulos *et al.*, 2020). In the absence of the standard portion size methods, this assessment procedure has been employed because of its applicability and feasibility across different range of settings, especially in the clinical and low resource settings (FAO, 2018). Both field workers and clinicians in low resource areas often use household models - utensils and other objects such as cooking ladles, spoons, cups etc. for portion size estimation (McClung *et al.*, 2018; Boateng, 2014). Although useful, household measures can be bulky and difficult to transport especially when fieldwork is involved. Furthermore, there is an increased likelihood of incorrect estimation because respondents may find it difficult to relate some of the objects to food (Kuevi, 2020).

In a study conducted in Ireland to evaluate the precision of portion size estimation aids, respondents all agreed that household measures were easy to use, and they were more likely to use these aids for portion size estimations of food items, but not for composite foods such as grated cheese, lasagne, and crisps (Faulkner *et al*., 2017). The study also reported that household measures were found to produce a narrower range of estimated weights as compared with food packaging and reference objects except for wine, mayonnaise, and cheddar (Faulkner *et al*., 2017). Also, a study that evaluated consumer perspective of portion size estimation aids observed that

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visual aids such as pots and cups, amongst other known HHM were most preferred and acceptable for the estimations of amorphous grains such as cereals: pasta and rice (Faulkner *et al*., 2017).

2.3 Comparison of rates of correct portion size estimation using both household measure and photographic food atlas

The previous findings by Aoutzoupoulous *et al*., 2020, point more to the accuracy of the photographic food atlas over household measures, due to its lower margin of error. The photographic food atlas with a reported accuracy of about 98%, (Harris-Fry *et al*., 2016; Nikolic *et al*., 2018), has been shown to be useful for the purpose of field dietary assessment across different settings, including rural areas (Lazarte *et al*., 2012). In Ghana, although the accuracy of the photographic food atlas has been determined in relation to selected food items from carbohydrate and protein food sources (Boateng, 2014; Kuevi, 2020), it has not yet gained wide usage among dietitians and nutritionists. This contrasts with the much greater use by clinicians of household measures as portion size estimation aids, despite their reported higher margin of error. (Aoutzoupoulous *et al*., 2020). Household measures are familiar to both participants and dietitians alike and are relatively easy to use. Household measures are known for their precision of portion size estimates (Faulkner *et al*., 2017) and this may also account for dietitians persistent reliance on it as a portion size estimation aid of choice. However, HHM have an additional disadvantage of not being easily mobile due to their bulkiness. The difference in equivalence of various household tools can also be a problem in our local context when estimating portion sizes, depending on the country of origin of a particular household measure. For example, a cup could refer to 250ml using imperial (UK) or 239.59ml using the US standard, depending on what is available on the Ghanaian market (Owusu *et al*., 1995). While pots and cups are most preferred and acceptable for the

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estimations of amorphous grains such as cereals (Faulkner *et al*., 2017), there are concerns of its applicability for all food items such as meat and fish, hence, the need to validate the photographic food atlas among these food groups for wide clinical and field therapeutic services.

2.3.1 Accuracy of portion size estimation using Photographic Food Atlas

There is evidence on the significant improvement of quantification of food using the Photographic Food Atlas, when standard sizes of food consumed by the population are displayed (Nelson *et al*., 1994, Nelson *et al*., 1996). Researchers have, over the years, recorded the effectiveness of the PFAs, their convenience, and how easy to use they can be, even in low literacy populations (Ovaskainen *et al*., 2008, Subasinghe *et al*., 2016). In a study aimed at using a PFA to improve the accuracy of a 24-hour dietary assessment of Malaysian foods, Mohdmarjan reported that out of the 23 food samples given to participants, 17 were accurately estimated using the weighing methods as a reference (Mohdmarjan, 1995). Turconi *et al*. in 2005, also recorded relatively fewer errors when the validity of the photographic food atlas was tested in quantifying food among 448 males and females in Pavia, Northern Italy (Turconi *et al*., 2005). In an effort to prove initial researchers' reports of the convenience and effectiveness of the PFA, the photographic food atlas tool has in consequence become the most investigated two-dimensional portion size estimation aid (Subar *et al*., 2015; Sharma and Chadha, 2017; Hotz and Abdelrahman, 2019).

The use of photographic food atlas from several studies conducted have reported a good range of accuracy rate. In Ghana, studies conducted in the development and validation of photographic food atlas for both carbohydrate and protein food reported 52% and 47% of accurate estimations respectively (Boateng, 2014, Kuevi, 2020). Similar and higher estimations have been recorded in other studies. Ovaskainen *et al*., (2008), recorded 51% and 49% correct estimation rates in men

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and women respectively, in their study carried out to assess the validity of the photographic food atlas among 161 adults in Turku, Finland. Villena-Esponera *et al,* (2019) and Amougou *et al,* (2016) also reported 66% accurate estimations out of 500 estimations in Ecuador and 77% accuracy rate in Central Africa respectively. A total of 90% of participants in a Greek study were able to select the correct image using a traditional food atlas of pies and pastry dishes in a dietary survey. According to the authors, the digital food atlas appeared generally suitable in large-scale dietary surveys in Greece to estimate average food intake among the population (Naska *et al.*, 2016).

Despite these high levels of correct estimations shown to have been recorded, a few studies documenting lower percentages have also been reported. For instance, in studies conducted by Biltoft-Jensen *et al,* (2017) and Nichelle *et al,* (2019), they both recorded correct estimation rates of 42% and 36% respectively.

As a result of the more broadly positive results for the PFA, Jayawardena and Herath, (2017) concluded that the photographic food atlas provided more accurate results in the majority of studies conducted (Jayawardena & Herath, 2017). Villena-Esponera *et al,* (2019) also acknowledged that food photographs were very useful and appropriate for portions size estimations in dietary surveys.

2.3.2 Accuracy of portion size estimation using household measures

Several studies have investigated how accurate food portion size estimation can be when household measures such as cups, plate, soup ladle, spoon etc. are used, but not in comparison with the use of photographic food atlas. A systematic review conducted by Amoutzopolus *et al.* 2020 to determine the strengths and weaknesses of portion size estimation aids in dietary assessment reported an estimated error of 53.1% to 87.7% with the use of the household measure.

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However, it has been stated that the household measure is a preferred tool when certain types of foods (such as amorphous foods) are being estimated (Faulkner *et al.,* 2017). This was the case because most participants interviewed during the study felt that they could easily relate to the day-to-day tools that are usually employed using the household measures (Faulkner *et al.,* 2017). Furthermore, Bernal – Orozco *et al.* 2012 reported in their study of the validation of portion size estimation aids in Mexico, that, household measures had an estimated error rate of 44.9% and was considered the second most preferred tool in terms of accuracy after the photographic food atlas in this study.

2.4 Differences in portion size estimation, from true weights using PSEAs.

Photographic food atlas is gradually becoming relevant in the field of epidemiological dietary studies, across different countries and population subgroups. As such, many studies are required to validate the use the photographic food atlas, to improve accuracy of portion size estimation in dietary assessment. One of such studies was conducted in Tunisia where authors developed and validated photography manual on eight food categories for the purpose of epidemiological dietary surveys (Bouchoucha *et al.,* 2016). This study used the photographic food atlas and the weighing method for the portion sizes consumed by the participants. According to the authors, sweets and animal products were underestimated by the participants using the photographic food atlas. But bread, pasta, fruits, vegetables, and dairy products were overestimated using the same photographic atlas (Bouchoucha *et al.,* 2016). The study further noted no significant difference between the two assessment methods in the estimations of the eight food samples used, except for

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the dairy products and pasta. The coefficient of correlation between the two methods was, however, highly significant, for the pasta and the dairy products (Bouchoucha *et al.*, 2016).

Another study was also conducted in the Middle East cultures (Lebanon) by Tueni *et al.*, (2012). The study used photographic atlas constructed from three pre-weighed portion sizes of 212 traditional Lebanese dishes, to assess pre-weighed food sample and for portion sizes consumed in the second phase of the assessment. The authors also noted no significant differences between actual and estimated portion sizes for all the food samples except for three dishes. According to the authors, the variations (0.2-6.3 grams) observed among the remaining three food samples were very much negligible (Tueni *et al.*, 2012).

Timon *et al.*, (2018) compared portion size estimates of older and young adults together with some professionals (nutritionists) using food atlas versus a computerized method in the United Kingdom. The authors similarly noted no significant difference in the participants' estimates using the atlas versus the computer food photographs format on larger food samples and spreads. Significant differences were, however, observed between the traditional food atlas versus the computerized food photographs in the estimation of portion size of smaller food samples. Using the food atlas resulted in underestimations of the smaller food samples as compared with the computerized version, which yielded more accurate estimates.

Overestimations of amorphous food samples and spreads were also observed using both methods, together with underestimations of larger food samples according to the authors (Timon *et al.*, 2018). A study conducted in Greece found different results (Naska *et al.*, 2016). According to Naska *et al.*, (2016) participants overestimated small food samples using photographic food atlas

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of traditional Greece pies and pastry dishes and rather underestimated the larger quantities in the study. An Ecuadorian study was conducted to validate images of a photographic atlas of food portions (Villena-Esponera *et al.*, 2019). In this study, the authors observed significant differences between the actual amounts of the food samples and the estimations with the use of household measures but not photographic atlas among the study population (Villena-Esponera *et al.*, 2019).

2.5 Factors associated with accurate portion size estimation with the photographic food atlas.

Various characteristics of the photographic food atlas are reported to affect respondents' ability to estimate portion size of food items. For example, differences in the number of portion sizes displayed have been shown to affect respondents' accurate estimates of portion sizes. Also, sizes of the picture, and camera angle from which the picture is taken, are said to independently influence portion size estimations (Ovaskainen *et al.*, 2008). Difficulty in estimating portion size of food was recorded by another author, when significant change in shape and appearance of food displayed occurred during preparation and consumption of those foods (Fang *et al.*, 2018). In instances when portion size of food was well defined (i.e., with foods that had known shapes to them), it was easier for participant to accurately estimate (Thoradeniya *et al.*, 2012). Faulkner *et al.*, (2017) also reported that in a qualitative study, participants expressed that they had difficulties in estimating amorphous foods such as cereals, rice, and pasta. Amorphous foods have also been shown to be the least accurately estimated food by participants, not just in adults but in children as well (Ayala, 2005, Reale *et al.*, 2019, Kuevi, 2020).

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Besides attributes of the photographic food atlas likely to affect its effectiveness, some participants characteristics are often expected to affect perception, memory and conceptualization during the portion size estimation process (Ovaskainen *et al.*, 2008). A study conducted by Nelson *et al.* (1996) in the United Kingdom, used eight food photographs for portion size and nutrient content estimations. According to the authors, sociodemographic characteristic such as age and sex influenced participants' estimates of portion sizes (Nelson, Atkinson, & Darbyshire, 1996). A decade later, Foster *et al.*, (2006) carried out a study to evaluate the need for age-appropriate food photograph in estimating food portion sizes in children, and reported that, age influenced portion size estimation, especially when age-appropriate photographic atlas was administered to children. According to a study in Greece, adolescents were more likely to underestimate food quantities with the use of photographic food atlas than adults (Naska *et al.*, 2016). Santos *et al.*, (2010) also conducted a study among adolescents and reported that they were five times more likely to underestimate their food intake (Bazelmans *et al.*, 2007, Santos *et al.*, 2010).

This finding was however, contradicted by Turconi *et al.*, (2005) in Italy**.** Turconi *et al.*, (2005) found that the age of the participants along with their sex, did not significantly influence the estimates of the portion sizes used in the study. Naska *et al.*, 2016 also reported findings which contradicted their study from two decades earlier. In their new study, the authors evaluated digital food photographic atlas in portion size measurement among 103 participants in Greece. The authors stated that the portion size estimates were independent of the participants' sociodemographic characteristics (sex, age, and educational attainment) (Naska *et al.*, 2016). With regards to sex, many reports have been made on the bases that females tend to accurately estimate portion sizes, compared to their male counterparts, the ability of women to estimate more

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accurately has been attributed to women been more familiar with the cooking experience (Yuhas *et al.*, 1989, Keenan *et al.*, 2018, Almiron – Roig., 2013). However, according to Bazelmans *et al.*, 2007, it was also reported that women were more likely to underestimate more, as compared to males who overestimated their food portions.

Another factor reported to significantly influence portion size estimation, among participants is their body mass index (BMI). According to Nelson *et al.*, (1996), body mass index of participants in United Kingdom influenced their portion size estimates (Nelson *et al.*, 1996). It has been observed that individuals with normal weights are more likely to estimate correctly, compared to individuals who are overweight and obese (Horne *et al.*, 2019). A study by Bazelmans *et al.*, (2007) among obese elderly in Belgian, reported that, they were more likely to underestimate their food portion. In support of this report, several studies have also observed that individuals who were not obese also had the tendencies to underestimate their food intake (Okubo & Sasaki, 2004).

In conclusion, the literature reviewed shows that the PFA is a useful and convenient portion size estimation aid. Although no direct comparisons between the PFA and HHM have been found in the literature reviewed, studies show that the PFA consistently performed at a higher percentage of accuracy compared to the HHM. In addition, participants characteristics on portion size estimation have not been conclusive.

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CHAPTER THREE

3.0 METHODS

3.1 Study Design

A facility-based cross-sectional methodology was adopted in this quantitative study.

3.2 Study Site

The study was conducted among churches selected from Spintex, a suburb of Accra, Ghana. The suburb is located in the north of Accra, stretching about 5.2 kilometres from the Tetteh Quarshie Interchange to the Tema Beach (King *et al.*, 2018). It lies at latitude: 5° 37' 55.92 and longitude: -0° 5' 26.16 of the capital city of Accra. Spintex is a vibrant and colourful suburb, with several markets, smart city malls, hotels, and restaurants. The suburb consists of several communities, including Texpo, Baatsona, Community 18, Manet, Coastal, and Kasapreko.

3.3 Study Population

The study population comprised adult Ghanaians (18 years and older) who attends orthodox, pentecostal, and charismatic churches in Spintex.

3.3.1 Inclusion Criteria

Participants for the study included only attendees of the selected churches. Apparently healthy Ghanaian males, and females who were eighteen years and above, the legal consent age, were enrolled after they signed the written informed consent.

3.3.2 Exclusion Criteria

The study excluded pregnant females and people who were averse or allergic to any of the study foods. Any person with any self-declared vision difficulties was also excluded from the study. The

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participant age limit was set at 70 years because of the likelihood of impairment in eye function and memory loss, among other conditions associated with old age, which may affect the validity of their responses (Ahmed & Haboubi, 2010; Sinclair, Hillson & Bayer, 2014).

3.4 Sample Size Determination

Using the following formula by Nelson and Haraldsdóttir, (Nelson and Haraldsdóttir,1998) a total of 70 study participants including 10 % for non-response were enrolled as follows:

$$n = [2\ \sigma^2\ (Z_{\alpha/2} + Z_{\beta})^2]\ /\ d^2$$

Where σ^2 is the variance of the estimates of the portion sizes, *d* is the size of the average difference between the estimated portion sizes and the actual sizes, and $(Z_{\alpha/2} + Z_{\beta})^{2}$ reflects the value for type 1 error and a statistical power of 80%.

$$n = [2\ (40)^2\ (1.96 + 0.84)^2]\ /\ (20)^2 = 25088\ /\ 400 = 63$$

calculated sample size/ (1-attrition rate)

$$63/\ (1-0.1) = 70$$

3.4.1 Sampling Procedure for Recruitment of Study Participants

Simple random sampling was employed by the study at different stages (first and second stage). First, to select one community within Spintex in Accra. A list of all the churches within the selected community (Nungua) was compiled to form a sampling frame for the second stage. The churches within Nungua were categorized into three main groups: orthodox, pentecostal, and charismatic. Secondly, simple random sampling was used again, to select one church from each of the three groups. The estimated sample size was then proportioned to the number of church members (an estimated number given by a church elder). The estimated number of church members were

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divided by the specific sample quotas to obtain different sampling intervals; 25th Pentecostal, denomination, 23rd for charismatic denomination and 51st for orthodox denomination for the selection of the study participants. Lastly, study participants were selected by systematic random sampling, using the calculated sampling interval (nth), specific to the selected church (Fig 3.1).

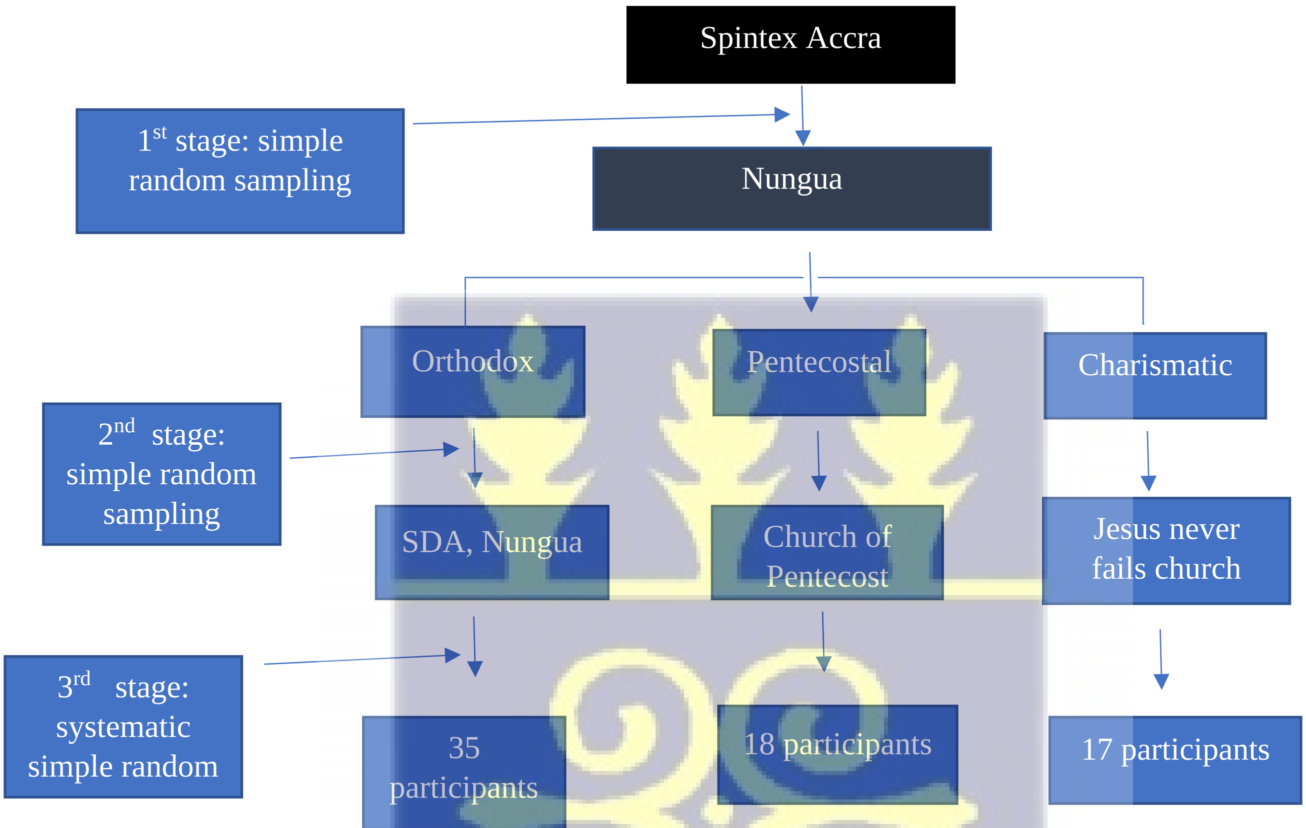

Figure 3.1: Sampling procedure for recruitment of study participants.

3.4.2 Sampling Procedure for Selection of Test Foods for the study

Purposive sampling procedure was employed to select four of the commonly consumed protein food sources identified by Kuevi (2020) in the Greater Accra Metropolitan Area. In that study 54 protein foods were identified and included in a photographic food atlas to be used as portion size

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estimation aid. The atlas was then validated using the top 12 most common protein foods (Kuevi, 2020). For this present study, the top four protein food sources (Atlantic mackerel *[Saman, in the local language]*, chicken thigh, boiled egg, and groundnut soup) were selected. Choice of the number of test foods (i.e., 4) was also influenced by the need to minimize participant fatigue, since this study required the use of two PSEA (i.e., photographic food atlas and household measures) for estimating various portion sizes, of each selected food item.

3.5 Study Variables

Covariates included sociodemographic characteristics about the study participants' ages, sexes, marital statuses, educational backgrounds, religions, ethnicities, occupations, and monthly household income. These variables served as the study's independent variables. Finally, the participants were offered food samples and aided with household measures and a photographic food atlas to estimate their portion sizes. The dependent variables for the study were the portion size estimations made by the participants.

3.6 Data Collection / Procedure

The data collection was subdivided into two parts. The first part involved participant enrolment and informed consent, as well as administering of questionnaire to participants through a personal interview. Anthropometric measurements (body weight and height) were also taken with a weighing scale (Seca 770, Seca, Hamburg, Germany) and a stadiometer (Seca 213, Hamburg, Germany). All the measurements were taken according to standard protocol as outlined below. Finally, participants were allowed to view the study food samples. The second part took place after a 24-hour time lapse. During this phase participants were only required to give their estimations,

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using both the HHM and PFA. They did so from memory as the study foods were not presented to them this time. The data collection procedure is summarized in the flow chart below.

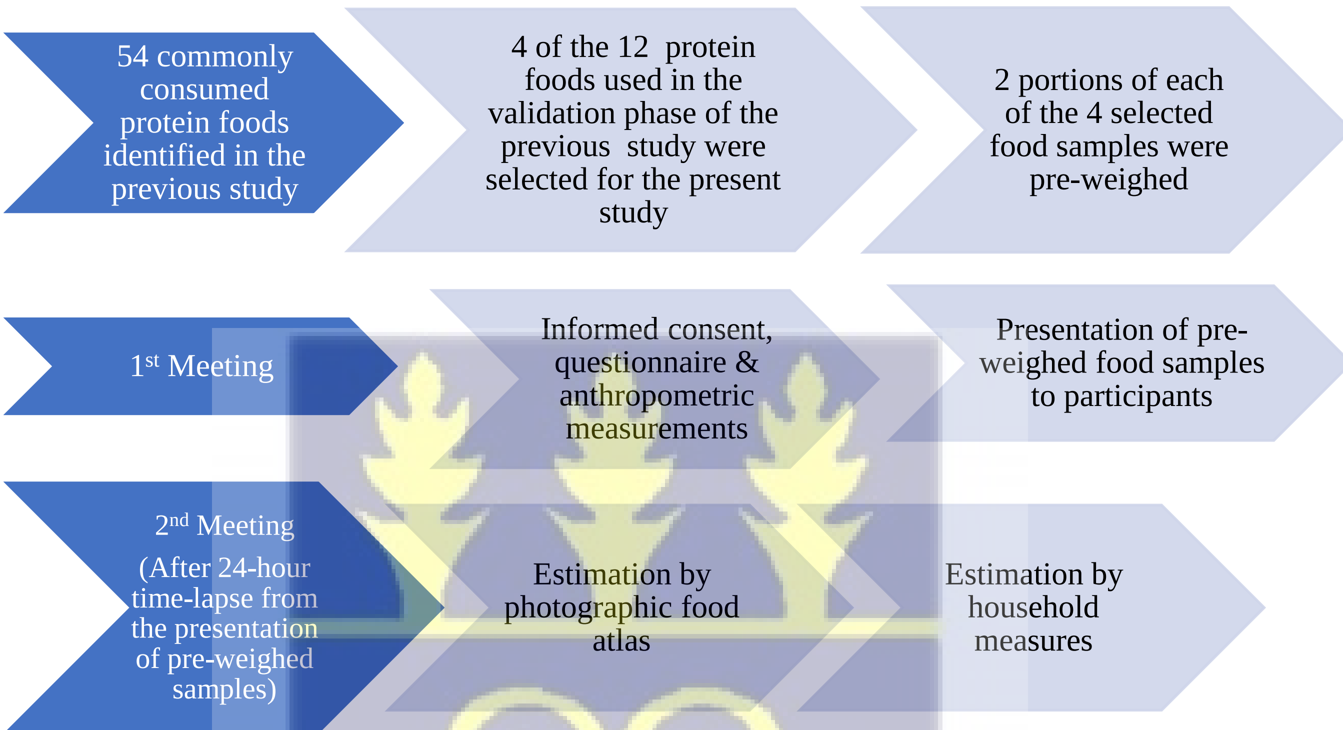

Figure 3.2 Flow chart of study procedure

3.6.1 Weight Measurement

On an electronic scale, weight was measured to the nearest 0.1 kg. Participants were asked to step on the scale barefooted, standing upright with their legs evenly distributed on the platform of the

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scale. In order to get the most exact readings possible, they had to take off all jewelry, watches, keys, extra clothing, and phones.

3.6.2 Height Measurement

A stadiometer was used to measure each participant's height to the closest 0.1 cm. They stood barefooted on the stadiometer's level platform, with their backs leaning on the upright board, and their heads stable and forward-facing. The pad at the participant's crown was adjusted for the accurate measurement to be taken.

3.6.3 Body Mass Index

Body mass index was calculated using the formula weight (kg)/height (m^2). The results were then categorized using WHO guidelines: underweight (18.5kg/m^2), normal (18.5 - 24.95kg/m2), overweight (25 - 29.99kg/m2), and obese (> 30.05kg/m2) (WHO, 2000).

3.7 Instruments for Data Collection

A structured study questionnaire was used to collect data (Appendix II). The questionnaire had five subsections. The first part elicited background information such as participants' sex, age, occupation, and educational level. Participants' medical history was explored in subsection two while subsection three solicited physical anthropometry such as weight and height. Subsections four and five examined the participants' estimates of portions sizes using the household measures and photographic food atlas.

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3.7.1 Tools Used in Estimation of Portion Sizes

The photographic food atlas developed for protein foods (Kuevi, 2020) as well as some household measures were used to enable participants to estimate the food portion sizes (Figure 3.3 and 3.4).

The participants were allowed to examine the pages of the photographic atlas that showed pictures of the study foods (i.e., boiled egg, Atlantic mackerel, chicken thigh, and groundnut soup). Each food in the atlas is captured in varying sizes and allocated codes with which the respondent can identify their choice (Figure 3.3). In turn, each code corresponds to a specific weight in the appendix of the atlas, accessed only by the interviewer.

The household measures used was a soup ladle and a matchbox. The soup ladle was used in the estimation of the amorphous food sample (groundnut soup) whiles the matchbox was used in estimating portion sizes of chicken thigh and Atlantic mackerel fish (Figure 3.4). Participants were asked to estimate the boiled egg sample as small, medium, or large.

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Figure 3.3: Photographic food atlas for protein food.

Image source: Kuevi, (2020).

Soup ladle 125ml

4.5x3x1 cm matchbox

Figure 3.4: Household measures.

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3.7.2 Portion Size Estimation

Two portions of each of the selected food items (i.e., selected foods) that had been pre-weighed (the weighing method is considered the gold standard) were presented to the participants, who then had to give their estimated sizes by matching each to whichever photograph from the food atlas that in their estimation, correctly depicted their perceived portion sizes. Next, the household measures were models with known weights in grams, which is expected to aid the participants in estimating their portion size. Different portions (with known weight in grams) of the same food items were showed to the participants to choose the appropriate portion of food that depicted the true weight of the food items, after a 24 hours' time lapse from when the food was initially displayed. The estimations made by the participants using the two methods, were compared with the actual weights of the selected food items (which had been determined by pre-weighing) to determine the accuracy of participants' estimation using the two methods of assessment. The food samples and their actual portion sizes presented to participants is shown in Figure 3.5.

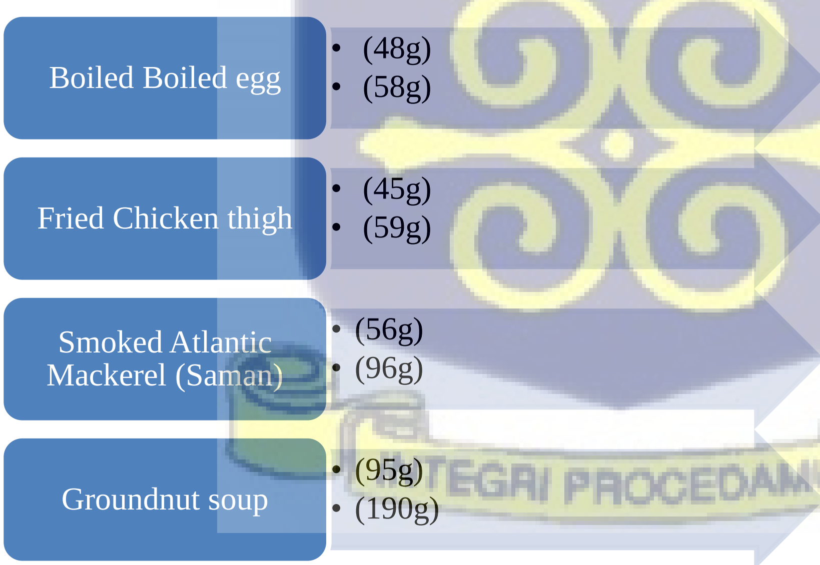

Figure 3.5: Portion sizes of study foods estimated by each participant.

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3.8 Data Analysis

The data was captured into Microsoft Excel and checked for completeness and accuracy of entries. Wrongly filled questionnaires and extreme data values were validated and cleaned. The cleaned data was then exported into Stata version 16 for statistical analysis. Categorical variables such as sex, education, ethnicity, religion, and marital status were summarized and presented in weighted frequencies and percentages, and continuous variables like age, estimated portion sizes, and body mass index were summarized and presented as means and standard deviations. A level of significance was set at $p \leq 0.05$ at a 95% confidence interval.

For study objective one (to assess the proportion of the participants who are able to estimate the selected portion sizes accurately using the household measures and the photographic food atlas) Accurate estimation was defined as, when participant estimated food portion sizes to be the same as the true weight of food samples. Estimations that were different from the true weight was considered inaccurate. Proportionate analysis was used to estimate the percentage of the participants who accurately estimated portion sizes of protein foods using the handy measures and photographic food atlas. Binomial regression was used to examine the difference in rates of accuracy of the estimations by the two portion size estimation aids. Participants' ability to determine the accurate portion size using the photographic food atlas was categorized into a binary outcome (that is, those who estimated the portion size correctly were entered "yes [1]" and those unable were entered "no [0]"). Participants scored between zero (0) and four (4) for the four food samples. The median score from the total correct estimates of the four food samples was used as the threshold to categorize the overall accuracy rate of both the HHM and PFA.

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For study objective two (to assess and compare portion size estimations obtained with the atlas to that derived from the use of household measures), mean and standard deviation were used to estimate the portion sizes of commonly consumed protein foods by household measures and food photographs. One sample t-test was used to test for differences between the true weight of the food samples and each of the mean estimate derived from the household measures and photographic food atlas. Simple proportion was also used to estimate the margin of deviation from the true weight of the food samples. Lastly, Binary logistic regression was modeled to assess the factors that influenced a participant's ability to accurately select portion sizes from the photographic food atlas (objective three). The strength of association was estimated at a 95% confidence level and in terms of odd ratios.

3.9 Quality Control Measures

Adequate training was the first measure of ensuring data quality. Two (2) field workers with nutrition or dietetics backgrounds were recruited and trained to conduct the interviews with the participants. The training was followed by pre-testing of the questionnaire among seven (7) selected church attendees in another suburb (Achimota) of Accra with comparable sociodemographic and economic characteristics. While the pre-testing provided an opportunity for the field workers to try out and perfect their interview skills, the principal investigator also used the occasion to identify errors and improve the questionnaire.

3.13 Ethical Considerations

The Ethical and Protocol Committee (EPRC) of the College of Health Sciences, University of Ghana, gave approval (CHS-Et/M.11-P4.7/2021/2022) for the study, shown in appendix 3. Permission was also sought from the appropriate authorities of the selected churches. Lastly,

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participants received oral and written information about the study so that they could voluntarily give their written informed consent if they agreed to be enrolled (Appendix 3). All data collected in this study was kept strictly confidential, and no personal or other information about individual participants was nor will be published in any report.

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CHAPTER FOUR

4.0 RESULTS

4.1 Background Characteristics of Study Participants

The socio-demographic background characteristics of study participants (n=70) and anthropometrics are presented in Tables 4.1 and 4.2. In terms of religious denomination, 14.3% were charismatic, 67.1% orthodox and 18.6% Pentecostal. Participant ages ranged from 18 to 67 years, with the majority being in the 20 – 40 years age group. Over half (i.e., 54.3%) of the participants were females, 84.3% had obtained at least primary education, and nearly half had tertiary education (47.1%). The result showed that almost all the participants had never received any form of nutrition counseling in their lifetime (94.3%) and only 11.4% reported a history of chronic disease. The mean BMI was 25.58 ± 4.81kg/m^2 with more than half of the study participants being either overweight or obese (37.1% and 17.1% respectively).

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Table 4.1: Socio-demographic background of participants

Variable	Categories	Frequency (n= 70)	Percent (%)
Age groups			
	≤20 years	10	14.3
	21-30 years	26	37.1
	31-40 years	21	30
	41-50 years	8	11.4
	≥50 years	5	7.1
Gender			
	Male	32	45.7
	Female	38	54.3
Ethnicity			
	Akan	31	44.3
	Ewe	18	25.7
	Ga/Ga-Adangbe	19	27.1
	Others	2	2.9
Education			
	No formal education	4	5.7
	Primary education	1	1.4
	Junior Sec Education	12	17.1
	Senior Sec Education	20	28.6
	Tertiary education	33	47.1
History of nutrition counselling			
	Yes	4	5.7
	No	66	94.3
History of chronic disease			
	Yes	8	11.4
	No	62	88.6
Nutritional status of participants			
	Underweight	3	5
	Normal weight	29	41
	Overweight	26	37
	Obesity	12	17
Marital status			
	Married	23	32,9
	Separated/widowed	4	5.7
	Single	43	61.4

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4.1.1 Anthropometric Characteristics

There was no significant difference in age and weight between the male and female participants in the study. However, the BMI of female participants was significantly higher than that of the males ($p = 0.005$). These results are presented in Table 4.2 below.

Table 4:2 Anthropometric Characteristics

Measures	Overall	Males (n=32)	Females (n=38)	P-values
	mean ± SD	mean ± SD	mean ± SD	
Age (years)	33.7 ± 11	32.8 ± 11	32.5 ± 12	0.920
Height (m)	164 ± 8	167 ± 8	162 ± 7	0.014*
Weight (kg)	69 ± 14	66 ± 12	71 ± 14	0.120
BMI (kg/m^2)	26 ± 5	24 ± 4	27 ± 5	0.005*

*Independent-sample T-test at the statistical significance of $\alpha \leq 0.05$

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4.2 Proportion of Participants Able to Estimate the Selected Portion Sizes Accurately By The Two Portion Size Estimation Methods.

The proportion of accurate portion size estimations, that study participants made using the two PSEAs (i.e., household measures and photographic atlas), varied by food items and estimation aids. For instance, using the household measures, most participants wrongly estimated the boiled egg sample whereas almost half of the participants made correct estimations with the photographic food atlas (Table 4.3). A binomial regression modeling between the two methods however indicated that the percentage difference was not significant. Similarly, although more participants accurately estimated the fried chicken thigh sample using the photographic food atlas (14.3%) than when they used the household measure (10%), the percentage difference was also not statistically significant. More participants accurately estimated the fish sample (Atlantic mackerel) using the household measure (42.9%) than the photographic food atlas (18.6%) ($p = 0.027$). On the other hand, significantly more participants accurately estimated the amorphous food sample (groundnut soup) with the photographic food atlas than using the household measure ($p<0.001$). In summary, more participants accurately estimated three (boiled egg, fried chicken thigh, and groundnut) of the four food items using the photographic food atlas than the household measures. But when the results are pulled together, the overall percentage of accurate estimations was higher for household measure (35.7%) as compared with the photographic food atlas (30%) though the difference was not statistically significant ($p=0.177$).

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Table 4.3: Proportion of Participants Able To Estimate The Selected Portion Sizes Accurately By The Methods

	Household Measures		Photographic Food Atlas		
Food samples	**Accurate (%)**	**Inaccurate (under, over) estimations**	**Accuracy (%)**	**Inaccurate (under, over) estimations**	**P-value**
Boiled egg	38.6	61.4 (54.3, 7.1)	48.6	51.4 (41.4, 10)	0.558
Fried chicken thigh	10	90 (8.6, 81.4)	14.3	85.8 (2.9, 82.9)	0.999
Fish (Atlantic mackerel)	42.9	57.1 (7.1, 50)	18.6	81.4 (4.3, 77.1)	0.027*
Groundnut soup	40	60 (1.4, 58.6)	41.4	58.6 (-, 58.6)	<0.001*
Overall Accuracy rate	35.7	64.8	30	70	0.177

*Binomial regression at the statistical significance of $\alpha \leq 0.05$

4.3 Comparison of Portion Size Estimations Obtained with The Food Atlas and Household Measures

Comparison of the portion sizes estimated with the aid of the two methods, differed from the true weights of all the food items in one-sample T-test. All the estimates of the food items derived from the photographic food atlas were consistently higher than those derived from the household measures.

Boiled egg portions estimated by the participants using the two estimation aids, were significantly different from the true weights. For example, the mean estimates of the photographic food atlas (48.8±6.5, p <0.001) and the household measures (46.2±6.2, p<0.001) significantly differed by 2% below and 4% above the true weight of boiled egg portion size one, respectively. Similarly, the mean

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estimates of boiled egg portion size two significantly differed by almost 16% and 11% below its true weight using the HHM and PFA, respectively.

Participants' mean estimates of the fried chicken thigh significantly differed by 36% (16 grams) and 107% (48.2 grams) above the true weight of portion size one using the HHM ($p < 0.001$) and PFA ($p < 0.001$), respectively. Similarly, the mean estimates of PFA and HMM for fried chicken thigh portion size two were significantly different from the true weight by 75% (44 grams) and 26% (15 grams), respectively. For both fish portion size one and two, the mean estimates using the PFA were significantly higher (48% [31 grams] and 38% [37 grams]) above the true weights of the food items as compared with 48% (31 grams) and 5% (5 grams) using the HHM.

Also, the mean portion size estimates of the groundnut soup samples using the PFA ($p < 0.001$) and HHM ($p < 0.001$) were significantly different from the standard weights. The PFA mean estimate of the portion size one was 132% (125 grams) above the true weight as compared with 95% (90 grams) using HHM. The PFA mean estimate of the portion size two, however, was 4% (7 grams) below the true weight as compared with 21% (39 grams) using HHM.

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Table 4.4: Comparison of Portion Size Estimations Obtained with The Food Atlas And Household Measures

Food samples	Portion sizes	True Weight (g)	Household Measures			Photographic Food Atlas		
			mean ± SD	% D	p-value	mean ± SD	% D	p-value
Boiled egg	(1)	48	46.2 ±6.2	4[a]	<0.001*	48.8 ± 6.5	1.7 [b]	<0.001*
	(2)	58	48.9 ± 7.6	15.7[a]	<0.001*	51.8 ± 7.6	10.7[a]	<0.001*
Fried chicken thigh	(1)	45	61.1 ± 18	35.7[b]	<0.001*	93.2 ± 37.8	107[b]	<0.001*
	(2)	59	74.1 ± 24.7	26.1[b]	<0.001*	103 ± 27.5	75[b]	<0.001*
Atlantic Mackerel	(1)	64	94.6 ± 38.1	47.8[b]	<0.001*	94.6 ± 38.1	48 [b]	<0.001*
	(2)	96	100.6 ± 41	4.8[b]	<0.001*	133 ± 43.2	38[b]	<0.001*
Groundnut Soup	(1)	95	185 ± 87.8	94.7[b]	<0.001*	220 ± 133.4	132[b]	<0.001*
	(2)	190	151 ± 64.7	20.5[a]	<0.001*	183 ± 98.6	3.7[a]	<0.001*

One-sample T-test at 95% confidence level, * means the comparison is statistically significant. %D is the percentage deviation of the mean estimate of the PSEA from the true weight of the food sample. [a] or [b] means the mean estimate is below or above the true weight of the food samples, respectively.

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4.4 Evaluation of factors Associated with Accurate Portion Size Estimation with the Photographic Food Atlas

4.4.1 Factors Associated with the Accuracy of Boiled egg Portion Size Estimation

In a logistic regression modeling, the age of the participants was not significantly associated with the accuracy of boiled egg portion size estimation. Younger age groups had higher odds of estimating the accurate portion size of the boiled egg samples than those above age of 50 years, though the results of associations were not statistically significant (table 4.5). Female participants were more likely to accurately estimate the portion size of the boiled egg samples than their male counterparts although the result was not significant. Similarly, the categories of educational levels and BMI were also not significantly associated with the accuracy of boiled egg portion size estimations.

Table 4.5: Factors Associated with the Accuracy of Boiled egg Portion Size Estimation

Variables	Categories	Estimate	Odd Ratio	P-value
Age		-0.044	1.0	0.061
Age Groups (*>50years*)	<20 years	1.386	4.0	0.280
	21-30 years	2.022	8.0	0.090
	31-40 years	2.071	8.0	0.086
	41-50 years	-19.8	0.0	0.999
Education (*no formal education*)	Primary education	21.2	2.0	0.999
	JHS education	0.693	2.0	0.554
	SHS/Vocation Training	0.405	1.5	0.712
	Tertiary education	0.305	0.7	0.773
Sex (*males*)	Females	0.020	1	0.967
BMI scores		-0.092	0.9	0.083
BMI cat (*obesity*)	Normal weight	-0.511	0.6	0.340
	Overweight	-1.204	0.3	0.091

*Logistic regression at a 95% confidence level.

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4.4.2 Factors Associated with the Accuracy of Fried chicken thigh Portion Size Estimation

Individual factors of the participants such as age and BMI were significantly associated with accurate portion size estimation of the fried chicken thigh sample. For example, younger age groups were less likely to accurately estimate the fried chicken thigh sample as compared with older participants above 50 years. Participants within the age groupings of 21-30 years and 31-40 years were significantly associated with the poor estimation of the fried chicken thigh samples. Similarly, increased BMI scores of the participants were significantly (P=0.026) associated with an accurate estimation of the fried chicken thigh samples. Further analysis showed in terms of BMI, that normal (p=0.042) and overweight (p=0.045) participants were significantly less likely to accurately estimate the fried chicken thigh samples. Sex and educational levels of the participants were not significantly associated with accurate portion size estimation of the fried chicken thigh samples.

Table 4.6: Factors Associated with the Accuracy of Fried chicken thigh Portion Size Estimation

Variables	Categories	Estimate	Odd Ratio	P-value
Age Groups (>50years)	<20 years	-2.603	0.1	0.062
	21-30 years	-2.890	0.1	0.014*
	31-40 years	-2.197	0.1	0.047*
	41-50 years	-0.916	0.4	0.433
Education (no formal education)	Primary education	0.000	1	0.999
	JHS education	18.81	1	0.999
	SHS/Vocation Training	20.10	1	0.999
	Tertiary education	19.70	1	0.999
Sex (males)	Females	0.614	1.8	0.339
BMI Scores		0.158	1.2	0.026*
BMI cat (obesity)	Normal weight	-1.609	0.2	0.042*
	Overweight	-1.700	0.2	0.045*

*Logistic regression at a 95% confidence level.

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4.4.3 Factors Associated with the Accuracy of Atlantic Mackerel Portion Size Estimation

Logistic regression modeling of the individual factors and accurate portion size estimation of the fish samples showed no significant association. For example, the sex, age, education, and BMI categories were not significantly associated with the accuracy of fish samples portion size estimations as presented in Table 4.7.

Table 4.7: Factors Associated with the Accuracy of Atlantic Mackerel Portion Size Estimation

Variables	Categories	Estimate	Odd Ratio	P-value
Age		-0.050	1	0.171
Age Groups *(> 50years)*	<20 years	20.36	1	0.999
	21-30 years	19.50	1	0.999
	31-40 years	19.76	1	0.999
	41-50 years	19.26	1	0.999
Education *(no formal education)*	Primary education	0.00	1	0.999
	JHS education	0.00	1	0.999
	SHS/Vocation Training	20.10	1	0.999
	Tertiary education	19.89	1	0.999
Sex *(males)*	Females	0.614	1.8	0.339
BMI Scores		-0.082	0.9	0.253
BMI cat *(Obesity)*	Normal weight	0.932	2.5	0.413
	Overweight	0.963	2.6	0.405

*Logistic regression at a 95% confidence level.

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4.4.4 Factors Associated with the Accuracy of Groundnut Soup Portion Size Estimation

In a logistic regression individual factors of the participants were not significantly associated with the portion size estimations of the amorphous food item (groundnut soup). The results showed age (p=0.377), female (p=0.475), BMI scores (p=0.637) and educational categories were not significant predictors of the accuracy of portion size estimation of the groundnut soup samples in Table 4.8.

Table 4.8: Factors Associated with the Accuracy of Groundnut Soup Portion Size Estimation

Variables	Categories	Estimate	Odd Ratio	P-value
Age		-0.021	1.0	0.377
Age Groups *(>50yrs)*	<20 years	0.000	1.0	0.999
	21-30 years	0.405	1.5	0.683
	31-40 years	-1.386	0.3	0.210
	41-50 years	-0.105	0.9	0.928
Education *(no formal education)*	Primary education	-21.20	0.0	0.999
	JHS education	-1.099	0.3	0.361
	SHS/Vocation Training	-1.386	0.3	0.226
	Tertiary education	-0.061	0.9	0.954
Sex *(males)*	Females	-0.361	0.7	0.475
BMI Scores		0.025	1.0	0.637
BMI cat (*Obesity*)	Normal weight	-0.602	0.5	0.394
	Overweight	0.026	1.0	0.970

*Logistic regression at a 95% confidence level.

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4.4.5 Factors Associated with the Overall Accuracy of Portion Size Estimation using PFA

Overall, the accuracy of portion size estimation using the photographic food atlas was not significantly associated with any of the individual factors of the participants in table 4.9.

Table 4.9: Factors Associated with the Overall Accuracy of Portion Size Estimation using PFA

Variables	Categories	Estimate	Odd Ratio	P-value
Age		-0.040	1.0	0.145
Age Groups (*> 50 years*)	<20 years	0.539	1.7	0.682
	21-30 years	1.076	2.9	0.364
	31-40 years	-0.405	0.7	0.751
	41-50 years	0.875	2.4	0.512
Education (*no formal education*)	Primary education	0	1	0.999
	JHS education	18.8	1	0.999
	SHS/Vocation Training	19.8	1	0.999
	Tertiary education	21.1	1	0.999
Sex (*males*)	Females	0.942	2.6	0.079
BMI Scores		0.018	1.0	0.894
BMI cate (*obesity*)	Normal weight	2.290	9.9	0.248
	Overweight	1.542	4.7	0.269

*Logistic regression at a 95% confidence level.

INTEGRI PROCEDAMUS

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CHAPTER FIVE

5.0 DISCUSSION

5.1 Background Characteristics of Study Participants

This study was a cross sectional study which aimed to assess the accuracy of portion size estimates of commonly consumed protein source foods using a photographic food atlas in comparison with household measures. A total of 70 participants were enrolled in this study, in the Spintex Nungua area of Accra. The mean age of the participants was 32.66 ± 11.4 years and with over half (54.3%) being females and 47.5% being male. Almost half of the participants were from the Akan ethnic group, and almost all the participants (84.3%) had obtained at least primary education. On the dietary factors or indices, almost all the participants had never received any form of nutrition counseling in their lifetime. The anthropometric measurements of participants showed that more than half (54%) of the participants were overweight or obese This is in line with reports that have pointed out the shift in nutritional imbalance, where the rate of overnutrition (i.e., overweight and obesity) is on the rise (Rasquinha *et al*, Ofori-Asenso *et al.*, 2016). The rise in overweight and obesity have been linked to unhealthy nutritional and dietary lifestyle, which increases one's risk of various dietary related non communicable disease (Amoah 2003; WHO, 2005).

5.2 Proportions of Accurate Estimations by the two Assessment Methods

Except for the fish sample (Atlantic mackerel), more participants estimated accurately boiled egg, fried chicken thigh and groundnut soup (amorphous food) samples using the photographic food atlas. On average, however, the proportions of accuracy by the two assessment methods were almost the same (35.7% and 30.0%, i.e., household measure and photographic food atlas respectively). For the specific food items with the use of the photographic food atlas, two other

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studies in Ghana reported accuracy rate of carbohydrate and protein source food of between 47-52% (Boateng, 2014; Kuevi, 2020). The current study found accuracy rate within this interval for the boiled egg samples but not the fried chicken thigh. Similarly, lower accuracy rates of the photographic food atlas have been reported in other studies as well 42% and 36% (Biltoft-Jensen et al., 2017; Nichelle et al., 2019). In contrast a related study in Greece, Nepal, and Europe, yielded over three times (90-98%) accurate estimates, with the use of the photographic food atlas as compared with the current study (Naska et al., 2016; Harris-Fry *et al*., 2016; Nikolic *et al*., 2018). Similarly, Villena-Esponera et al, (2019) and Amougou et al, (2016) reported higher accuracy rates (66% and 60%) respectively with the use of the photographic food atlas in Ecuador and Central Africa.

Naska et al., (2016) suggested that photographic food atlas produced more accurate results, but that its effectiveness was limited to smaller food items. This is because perception, conceptualization and memory which are necessary elements with the use of the photographic food atlas are affected by a number of factors including the different food portion sizes, their placement in the food atlas, the dimensions of each photograph, and the camera angle by which each of them was taken (Jayawardena & Herath, 2017). This was observed in the field note report as participants in the current study found it difficult to use the image of smoked Atlantic mackerel portions captured in the atlas. The shape of the Atlantic mackerel presented in the photographic food atlas in various sizes, does not entirely represent the manner in which fish is consumed generally. Depending on the individual, it could be shredded, divided vertically or horizontally, this could have influenced participants ability to recall and conceptualize the estimated size accurately, compared to when the matchbox was used, which appeared to have been a more relatable portion size estimation aid for Atlantic Mackerel.

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The proportion of accurate estimates (10-42.9%, and average percentage of 33.2%) with the use of household measures was not statistically different from the photographic food atlas (14.4-48.6%, and average percentage of 30.0%) in the study (p<0.177). Although, the household measure is a more relatable portion size estimation aid across different population groups (Faulkner et al 2017), significant margin of error has been observed with its use. The current study observed a margin of error of about 76.8%. which was similar to the reports (44.9-87.7%) of other studies (Orozco et al., 2012; Amoutzopolus et al., 2020). Most participants related better nonetheless with the household measures (matchbox) in estimating the Atlantic Mackerel, than the photographic food atlas regardless of this significant error margin. A similar observation was made in a dietary survey, where household measures were often preferred to the photographic food atlas despite the significant margin of error (Faulkner et al 2017).

5.2.1 Comparing the Accuracy of Estimates among both PSEAs.

Although household measures have been reported to be user friendly and widely accepted in dietary surveys and clinic settings (Faulkner et al., 2017), data largely support the use of photographic food atlas, for portion size estimations. Higher margin of error has been associated with the use of the household measure (Faulkner et al., 2017; Orozco et al., 2012; Amoutzopolus et al., 2020). Three of the four food samples (boiled egg, fried chicken thigh and groundnut soup) examined in the study indicated that the photographic food atlas was a better estimation aid of portion size, except for the fish sample which participants evidently found difficult to estimate. This was possibly due to participants familiarity with the matchbox used in the estimation. Participants also likely had difficulty conceptualizing the portion size of the fish due to the variation in shape of how fish in general can be consumed. Jayawardena and Herath, (2017) similarly noted that different food portion sizes on the food atlas, their

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placement, the dimensions of each photograph, and the camera angle by which each of them was taken, can all affect how accurately participants estimate portion sizes.

This means that per the number of food items examined in the study, photographic food atlas was a better portion size estimation aid. The current study, however, observed an overall higher accuracy percentage of 35.7% in favour of the household measures. From this study the household measure could be a better tool in estimating some protein foods in our local context, especially during nutritional assessment to get accurate estimations for fish, which is widely consumed by Ghanaians. Because little or nothing can be done with how people decide to consume their fish (in terms of its shape and appearance), which could ultimately impact how accurately fish is conceptualized and estimated using the photographic atlas (Faulkner *et al.*, 2017).

5.3 Comparison of Portion Size Estimations by PSEAs

Portion size estimates for all food samples (fried chicken thigh, smoked atlantic mackerel (locally known as *Saman*), boiled egg and groundnut soup) using the Photographic Food Atlas were significantly overestimated by participants, compared to the household measure.
Similar observations were made in Greece with the use household measures, whereby most study participants underestimated food samples, but not with the photographic food atlas (Naska et al., 2016). By contrast, a study in Tunisia observed that participants underestimated animal products with the use of photographic food atlas (Bouchoucha et al., 2016). However, dairy, and cereal products, fruits and vegetables in the Tunisian study were overestimated in comparison to their standard weights of the food items. The estimates of all the food items including the animal source foods were not significantly different as in this current study. (Bouchoucha et al., 2016).

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Also, the finding in the current study is contradicted by the report from a study in Lebanon, in which 212 different traditional dishes to assess errors between food portions sizes consumed by participants and the actual quantity presented. (Tueni et al., 2012). Although some variations in portion sizes estimated were observed among three of the 212 dishes, which was stated by the researcher to be not statistically significant, the variation in the present study is clearly statistically significant, where participants estimation varied from the true weight (p<0.001) (Tueni et al., 2012).

Studies have stated the difficulty in accurately estimating amorphous food (Faulkner et al., 2017, Ayala, 2005, Reale et al., 2019) which was seen in this study in the case of groundnut soup. Overestimation of amorphous food items in this study was similarly observed in a UK study, with the use of the photographic food atlas (Timon et al., 2018). Kuevi (2020) also observed that from all food samples estimated by participants in a validation study of PFA, for protein-source foods, lower percentages of 38%, 25% and 31.4% accurate estimations were made for groundnut soup, powered milk, and evaporated milk respectively, compared to other food samples used in the study. These other food samples achieved higher percentages of accurate estimations which were greater than 50% (Kuevi, 2020). The difficulty in estimating amorphous foods could be attributed to their lack of a shape of their own. They would normally take up the shape of the container or bowl in which they are placed. This increases the possibility of them been presented in an unfamiliar shape or form, possibly not relatable to the participant.

The use of the photographic food atlas generally resulted in underestimations of smaller food samples across many of the studies (Bouchoucha et al., 2016; Tueni et al., 2012). The variations, however, reported in these studies were not statistically significant as observed in the current study. Comparatively, photographic food atlas produced overestimations of all four food samples in the study than the household measures. Photographic food atlases have been

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developed to aid in portion size estimation in different countries and only recently for carbohydrate and protein foods in Ghana, as such participants in this present study were clearly not familiar with the use of this portion size estimation aid which probably caused the overestimations observed.

5.4 Factors Associated with Accurate Portion Size Estimations Using PFA.

Many reports have been made from across the globe of factors associated with the accuracy of portion size estimations using the photographic food atlas. These include the physical characteristics of the images (such as the size, angle of the picture, dimension, and placement) used for the development of the food atlas (Jayawardena & Herath, 2017). Significant changes in sizes and appearance of food have also been reported by Fang et al. (2018), to be associated with difficulty in accurately estimating portion size, due to the variation in the processes of food preparation.

Participant characteristics such as the age of the participants in this study had no significant associations with the accuracy of portion size estimation (except the estimation of the fried chicken thigh samples) as observed in other studies, using photographic food atlas (Turconi et al., 2005; Naska *et al.*, 2016). Also, with regards to age, it's been shown that older adults tend to poorly estimate portion sizes of food compared to younger adults which are mainly cited to be as a result of older adults not been able to recall properly (Chambers et al., 2000). This was observed in this study. Although not statistically significant, younger adults have higher odd ratios of accurately estimating their portion sizes compared to the older adults.

While sex and age remained sufficient factors influencing portion size estimation in some studies conducted in the United Kingdom (Nelson et al., 1996; Foster *et al.*, 2006), the current study found no such association among the participants.

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Except for one of the food samples used in this study (groundnut soup), females were more likely to produce accurate estimates as compared with males, though the results were not significant (*p*-0.475). Findings by, Yuhas et al., (1989), Keenan et al., (2018) and Almiron–Roig, (2013) explained that females were more familiar and experienced in cooking and were therefore more likely to produced accurate estimates than males.

Body mass index (BMI) significantly influenced the accuracy of portion size estimations in the current study. Participants with BMI within the normal range have been identified to be able estimate portion sizes accurately compared to participants who are overweight and obese (Okubo and Sasaki, 2004; Horne et al., 2019). As reported in the United States by Horne et al., 2019 in a study which aimed to examine how accurate estimates of caloric content of foods were when the photographic atlas was used. 840 psychology students were enrolled, and they observed significant overestimation of calories content using the food photographs. This was particularly noted among students who were overweight and obese (Horne et al., 2019). Contrary to the observation made in the study by Horne et al. (2019), Obese participants in this study had a rather higher chance of accurate estimations as compared with normal and overweight participants. In contrast to the current finding, normal weight participants in the USA were more likely to estimate portion size accurately (Horne et al., 2019). Reports on the influence of BMI on portion size estimation is varied across studies (Nelson et al., 1996; Horne et al., 2019). For example, while obese elderly Belgians underestimated portion size (Bazelmans *et al*, 2007), this association was not observed among obese Japanese (Okubo & Sasaki, 2004). Undoubtedly, the weight of a person significantly influences their food intake (Dalle Grave et al., 2018), and hence may likely impact on the person's perception of how much food they have consumed and what portion size they will report when interviewed during a dietary assessment. Partly because overweight and obese persons feel the need to avoid being

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embarrassed by how much they actually eat and also, they are more likely to engage in dieting in a bid to control their weight (Lean 2004; Zegman 1984).

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CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Portion size estimation aids remain relevant in dietary assessment and for appropriate diet intervention. With the aim of assessing the accuracy of portion size estimates of commonly consumed protein source foods, a total of 70 participants were recruited who made 560 estimations (280 estimation HHM and 280 estimation PFA). An overall proportion of accurate estimation of 35.7% and 30% for household measure and the photographic food atlas respectively was recorded. Although most food samples in the study were estimated accurately using the photographic food atlas, the fish sample (Atlantic Mackerel), which is considered as a major protein source in our local context, had a higher proportion of accurate estimation when HHM was used, which makes the household measure (matchbox) a more suitable PSEA in estimating fish in dietary survey and assessment in Ghana. Participants factors such as age, sex, BMI, and educational background were not significantly associated with participant ability to accurately estimate portion sizes of food samples presented to them.

6.2 Limitations

- The photographic atlas of commonly consumed protein source foods in Greater Accra Metropolitan Area (GAMA) contains photo series depicting portion sizes of at least 54 different foods, 12 of which were selected for validation of the atlas. However, only 4 of the protein foods were selected for this current study and this limits the generalizability of the results since the selected foods are not fully representative of the atlas.
- Participant sample size used could affect the generalizability of findings across the Ghanaian population.

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6.3 Recommendations

Based on the findings from this study, it is recommended that similar studies be carried out to test the other photo series in the photographic food atlas and provide conclusive evidence regarding the accuracy of the PFA in comparison to HHM.

6.4 Contribution to knowledge

- The study and its findings add more information to the few existing evidence on the use of the photographic food atlas for dietary survey and assessment in Ghana.
- This study has also provided evidence on the accuracy of the photographic food atlas for portion size estimation in the Ghanaian setting.

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APPENDICES

Appendix 1

Study Questionnaire

Thesis Title: **Comparison of Household Measures to Food Photographs for Portion Size Estimation of Protein Food Sources**

Participant code/ID: ____

PART 1: SOCIO-DEMOGRAPHIC BACKGROUND INFORMATION

SN	Question	Response
1.	**How old are you?**	[.........................]
2.	**Gender**	
	a. Male	[ ]
	b. Female	[ ]
3.	**What is your highest educational level completed?**	
	a. No formal education	[ ]
	b. Primary education	[ ]
	c. Junior secondary education	[ ]
	d. Senior secondary education	[ ]
	e. Tertiary education	[ ]
4.	**Which one best describe your tribal origin?**	
	a. Akan	[ ]
	b. Ga/Ga-Adangbe	[ ]
	c. Ewe	[ ]
	d. Others, (please specify)	[……………………]
5.	**Marital status**	
	a. Married/cohabitating	[ ]
	b. Separated/divorced/widowed/widowered	[ ]
	c. Never married/single	[ ]
6.	**Occupation**	
	a. Artisan (e.g., hairdresser, carpenter, mason etc.)	[ ]
	b. Traders (e.g., market women, street vendor, shop attendant, etc.)	[ ]
	c. Public/civil servant	[ ]
	d. Business owner/self-employed/entrepreneur	[ ]
	e. Unemployed	[ ]
	f. Others, (please specify)	[……………………]
7.	**What is the estimated monthly income of your family?**	[……………………]

PART 2: MEDICAL HISTORY

SN	Question	Response
1	Do you have any known history of chronic conditions? (These include diabetes, hypertension, stroke, liver condition etc.)	
	a. Yes	[ ]

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b. No [ ]

2 If "YES" to the above question, please specify the condition

[…………………………………….....]

3 Have you visited the hospital for dietary counseling before?

a. Yes [ ]

b. No [ ]

PART 3: PHYSICAL MEASUREMENTS

Measurement	First Reading	Second Reading	Average reading
Height (cm)	[............................]	[............................]	[............................]
Weight (kg)	[............................]	[............................]	[............................]

PART 4: ESTIMATION OF FOOD ITEMS USING HOUSEHOLD MEASURES

Food	Coded portion displayed	Selected portion from HHM	Estimated weight	Rating
Boiled egg				
Fried chicken thigh				
Smoked *Saman*				
Beef				

1 Correct estimation (CE); 2 Under estimation (UE); 3 Over estimation (OE)

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PART 5: ESTIMATION OF FOOD ITEMS USING PHOTOGRAPHIC FOOD ATLAS

Food	**Corresponding code of selected food**	**Estimated weight**	**Rating**
Boiled egg			
Fried chicken thigh			
Smoked *Saman*			
Beef			

1 Correct estimation (CE); 2 Under estimation (UE); 3 Over estimation (OE)

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Appendix 2

Consent Form

UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES
ETHICAL AND PROTOCOL REVIEW COMMITTEE

Office Use. Protocol ID:

Title of Research Project: comparison of household measure to food photographs for portion size estimation of commonly consumed protein food sources in Accra

Principal Investigator: [Blessing Ama Ijenkeri Norgbe] **Address:** [University of Ghana, Department of Dietetics Korle Bu campus, bainorgbe@st.ug.edu.gh, Tel: +233556876534]

General Information About Research

My Name is Blessing Ama Ijenkeri Norgbe, and I am a final year student at the department of dietetics, school of Biomedical and Allied Health Science, University of Ghana. Myself and my supervisor Dr. Anna Amoako-Mensah who is a senior lecturer in the department of dietetics are conducting research titled 'Comparison of household measure to food photographs for portion size estimation of commonly consumed protein food sources in Accra' that is been carried out to assess the accuracy of portion size estimates of commonly consumed protein source foods when a photographic food atlas is used in comparison to when household measures, utensils, and objects are used. Data collection will require two meetings which will be held at least 24 hours apart. First contact will require giving your consent after which a questionnaire will be administered to you to obtain your background information such as your age, gender, etc., your body measurements (weight and height) will also be taken to determine your body mass index (BMI). Lastly, some food will be displayed, and you will be asked to identify them at the second meeting.

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Possible Risks and Discomforts

To the best of our knowledge, there is no risk (physical, emotional, or psychological) associated with this study. You are, however, at liberty to discontinue the study if you foresee any risk with your participation in the study.

Possible Benefits

It is our hope that the data you provide will help to determine whether dieticians can rely on the use of a photographic food atlas as an accurate dietary assessment tool during diet therapy. The study will not offer you any direct monetary benefit for your participation.

Confidentiality

All the information you provide in relation to this study will be strictly protected. Your name will not be linked to any personal information you provide, and no one will be able to trace any information you provide to you in the future.

Compensation

There will be no cost on your part for participation in the study. The study will present a token of gift items as an appreciation of your time should you decide to participate in the study.

Voluntary Participation and Right to Leave the Research

The study holds the right to terminate the interview if your responses or participation does not serve the purpose of the study. You equally have the right to discontinue the study if you feel the need to without stating any compelling reason.

Contacts for Additional Information

For further inquiries about this research, kindly contact the following address below.

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Researchers contact: Blessing Ama Ijenkeri Norgbe, department of dietetics, University of Ghana. Tel: +233556876534. Supervisor's contact: Dr. Anna Amoako-Mensah Department of Dietetics, University of Ghana. Tel: +233204679353

Your Rights as a Participant

If you have any questions about your rights as a research participant you can contact the EPRC Office between the hours of 8 am-5 pm on **+233 [030] 294 0528, +233 [030] 266 5103** or email address: **eprc@chs.edu.gh**

Statement of Consent/Voluntary Agreement

The above document describing the purpose, benefits, risks, and procedures for the research Title: Comparison of Household Measure to Food Photographs for Portion size estimation of commonly consumed protein food sources in Accra has been read and explained to me in detail. I have been allowed to ask any question(s) I have about the research and my question(s) has/have been answered to my satisfaction. I have been told that I may contact the ethical and protocol review committee on **+233 [030] 294 0528, +233 [030] 266 5103** or email address: **eprc@chs.edu.gh** and Blessing Ama Ijenkeri Norgbe (+233556876534 or email address: bainorgbe@st.ug.edu.gh) if I have questions about my rights as a study participant, to discuss problems, concerns or suggestions related to the research.

I understand that a copy of the information sheet and the informed consent forms will be given to me to take home after it has been signed. I have read the consent form and agree to participate in this research study voluntarily.

Signature/Thumb print of Participant	Date
Signature/Thumb print of Obtaining Consent	Date

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Statement of Witness

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered, and the volunteer has agreed to take part in the research voluntarily.

Signature/Thumb print of Participant	Date
Signature/Thumb print of Obtaining Consent	Date

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Appendix 3

Ethics Clearance

UNIVERSITY OF GHANA

COLLEGE OF HEALTH SCIENCES

ETHICAL AND PROTOCOL REVIEW COMMITTEE

EPRC/JULY/2022

August 3, 2022

Miss Blessing Ama Ijenkeri Norgbe
Department of Dietetics
School of Biomedical and
Allied Health Sciences
Korle-Bu

ETHICAL CLEARANCE

Protocol Identification Number: ***CHS-Et/M.11 – P4.7 /2021-2022***

FWA: 000185779 **IORG: 0005170** **IRB: 00006220**

The College of Health Sciences Ethical and Protocol Review Committee (EPRC) on August 3, 2022 reviewed and approved your re-submitted research protocol.

Title of Protocol: **"Comparison of Household Measure to Food Photographs for Portion Size Estimation of Commonly Consumed Protein Food Sources in Accra"**

Principal Investigator: Miss Blessing Ama Ijenkeri Norgbe

This approval requires that you submit six-monthly review report(s) of the study to the Committee and a final full review report to the EPRC at the completion of the study. The Committee may observe, or cause to be observed, procedures and records of the study before, during and after implementation.

Please note that any significant modification(s) to this project/study must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this study to the EPRC within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee's duty to review the ethical aspects of any manuscript that may be produced from this study. You will therefore be required to furnish the Committee with any manuscript for publication.

This ethical clearance is valid till August 3, 2023.

Please always quote the protocol identification number in all future correspondence in relation to this protocol.

Signed: ....

Professor Andrew Anthony Adjei
Chair, Ethical and Protocol Review Committee

cc: Provost, CHS
Dean, SBAHS
Head, Dietetics

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