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DEVELOPMENT AND VALIDATION OF A PHOTOGRAPHIC FOOD ATLAS WITH PORTION SIZES OF COMMONLY CONSUMED ANIMAL AND PLANT PROTEIN SOURCE FOODS IN THE GREATER ACCRA METROPOLITAN AREA

BY

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DECLARATION

I declare that this thesis is the report of research undertaken by me under the supervision of Prof. Matilda Steiner-Asiedu, Prof. A.G.B. Amoah and Dr. Matilda Asante. All references to other people's work have been duly cited.

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ABSTRACT

Background: Accurate estimation of food portion size among free-living persons during dietary assessment is a common challenge. The weighed food intake presently regarded as the gold standard method is time and resource intensive with a high respondent burden. Retrospective methods such as the food frequency and 24-hour dietary recall where portion size estimation aids are employed in lieu of weighing are thus more frequently used. Among the portion size estimation aids, there is accumulated evidence that photographic food atlases are highly convenient and effective. So far, the only one based on the Ghanaian diet covers carbohydrate foods.

Aim: To develop and validate a photographic atlas for portion size estimation of commonly consumed animal and plant protein source foods in the Ghanaian diet.

Method: Fifty-four commonly consumed animal and plant protein source foods were identified in a cross-sectional survey among 834 adult residents (age ≤18 years) in Greater Accra Metropolitan Area. Colour photographs of each food in graduated portions of between 1 and 8 were produced and bound. Following a pilot study (n=50), the atlas was validated by the visual perception method in which 127 participants from the cross-sectional study estimated 47 predetermined portions of 12 test foods by comparing them with portions shown in photo series from the atlas. Participants' estimations were categorized as correct (if the exact/correct picture of portion displayed was selected), adjacent (if picture immediately before or after the correct picture was selected) or distal (any other selections). Correct and adjacent estimations were classified as acceptable. Differences in proportions of accurate (correct) and acceptable (correct and adjacent) estimations across sex,

age group, BMI and educational status were examined by Pearson's chi square test of independence at $p \leq 0.05$.

Results: A total of 5894 references to 54 commonly consumed protein source foods were found in the 3-day 24HDR assessments. Fish and sea foods were most frequently consumed (34.6% of total protein food consumption occasions) followed by poultry (21.3%), legumes (18.8%), meat and meat products (13.6%), milk and milk products (11.7%). The atlas produced comprises 62 sets of serial, guide and range photos. In the validation, participants with tertiary education made a significantly higher proportion of accurate estimations than those with no formal education, primary or secondary school education. The proportion of accurate and acceptable estimations also differed according to the size of portion evaluated. Small portions were generally better estimated than large portions. No evidence of statistically significant differences in the proportions of accurate or acceptable estimations was found across sex, age group or BMI. Participants found amorphous foods challenging to estimate. In this regard, evaporated milk was the most difficult: nearly half (48.4%) of its portion size estimations were distal. The proportion of accurate (exact/correct) estimations observed for the 12 test foods ranged from 19.3% (fried tilapia fingerlings) to 88% (grilled sausage) while acceptable estimations ranged from 51% (evaporated milk) to 95.8% (boiled egg).

Conclusion: In this study, a high proportion (i.e. 80%) of the 5969 portion size evaluations made during validation corresponded to either the correct portion or the one directly adjacent to it. Based on these results, the atlas produced is a potentially useful tool for portion size estimation of animal and plant protein source foods in the Ghanaian diet.

DEDICATION

'How many things you have done......If I were to try to tell………They would be too numerous to recount!' (Psalm 40:5).

I dedicate this thesis first to my Heavenly Father who keeps showing his strength in my behalf and whose loyal love endures forever. Secondly to my mother and in memory of my father.

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LIST OF ABREVIATIONS

24HDR - 24-Hour Dietary Recall

AAS - Amino Acid Scores

AMA - Accra Metropolitan Assembly

AMDR - Acceptable Micronutrient Distribution Range

BMI - Body Mass Index

CHD - Coronary Heart Disease

CVD - Cardiovascular Diseases

DAPA-Toolkit - Diet, Anthropometry and Physical Activity Measurement Toolkit

DES - Dietary Energy Supply

DIAAS - Digestible Indispensable Amino Acid Score

FAO - Food and Agricultural Organization

GAMA - Greater Accra Metropolitan Area

GHS - Ghana Health Service

GSS - Ghana Statistical Service

HDIS - High Density Indigenous Sector

HDLCS - High-Density Low-Class Sector

LDHCS - Low-Density High-Class Sector

LDMCS - Low-Density Middle Class

LDNDS - Low Density Newly Developing Sector

LED - Light Emitting Diode

LEKMA - Ledzokuku-Krowor Municipal Assembly

MDIS - Middle Density Indigenous Sector

MDMCS - Medium Density Middle Class Sector

MMD - Metropolis, Municipals and Districts

NABCO - Nation Builders Corps

NCDs - Non-Communicable Diseases

NDNS - National Diet and Nutrition Survey

NHANES - National Health and Nutrition Examination Survey

PDCAAS - Protein Digestibility Corrected Amino Acid Score

PFA - Photographic Food Atlas

PSEA - Portion Size Estimation Aid

RDA - Recommended Daily Allowance

RF - Rural Fringe

UK - United Kingdom

UNU - United Nations University

USA - United States of America

USDA – United States Department of Agriculture

WHO - World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Dietary assessment is one of the four main approaches to assessing nutritional status for use in medical nutrition therapy and for nutrition education and counselling. It is also a key component in any research which requires information about dietary intake. Dietary assessment involves the estimation of food/nutrient intake as well as dietary pattern of individuals in the household or population group over time (FAO, 2018). The specific methods employed may be indirect, where secondary data such as food balance sheets are used, or direct, where data is elicited from individuals. Assessment may be carried out prospectively at the time of food consumption or retrospectively on food that has already been consumed. Choice of an appropriate dietary assessment approach is based on the type of information required. For example, the focus may be to elicit information about the types and/or amounts of food consumed, estimation of nutrient intake or an appraisal of eating habits. No matter the approach used, accuracy in dietary assessment is essential (Previdelli *et al*., 2019).

Portion size estimation is critical whenever the outcomes of dietary assessment include quantification of food and/or nutrient intake and much depends on its accuracy. It cannot be overlooked during planning and monitoring in individual diet counselling. Portion size estimation is also indispensable for assessing population dietary intakes, researching diet-related health issues and to inform food and nutrition programs and policies (Gibson *et al*., 2017).

Weighed food intake is regarded as the gold standard for accurate measurement of food intake (Gibson, 2005). In this method, all food and beverages consumed by the respondent is weighed at the time of intake and recorded. Any left overs are also weighed and recorded so that the actual amount of food/beverage consumed can be calculated. Inaccuracies in estimation of intake have been reported even with the use of weighed food records. Decades ago, Hill and Davies (1999) found that in comparison with real energy intake calculated from the doubly labelled water technique, respondents underreported their intake (from weighed food records) by an average of 21% /day. Furthermore, use of this method is challenging. It is time-consuming, expensive, burdensome for respondents and also likely to influence consumption (Nikolić *et al.*, 2018, Wolper *et al.*, 1995).

Consequently, other methods such as food frequency and 24-hour dietary recall are more commonly used. The food frequency method requires participants to report how often the foods and beverages of interest were consumed over a specified time period. A major drawback of the food frequency method is that it is not easily quantifiable (Thompson and Byers, 1994). The 24-hour dietary recall involves recollection of all food and beverage consumed by the respondent in the 24 hours prior to the interview. According to Gibson *et al.* (2017), the 24-hour recall is the most frequently used approach in low income countries because it can be 'designed to be culturally sensitive and cognitively easy, making it especially suitable for respondents with limited education'. Besides, additional information about source of food, preparation methods and timing of meals among others, can be sought (Thompson *et al.*, 2015). The interview can be repeated to obtain a better estimate of intakes. Because it is a retrospective method, the interview does not directly influence food habits.

Nevertheless, these self-reported dietary assessment methods are not without limitations. Notable difficulties associated with their use are errors of omission (failure to recall food that was actually eaten), errors of intrusion (reporting foods that were in fact, not eaten) and inaccurate estimation of portion sizes. A number of measurement aids have been employed, specifically to minimize the errors associated with quantitative estimation of food consumed, including food models, household measures (Ovaskainen *et al*., 2008) and photographic food atlases (Biltoft-Jensen *et al*., 2018). A photographic food atlas is a 'set of photographs depicting different amounts of foods and usually bound together in a single volume' (Nelson and Haraldsdottir, 1998a). The foods included in the atlas are usually those commonly consumed by the target population, and each food is captured in about three to eight portions.

Apart from its main use to aid portion size estimation during dietary assessment (Ovaskainen *et al*., 2008), the photographic food atlas (PFA) has also been used to teach portion size of commonly consumed foods (Marjan, 1995) and during nutrition education sessions as part of efforts to improve dietary intake (Small *et al*., 2009). In areas where illiteracy and semi-literacy are common, PFAs can be an invaluable resource (Subasinghe *et al*., 2016). The 2010 census report of Ghana indicated that though literacy level has improved, up to 28.5% of the population above the age of 15 years is illiterate (Ghana Statistical Service, 2013a). A comprehensive PFA of common Ghanaian foods is thus a relevant tool for dieticians and other nutrition professionals practicing within our context to have at their disposal.

1.2 Problem statement

Estimating the food portion sizes of free-living persons during dietary assessment is challenging. Currently, in Ghana, aids for estimating portion size usually consist of household objects, utensils, and other three-dimensional objects. Animal source foods in particular, present a special difficulty. For instance, the matchbox which is frequently employed to assist the estimation of all types of meat, fish, poultry and offal can aggravate incorrect estimation because it does not readily relate to these foods in terms of shape, size, texture and presentation.

User-friendly tools are important to facilitate and improve the quality of data obtained whether in research or clinical practice. In this respect, comprehensive and validated PFAs have been in use for years in South Africa (Venter *et al*., 2000), the UK and many parts of Western Europe (Nelson and Haraldsdottir, 1998b) among others. More recently, PFAs have also been developed and tested in a number of African countries including Burkina Faso (Huybregts *et al*., 2007), Cameroon (Amougou *et al*., 2016), Tunisia (Bouchoucha *et al*., 2016), and other parts of the world (Nikolic´ *et al*., 2018, Harris-Fry *et al*., 2016, Jayawardena and Herath, 2017).

So far in Ghana, the only PFA developed and validated for portion size estimation covers the carbohydrate foods only (Boateng, 2014). This is justified as a first step since carbohydrate foods make up the bulk of the typical Ghanaian diet. However, these carbohydrate foods are more often than not consumed with animal and plant protein source foods within or as part of composite foods like stews, soups and sauces. A recent publication on dietary patterns of Ghanaians showed that protein contributes about 11.5% and 31.6% of total energy intake in rural and urban Ghana, respectively (Galbete *et al*., 2017).

Moreover, other ingredients (for instance vegetables, micronutrient-rich condiments, herbs and spices) used in preparation of these foods (e.g. protein rich composite foods like *palaver sauce*), add to their nutritional value (O'Brien *et al*., 2003, Mwangi *et al*., 2017). Wrong portion size estimation of such foods therefore affects calculation of other nutrients also. In view of this the need to complete the atlas for all food groups so as to ensure applicability and efficacy for use in our setting cannot be overemphasized. In this study a photographic atlas of animal and plant protein food sources was developed and validated to help address this urgent gap in dietary assessment methodologies as it currently stands in the country.

1.3 Significance of study

To ensure high-quality healthcare service delivery, there is the need for tools that are suitable and as far as possible, also culturally sensitive and tailored to the setting within which they will be employed. This is certainly also true of dietary assessment tools because differences in food environment and social structure brings variation in dietary patterns (including specific food choices and how they are consumed) (Trolle *et al*., 2013, Morita *et al*., 2015, Gupta *et al*., 2016). The photographic atlas of commonly consumed protein foods in Accra will aid not only dieticians and other nutrition professionals, but also researchers to correctly assess and analyze dietary information pertaining to this macronutrient.

Reducing the inaccuracies of portion size estimation may eliminate erroneous conclusions about food/nutrient intake and diet related diseases and will positively impact the appropriateness and effectiveness of dietary interventions. Other far reaching consequences including misguided food and nutrition policies as well as misallocation of resources can be avoided or significantly reduced.

Since plant protein sources were captured, this study also has implication for analyses of nutrient intake, diet quality and nutrient adequacy of vegetarians in the population. The findings from this research can also provide baseline material for advancing toward the digitalized dietary assessment methods that are fast gaining ground especially in more developed countries.

1.4 Aim of study

To produce and validate a photographic food atlas for use in portion size estimation of animal and plant protein source foods consumed in Greater Accra.

1.5 Specific objectives

1. To identify and categorize commonly consumed protein source foods (animal and plant).
2. To develop a photographic atlas with portion sizes based on the identified animal and plant protein foods.
3. To estimate and validate cooked portions of the foods against the developed photographic food atlas, on the basis of gender, age, body mass index and educational level.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Classification and uses of protein

'Protein' comes from a Greek word that means prime or primary, in reference to the fact that this nutrient is a basic constituent of animal and human tissue (Wu, 2016). Proteins are involved in all physiological processes. It supplies the body with amino acids and nitrogen to allow regular turnover of tissue and functional body proteins such as enzymes (Elmadfa and Meyer, 2017).

Classification by food source

Protein is classified in various ways. The simple classification into plant and animal protein is based on the food source. Studies indicate that plant-based foods are the leading source of protein globally, comprising 57% of daily protein intake, followed by meat (18%), dairy (10%), fish and shellfish (6%), and other animal products (9%) (Food and Agricultural Organisation, 2010). Notable exceptions to this pattern are the UK and USA where animal foods are the main source of protein and contribute approximately two thirds of total daily protein intake (Smit *et al*., 1999, Lonnie *et al*., 2018).

Contribution of these protein sources to total energy intake varies. Dietary intake data of 17,386 persons in the NHANES 2007–2010 showed that poultry and meats were the top two protein sources but contributed only 4% to total daily energy intake (Phillips *et al*., 2015). Similar observations from NHANES 2003-2006 showed that though animal food proteins are major contributors to dietary protein intake among North Americans, their contribution to total dietary energy intake is relatively low. Likewise, in Ghana, plant but not animal food sources are the major contributors to total dietary energy intake (Galbete *et al*., 2017).

Classification by amino acid composition

Protein may also be classified in terms of amino acid composition, as complete (i.e. all essential/indispensable amino acids which cannot be synthesized in the human body at all or in amounts needed to adequately meet physiological needs are present), or incomplete, if one or more essential amino acid(s) is/are absent. Some nonessential amino acids are precursors for the synthesis of other amino acids (e.g. proline and glutamate for arginine) but a balanced intake of essential and nonessential amino acids is needed to prevent the high metabolic cost of using indispensable amino acids to synthesize dispensable amino acids (Wu *et al*., 2013).

According to WHO, the quality of a protein can be evaluated by the amount and proportion of individual amino acids that can be absorbed from it and utilized by the body (WHO/FAO/UNU, 2007). To this end, the Protein Digestibility Corrected Amino Acid Score (PDCAAS) scoring system and Digestible Indispensable Amino Acid Score (DIAAS) have been applied to measure protein quality. The PDCAAS expresses the first limiting essential amino acid content of the test protein as a percentage of the content of the same amino acid in a reference pattern of essential amino acids (FAO and WHO, 1990). The resulting value is then corrected for true faecal digestibility of the test protein. The DIAAS is similar to PDCAAS except that it takes into consideration ileal digestibility as a more accurate measure of digestibility (FAO, 2013). In comparison to plant protein sources, animal source proteins supply all the nine indispensable amino acids in approximately adequate amounts and so are considered of higher quality. Animal source proteins therefore have higher amino acid (AAS) scores (i.e. ratio of its content of indispensable amino acids to the amount required) (WHO/FAO/UNU, 2007). Furthermore, protein from animal source foods are more easily digestible by the human body and more bioavailable.

In the case of plant source proteins, bioavailability is limited by the presence of antinutritive factors such as tannins. The presence of dietary fibers which are indigestible by the human gastrointestinal tract further reduce accessibility of plant source proteins (Arte *et al.*, 2015, Mandalari *et al.*, 2008). Hence, animal source proteins score highest on all other quality measures.

There is evidence that varied /mixed plant protein sources can provide adequate protein nutrition in healthy adults even if the diet is devoid of animal protein (Mariotti, 2017, Watford and Wu, 2018, Hoffman, 2004). The problem with such dietary patterns though is that due to their low digestibility, greater quantities of the plant food sources are required to meet protein requirements. In the long term, this can lead to excess energy intake and its attendant negative health consequences (Kurpad and Minocha, 2017). A comparison of the amino acid content of selected animal and plant protein food sources to FAO/WHO reference protein is shown in Table 2.1 from (Elmadfa and Meyer, 2017).

Table 2.1: Amino acid pattern (mg/g protein) of dietary animal and plant proteins compared to the FAO/WHO reference protein

	Amino Acid								
Protein	His	Ile	Leu	Lys	SAA	AAA	Thr	Trp	Val
Beef, tenderloin, 1/8 fat, all grades, raw	31.9	45.5	79.6	84.5	39.0	71.4	39.9	6.6	49.6
Pork, tenderloin, lean only, raw	43.2	49.2	85.1	92.7	39.1	80.0	44.9	10.5	52.2
Chicken, breast, meat only, raw	31.0	52.8	75.0	84.9	40.5	73.3	42.2	11.7	49.6
Cod, Atlantic, fillet, raw	29.4	46.1	81.3	91.9	40.3	72.8	43.9	11.2	51.5
Egg, chicken, raw	24.5	53.3	86.3	72.5	51.7	93.7	44.1	13.3	68.2
Milk, cow, whole	27.0	60.0	97.3	78.8	33.9	95.8	44.8	13.9	66.7
Wheat, soft red winter, whole grain	24.9	38.4	74.1	30.6	46.0	81.1	33.2	-	48.3
Wheat flour, white, unenriched	20.3	33.7	64.6	26.8	40.5	54.2	27.2	11.6	40.2
Soybean, mature seeds, raw	30.1	54.0	90.7	74.1	32.9	100.3	48.4	16.2	55.6
WHO/FAO reference infant	21	55	96	69	33	94	44	17	55
WHO/FAO reference child 3+ yrs, adult	16	30	61	48	23	41	25	6.6	40

AAA, aromatic amino acids (i.e., phenylalanine and tyrosine); His, histidine; Ile, isoleucine; Leu, leucine; Lys, lysine; SAA, sulfur amino acids (i.e., methionine and cysteine); Thr, threonine; Trp, tryptophan; Val, valine.

Quality of dietary protein has important implications for children and adults alike. The effect of poor dietary protein quality is especially profound during pregnancy and in the first year of life (Minocha *et al*., 2017). For example, the amino acids arginine and methionine are required for buildup of fetal lean tissue. Methionine is also required to provide methyl groups for the methylation of the fetal genome (Dasarathy *et al*., 2010). In infants, inadequate quality protein intake results in sub-optimal lean mass, length and height development. Among adults, studies have associated poor protein quality diets with sarcopenia (Paddon-Jones *et al*., 2008), and low muscle mass. A study of elderly Finnish women found that higher consumption of total and animal protein was associated with higher lean body mass (Elmadfa and Meyer, 2017). Similar results were obtained in the Framingham Osteoporosis Study in which higher total and animal protein intake was associated with lower loss of bone mass (Tucker *et al*., 2001). Low muscle mass in turn has negative implications for mobility and is also a risk factor for diabetes (Unni *et al*., 2009).

2.2 Other nutrients in protein food sources

Protein-rich foods provide other essential nutrients (Elmadfa and Meyer, 2017). Many of these nutrients are of public health concern because their consumption is likely to be less than what is needed to prevent the adverse health effects of deficiency associated with them (Phillips *et al*., 2015). In many parts of the world, this category includes iron, folate (especially among pregnant women and women of childbearing age) and vitamin B_{12} (in the case of the elderly) (Phillips *et al*., 2015). Zinc, selenium, and the B vitamins are all key nutrients that abound in animal source protein foods. Among the US population, fresh and lean pork provided '11% to 19% of total saturated fat, phosphorus, potassium, riboflavin, niacin, vitamin B_6, and vitamin B_{12} in the diets of consumers and contributed 21% and 16%, respectively, of total zinc' Murphy *et al*. (2011).

The omega 3 polyunsaturated fatty acid content of fish and the positive health effects of consumption on cardiovascular diseases (CVDs), inflammation and cancer prevention are well documented (Khalili Tilami and Sampels, 2017). One to two servings of fish per week is recommended to provide protection against ischemic stroke and coronary heart disease (FAO and WHO, 2011). Fish is one of the few foods that naturally contain vitamin D (Holick and Chen, 2008) a vital nutrient needed to prevent rickets and low mineral density. Vitamin D deficiency has been linked with diabetes (Holick, 2008) and CVDs (Norman, 2008). Fish is also a significant source of vitamin B_{12}, calcium, phosphorus, iodine and selenium (Khalili Tilami and Sampels, 2017).

Consumption of plant-based protein foods is associated with nutrient adequacy and a healthful dietary pattern (Bianchi *et al*., 2016). Nuts for example, provide dietary fiber, vitamin E and magnesium (Santarpia *et al*., 2017, O'Neil *et al*., 2012). Pulses are low fat dry-harvested leguminous crops (FAO, 1994). In the food-based dietary guidelines in some countries (Ireland, Canada and Bulgaria included) they are placed in the meat and alternatives group.

Dry beans, lentils and other pulses contain substantial amounts of micronutrients (Marinangeli *et al*., 2017). One hundred grams of kidney beans boiled without salt contains 230 mg folate, which corresponds to over 57% of the RDA (Ahnen *et al*., 2019). Mitchell *et al*. (2009) reported that Americans who ate about 'half a cup of cooked dry pulses on the day of food intake assessment' had higher intakes of not only protein, but also 'fiber, zinc, iron and magnesium, and lower intakes of saturated fat and total fat'. Similar observations were made among Canadian subjects who ate at least 99 g of cooked pulses on the day of assessment (Mudryj *et al*., 2012).

In both studies, intake of Vitamin B_{12}, D, calcium and riboflavin, all of which are less abundant in pulses, did not differ between pulse eaters and non-eaters. Thus, the conclusion was drawn that higher intakes of the previously-mentioned nutrients were the result of pulse consumption. Legumes and other protein-rich plant foods also contain phytosterols, soluble fibers and phospholipids which inhibit cholesterol absorption (Jesch and Carr, 2017). They are thus included in the food sources encouraged as part of a healthy dietary pattern to lower CVD (Carson *et al*., 2020).

2.3 Dietary protein and human health

2.3.1 Effects of protein deficiency

Ingestion of protein as a source of amino acids is essential for most biological processes. Digestion and absorption of nutrients in the small intestine, as well as transport of nutrient in the blood all require protein. For this reason, protein deficiency has serious implications for human health. Protein-energy malnutrition remains a serious problem globally, causing an estimated 6 million deaths each year (Wu, 2016). In Africa, the problem is especially pronounced among children under the age of five, those aged 6-9 years and women of reproductive age (African Union Commission, nd). Globally, other vulnerable population groups are the elderly (Crichton *et al*., 2019), persons in long-term care facilities and those living with chronic diseases e.g. cancer patients (Arends *et al*., 2017), chronic liver disease (Nishikawa *et al*., 2016) and chronic kidney disease (Iorember, 2018). Protein deficiency in humans has multiple effects, a few of which are; impaired nutrient absorption, transport and storage, intrauterine growth restriction, mood disorders, muscle weakness, fluid retention, skin atrophy and loss of hair (Wu, 2016).

2.3.2 Effects of high protein intake

Protein has been shown to cause greater satiety than other macronutrients (Morell and Fiszman, 2017, Cuenca-Sánchez *et al.*, 2015). The precise mechanism behind these observations is not completely understood but a number of possible explanations, including inhibition of ghrelin (an appetite promoting hormone) and stimulation of fatty acids and glucose oxidation in skeletal muscle have been described in literature (Morell and Fiszman, 2017). Based on this, some promote high protein intake as an effective weight loss strategy (Pesta and Samuel, 2014). For example, the Acceptable Macronutrient Distribution Range (AMDR) guideline is 10-35% of calories as protein. In comparison popular weight loss diets such as the South Beach diet (low carbohydrate, high protein) and Stillman diet (low carbohydrate, high protein, low fat) recommend 39 and 64% respectively (St. Jeor *et al.*, 2001). Concerns have been raised about potentially dangerous consequences of long-term protein intake above the safe upper limits. Such consumption levels can cause the body to surpass its ammonia detoxification capacity, leading to hyperaminoacidemia, injury to the liver and kidney (Ko *et al.*, 2017), hyperinsulinemia (Wu, 2016, Samal and Samal, 2018), poor bone health (Hoffman, 2004) and increased risk of some cancers and CVD (Song *et al.*, 2016).

2.3.3 Effect of protein source on health

Beyond the amount consumed, attention has also been paid to the effect of protein source on health. Song *et al*. (2016) found that high intake of animal protein was positively associated with cardiovascular mortality, while high plant protein intake was inversely associated with all-cause and cardiovascular mortality. Similarly, Budhathoki *et al*. (2019) also assessed the associations between animal and plant protein intake and all-cause and cause-specific mortality. In that cohort study of 70,696 Japanese adults, higher plant protein intake was associated with lower total mortality. Animal protein intake was not associated with mortality outcomes but replacing plant protein for red or processed meat protein was associated with lower risk of total, cancer-related, and CVD–related mortality.

Analysis of data from 81,337 participants of the Adventist Health Study-2 found only weak positive association between animal protein and CVD mortality and in the case of plant proteins, no association (Tharrey *et al*., 2018). But, when protein source was specified, it was observed that high meat protein scores were associated with higher CVD mortality risk while high nuts and seeds protein scores were associated with a lower risk (Tharrey *et al*., 2018). Research in this area is complicated by multiple factors. Protein source foods supply other nutrients apart from protein. Besides, they are often consumed not in isolation, but rather in combination with other foods. Lifestyle factors also present further confounders which together make it difficult to clearly enunciate the effect of protein on health outcomes. Even so, the aforementioned studies and many others point to better health outcomes with a dietary pattern that emphasizes higher intake of plant protein than animal protein.

2.4 Protein intake recommendations

Estimates of dietary requirements for human protein intake are dependent on dietary factors e.g. energy intake, amino acid content and proportions in the diet; physiological characteristics including age, physical activities and sex; pathological states e.g. infection and trauma, and environmental factors. An RDA of 0.80 g of good quality protein/kg body weight/d is frequently cited for adults of age 19 years and above (Institute of Medicine, 2005). Adequate protein intake can prevent anaemia among pregnant women, premature delivery, bleeding during child birth and low birth weight babies. In view of these requirements, 10 or 15 g extra is recommended for women who are pregnant or lactating respectively (Watford and Wu, 2018). Children (because they are growing) and individuals who are seriously ill may require more. Athletes and elderly persons may also require more protein due to their peculiar circumstances (Ahnen *et al*., 2019). Table 2.2 below is a summary of current protein intake recommendations and safe upper limits.

Table 2.2: Human Dietary Protein Requirements

		Recommended dietary allowance (g/kg body weight/day)		**Safe upper limits (g/kg body weight/day)**
Group	**Age (years)**	**IOM[a]**	**FAO/WHO/UNU[b]**	
Infants	0.3-0.5	1.52	1.31	4.7
	0.75-1.0	1.50	1.14	
Children	1-3	1.10	1.02	5.1
	4-8	0.95	0.92	
Adolescents	9-13	0.95	0.90	
	14-18 (boys)	0.85	0.87	
	14-18 (girls)	0.85	0.85	
Adults	≥ 19	0.80	0.83	
Adults	>18			3.5

Source: (Wu, 2016)
[a]RDA values published by the Institute of Medicine (Institute of Medicine, 2005).
[b]RDA values published by the Food and Agricultural Organization/World Health Organization and United Nations University (WHO/FAO/UNU, 2007).

2.5 Protein food sources in the Ghanaian diet

The typical Ghanaian diet is dominated by carbohydrate-based foods. The 2009 nutrition profile for Ghana reported that starchy roots and cereals together represented 72% of the dietary energy supply (DES) (Agble *et al*., 2009). A recent study of Ghanaian food consumption patterns indicated that carbohydrates made the largest contribution to daily energy intake in urban Ghana, and 'more so' in rural areas (Galbete *et al*., 2017). This pattern has also been observed among Ghanaian migrants oversees (Gibson *et al*., 2015). Nevertheless, animal and plant protein food sources also feature in the Ghanaian diet, usually as an accompaniment to the carbohydrate staples. In Ghana, as in many other parts of the world, plant protein sources are cheaper than animal source foods (Ministry of Health, 2009) and contribute about 65% of total protein intake as compared to 35% from animal sources (Wu, 2016).

Popular examples of plant protein dishes include groundnut (peanut) soup (Meng *et al*., 2018b), and palava sauce which is prepared with cocoyam leaves and melon (*Cucumeropsis manii*) seeds known locally as agushie (Agble *et al*., 2009). Groundnuts form the basis for several popular snacks. Roasted or boiled groundnuts, 'dzowe' (made from groundnut, maize, sugar and spices), 'kulikuli' and 'nkate' cake are a few examples (Meng *et al*., 2018a). In a recently published research which was conducted in rural northern Ghana, legumes (specifically cowpeas, groundnuts and soybean) contributed 22% to total protein intake among non-breastfeeding children aged 12-23 months (de Jager *et al*., 2019). These foods also contributed greater than 10% of their total folate, iron and niacin intake.

Though Ghanaian dishes feature a variety of animal foods such as beef, pig feet, goat meat and eggs (Heinbuch, 1994), fish is a major source of animal protein likely because of its relative affordability (Komatsu and Kitanishi, 2015). Per capita fish consumption in Ghana is reported as among the highest in West Africa (Heinbuch, 1994). A survey conducted over two decades ago indicated that it comprised 64% of the total animal protein intake (Heinbuch, 1994). More recently Gibson *et al*. (2015) who compared the diet of first-generation diasporic Ghanaian adults in the UK and adult Ghanaians at home reported that together with soups and stews, fish contributed to 46% of the protein intake (by Ghanaians at home). Also, the 2014 Ghana living standards survey reported that it comprised 15.8% of total household food expenditure (Ghana Statistical Service, 2014b). In comparison, meat made up 7.6% while the figure for milk, cheese and eggs was 3%.

2.6 Portion size estimation in dietary assessment

In dietary assessment, portion size refers to the amount of a particular food including any subsequent helpings, that is consumed at an eating occasion (Nelson and Haraldsdottir, 1998a). Left overs of the food are not considered as part of the portion (Sharma and Chadha, 2017). Portion size estimation is necessary in dietary assessment, whether to describe the intake of a population through use of individual measurements or in clinical evaluation of individual diets for dietary counselling. It is also fundamental for the conversion of food consumed into intake of nutrients and other constituents of interest. Incorrect estimation of portion sizes causes errors in estimation of energy and other nutrient intakes (Gibson *et al*., 2017), and any subsequent analysis e.g. comparison with dietary guidelines, assessment of nutrient adequacy, and evaluation of relationships between intakes and health outcomes will be flawed (Gibson *et al*., 2017).

Unfortunately, portion size estimation is a difficult task. There has always been awareness of the fact that people struggle to estimate the amount of food they recall to have consumed in the past, present or even that is presented directly to them (Young and Nestle, 1995). Years after Huenemann and Turner (1942) identified portion size estimation errors as the main source of error in diet records, it is still recognized as the most important reason for misreporting in dietary assessment (Nichelle *et al*., 2019, Hernandez *et al*., 2006). Similarly, it was cited as a major issue of concern in a recent report on the problems that confront dietary assessment methods in Africa (Pisa *et al*., 2018). While training individuals certainly improves their estimation skills, accuracy is still reportedly low even after such training (Howes *et al*., 2017).

The challenge of accurate portion size estimation is not limited to lay persons (Timon *et al*., 2018). In a decade old investigation, Japur and Diez-Garcia (2010) found that 47% out of 1169 observations made by nutrition students were underestimations while 34.5% were overestimations. One study in Japan compared the ratio of self-reported intake to biomarker-based intake as an index of reporting accuracy between dietitians and non-dietitians. There was no significant difference in the degree of misreporting between the two groups, but the dieticians 'tended to under-report sodium and protein intake more severely than non-dieticians and overreported potassium intake more obviously' (Sugimoto *et al*., 2016). According to the report, although no significant difference was found in the degree of misreporting between the two groups, there was a greater tendency to under-report intake of sodium and protein and to overreport potassium intake among the dieticians.

In their conclusion, Sugimoto *et al*. (2016) asserted that the misreporting they observed among dieticians might be associated with health consciousness and nutrition knowledge. This seems to suggest that wrongful omission or inclusion of food and portion size estimation errors would have been largely intentional. Their study design however did not allow genuine challenges with portion size estimation to be ruled out.

Only 24-33% of nutritionists, dieticians and nutrition researchers recruited in a recent Malaysian study were able to accurately estimate portion size within 10% of the actual weight (Fatehah *et al*., 2018). Granted, the study involved use of digital food images for which only one participant had previous experience. Still, these examples together underscore the vulnerability of individuals to portion size estimation errors despite their nutritional knowledge/training or lack of it.

2.7 Factors that influence portion size estimation

The factors that influence portion size estimation can be broadly categorized into food and subject characteristics (Young and Nestle, 1995). Food characteristics include size and type of food while factors like age, gender, income, eating habits, body weight and training constitute subject characteristics. A few of these are outlined in the following paragraphs.

2.7.1 Food characteristics

Fang *et al*. (2018) noted that the difficulty of portion size estimation is increased by the vast changes in shape and appearance of food that occur during its preparation and consumption. Portion size of unit foods (Reale *et al*., 2019) and foods with a well-defined shape seem to be easier and more accurately judged than amorphous foods that take up the shape of whatever container they are placed in (Thoradeniya *et al*., 2012). Participants of a qualitative study which sought to evaluate effectiveness of portion size estimation aids from the perspective of consumers admitted that amorphous foods particularly breakfast cereals, pasta and rice are difficult to estimate (Faulkner *et al*., 2017). Reports from a number of studies show that after training in portion size estimation, amorphous foods remained the least accurately estimated by study participants (Weber *et al*., 1997, Arroyo-Izaga M, 2007, Ayala, 2006). The challenge with amorphous foods has also been noted among children (Reale *et al*., 2019, Olafsdottir *et al*., 2016).

Regarding the size of food, the so-called flat-slope syndrome problem, where smaller portions are likely to be overestimated and vice versa is widely recognized (Faggiano *et al*., 1992, Nelson *et al*., 1994, Harnack *et al*., 2004, Kirkpatrick *et al*., 2016, Keenan *et al*., 2018). Presentation of plated food i.e. as a stack or spread out, influences consumers' perception of portion size. Szocs and Lefebvre (2017) recently demonstrated this in an experiment where food displayed horizontally was perceived as larger than when the same portion size of food was displayed vertically.

2.7.2 Subject characteristics

Age: Poor memory and quantitative skills are among the frequently cited reasons for portion size estimation error (Chambers *et al*., 2000). Older adults for instance are believed to have a harder time with portion size estimation because of the natural decline in memory that is associated with ageing (Ward *et al*., 2019). In some cases, what is construed as underreporting may actually be a true reflection of undereating, which is a common issue among the elderly (Volkert and Schrader, 2013). All the same, there are reports that older ones have difficulty in recalling both the food and quantity of food (Ervin and Smiciklas-Wright, 2001), and that errors increase with age (Johansson *et al*., 1998a). One study involving routinely collected clinical data identified both under reporters and over reporters among 70-96-year old study participants (Soriano *et al*., 2018). Jeon *et al*. (2018) observed that total energy intake by 24 hr recall was slightly under-reported by - 4.4% (in comparison with the doubly labelled water method) among elderly male subjects (mean age 72.5 ± 3.9 years). This notwithstanding, there was no significant difference between total energy intake and expenditure ($p= 0.069$), indicating that the dietary intake estimates provided by the participants was valid.

In a study to examine memory and dietary recall among a group of 94 elderly persons (age 58 years and older), Ervin and Smiciklas-Wright (2001) concluded that the participants' ability to recall both the names of the food and the quantities was poor. There are two important limitations with the study by Ervin and Smiciklas-Wright (2001). Firstly, no portion size estimation aids were used. Nonetheless, some studies that employed food models and other aids made similar conclusions (Chianetta and Head, 1992, Dubois and Boivin, 1990). A second limitation is the fact that no other age group was tested for comparison and therefore the authors could not say if older adults are 'worse than other adults at estimating or recalling portion sizes' (Ervin and Smiciklas-Wright, 2001).

Concerns about accuracy of dietary recall have also been raised regarding young children whose cognitive abilities are not yet fully developed (Frobisher and Maxwell, 2003, Young and Nestle, 1995, Foster and Bradley, 2018, McPherson *et al*., 2000). However, as inability to estimate portion sizes correctly has been reported among other age groups too (Mushquash *et al*., 2018, Nissinen *et al*., 2018, Santos *et al*., 2010, Schap *et al*., 2011, Schwartz and Byrd-Bredbenner, 2006), it suggests that the phenomenon may well be 'independent of age' (Young and Nestle, 1995). Indeed, some findings imply that portion size estimation ability of older ones was similar to young adults (Timon *et al*., 2018).

Body weight: Compared to persons whose BMI is within the normal range (Horne *et al*., 2019), overweight and obese individuals may more frequently misstate their portion sizes, often believing it is smaller than it really is (Wehling and Lusher, 2017). These inaccuracies may be associated with attempts to control body weight through dieting (Heitmann, 1993, Crawley and Summerbell, 1997). In the Fleurbaix Laventie Ville Santé study in France, Lafay and colleagues reported that as many as 16% of the participants (501 women and 529 men; free-living, weight stable, age >15 y) underreported their food intake. Notably, underreporting was significantly more common in obese than non-obese participants ($p<0.001$) (Lafay *et al.*, 1997). Also, obese adolescents in one study were five times more likely to under-report their intake as compared to their counterparts who had a normal weight (95%CI 2.0-12.7) (Santos *et al.*, 2010). A similar trend was seen among an elderly Belgian population (Bazelmans *et al*., 2007) and a Dutch sample aged between 20 and 70 years (Trijsburg *et al*., 2016).

On the contrary, under-reporting was found to be prevalent among a group of 1889 young Japanese women (aged 18-20 years), 95% of whom were non-obese (BMI <25 kg/m^2; Mean ± SD: 20.8 ± 2.6 kg/m^2) (Okubo and Sasaki, 2004). Similar to the observations made by Sugimoto *et al.* (2016), these results were no doubt influenced by the fact that all the participants were university students enrolled in dietetics and substantiates the body of evidence regarding the influence of social desirability and approval on accuracy of dietary self-report (Maurer *et al*., 2006, Hebert *et al*., 1997, Hebert *et al*., 1995). In this case, a higher educational level, and/or a background in nutrition and dietetics posed social pressure on subjects to produce desirable responses about their dietary lifestyle and practices that they felt is expected of them as 'experts' in nutrition. Beyond such exceptions, majority of studies support Wehling and Lusher (2017) who after systematically reviewing 34 papers published between January 1982 and March 2016, concluded that 'accuracy of food intake decreases with BMI or adiposity'.

Gender: There are reports that women perform better at estimating portion sizes than men (Keenan *et al*., 2018, Yuhas *et al*., 1989, Almiron-Roig *et al*., 2013, Gnardellis *et al*., 1998). This may be related to the fact that in many cultures, women generally have more experience with food preparation and thus greater opportunity to measure and gauge food quantity. It could not be ascertained from literature whether the same is true for men with considerable culinary abilities. Young and Nestle (1995) also pointed to lack of investigation into portion size estimation skill 'in men and women with equivalent experience in food handling' leaving 'the question of gender specificity open'. Yet, women may be more likely to under-report intake (Fereidoun, 2005, Shaneshin *et al*., 2012, Johansson *et al*., 1998b). In the 'quality of life after 65' study for example, under-reporting was more predominant in women while over-reporting was more prevalent in men (Bazelmans *et al*., 2007). Explanations for this trend include desire for weight loss and sensitivity to appearance and fitness which are all hypothesized to be stronger in women than men (Fereidoun, 2005, Gemming *et al*., 2014).

2.8 Aids for portion size estimation in dietary assessment

The ideal approach for accurate portion size estimation is to weigh and record all of the food and drinks eaten in the period being assessed. In addition to being expensive and placing a high burden on respondents, this method is often impractical as it 'requires a highly motivated and committed subject population, which is unlikely to be representative of the general population' (Foster *et al*., 2009). The problem is compounded when food is consumed from varying sources away from home (Foster *et al*., 2009), food is eaten from a common bowl with others (Hundson, 1995) and when multiple-item/mixed dishes are consumed.

Alternatives to the weighed food intake require subjects to estimate the portion size of the foods that they consumed. This is done with the aid of a variety of tools including photographs, food replicas and food models (Hackett *et al.*, 1984; Cameron and Van Staveren, 1988; Nelson *et al.*, 1997) and common objects such as card decks and tennis balls (Byrd-Bredbenner and Schwartz, 2004). As dietary patterns differ immensely and is subject to factors like geographic location, culture and ethnicity, these tools must be developed and validated for use in specific populations (Trolle *et al.*, 2013).

Portion size estimation tools aid respondents to 'reconstruct' the food portion consumed (Japur and Diez-Garcia, 2010) and while errors are not totally removed, they are reduced albeit by varying degrees. Household measures and utensils are by far the most popular but come with a number of disadvantages. Besides their being bulky, cumbersome and therefore not easy to carry about when field work is involved, the assumed volume of these items may be erroneous and differ widely in size and volume. This is the case with the abundance of serving spoons, ladles and eating utensils available on the Ghanaian market. Over two decades ago, Owusu *et al.* (1995) identified at least 13 teaspoons with measures ranging from 2.55 to 5.5 milliliters. One cup may refer to 284.13 ml, 239.59 ml, 227.3 ml or 250 ml depending on whether it is an Imperial, US, Canadian or Metric cup, respectively. Depending on its origin, a tablespoon could be 14.8 ml (US), 15 ml (Metric) or 20 ml (Australian). Estimations must also consider whether these measurements are heaped or level (Wrieden and Momen, 2009). Since there are many possibilities for what different persons might consider as a household measure, difficulties can arise if for example some measures in a food record cannot be accurately identified and converted to weight or volume for nutrient analysis.

Some novel tools have also been described in literature. Godwin *et al*. (2006) published their research on the use of an adjustable wedge which was developed for portion size estimation of pizza, pie, cake and other wedge-shaped foods. Respondents in that study were reportedly more confident in their ability to estimate portion size with the use of the wedge as compared to a ruler. Nevertheless, misestimation was not reduced especially for larger foods and the method was no better than the use of a 12-inch ruler.

The accuracy of hands as a prospective novel PSEA was tested by Gibson *et al*. (2016) in two different portions of 21 foods and liquids among 67 participants. The method had three components. The finger width ('dimensions of food measured using width of fingers as a ruler'), fist (food compared to volume of fist up to wrist joint') and tip where food was compared against the volume of the tip of the thumb. The results indicate that this approach worked well for geometrically shaped foods (80% within +/- 25% of the true weight of food or liquid, compared to 29% for estimates with household measures). However, as there was no BMI or age restriction in participant recruitment, and also considering that they were all very well educated (university staff and students), the generalizability of these observations is quite limited.

Advances in technology have led to an increase in exploration of smart food assessment tools. Technology-based aids include remote food photography where portion size is estimated from digital photographs that respondents take of their meals with a mobile device specially fitted for the purpose (Jia *et al*., 2014, Stumbo, 2013, Martin *et al*., 2009). The respondent is required to take pictures before and after their meal. The pictures are used to estimate food volume and then converted to nutrient values by use of nutrient analysis database.

A disadvantage of this is the fact that participants must take these pictures each time they are about to eat or drink. This may be disruptive and burdensome if several courses of food are eaten at a meal or several meals and drinks are taken throughout the day (Jia *et al*., 2014).

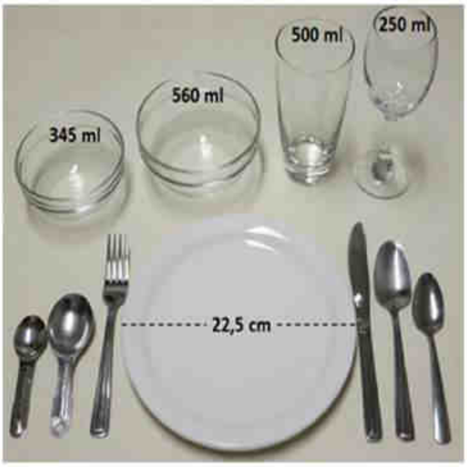
Another is the wearable camera with sensors for monitoring dietary intake. The sensors may operate on the basis of one or more approaches e.g. inertial, electromyography, capacitive, acoustic, visual etc. The number of researches into these sensing technologies have increased in the past decade. Vu *et al*. (2017) provide a comprehensive review of wearable food intake monitoring vis-à-vis current sensing platforms and their data analytic methodologies. In one recent pilot study conducted in a semi-rural community in the Eastern Region of Ghana, the feasibility of using the automatic ingestion monitor, a wearable chewing sensor and micro-camera to monitor acquisition, preparation and consumption of food was confirmed (Anderson *et al*., 2019). These emerging technologies have the advantage of requiring little effort on the part of respondents beyond wearing the devices. Such passive assessment therefore implies less respondent burden. Another advantage is non-reliance on respondent memory and recall which then reduces opportunity for errors associated with misreporting of food and portion sizes. The main drawback is the potential high cost associated with the devices.

Portion size estimation tools can generally be classified as two dimensional or three dimensional (Byrd-Bredbenner and Schwartz, 2004). In addition, some literature recognize one dimensional tools such as food labels, till receipts and portion guides (Amoutzopoulos *et al*., 2020). A list of the different types of portion size estimation tools is presented in Table 2.3. and pictures of some of these tools are shown in Figure 2.1.

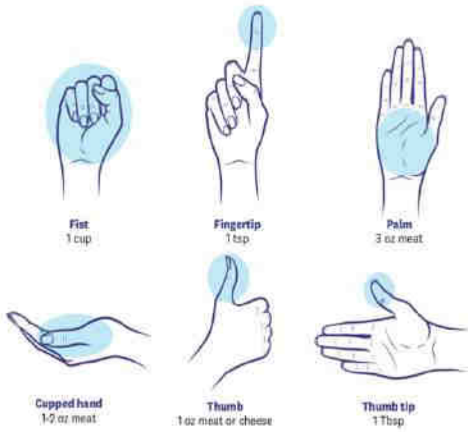
Table 2.3: Examples of tools/aids for portion size estimation

Category	Examples
One dimensional	Portion lists
	Food guides
	Labels/food packaging
	Till receipts
Two dimensional	Food photos (e.g. photographic atlas; Fig 2.1)
	Electronic images
	Food diagrams/drawings
	Non-food object images (e.g. images of golf balls, tennis balls etc.) (Fig 2.1)
	Utensil images
	Hand images (Fig. 2.1)
Three dimensional	Household utensils including measuring utensils
	Food scales
	Food replicas and models (e.g. golf balls, deck of cards, plastic meat pieces, thickness sticks, modelling clay, bean bag, and wedge)
	Ruler
	Hands
	Adjustable wedge (concentric circles with movable are attached to the centre to allow extension to outermost circle. Often used to assess portion size of wedge-shaped foods such as pizza and pies)
	International food unit and food volume measurement aid: A 4x4x4 cm cube (volume 64 ml) which can be divided into eight single 2 cm sub-cubes for estimating smaller portions
	Automated devices such as the wearable automatic ingestion monitor with camera to monitor acquisition, preparation and consumption of food.

Sources: Amoutzopoulos *et al*. (2020); Bucher *et al*. (2017); Sharma and Chadha (2017); (Vu *et al*., 2017)



Household utensils



hand images

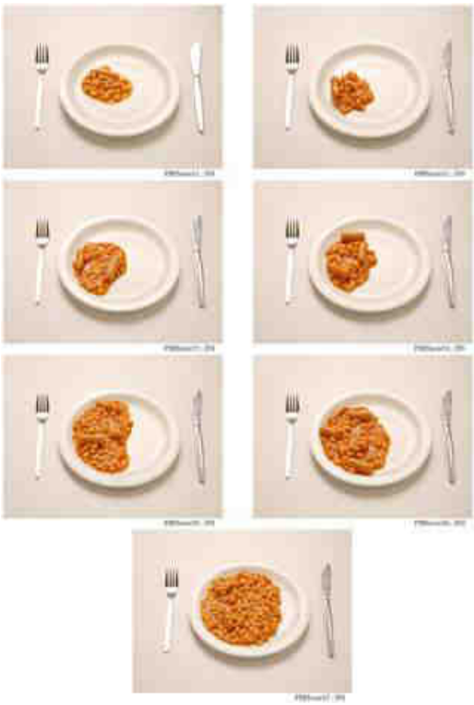


Photo series from a photographic atlas
(Foster *et al*., 2017)

3-D portion size estimation aids
(Mushquash *et al*., 2018)

Figure 2.1: Some portion size estimation aids

2.9 Portion size estimation with photographic food atlas

A photographic food atlas is a series of food photographs bound into a single volume (Nelson and Haraldsdottir, 1998a). Each photograph series depict different foods in different portion sizes that are arranged in incremental or decremental order. Some atlases have been developed and validated for general use among populations. Others were developed for special use; e.g. the photographic atlas of Spanish food consistency for nutritional intervention of dysphagia (Ruiz Brunner *et al.*, 2019) and the atlas by Lombard *et al.* (2013) for use in rural areas of the Eastern Cape Province of South Africa with a high incidence of squamous cell oesophageal cancer. Some atlases are tailored for specific age groups (Foster *et al.*, 2009, Brito *et al.*, 2012, Biltoft-Jensen *et al.*, 2018) and classes of food (Mathews *et al.*, 2018).

There is evidence that accuracy of food quantification significantly improves when an atlas of food photographs showing standardized portions of foods consumed by a population is used (Nelson *et al.*, 1994, Nelson *et al.*, 1996). Over the years, researchers have found them to be effective (Marjan, 1995, Turconi *et al.*, 2005, Ovaskainen *et al.*, 2008), easy to use and convenient in low literacy populations (Subasinghe *et al.*, 2016). As a result, photographic food atlases have gained increasing use globally and are presently the most commonly investigated two-dimensional portion size estimation aid (Sharma and Chadha, 2017, Hotz and Abdelrahman, 2019).

In regards to limitations with the use of the photographic atlas, Asar *et al.* (2010) noted that a large number of photographs may be required to create the atlas in cases where commonly consumed foods are numerous. The problem with this is that the creation of such an atlas will be more time consuming and costly. Using the atlas will also require more time and thus increase the duration of the dietary assessment interview. Furthermore, because food packaging, selection and preferences among populations are dynamic, regular validation of the food photographs is essential, particularly for those food items which are consumed daily (Ovaskainen *et al*., 2008). It is also important to recognize that as noted by Bernal-Orozco *et al*. (2013), even if people pay heed to how much food they consume, it is a challenge for them to visualize, remember and translate it into an image. So, although food photographs improve portion size estimation, considerable skill is required on the part of respondents.

2.10 Development and validation of photographic food atlases (PFA)

At least three distinct steps are involved in the development of all PFAs. First, data on foods consumed by the target population must be obtained (Nelson and Haraldsdottir, 1998b) to facilitate the generation of a list of relevant foods to be included in the atlas. Based on the information collected, a photo series of selected foods is developed and finally validated in the target population to assess its practical use (Nelson and Haraldsdottir, 1998a).

2.10.1 Identification of commonly consumed foods from food consumption data

The ideal approach to achieve this is to collect food consumption data through cross-sectional survey of a sample that is representative of the target population. This is a challenging endeavor in terms of time and financial resources required (Steyn *et al*., 2003) but yields information that is useful and invaluable. Besides a list of commonly consumed foods, such studies especially when conducted at the national level can be designed to afford understanding of existing biodiversity in food systems, capture nutritional challenges, changing dietary practices as well as diet and disease relationships (Sharma *et al*., 2007, Sharma *et al*., 2009, Ramdath *et al*., 2011).

Some surveys have led to the development of high-quality country-specific food composition databases to aid in correct measurement of dietary intake (Ene-Obong *et al*., 2013) and some have guided policy makers to identify pertinent nutrition deficiencies and appropriate food vehicles for national fortification programs (Labadarios *et al*., 2005). Other food consumption studies have explored the contribution of commonly consumed foods to nutrient intakes (Ayogu *et al*., 2017), explored dietary patterns (Steyn *et al*., 2003, Galbete *et al*., 2017) and food choices of populations (Meng *et al*., 2018b), provided a basis to develop food exchange lists (Fadupin, 2009) and investigated portion and serving sizes of common foods (Sanusi and Olurin, 2012, Jayawardena *et al*., 2012).

An important consideration when classifying a food as commonly consumed is the ultimate way in which the data will be used. As an example, in surveys held as a prelude to food fortification, the number of consumers of a food as well as the mean daily intake are of primary concern (Coates *et al*., 2012). Once the intent is established, a number of options are available for ranking commonly consumed foods, including total number of times each food was recorded, proportion of individuals who reported intake of food and total amount of the food consumed. This procedure is summarized below in Table 2.4 (Faber *et al.* , 2013).

There are merits and demerits with each approach. If ranking is based on the number of times a particular food is consumed, the food may be classified as highly common when in reality only a few persons (relative to the sample size) may have consumed it. Persons who are truly non-consumers of a specific food may be difficult to distinguish from those who consume it occasionally but did not do so during the study period. Where total amount of the food consumed is used, foods consumed in small but nutritionally significant quantities may be out-ranked or overlooked entirely (Faber *et al*., 2013).

The total enumeration approach where all foods reported by respondents are included, is used by some researchers to reduce the effect of these limitations. Mbhenyane *et al*. (2005) adopted this approach when they investigated indigenous food consumption among college students and found a rather low variety of food intake among the respondents. Where proportion of individuals who reported intake is used, some define common foods as those consumed by at least 5% of respondents, or 85% if the food list is extensive (MacIntyre *et al*., 2002).

In lieu of dietary surveys, 'informal or subjective methods such as consultation with food service professionals, local cook books, restaurant and cafeteria menus, interviews with cooks/chefs in households and restaurants' (Hotz and Abdelrahman, 2019) are easier. However, the information obtained may be incomplete and non-reflective of the population of interest (Hotz and Abdelrahman, 2019). Another easier, cheaper and quicker alternative to use is the focus group discussion technique where a moderator uses an interview guide to solicit information from groups typically consisting of 6 to 8 persons. A decade ago, Samuda *et al*. (2009) took this approach to identify the most frequently consumed foods which contributed significantly to the diet of the Jamaican populace. Discussions were held with twenty groups consisting of 4 to 13 persons. The resulting list of foods formed the core of foods to update the Jamaican food composition database at the time. The main limitation of using focus groups is the limited generalizability of results due mainly to small sample size. Still, this may not be a major issue if there is homogeneity in the common foods eaten across the geographical regions which the sample represents.

Table 2.4: Identification and ranking of commonly consumed foods

Procedure	Merits and demerits
Total number of times each food was recorded	
	• Shows consumption frequency • Number of consumers, portion size & frequency of daily consumption is not considered • Is influenced by the assessment method. E.g. In a 24-h recall/record, one individual may consume a certain food several times during the reference period; while another may not take that food at all, leading to overestimation of consumption within the sample. On the other hand, when food frequency questionnaire is used, the number of responses to an item reflects the number of individuals who consume the food but may not differentiate between frequent and infrequent consumers (e.g., daily or monthly consumption) • May exceed the total number of study participants (24-h recalls/records) for frequently consumed foods
Percentage of individuals who report consumption of a food	
	• Shows the percentage of consumers but not the quantity consumed or frequency of consumption • Persons who never eat a food are not distinguished from those who only refrained during the reference period for dietary intake. Both groups are identified as non-consumers • Gives information to identify the most commonly and least commonly consumed foods • Frequency of consumption and the amount consumed are not captured • Can be misleading if amounts consumed are small or if consumption is occasional
Total intake by sample studied	
	• Foods eaten in small quantities may be overlooked though they may be nutritionally important • Provides no information on number of consumers • Provides useful information for the determination of dietary exposure to beneficial and harmful substances
Mean daily intake per person	
	• Can be used to identify proportion of low or high consumers relative to a standard • Applies only to consumers of the food item during the reference period • Is affected by age and sex, thus affecting comparability
Per capita intake	
	• Includes the whole sample regardless of whether the food item was consumed or not • Is comparable to daily intake for consumers of commonly consumed foods • May differ from daily intake of consumers for foods eaten by only few respondents
Energy and/or nutrient contribution by foods and/or food groups	
	• Identifies food sources of nutrients • Total energy/nutrient intake is required for interpretation

Source: Faber *et al.* (2013)

2.10.2 Production of food photographs

2.10.2.1 Size, colour and background of photographs. Life-size pictures do not appear to confer greater accuracy to portion size estimation than when pictures are smaller (Pietinen *et al*., 1988, Thoradeniya *et al*., 2012). Only a few atlases present all the food pictures in life-size (Harris-Fry *et al*., 2016). For most atlases life-size photos are limited to pictures of beverages (Jayawardena and Herath, 2017) and crockery (Al Marzooqi *et al*., 2015, Foster *et al*., 2017). Whether photos are in black and white or colour seem to make no difference in errors with portion size estimation, but respondents reportedly find color food photographs more interesting (Nelson and Haraldsdottir, 1998b). This may be important especially where the research involves long interviews and respondents can easily lose interest or become inattentive (Jayawardena and Herath, 2017). In terms of photograph background, the recommendation is to make it unobtrusive and neutral (Nelson and Haraldsdottir, 1998b).

2.10.2.2 Lighting, angle of photography and camera settings: Food photography involves multiple specifications (Smith *et al*., 2010). For example, careful thought and planning for lighting, angle of capture, and camera settings are critical to the quality of photographs produced. The appearance of food in its natural state is best captured in daylight but regardless of the lighting source, steps must be taken to prevent or reduce shadows to the barest minimum (Smith *et al*., 2010) and maximize clarity (Jayawardena and Herath, 2017). A 45° angle is accepted by most as the optimum to capture depth, width and height of food (Nelson and Haraldsdottir, 1998b; Smith *et al*., 2010; Harris-Fry *et al*., 2016) and to represent the 'view of a person of average height, sitting at a table and looking at a plate of food on the table in front of him' (Jayawardena *et al*., 2017). An exception was reported by Amougou *et al*. (2016), who used 55 ° for a similar effect.

2.10.2.3 Number of portion sizes and order of presentation: The number of portion sizes depicted in many atlases ranges from 1 to 8. An odd number of portions is best avoided to prevent bias introduced by a tendency to choose the middle portion. Presentation of portions in order of increasing size is by far the commonest. Nelson and Haraldsdottir (1998b) noted that this style of presentation can lead to bias if some respondents consistently choose extreme portions without careful consideration of all the photos. Using a random arrangement can prevent this but will also substantially increase respondent burden. They recommended ordering the images in ascending order on some pages and in descending order for others is therefore suggested (Nelson and Haraldsdottir, 1998b).

2.10.3 Validation of photographic food atlas

In validation studies the degree of agreement between actual portions of food and that estimated with the atlas is assessed. As noted by Nissinen *et al.* (2018), these validation studies estimate the precision with which various quantities of a variety of foods can be evaluated when the atlas is used. Such studies also help to identify foods which are challenging to evaluate accurately. Depending on the study design, inferences can also be made about how accurately nutrient intakes can be estimated with the tool (Nissinen et al., 2018). According to Bernal-Orozco *et al*. (2013) differences in photographic atlas validation studies stem from the cognitive processes involved, respondent characteristics, the number of foods validated, statistical methods used and how the results are presented.

Concerning the cognitive processes involve, three skills, i.e. perception, conceptualization and memory are necessary for respondents to relate an amount of food to the portions shown in a food photographs in order to estimate their food portion size (Nelson *et al.,* 1994). Perception is the ability to recognize a portion of food in sight from portions shown in a photographic atlas. In conceptualization, the portion of food to be related to those shown in the photographs was seen previously but is no longer insight. Memory is the ability to remember the amount of food seen or ingested (Nelson and Haraldsdottir, 1998a). Conceptualization is especially influenced by memory since the portion of food is not present but must be recalled (De Keyzer *et al*., 2011) such as when dietary intake is assessed retrospectively (Nelson and Haraldsdottir, 1998a). Literature shows that depending on the research design, studies may address one, two or all three elements. A summary of the cognitive skills addressed in some validation studies is provided by De Keyzer *et al*. (2011) (Table 2.5). The influence of respondent characteristics like age, gender, educational level, training and others on portion size estimation have been explored with varying results (Amoutzopoulos *et al*., 2020). Further differences arise from the number and size of food portions evaluated (Naska *et al*., 2016), and number of foods involved. Validation studies that included as few as 5 foods (Szenczi-Cseh *et al*., 2017, Flax *et al*., 2019) and as many as 163 foods (Bernal-Orozco *et al*., 2013) have been reported.

Regarding statistical methods used and how the results are presented. Many studies examine the degree of error between the actual and estimated weight and determine whether it is statistically significant. Both significant and non-significant errors have been reported in literature (Subar *et al*., 2010, Nelson et al., 1996) though it is generally agreed that the degree of such error is greater when food portion size is determined without the atlas. Other studies determine accuracy of the atlas by comparing estimated and actual weights of individual foods within the atlas and finding the average error. Where the studies compared a photographic food atlas and other PSEAs, these analyses are done for each tool to determine which has higher precision. Bland-Altman plots may also be used to assess the degree of agreement between each PSEA and the true (i.e. weighed) value (Harris-Fry *et al*., 2016, flax *et al*., 2019). The most frequently used approach which was also used in this present study is to find the percentage of correctly or wrongly estimated foods (or in some studies, the percentage of respondents in each category). In studies involving conceptualization or memory, correlations between actual and estimated weights can be assessed when the actual amount of food varies depending on amount consumed by respondents rather than being constant (as is the case where pre-weighed foods are used) (Bernal-Orozco *et al*., 2013).

The visual perception method employed in this present study is frequently used in food photograph validation studies. A broad description of the method is as follows: participants/respondents examine plated portions of food and then from a photo series of that food item, indicate the portion that in their estimation best represents it. This procedure has been used and reported in several studies albeit with a few variations. Actual foods may be pre-weighed by the researchers (Nikolic´ *et al*., 2018, Szenczi-Cseh *et al*., 2017) or weighed after participants serve themselves (Flax *et al*., 2019, Bouchoucha *et al*., 2016) at home or in a controlled environment. The latter approach is clearly more challenging, time costly and burdensome to respondents. However, it better portrays the real-life conditions under which the atlas will be used (e.g. unless it is part of a study design, a researcher, dietitian or other health professional conducting a 24 h recall interview would not have been involved in serving food to the respondent). Conception is evaluated if the actual served food is removed before respondents estimate its portion size from the food photographs. Procedures may also differ with regard to the amount of time allowed between exposure to actual food portions and estimation with the food atlas. Errors in memory can be detected if a time lapse of at least twenty-four hours is allowed.

Table 2.5: Examples of validation studies of food photographs for portion size estimation

Reference	Study design	Psychological elements			Participants
		P	C	M	
Ovaskainen *et al*. (2008)	Present portion size: photo portions selected at presentation v. weight of the presented portions	‡			Men and women 25–65 years n 146
Huybregts *et al*. (2007)	Portion size of test meal: photo portions selected after test meal v. weight of the test meal portions		‡	‡ (24 h)	Women 15–45 years n 257
Turconi *et al*. (2005)	Portion size of test meal: photo portions selected after test meal v. weight of the test meal portions		‡		Men and women 6–60 years n 448
Frobisher and Maxwell (2003)	Portion size of test meal: photo portions selected after test meal (not consumed) v. weight of the test meal portions		‡	‡ (3-4 d)	Adults 17–82 years n 47
Robson and Livingstone (2000)	Portion size of test meal: photo portions selected after test meal v. weight of the test meal portions		‡	‡ (24 h)	Men and women 18–36 years n 30
Nelson *et al*. (1996)	Portion size of test meal: photo portions selected after test meal v. weight of the test meal portions		‡		Men and women 18–90 years n 136
Nelson *et al*. (1994)	Present portion size: photo portions selected at presentation v. weight of the presented portions	‡			Women 18–90 years n 51
Faggiano *et al*. (1992)	Size of test meal portion: photo portions selected after test meal v. weight of the test meal portions		‡	‡ (24 h)	Men and women 35–64 years n 103

Source: De Keyzer *et al*. (2011).

P, perception; C, conceptualization; M, memory (time lapse before recall).

2.11 Published studies on production of photographic food atlases

Studies that relate to the development of photographic food atlases are well-documented in literature. Some early examples are shown in Table 2.6 below. Similar studies have been carried out in Burkina Faso (Huybregts *et al*., 2007), Cameroon (Amougou *et al*., 2016), Brazil (Brito *et al*., 2012) and many other countries. A few recent examples are related in the following paragraphs.

Table 2.6: Examples of country-specific photographic food atlases

Country	Year	Title of atlas	Number of photos in atlas	Number of portions
Finland	1985	Annoskuvakirja	126	3
Poland	1991	Album Porcji Produktow I Potraw	135	3
France	1994	Portion Alimentaries	245	3
Russia	1995	Albomportsiy Productov I Bljud	63	3
EPIC	1995	EPIC-SOFT Portion Picture Book for Estimation of Portion Size	140	4 to 6
Portugal	1996	Manual de Quantificacao d'Alimentos	110	3
Portugal	1996	Modelos fotographico para Inquiritios Alimentares	58	4
Portugal	1996	Registro Photografico para Inqueritos Dieteticos	71	3
Sweden	1997	Swedish Photographic Atlas of Food Portion Sizes	15	5
UK	1997	Food Portion Sizes: A Photographic Atlas	98	8

Source: Nelson and Haraldsdottir (1998b)

EPIC: European Prospective Investigation into Cancer and Nutrition

UK: United Kingdom

United Arab Emirates (UAE): Details about the development of the food atlas of portion sizes for the UAE was published by Al Marzooqi *et al*. (2015). The atlas includes 115 food selected on the following basis: indigenous Middle Eastern and UAE foods, foods that cannot be easily estimated with household measures or units, foods with peculiar shapes and sizes and foods for which commercial standardized amounts are unavailable. Portion sizes from the UK Food Atlas were used for foods common to the UAE and UK. That for traditional foods were obtained from a combination of household surveys [of families recruited through the UAE university], a food instruction manual from the Kuwait Institute of Scientific Research and interviews with experienced chefs. Most foods (n=82) were photographed as a series of photos with increasing portion size (8 per page). The rest are photo guides (1 or 2 pictures that reflect sizes commonly available on the market). The atlas also contains 6 pictures of household measures of different sizes as well as life-size pictures of the dinner plate, side plate and bowl used.

Cameroon: Production of two local atlases for use in dietary assessment among Cameroonian adults and children was reported by Amougou *et al.* (2016). Following initial interviews with chefs, vendors and women in charge of cooking at home, focus group discussions were held to decide on appropriate categorization of foods identified. Whenever these foods were served to participating adults or children at home or in a restaurant, each item was weighed and recorded. In total, 764 food portions were weighed for adults and 269 for children. A medium portion (D) was defined as the mean of all weights obtained for a food item (separately for adults and children). The three-sigma rule was applied to obtain the large portion size ‘F’ (mean + 1 SD), the small portion ‘B’ (mean – 1 SD) and four intermediate portion sizes ‘A’, ‘C’, ‘E’ and ‘G’ (mean -1.5 SD, mean -0.5 SD, mean + 0.5 SD and mean + 1.5 SD respectively). Only the small, medium and large portion sizes were photographed and shown in the atlas.

Food labels were consulted for information about the weight of processed foods. All the pictures were enlarged to 75 by 100 mm to make them as realistic as possible.

Southern Nepal: Harris-Fry *et al*. (2016) followed the method outlined by (Nelson and Haraldsdottir, 1998b) to develop an atlas of commonly consumed foods for dietary assessment in southern Nepal. The atlas comprised forty life-size colour-printed pictures of indigenous foods prepared by local women and vendors. The maximum number of different portions for any of the foods was six depending its importance in the local diet. For instance, there were more options for major items like rice. Initial portion sizes were selected after consultation with local community members and perusal of published data on portion sizes from Nepal. Pictures were photographed at an approximate angle of 45° angle to best depict depth and width of portions. Pictures were photographed at an approximate angle of 45° angle to best depict depth and width of portions. The original setting and utensils were omitted and the food images were superimposed on the image of a plain utensil for consistency and to eliminate distractions from non-food variations (Harris-Fry *et al*., 2016). Microsoft word, Adobe Photoshop and GNU Image software were used for processing the pictures.

Tunisia: The Tunisian food photography manual consists of 400 photos of typical Tunisian foods from eight food groups namely, bread, cereals potatoes, vegetables, fresh fruits, animal products, dairy products, sweet products (Bouchoucha *et al*., 2016). Each food is presented in three portions (i.e. small, medium and large) arranged in increasing order of size and incorporates a scale to allow selection of intermediate sizes. Beyond the statement that they are 'considered representative of the Tunisian population consumption' (Bouchoucha *et al*., 2016), no clear explanation is given as to how the three main portion sizes were obtained. Similar to the Balkan Region atlas, the Tunisian atlas includes a list of actual weight of the portions in the appendix rather than within each picture.

Sri Lanka: The methods used to create a photographic food atlas of common indigenous and non-indigenous foods in Sri Lanka was recently published by Jayawardena and Herath (2017). Altogether, 125 foods commonly eaten by Sri Lankan adults were included in the atlas. Most of these foods were photographed in increasing portion sizes (n =88) while the rest were range photos (showing sizes and varieties of particular foods) or guide photos that represent brands of items found on the market.

Rice is a common staple in Sri Lanka. The medium coconut spoon popularly used to serve rice can contain up to 100 g of rice. Thus, starting from 100 g, rice and other staples consumed as alternative choices in its place were measured as 8 portions in 100 g increments. Foods consumed in lower amounts were measured similarly but with half the starting portion of staples (i.e. 50 g). starting portion sizes of curries and meat equivalents served with the staples were measured with a table spoon (average weight 15 g) and subsequent portions were measured in 15 g increments. Common accompanying dishes such as dark leafy vegetables were measured in 7.5 g ingredients. portion size for some traditional foods were either agreed upon on consultation with housewives (from 10 households) or purchased from local restaurants to represent the range of sizes available. An average cup of 200 ml was taken as the median portion for drinks, 100 ml for a smaller portion and 300 ml for a higher portion. Drinks were measured. Portion sizes of pizza, bread and other foods not usually prepared at home were obtained by weighting samples from typical outlets. Except for liquid foods which were photographed at 90° in a glass to provide life-size images, all other foods were photographed at the widely recommended 45 ° angle.

Balkan Region: The recently developed food atlas for portion size estimation in the Balkan Region contains 135 commonly consumed foods representing ten food groups (Milk and milk products, Eggs, Meat or meat products, Seafood or related products, Grain or grain products, Nuts, seeds or kernel products Vegetables or vegetable products Fruit or fruit products, Sugar and sugar products/sweets Non-milk beverages) and miscellaneous food products in up to four portion sizes each (Nikolic´ *et al*., 2018). The average portion of each food as obtained from previously conducted food consumption surveys and pilot studies was defined as the medium portion size and assigned a coefficient of 1. Small and large portions were obtained by multiplying the medium portion by 0.5 and 1.5 respectively, while the extra-large portion was calculated by multiplying the large portion by 1.5. Traditional sausage, bread rolls and a few other standardized items were presented as single photos. Each food item has a unique identity code with portions identified with uppercase letters arranged alphabetically in order of increasing size. Actual weights of the portions are not included with the photos but rather listed in a separate codebook.

2.12 Summary

In summary, accurate dietary intake measurement continuous to be a challenging task to date. A major part of the problem is linked to portion size estimation errors. The 24-hour recall method commonly used to obtain dietary information depends on respondents to recollect and describe past food intake, including amount consumed (Ding *et al*., 2020). Different portion size estimation tools continue to be explored with the aim of improving the reliability of the reports of food portions consumed. In this endeavour, the photographic food atlas has a long history of use. Its validity has been tested in a wide variety of settings globally and despite some limitations, has provided evidence for its usefulness in quantifying food portions (Ding *et al*., 2020). A photographic atlas is a bound volume comprising a series of photographs of graduated sizes for each food item. Due to variations in dietary patterns, tools like photographic food atlases must represent the most important foods consumed locally instead of simply adapting what is used in another country (Korkalo *et al*., 2013). Thus, an atlas of commonly consumed protein source foods in the Ghanaian diet was produced in this study to augment the carbohydrate-based tool by Boateng (2014) and contribute towards a more complete tool applicable to our local setting.

CHAPTER TRHEE

3.0 METHODOLOGY

3.1 Study design

This study comprised three distinct phases and therefore used multiple designs specific for each phase. The first was a descriptive cross-sectional survey of commonly consumed animal and plant protein food sources. In phase two, which was a laboratory study, the foods identified in phase one were produced, plated and captured in photographic series for the production of the photographic food atlas. The final part of the research was a validation study of the atlas produced during phase two.

3.2 Phase 1: Descriptive cross-sectional survey of protein source foods

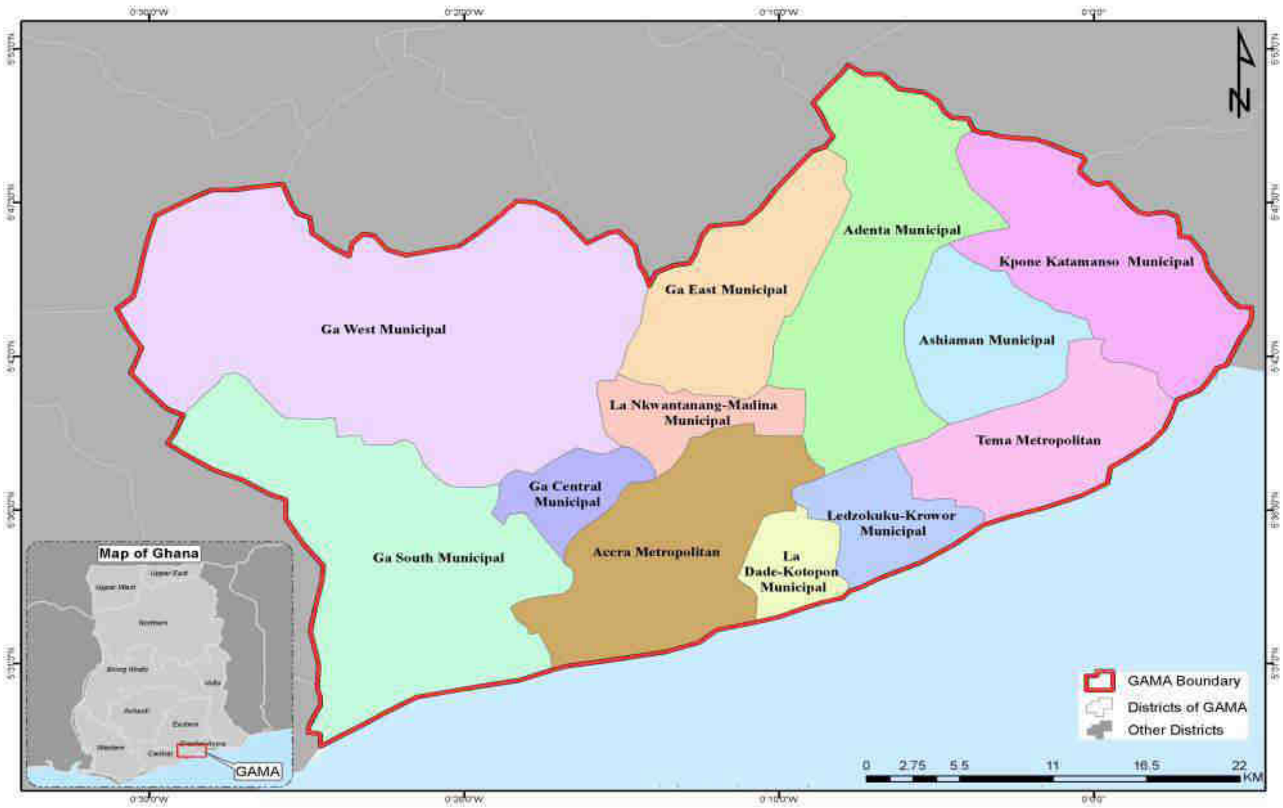
A descriptive cross-sectional study is a non-experimental research design that involves one-time collection of data to describe characteristics of interest as they exist in a population (Vissbr *et al*., 2000). Though inferences may be made about possible relationships, descriptive cross-sectional studies cannot determine cause and effect (Boushey *et al*., 2006). It is non-experimental because there is no manipulation of variables. Rather, information is gathered to determine the presence or level of the variables of interest as they exist in a defined population at one particular time (Zangirolami-Raimundo *et al*., 2018). In the first phase of this research, information on the profile of plant and animal source protein foods consumed in the Greater Accra Metropolitan Area (GAMA) was obtained as a basis for producing a photographic atlas for dietary assessment.

3.2.1 Study area

Communities for the cross-sectional survey were chosen from the Greater Accra Metropolitan Area (GAMA) within Greater Accra, the capital of Ghana. The metropolis covers an area of approximately 1,500 km^2 and currently comprises 2 Metropolitan (Accra; and Tema) and 10 Municipals areas (Ashaiman, Ledzokuku-Krowor, La Nkwantanang–Madina, La Dade-Kotopon, Adentan, Ga Central, Ga South, Ga West, Ga East and Kpone-Katamanso (Ministry of Local Government and Rural Development, 2017), (Fig 3.1). The Accra Metropolitan area is the nucleus of GAMA and a prime centre of socioeconomic activity and infrastructural development in the country (Oduro *et al*., 2015, Owusu, 2015). This has resulted in a high concentration of population in the national capital which in turn has led to a spill over into the rest of GAMA (Owusu and Oteng-Ababio, 2014). Estimates from the 2010 census indicated that the population of GAMA was about 3,756,423 (approximately 16.3 % of the national population) (Ghana Statistical Service, 2012). However, it was projected to rise to 4.7 million by 2020 (Bokpin *et al*., 2020). A majority of the population are urban dwellers and 63% are aged 18 years and older (Ghana Statistical Service, 2012).

Residential areas within GAMA range from low income to high income areas (Addo, 2016). These are distinguishable by income levels but also housing density, environmental quality, infrastructure and amenities. There are three broad categories (Songsore *et al*., 2009). Low class areas consist of the high-density low-class sector (HDLCS), the high density (HDIS) and middle density (MDIS) indigenous sectors mainly occupied by the native Ga tribe and the rural fringe (RF). Middle class areas are made up of the low-density middle class (LDMCS) and medium density middle class (MDMCS) sectors. The low-density high class (LDHCS) and low density newly developing (LDNDS) sectors combine to make up the high-class areas.

In many cases, GAMA's MMDs have a combination of residential areas of different sectors/classes. A mix of income levels can also sometimes be observed within residential areas in spite of their specific designation. Ardayfio-Schandorf (2012) for example, noted that a number of areas designated as low-class due to their poor planning, bad roads and high density had gone through drastic changes. Some of such areas have even developed into middle-high class residential areas (Addo, 2016). Conversely, some households in high-class areas have no evidence of wealth. According to the Ghana Statistical Service, a majority of the population in GAMA generally live in 3rd and 4th class residential areas [which correspond with the low-class residential designation] (Ghana Statistical Service, 2014a).



Source: (Owusu, 2015)

Fig 3.1: Map showing the study area

3.2.2 Study population

The study population were adults aged 18 years or older, living in GAMA. Participants for the study were enrolled on the basis of predefined inclusion criteria which were used to determine eligibility.

3.2.3 Inclusion and exclusion criteria

Eligible participants were identified as apparently healthy males and females aged 18 years or older who resided in any of the thirty selected communities of GAMA at the time of study. Any persons on a therapeutically modified diet and pregnant women were excluded. Participants had to give written informed consent.

3.2.4 Sample size determination

The number of participants for the cross-sectional survey was obtained from the WFP/CDC (2005) formula below:

$$n = z^2 \times \frac{p\,(1-p)}{d^2} \times DEFF$$

Where 'n' is the sample size, 'z' is the percentile of the required confidence interval (1.96), p is the population estimate (0.6), 'd' is the allowable error (0.05) and DEFF (2) is the default design effect to achieve precision similar to that which will be obtained by systematic or simple random sampling (Lwanga and Lemeshow, 1991). A minimum sample size of 738 was obtained. In order to compensate for a 10% attrition/incomplete data, the total target was 820 participants as follows:

$$calculated\ sample\ size\ /\ (1 - attrition\ rate)$$

$$= \frac{738}{1-0.10} = 820$$

3.2.5 Participant recruitment

In line with the recommendation by WFP/CDC (2005) that 'for a given overall sample size, having fewer than 25-30 clusters may lead to a high design effect and an unacceptable loss of precision…. more than 30 often does not increase the precision enough to justify the additional cost', and also with the resources available for the study in view, participants were sampled from thirty communities in GAMA (in this study, the clusters were the communities). At the first stage of sampling, six GAMA MMDs (Accra metro, Tema metro, LEKMA, Adentan, Ga central and Ga South) were randomly selected by means of a free online random number service (RANDOM.ORG).

It is known that income levels affect food choice and dietary intake patterns (Muhammad *et al*., 2017), and differences exist in the diet of persons in lower income and higher income groups (French *et al*., 2019). Protein is regarded as one of the most expensive portions of the diet (Schonfeldt and Gibson Hall, 2012). This is especially true of animal source protein. Based on these, it was assumed that protein food choices may differ between different income levels. Hence, the next stage of sampling involved purposive selection of study communities with the aim to include communities from across all the income classes of residential areas in the metropolis.

Information on the income classes was obtained from the classification of residential areas in GAMA (Songsore *et al*., 2009), classification of settlements in the Ledzokuku Municipality

(Ledzokuku Municipal Assembly, 2018), AMA income stratification of Accra, gazetted AMA property tax rating zones for residential areas (Local Government Bulletin, 2018) and other sources (The World Bank, 2010, UN-HABITAT, 2012, Ardayfio-Schandorf, 2012, UN-HABITAT, 2011, Ghana Statistical Service, 2014a). The proportion of communities from low (51%), medium (34%) and high class (15%) areas were selected according to the sampling distribution in the Ghana housing profile (UN-HABITAT, 2011). The selected areas were Abeka, Abofo, Abossey Okai, Accra New Town, Adabraka, Adenta, Adjirigano, Agblezaa, Ashaley Botwe, Bortianor, Bubuashie, Tema Community 11, Dansoman, East Airport, Gbawe, Kanewu, Korle bu, Latebiokorshie, McCarthy Hill, Mamprobi, Mataheko, New Legon, Nima, North Kaneshie, Obom, Palas Town, Santa Maria, Teshie Nungua Estate, Twibleoo and Weija.

Time and logistic constraints prevented the selection of a truly random sample. Only one eligible person per household was recruited so that participation will be as diverse as possible. At least 50 persons were targeted per area to minimize the effect of non-response. In each area, an authority figure (e.g. Assembly men, Local committee chairmen, School heads, Religious leaders) was contacted for help with participant recruitment and a venue for data collection. In most cases, they appointed volunteers to work with members of the research team who lived closest to the area to recruit potential participants and schedule a venue and time for the research team's visit. Those who visited the study venue at the designated time, satisfied the inclusion criteria and consented to join were enrolled.

All who came to the venue (irrespective of whether they enrolled or not) were offered a healthy eating fact sheet in appreciation of their time. Details of communities and number of participants enrolled is presented in Table 3.1.

Table 3.1: Number of participants enrolled in selected communities

Classification of community	MMDA	Community (number of persons enrolled)
[1]High class	Tema Metro	Community 11 (21)
	LEKMA	East Airport (27), Teshie Nungua Estate (23)
	Adentan	Adjirigano (21)
	Ga South	McCarthy Hill (19)
Subtotal		***111***
[2]Middle class	Accra Metro	Abeka (29), Dansoman (28), Latebiokorshie (24), Mataheko (34), North Kaneshie (19)
	Adentan	Adenta (32), Ashaley Botwe (29), New Legon (22)
	Ga South	Gbawe (22), Weija (22)
subtotal		***261***
[3]Low Class	Accra Metro	Abofo (32), Abossey Okai (26), Accra New Town (36), Adabraka (29), Bubuashie (28), Korle bu (27), Mamprobi (33), Nima (35)
	Tema Metro	Kanewu (25)
	LEKMA	Agblezaa (31), Twibleoo (29)
	Ga South	Bortianor (33), Obom (36),
	Ga Central	Palas Town (34), Santa Maria (28)
Subtotal		***462***
TOTAL		**834**

[1]Equivalent to: IZ01 (1st class of AMA four income-levels stratification of residential areas); class 1A &1B (property tax rating zones, Local Government Bulletin (2018); and low-density high class (LDHCS)/low density newly developing (LDNDS) sectors (classification of residential areas in GAMA, Songsore *et al*. (2009)).
[2]Equivalent to: IZ02; class 2A & 2B; low-density middle class (LDMCS)/medium density middle class (MDMCS) sectors.
[3] Equivalent to: IZ03 and IZ04; class 3A, 3B and 3C; high-density low-class sector (HDLCS)/high-density indigenous sector (HDIS)/middle density indigenous sector (MDIS)/rural fringe (RF).

3.2.6 Data collection

Data collection for the descriptive cross-sectional study involved the use of interviewer-administered questionnaires to obtain demographic information and food intake data. Some anthropometric measurements were also taken.

3.2.6.1 Background information

A semi-structured interviewer administered questionnaire (Appendix 3) was designed to collect information on participants' age, gender, educational background, occupation, ethnicity, marital status, religion, and telephone contact details. Participants' willingness to take part in the validation study was noted at this first contact.

3.2.6.2 Three-day 24-hour-dietary-recall

The 24-hour dietary recall is a direct retrospective dietary assessment method in which respondents are assisted to recall and report all foods and beverages consumed in the preceding 24 hours (FAO, 2018). It poses less respondent burden and lends itself for use with large sample sizes because it is a relatively fast method. A 3-day 24-hour recall was chosen rather than single recall to obtain information as close as possible to participants' usual intakes and daily variations in consumption (Gibson, 2005, Shamah-Levy *et al.*, 2016). An inherent weakness of this dietary assessment method which relies solely on the respondent's memory, is under or overreporting of food intake. Efforts to improve its accuracy led to the USDA multiple-pass format (Moshfegh *et al.*, 2008) which was first used in the 1999-2000 National Health and Nutrition Examination Survey in the USA (Briefel and Johnson, 2004). Since that time, the method has been validated in a number of low- and middle-income countries (Gibson *et al.*, 2017).

The original multi pass method involves four steps. Briefly, in the first step, all foods and drinks consumed in the preceding 24 hours are recalled and listed. Next, the foods and drinks are described. Thirdly, the portion size of foods and drinks consumed are estimated. In the final step the interviewer reviews the recall with the respondent to ensure accuracy of the record (Gibson and Ferguson, 2008).

In this study, the triple pass, a modified version of the multi-pass was used (Nelson *et al*., 2007). After explaining the purpose of the dietary interview, participants were asked to report everything they ate or drank from the morning they woke up on the previous day until the last food before they got up on the morning of the interview. Next, details about the time of consumption, description of food including who prepared it or where it was bought, brand names where applicable/known, foods eaten in combination (e.g. sandwiches, milk in tea and other beverages) and quantities consumed (based on common household measures and food models) were elicited. Finally, the information was reviewed with the participant in chronological order while prompting for any additional eating occasions and also clarifying portion sizes.

The information was captured on a record sheet designed for this purpose (Appendices 4a and b). The assessment was done for two non-consecutive week days and one weekend day to capture more variability in individual diets (Hebert *et al*., 2014, Moshfegh *et al*., 2008, FAO, 2018). Apart from the first recall which was done in person at the first contact, the other two recalls were done via telephone.

3.2.6.3 Recipe collection

Sixteen out of 78 participants who agreed to provide recipes and were given recipe booklets (Appendix 5a) did so. Each volunteer received careful explanation of how to complete the recipe booklets. They were asked to weigh and record every ingredient whenever possible, or to employ the aid of common household measures. The procedures and measurements in the recipes were clarified with each volunteer at the point of collection.

3.2.6.4 Anthropometric measurements

Height: A stadiometer (Seca 213, Hamburg, Germany) was used to measure participants' height to the nearest 0.1 cm. Participants stood barefooted on the level platform of the stadiometer, with their backs against the vertical board and their head in the Frankfort plane (i.e. head held such that the lower eye socket to the ear was perpendicular to the vertical board of the stadiometer). The sliding piece of the stadiometer was then moved to the crown of the participant's head for the reading of height.

Weight: Weight was measured to the nearest 0.1kg on an electronic Seca scale (Seca 770, Seca, Hamburg, Germany) while the participant stood upright and barefooted with weight evenly distributed on their two legs on the scale's platform. In order to make the measurement as accurate as possible, objects and accessories such as phones, keys and watches were first removed.

Body mass index determination: Body mass index (BMI) was calculated as weight (kg)/height(m)^2 and categorized according to the following WHO guidelines: underweight (<18.5 kg/m2), normal (18.5–24.9 kg/m2), overweight (25.0–29.9 kg/m2), and obese (≥30.0 kg/m2) (WHO, 2000).

3.2.6.5 Collation of commonly consumed animal and plant protein source foods

All animal and plant protein source foods were identified and collated from the 24-Hour dietary recalls dietary assessment data. First, a list of all animal and plant protein source foods was compiled from each dietary recall form. Next, all foods reported by each study participant was entered into a Microsoft excel worksheet. Using the compiled list, the find and replace feature in Microsoft excel was used to collate the total number of times each protein food was recorded as well as the number of different participants who reported consumption. The total number of times that each food is recorded reflects the frequency of consumption (for frequently consumed foods this may exceed the number of participants), while the number of individuals who report consumption shows the proportion of consumers (Faber *et al.*, 2013).

Protein foods were grouped into six broad categories: fish, legumes, meat, milk and milk products, poultry, other (for items e.g. snail, that did not fit into any other group). Commonly consumed foods were defined as those that were reported by at least 1% of participants during the study period (Faber *et al.*, 2013). The final list of foods captured in the atlas is shown in Table 4.3a.

3.3 Phase 2 (laboratory study): Production of photographic food atlas

3.3.1 Food preparation and portion size selection

The identified commonly consumed animal and plant protein source foods were either purchased or cooked in the therapeutic catering laboratory of the Department of Dietetics on the Korle-Bu campus of the University of Ghana using recipes collected from study participants, food vendors, on-line recipes or the recipe book by Amoako-Kwakye (2010) (Appendix 5b). Foods that were bought already prepared were purchased from vendors at Okaishi, Kaokudi and Spintex, all in

Accra. Wet-smoked fish was bought from fish mongers in Chorkor, dry smoked fish from the Tuesday market (Korle-Gonno), fresh fish and meat from Kaneshie Market. Purchases were also made at Tema (Volta Catch; fresh tilapia), Accra Mall (milk and milk products) and Madina (Jafamco foods; poultry products). All other purchases were made at Kaneshie market.

Since most Ghanaian foods lack standard serving sizes, an approach similar to that of Boateng (2014) was used to determine initial portion sizes of the various foods. This was necessary to ensure consistency and allow the two atlases to be merged. Accordingly, portion sizes from the Food Weights/Handy/Measures booklet by Owusu *et al*. (1995), food exchange lists of local foods in Nigeria (Fadupin, 2009), and exchange list for meal planning (Krause and Raymond, 2008) were consulted. Whenever applicable, the portion sizes of foods as they were sold was used or determined at the discretion of the researcher (in consultation with other nutrition professionals). For example, grilled sausage khebab, roasted and boiled groundnuts are not usually prepared in the home and were purchased from typical vending sources and their weights recorded. Once the initial portion size had been determined, subsequent portions were determined in increments of one portion. Portions were measured with ladles, measuring cups and spoons of various capacities, and other household measures as applicable and weighed in triplicate with a kitchen scale of 5-kilogram capacity and 1-gram precision (Fig 3.2). The mean of the three measurements was calculated and recorded as the weight for that portion.

Flat (stewing) ladle and soup ladle

measuring cups (1 cup: 250ml, ½ cup, 1/3 cup ¼ cup)

¼ tea spoon, ½ tea spoon, 1 tea spoon (5ml), 1 tablespoon (15 ml)

70 g tomato paste tin, 210 g tomato paste tin, 160 g evaporated milk tin, 125 g sardine tin.

4.5x3x1 cm matchbox

Weighing scale

Fig 3.2: Measuring utensils, handy measures and weighing scale used in food preparation

3.3.2 Food presentation and photography

Utensils for presenting the food items for photography comprised flat dinner plates (27 x 22 cm), soup bowls (20 x 9 x 7 cm), side plates (19 x 11 cm) and drinking glasses (250 ml). Apart from the colourless drinking glasses, all other crockery used were white in colour (Fig 3.2). White coloured crockery was chosen to provide the best contrast with foods for the photographs.

Flat dinner plate

Soup bowl

Side plate

Drinking glass

Fig 3.3: Serving utensils used for food presentation

The foods were captured by a professional photographer in an LED light box using a digital Nikon camera (D3200, Nikon, Japan) under standard lighting conditions (Nikolić *et al.*, 2018). The camera was mounted on tripod at a distance of 55 cm and angle of 45 degrees which is assumed to represent the 'view of a person of average height, sitting at a table and looking at a plate of food on the table before him' (Jayawardena and Herath, 2017). Portions of milk were photographed at an angle of 90 degrees for life size photos images that will be easier to see through the clear drinking glass (Jayawardena and Herath, 2017).

Pictures were uploaded on computer and processed with Microsoft word and Adobe Photoshop CC 2017 (version 18.0.0) to ensure that the crockery were uniform to scale in all photographs and the colour balance was consistent. Printing was on white A4 sheets (210 by 297 mm) as per the recommendations of Nelson and Haraldsdottir (1998b) to provide just enough space to comfortably hold photo series of up to eight portions in addition to other information (e.g. codes) required. The print outs were coded, laminated and ring bound (Fig 3.3). All pictures were colour printed.

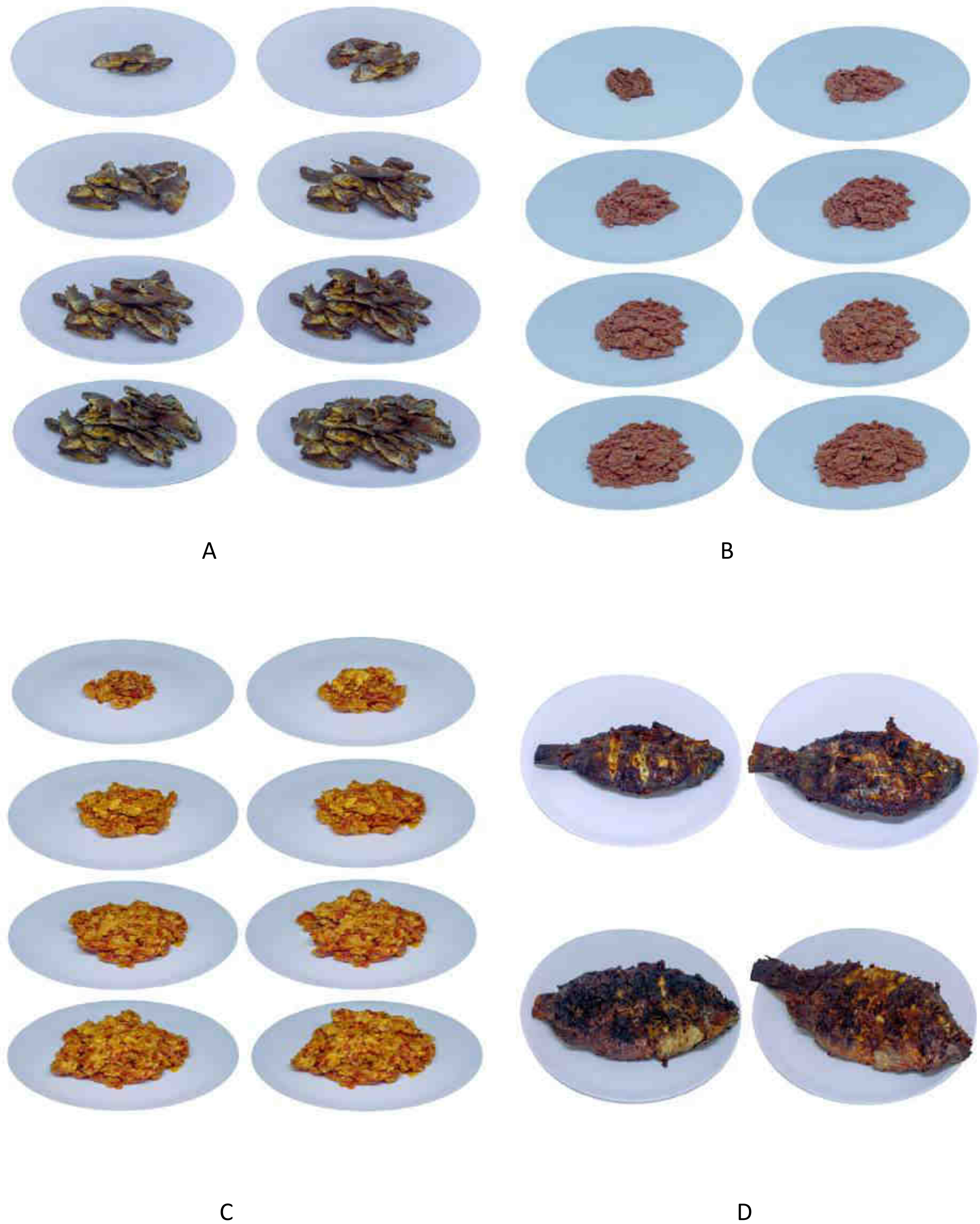


Fig 3.4: Sample photo series (fried tilapia fingerlings, corned beef, egg stew and grilled tilapia)

3.4 Phase 3: Validation of photographic atlas

The last phase of this study was validation of the photographic food atlas to give an indication of the suitability of the picture series to assist persons in estimating portion size (Szenczi-Cseh *et al.*, 2017). Validation was conducted by the visual perception method (Naska *et al.*, 2016, Nikolic´ *et al.*, 2018, Ovaskainen *et al.*, 2008). Accordingly, participants were required to directly compare the pre-weighed foods shown on the plates to those in the photographs from the atlas and then choose one picture with the portion size that in their estimation, best matched the one on the plate (Nelson and Haraldsdottir, 1998a).

3.4.1 Selection, preparation and presentation of foods for validation

The commonly consumed protein foods in each of the six categories were ranked in decreasing order of the percentage of individuals who reported consumption and the top two from each category was selected, making a total of 12 food items for the validation study (Table 4.4). Four different portions of each food item (with the exception of boiled egg which had three portions) were randomly chosen bringing the total number of food portions presented for validation to forty-seven (47). The portion sizes and order of presentation of foods were randomly assigned to four tables with the RAND function in Microsoft excel.

Selected food items for validation were purchased or cooked the same way as was done for production of the photographic food atlas. Each of the twelve food items was then weighed to the exact amounts corresponding to the chosen portion sizes from the atlas, plated and labelled. The four tables set up each displayed the same twelve food items but different portion sizes so that no table displayed more than one sample of each food. The respective photo series printed from the atlas were placed above each plate of food.

3.4.2 Validation procedure

The validation was piloted with 50 volunteers from Martey Tsuru (in Accra) to refine the protocol if necessary, as well as train the research team on the data collection procedures involved (Nichelle *et al*., 2019). The results were not combined with those of the main study. Based on feedback obtained, evaluation forms were slightly modified from those used during piloting (Appendix 6) to prevent mix-ups and save time for participants: each form was labelled according to the table number it was to be used for and the codes of the displayed food were pre-typed onto the form so that participants had only to write the code of the portion they had picked (from the respective photo series) next to it in the column provided (Appendix 7).

Validation was organized on the premises of the school compound of the Martey Tsuru Presbyterian Basic School in Accra. Sample size for the main validation was calculated according to the recommendation by Nelson and Haraldsdottir (1998a). To detect a difference of 20 % with a significance of 5 %, power of 80 % and assuming a CV of 50 % plus non-response rate of 20 %, a minimum of one hundred and twenty-five individuals were required to carry out portion size estimations. These were subsequently sampled from among the 408 who during the initial cross-sectional survey agreed that they could be contacted for possible inclusion in this phase of the study. In attempt to prevent crowding, participants of the main validation were given one of two different reporting times (9am or 11am).

Validation started at 9 am and closed at 5.40 pm. Hygiene protocols to prevent the spread of COVID-19 pandemic were strictly observed. On arrival, participants were directed to the handwashing stands provided to wash and sanitize their hands with 70 % alcohol-based sanitizer. Face masks were made available to those who came without one.

After verbally affirming their willingness to participate, oral explanation of the validation procedure was given. Each participant's weight and height were measured and recorded together with their study ID on an evaluation form which was handed to them before they proceeded to the food assessment area (Fig 3.6). Everyone was provided with their own pencil, eraser and evaluation forms. As described previously (section 3.4.1), four tables were set up, each with the same 12 food items but in different portion sizes (Fig 3.7). This was done to reduce bias and increase randomization for the selection. Participants visited each of the four tables in order to complete evaluation of all the food portions.

Members of the research team directed the flow of human traffic and prevented congestion around the tables. Participants in waiting areas were also spread out to encourage social distancing. No communication was allowed between the participants during the validation process so that all could make independent evaluations. However, the researcher and other members of the team were on hand to assist and to address any issues or questions. Participants assessed the served portions of each food item and then wrote the selected code from the photo series which they perceived as identical in portion to the plated food, next to the name of the food on the evaluation form (Fig 3.8).

3.5 Training of field staff

Members of the research team were trained on all data collection procedures involved in the study. Resources on the proper protocol for height and weight measurement was obtained from the anthropometry procedures manual of National Health and Nutrition Examination Survey (CDC, 2017).

Training for administration of the 24-hour dietary recall was based on guidelines developed for the Low-Income Diet and Nutrition Survey (DAPA-toolkit) (Appendix 12). Training included discussions on ensuring that participants remained at ease throughout the interview, minimizing social desirability bias, avoiding a judgmental attitude towards participants' food intake and use of non-leading probes.

Attention was paid to how participants' protein foods will be captured to ensure uniformity in information. For example, the importance of verifying cooking methods (e.g. boiled/fried egg; roasted/boiled groundnuts) was emphasized. Each interviewer was required to collect information that was as specific as possible regarding for example the type and part of meat (e.g. boneless cow meat, pig's feet, fried chicken wings, etc). In the case of fish, participants were to be asked the name of fish and how it had been processed, e.g. dry-smoked 'keta school boys' (anchovies), wet-smoked 'saman' (Atlantic mackerel), etc. Such specific details were left out only if the participant could not provide them. After the training, permission was sought to practice for two weeks at the University of Ghana Medical School Clinic on the Korle-Bu campus. Altogether, the team had 14 members: the principal Investigator, 2 registered Dieticians, 4 Dietetics undergraduates, 2 Nutrition graduates and 5 NABCO (Nation Builders Corps) personnel.

3.6 Pretesting of study procedures and data collection instruments

The cross-sectional survey questionnaires as well as the procedure and questionnaire for validating the photographic food atlas were all pretested. In all cases, the resulting data collected were not combined with those of the main study. Study design and data collection are summarised in Figure 3.5.

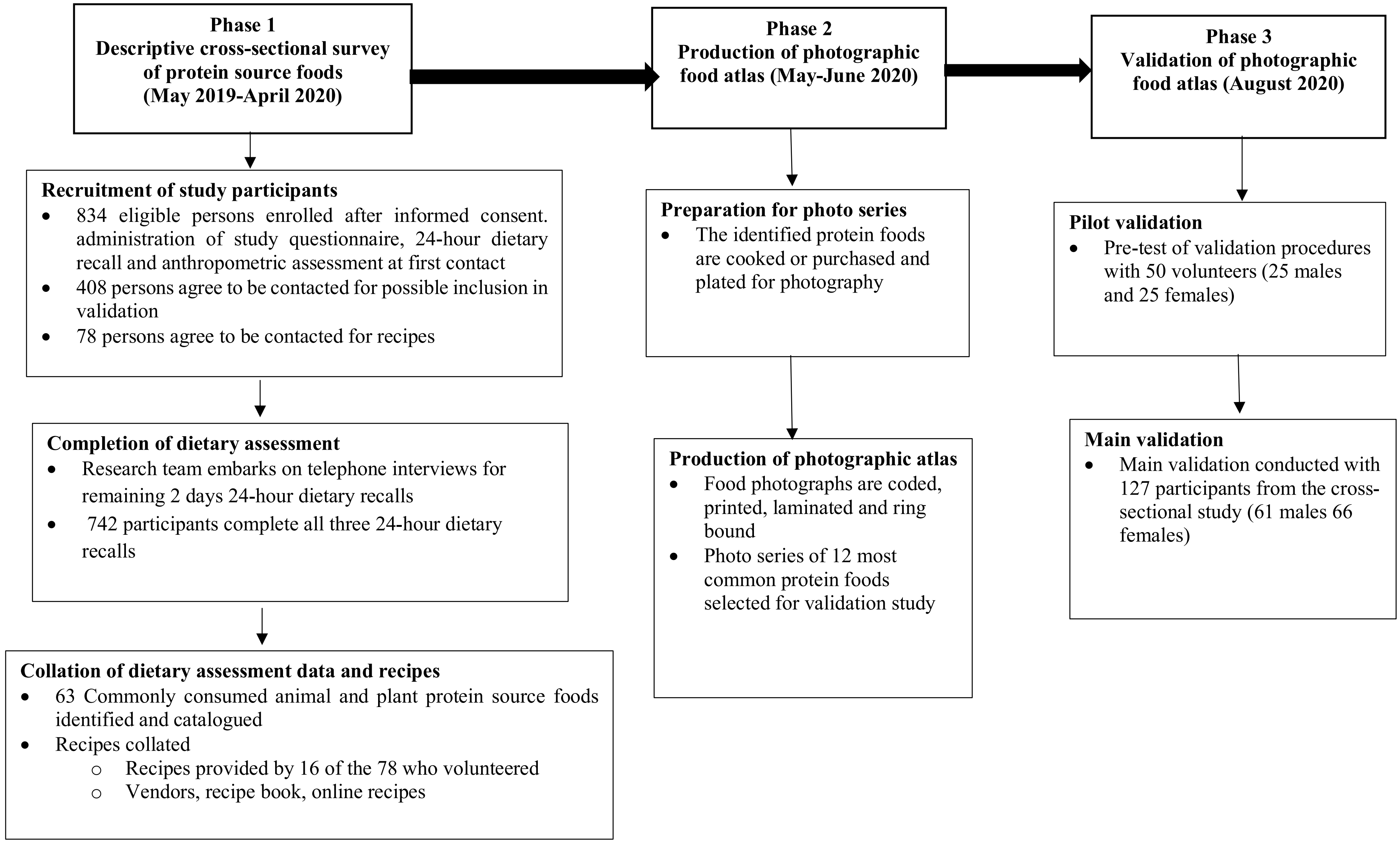


Fig 3.5: Summary of study design, timelines and data collection

Fig 3.6: Participant going through initial interview and anthropometric assessment

Fig 3.7:One of the four tables set up for validation

Fig 3.8: Some participants evaluating the test foods during the validation study.

3.7 Ethical issues

Ethical clearance to carry out this study was granted by the Research Ethics and Protocol Review Board of the College of Health Sciences, University of Ghana (CH-Et/M.8-4.7/2018-2019; Appendix 1). All participants signed and returned a written informed consent form prior to being enrolled into the study (Appendix 2). Consent was further affirmed during the pretesting of procedures (pilot validation) as well as the main validation.

Participants for the validation (both the pilot and main validation) were given prior notice of the foods and ingredients involved so that persons who might be allergic or intolerant of any item could withdraw their offer to take part. Even though participants were not required to ingest any of the study foods, this precaution was taken in order to forestall any potential dangers. No participant withdrew on this account.

3.8 Data management and confidentiality

The identities of participants were protected by the use of IDs (identity numbers) on all questionnaires. Questionnaires and other forms were stored securely under lock and key to control access to them. Furthermore, computers for data entry and analysis were password protected to prevent access by unauthorized persons. No data by which participants could be identified was or will be published at any point in time. Hard copy data will be disposed of after five years.

3.9 Data handling and statistical analyses

Data was initially captured in Microsoft Excel, cleaned and then exported to SPSS (statistical package for social sciences; version 21, SPSS, Chicago, IL, USA) for statistical analyses. Statistical significance was set at $p \leq 0.05$ for all statistical analyses carried out in this study.

Background characteristics of participants [in cross-sectional survey and validation study] was assessed for normality by the Kolmogorov-Smirnov test and also by visual inspection of histograms with reference to measures of skewness and kurtosis (Ghasemi and Zahediasl, 2012). They were described with frequency distributions for qualitative data (i.e. gender, BMI category, educational level) or as descriptive statistics (mean and standard deviations or median and interquartile ranges for non-normally distributed data) for quantitative variables (i.e. age, weight, height and BMI). Independent samples t-test or non-parametric independent samples Mann-Whitney U test (in the case of non-normal distributions) was used to investigate whether there were significant gender differences with respect to the continuous variables (age, height, weight and BMI). Chi square test of independence was used to assess association between gender and other categorical sociodemographic variables (level of education, tribe, marital status and religion). Most commonly consumed animal and plant protein source foods were reported as frequencies and percentages of the number of times each food was reported in the pooled 3-day 24-hour recall data, and the number of participants who reported consumption of same.

Regarding portion size estimation data from the validation study, differences between estimated and true portion sizes were calculated as the picture number selected minus the picture number of the true portion when comparing food items presented on plates with photographs from the photographic atlas. They were then classified as correct/exact if the bias was zero (i.e. if the true portion picture was chosen), underestimation if the bias was -1 (i.e. portion immediately below the true portion was selected), overestimation if the bias was +1 (i.e. if the portion immediately above the true portion was selected) and distant/distal if bias was greater than +1 or -1 (i.e. portion selected is more than 1 portion above or below the true portion).

The number and percentage of correctly identified, adjacent (i.e. over and underestimations) and distal portions chosen were calculated for the total sample and according to sex, age, BMI status, educational level, and the portions of food items used for validation. Furthermore, chi-square test for independence (or Fisher's exact probability test if more than 20% of cells had expected counts less than five) was used to assess disparities in (i.e. percentages of correctly chosen photographs) and acceptability (correct and adjacent selections were considered acceptable) on the basis of sex, age (<30 years, 30-44 years, 45-64 years), BMI (Underweight, normal weight, overweight, obese), highest educational level attained (no formal education, primary, secondary, tertiary) and specific portions of food items presented.

3.10 Quality control

The research team was prepared during training and pretesting of study questions so as to reduce inconsistencies in data reporting to a minimum. At the end of each day, completed questionnaires were picked at random for inspection and any discrepancies or errors detected were resolved. Similar checks were carried during and after data entry with the sort and filter function of Microsoft excel to ensure that the captured data faithfully represented the information collected on the questionnaires.

CHAPTER FOUR

4.0 RESULTS

4.1 Participant background characteristics

Background and anthropometric characteristics of participants are presented in Tables 4.1 and 4.2 respectively. A total of eight hundred and thirty-four (834) persons were recruited. Dietary assessment consisted of 24-hour dietary recalls on three non-consecutive days: one collected face to face at the initial contact and the remaining two over telephone. Only one or two 24-hour dietary recalls were obtained from ninety-two of the participants (forty-six persons could not be reached on phone after several attempts; 35 persons said they were no longer interested when they were telephoned and 11 persons insisted they were too busy to talk whenever contacted). The remaining 742 participants (50.9% males and 49.1% females) completed all three required dietary recalls and were included in analyses. Their mean age was 34 years ranging from 18 to 76 years. Male participants were older than the females ($p=0.005$). The highest level of education attained by most participants (48.4%) was secondary school education. Gender differences were noted in marital status ($p<0.001$) and educational status ($p=0.028$).

Close to half of all participants (48.4%) were employed in the formal sector or skilled work. Significant differences were found in employment status of male and female participants. For instance, the proportion of males engaged in skilled work was higher than that of females (34.9% vs 15.1%), while trading, commerce and related occupations were more prevalent among females (31.3%) than males (12.4%) ($p<0.001$). In terms of ethnicity and religion, a majority of participants were Akan (45.3%) and Christian (89.2%). These did not differ significantly between males and females.

Table 4.1: Socio-demographic background of study participants

Variable	Male n=378	Female n=364	Total n=742	p-value
Age (years)				
Mean ± SD	35.3 ± 12.4	32.7 ± 11.3	34.1 ± 11.9	0.005*
Marital status n (%)				
Married/cohabiting	199 (52.6)	138 (37.9)	337 (45.4)	<0.001*
Never married	171 (45.2)	179 (49.2)	350 (47.2)	
[1]Other	8 (2.1)	47 (12.9)	55 (7.4)	
Ethnicity n (%)				
Akan	170 (45.0)	166 (45.6)	336 (45.3)	0.201
Ga/Dangme	91 (24.1)	79 (21.7)	170 (22.9)	
Ewe	75 (19.8)	61(16.8)	136 (18.3)	
[2]Other	42 (11.1)	58 (15.9)	100 (13.5)	
Religion n (%)				
Christian	333 (88.1)	329 (90.4)	662 (89.2)	0.201
Moslem	32 (8.5)	29 (8.0)	61 (8.2)	
Traditionalist	1 (0.3)	2 (0.5)	3 (0.4)	
[3]Other	12 (3.2)	4 (1.1)	16 (2.2)	
Highest educational level completed n (%)				
None	19 (5.0)	37 (10.2)	56 (7.5)	0.028*
Primary	21 (5.6)	31 (8.5)	52 (7.0)	
Secondary	194 (51.3)	165 (45.3)	359 (48.4)	
Tertiary	126 (33.3)	111 (30.5)	237 (31.9)	
[4]Other	18 (4.8)	20 (5.5)	38 (5.1)	
Employment n (%)				
Formal sector[5]	98 (25.9)	74 (20.3)	172 (23.2)	<0.001*
Skilled worker[6]	132 (34.9)	55 (15.1)	187 (25.2)	
Trading[7]	47 (12.4)	114 (31.3)	161 (21.7)	
Unskilled worker[8]	42 (11.1)	39 (10.7)	81 (10.9)	
Unemployed	18 (4.8)	30 (8.2)	48 (6.5)	
Other[9]	41 (10.8)	52 (14.3)	93 (12.5)	

*Chi square test of independence; significant at $p \leq 0.05$. [1]Widowed, divorced/separated. [2]Northern and Upper regions
[3]Atheist, non-religious, refused. [4]Technical/vocational school, Montessori training.
[5]Skilled professionals e.g. Doctors, teachers, accountants, etc. [6]Artisans, craftsmen etc. [7]Trading, commerce and related work
[8] Laborer, factory hand, cleaner etc. [9]Retired, student, apprentice, housewife.

Mean BMI of the female participants was significantly higher than that of the males ($p<0.001$). Significant differences were also noted between male and female participants with respect to their BMI classes. Overall, a majority of the study participants were within the normal weight category (52.7%), almost 30% were overweight and 14% were obese (Table 4.2).

Table 4.2: Anthropometric profile of study participants

Variable	Male (n = 378)	Female (n = 364)	Total (n= 742)	p-value[2]
Height (m)				
Mean (SD)	1.71 ± 0.1	1.6 ± 0.1	1.7 ± 0.1	<0.001
Weight (kg)				
Mean (SD)	69.8 ± 11.9	67.6 ± 13.0	68.7 ± 12.5	0.006
BMI (kg/m^2)				
Mean (SD)	23.9 ± 3.8	26.3 ± 5.0	25.1 ± 4.6	<0.001
[1]BMI classification n (%)				
Underweight <18.5 kg/m^2	14 (3.7)	11 (3.0)	25 (3.4)	<0.001
Normal weight 18.5- 24.9 kg/m^2	233 (61.6)	158 (43.4)	391 (52.7)	
Overweight 25-29.9 kg/m^2	104 (27.5)	118 (32.4)	222 (29.9)	
Obese ≥ 30 kg/m^2	27 (7.1)	77 (21.2)	104 (14.0)	

1(World Health Organization, 2000)

[2]Independent samples Mann-Whitney U test; significant at $p\leq 0.05$

4.2 Animal and plant protein food choices of study participants

Five thousand eight hundred and ninety-seven (5894) references to consumption of animal and plant protein source foods were identified from the 3-day dietary recall assessments administered. These foods were grouped into five categories: fish and seafood, poultry and poultry products, meat and meat products, milk and milk products, legumes. The frequency of consumption from each group is presented in Table 4.3. Further details about the specific food items in each category, including number of participants who reported consumption for each are tabulated in Appendices 11a to 11f). Foods in the fish category were the most frequently consumed animal protein source making up almost 35% of protein foods and reported by the highest average number of participants (Table 4.3). Within the fish and seafoods group, canned fish was approximately 4.9% of reported consumption, 3% were shell fish and 2.5% were dried salted/fermented fish. The remaining 90% (in decreasing order of reported consumption) were wet hot smoked, fried, dry hot smoked, or fresh/steamed fish.

Food items most frequently consumed after fish were (in decreasing order) from the poultry, legumes and meat groups. Within the poultry and poultry products group, chicken consumption was reported by 73% of participants (Appendix 11b). But in terms of frequency of consumption, eggs were the single most frequently consumed food item in the group. Turkey and guinea fowl were the least frequently consumed items. Among the legumes, groundnut soup was highest on the list. It was consumed almost one and a half times more frequently than *palava sauce*, the next highest on the legume list. The two items together with roasted groundnuts, beans and *koose* were the top five most frequently consumed legume food products. There were 801 reports of meat consumption, out of which, beef accounted for 52.2 %. *Wele* (cow hide) came in second and was followed by goat meat. Grasscutter was the only bushmeat observed and it formed 0.3% of total meat reports. The only canned product noted in the meat and meat products group was corned beef). In the case of sausage, 3.9% of study participants (Appendix 11d) could not say whether these were pork, beef or chicken sausages.

Milk and milk products recorded the lowest frequency of intake at 11.7 % of all protein foods consumed. Within that group, evaporated (full cream) milk was most prevalent and made up 65.2% of consumption (Appendix 11e). Low fat milk and skimmed milk were scarcely reported and no participant consumed fresh milk.

As mentioned earlier, details about the food items in each category and the number of participants who reported consumption is listed in Appendices 11a to 11e. It must be noted that some on those lists in the appendix are a consolidation of several individual items. For instance, though not all participants could specify, some indicated consumption of various chicken parts cooked by different methods. Similarly, beef, beans, egg and groundnut comprised individual food items cooked with a variety of methods. Unidentified fishes included in the list refers to fishes which participants could identify only by the way they had been prepared and not by their specific names. Nearly 72 % of participants could not provide the name of the fish they reported to have eaten on 807 occasions (i.e. 39.6% of total frequency of fish intake).

Table 4.3: Animal and plant protein food choices of study participants

Food group	No. of times reported	% of total food items reported	Main foods in group (no. of times reported)
Fish & seafood	2038	34.6	Fish (1837), canned fish (99), shell fish (61), salted dry/fermented fish (51).
Poultry & poultry products	1256	21.3	Chicken (457), eggs (747), gizzard (32), chicken sausage (12), turkey (7), guinea fowl (1).
Legumes	1110	18.8	Groundnut soup (283), *palava sauce* ([1]*kontomire with* [2]*agushie*) (186), groundnuts (roasted/boiled) (186), beans (184), [3]*koose* (177), tom brown (39), *agushie* stew (19), soya milk (9), baked beans (8), bambara beans (7), almond milk (5), *agushie* soup (4), groundnut cake (2), tofu (1).
Meat & meat products	801	13.6	Beef (418), [4]*wele* (152), goat meat (77), snail (38). [5]Unspecified sausages (38), corned beef (28), pork (22), cow tripe (14), cow feet (8), salted beef (7), bush meat (grass cutter) (2), bacon (1), beef sausage (1) dog meat (1), Mutton (1).
Milk and milk products	689	11.7	Evaporated milk (449), powdered milk (103), flavoured ice cream (78), [6]*brukina* (19), non-diary milk (17), cheese (13), yoghurt (4), condensed milk (3) low fat milk (2), skimmed milk (1).
Total	5894	100	

[1]Cocoyam leaves

[2]melon (*Cucumeropsis manii*) seeds

[3] A deep-fried bean cake that is made from thick cowpea paste

[4]Cowhide

[5]Participants could not specify whether these grilled sausages were chicken or beef sausages.

[6]Fermented milk with millet

4.3 Description of photographic food atlas

Fifty-four animal and plant protein foods satisfied the criteria of consumption by at least 1 % criteria of participants, and were therefore included in the atlas (Table 4.4). Almost 6 % of participants reported intake of Tom brown but it was left out to avoid duplication since it is already captured in the atlas of carbohydrate foods developed by Boateng (2014). Food items in the atlas were arranged in five parts: fish and other seafood, poultry and poultry products, legumes, meat and meat products, milk and milk products. In total, the atlas contains sixty-two sets of serial, range and guide photographs.

The serial photographs consist of foods in 8 (n= 21), 6 (n=7) or 4 (n=14) and 2 (n=4) portions arranged in ascending or descending order, starting with the smallest or biggest portion size on the top left-hand side of the page for easy comparison. The combination of ascending and descending order of arrangement is to discourage individuals from automatically selecting the largest or smallest portion size. One item (laughing cow cheese) is presented in a single portion. The atlas further contains 5 guide photographs (showing brands or types of a food item or category commonly seen on the market) and 10 range photographs (showing different sizes of a specific food item typically available) are presented in the atlas. Each food has a unique code made up of a combination of capital letters and three-digit numbers (e.g. PM001, i.e. portion 1 of powdered milk). Portions of food within photo series, range or guide photographs are labelled with the food code arranged alphabetically to reflect the gradual increase or decrease in portion size. To avoid bias and misreporting, the actual weight of the portions of each food is presented separately from the photographs as an addendum. Pictures of the crockery used are also included. Recipes, codes and weight of the food portions depicted in the atlas as well as macronutrient composition of the foods, are shown in Appendices 5b, 9, and 10, respectively. Appendix 13 contains sample pages from the atlas.

Table 4.4: Animal and plant protein source foods depicted in the photographic food atlas

Group	Food items
Fish and seafoods	*Abobi/ Keta school boys* (hot dry smoked anchovies), *Adwene* (catfish; hot dry smoked)(2 sets), *Amane* (hot dry smoked Herring) (2 sets), Cassava fish (fried), Cassava fish (steamed), crab, *Kako*, *Koobi*, *Kpanla* (Horse mackerel; fried), Mackerel (canned), *Odaa* (Big eye tuna, hot wet smoked), *Okpoku* (Frigate mackerel, hot wet smoked), Red fish (Sea bream; fried), Red fish (Sea bream, steamed), *Saman* (wet hot smoked Atlantic mackerel), Sardine (canned), Shrimps (fried), Tilapia fingerlings (fried), Tilapia (grilled), Tilapia (steamed).
Poultry and poultry products	Chicken drumstick (fried), Chicken thigh (fried), Chicken wings (fried) (2 sets), Egg (boiled), Egg (fried), Egg stew, Gizzard (fried), Sausage (fried chicken sausage).
Legumes	Groundnut (boiled), Groundnut (roasted), Groundnut paste, Groundnut soup, *Koose*, *Palava sauce*, Beans (boiled), Beans (stew), Soya milk.
Meat & meat products	Beef (boneless, fried), Beef (boneless, steamed), Corned beef, Goatmeat (steamed), Kotodwe (smoked cow feet), cow tripe, Pig feet, Sausage (grilled beef sausage), Snail, *Wele* (cow hide).
Milk & milk products	Brukina, Cheese (laughing cow), Evaporated milk (4 sets), Flavoured ice cream, Non-dairy milk, Powdered milk (3 sets), *Waagashi* (local cheese).

Brukina: A local yogurt-cereal snack. It is made from fermented milk, sugar and boiled millet. **Beans:** All types of small dry cowpeas e.g. red kidney, white, brown, black eyed etc. are locally referred to as beans. Beans are normally boiled and eaten with gari, palm oil and plantain ('red red'), cooked with rice and sorghum leaves (waakye) or pre-boiled and then used for beans stew. ***Kako***: Hard dried fermented salted fish. Kako is processed from such fish as sharks, skates and rays. ***Koobi***: Koobi is prepared by salting and fermenting tilapia. ***Koose***: spicy deep-fried beans cake. ***Palava sauce***: A popular sauce prepared with cocoyam leaves and agushie i.e. melon (*Cucumeropsis manii*) seeds. The sauce is commonly eaten with boiled rice or *ampesi* (i.e. boiled plantain, yam, cocoyam or other root tubers of choice). ***Waagashi***: A local cheese similar to cream cheese. For milk to coagulate, *Calotropis procera* leaf extract is used. Waagashi is sliced and fried to be eaten as a snack with powdered pepper. Some also use it in place of meat in stew. ***Wele:*** Singed cowhide popular in tomato stews eaten with waakye and in okro stew/soup.

4.4 Validation of photographic food atlas

4.4.1 Selected food items for validation

Two foods with the highest percentage of consumers among study participants were selected from each protein category for the validation study. Snail and grilled sausages were added to represent foods shown as range photographs and single unit increments, respectively. Hence in total twelve foods were used. Four different portions of these twelve food items (except boiled egg which is represented by 3 portions in the atlas) were randomly chosen from portion sizes included in the photographic atlas. The portions validated thus amounted to 47 (4 portions each of 11 different foods plus 3 portions of boiled egg). Table 4.5 shows the list of food items and portion sizes selected for validation. Codes used for labelling the portions are tabulated in Appendix 8.

Table 4.5. Selected food items, portions and order of presentation for pilot and main validation

Food item	Portions			
	Table 1	Table 2	Table 3	Table 4
Beans (boiled)	1	7	5	2
Beef (boiled boneless)	3	1	4	2
Chicken thighs (fried)	4	2	3	1
Egg (boiled)	3	-	1	2
Evaporated milk	1	3	2	4
Tilapia fingerlings (fried)	3	5	7	2
Groundnut soup	2	8	4	7
Powdered milk	2	3	4	1
#*Saman* (wet hot smoked)	1	3	6	5
Sausage (grilled)	1	4	2	3
Snail (boiled)	2	1	4	3
‡*Wele* (stewed)	3	1	4	2

#Atlantic mackerel; ‡*cow* hide

4.4.2 Terms associated with validation of portion size estimation tools

A number of terms are associated with studies on validation of portion size estimation tools such as the photographic food atlas (PFA). Portion size estimations fall within three broad categories in terms of the position of the selected portion picture in the photographic series, relative to that of the correct picture of the actual portion displayed for estimation. An ***exact or correct*** **estimation** was made when the correct picture representing the portion size displayed is chosen. The bias of such estimations is zero (0). In this study, percentage or proportion of exact/correct estimations made is referred to as ***accuracy***. An ***adjacent estimation*** was made when the photograph directly adjacent to the one that shows the actual portion displayed was picked. There are two possible outcomes of adjacent estimations, namely ***overestimation***, when the quantity of food in the picture chosen is one portion size larger than the correct one, and ***underestimation*** when it is one portion size smaller. Due to the fact that exact precision cannot be achieved in portion size estimation, and acceptable levels of accuracy has yet to be established (Hernandez *et al*., 2006, Ovaskainen *et al*., 2008, Szenczi-Cseh *et al*., 2017) estimations within +/- 1 photograph were deemed acceptable in this study. Consequently, while only exact estimations were accurate, both exact and adjacent estimations are referred to as ***acceptable***. The combined proportion/percentage of exact and adjacent estimation is denoted as acceptability. Selection of pictures which represent food quantities that are greater than one portion size more or less than the actual portion displayed were categorized as ***distal/distant estimations***.

4.4.3 Pilot validation

The procedure for validation of the photographic atlas was piloted with fifty volunteers (25 males and 25 females). Their ages ranged from 18 to 69 years with a mean of 28 ± 9 years. Male and female participants did not differ in weight or age. Males were however significantly taller than females ($p<0.001$). A little over half of the total sample (54%) had BMI within the normal weight range and more of the female participants were obese as compared to the males (28% vs 4% respectively; $p=0.03$). With respect to educational levels, the proportion of male participants with primary education was greater than their female counterparts and more females than males had finished their education at the secondary school level ($p=0.02$).

The 50 persons who participated in the pilot validation made 2350 evaluations. Forty-eight-point five percent (48.5%) of those evaluations were correct evaluations for which participants chose exactly the right picture that represented the portion size of food displayed. The proportion of adjacent under and overestimations were 11% (n=259) and 19.8% (n=465) respectively. Distal estimations accounted for 20.7% (n=487). Sausage had the highest proportion of accurate estimations (86.5 %). At the other extreme, 86.5 % of the portion size estimations made for powdered milk were inaccurate. The proportion of acceptable portion size estimations was generally high and ranged from 98% (boiled egg) to 54.5 % (evaporated milk). Overall, 79.3% (n=1863) of portion size estimates made in the pilot study were acceptable.

4.4.4 Main validation

4.4.4.1 Background of participants in main validation

There were 127 participants in the main validation study (52 % females). Their ages ranged from 18 to 60 years. A majority of participants had been educated to the secondary school level. A significantly higher proportion of female participants than the males had never received any formal education ($p = 0.013$). Their BMI was in the range of 17.5 to 45.1 kg/m^2 with a majority in the normal weight category (64.6%). Though the BMI of females were higher than the males (p=

0.005), there was no evidence of statistically significant difference in the distribution of underweight, normal weight, overweight and obesity between the sexes. These results are presented in Table 4.6 below.

Table 4.6: Characteristics of main validation participants

Variable	Male n= 61	Female n=66	Total n=127	p-value[2]
Age (years) Median (IQR)	27 (12)	28 (10)	28 (11)	0.164
Age groups n (%)				
< 30 years	40 (65.6)	38 (57.6)	78 (61.4)	0.388
30-44 years	17 (27.9)	19 (28.8)	36 (28.3)	
45- 64 years	4 (6.6)	9 (13.6)	13 (10.2)	
Educational background n (%)				
None	1 (1.6)	11 (16.7)	12 (9.4)	0.013
Primary	9 (14.8)	4 (6.1)	13 (10.2)	
JHS/SHS	34 (55.7)	30 (45.5)	64 (50.4)	
Tertiary	17 (27.9)	21 (31.8)	38 (29.9)	
Height (m) Median (IQR)	1.7 (0.11)	1.6 (0.10)	1.6 (0.1)	0.081
Weight (kg) Median (IQR)	63.3 (18.2)	60.9 (13.9)	62.7 (14.9)	<0.01
BMI (kg/m^2) Median (IQR)	22.4 (4.2)	24.4 (6.1)	23.2 (5.4)	0.005
[1]**BMI classification** n (%)				
Underweight (<18.5 kg/m^2)	3 (4.9)	1 (1.5)	4 (3.1)	0.069
Normal weight (18.5-24.9 kg/m^2)	45 (73.8)	37 (56.1)	82 (64.6)	
Overweight (25-29.9 kg/m^2)	9 (14.8)	20 (30.3)	29 (22.8)	
Obese (≥ 30 kg/m^2)	4 (6.6)	8 (12.1)	12 (9.4)	

1(World Health Organization, 2000)

[2]Independent samples Mann-Whitney U Test significant at the p ≤ 0.05.

4.4.4.2 Overall portion size estimation with photographic food atlas

Participants performed a total of five thousand nine hundred and sixty-nine (5969) portion size evaluations by comparing actual portion sizes of test foods and photographs of the foods in the atlas. Close to half (47%; n= 2781) of these were correct estimations (Fig 4.1), meaning that the photographs that actually showed the portion sizes displayed were chosen. Within the total number of adjacent estimations (33 %), there were approximately twice as many overestimations compared to underestimations (22%; n = 1283 vs 11%; n = 685). The remaining 20% were distal estimations, which implies that participants chose pictures that were more than one photograph away from the correct one. In other words, those distal estimations represented deviations of more than one portion above or below the actual portion size displayed.

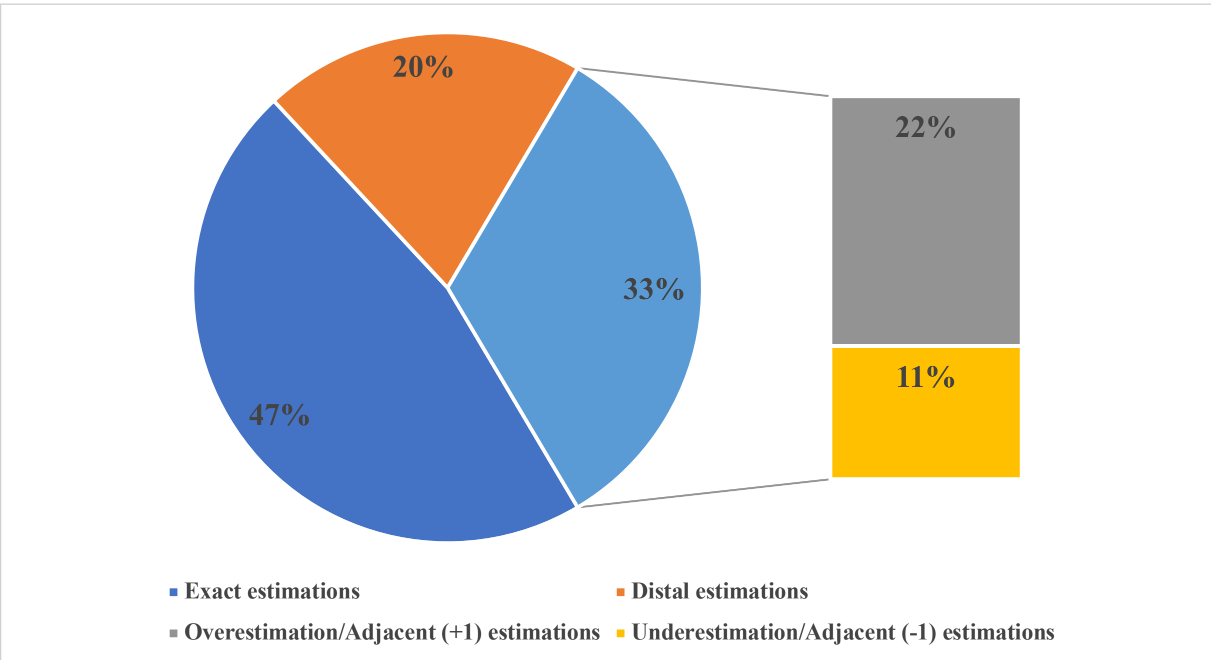


Fig 4.1: Classification of all 5969 portion size estimations made during the main validation

The 5969 consisted of 508 evaluations each for 11 test foods and 381 evaluations for boiled egg. Overall, sausage, *wele* and boiled egg had the highest number of correct estimations. The highest number of distal estimations were made for evaporated milk, smoked *saman* (Atlantic mackerel) and fried tilapia fingerlings (48.7%, 37.4% and 32.9% respectively). Fried tilapia fingerlings, snail and groundnut soup were the most often overestimated food (i.e. portions chosen were one portion above the correct one) while the highest proportion of underestimations were made for powdered milk, smoked *saman* and boiled egg. A summary of all estimations made for the twelve test foods is presented in Figure 4.2.

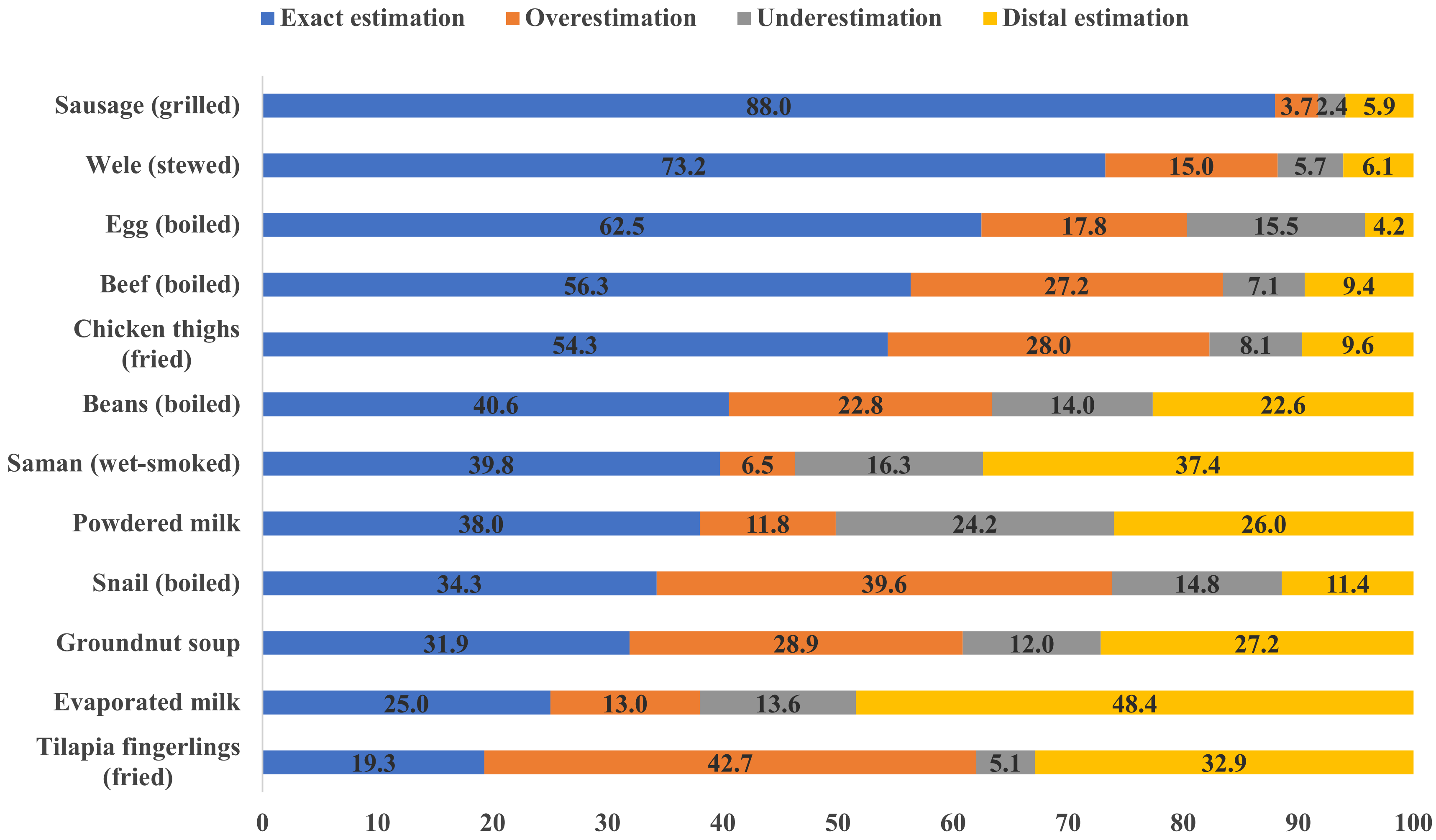


Fig. 4.2: Percentage of overall correct, adjacent or distal portion size estimations of test foods made with the PFA

4.4.4.3 Accurate and acceptable portion size estimations for each test food

Table 4.7 shows the percentage of accurate estimations made for each test food. Accuracy corresponds with the percentage of correct/exact estimations made. By this classification, all others i.e. adjacent and distal were inaccurate. However, to assess the appropriateness of the photographic food atlas, correct and adjacent estimations were considered acceptable (Nichelle *et al.*, 2019). The proportion of accurate estimations differed for each food, ranging the highest for sausage (88%) to the lowest of 19.3% for fried tilapia fingerlings. The proportion of acceptable estimations (i.e. proportion of correct and adjacent estimations combined) was high (> 60%) for all the foods evaluated except evaporated milk (51%) (Fig 4.3). As observed with accuracy, the proportion of acceptable estimations differed for different foods.

Table 4.7: Proportion of accurate portion size estimations for each test food

Food	Percentage of accurate estimations (%)
Sausage (grilled)	88.0
‡*Wele* (stewed)	73.2
Boiled egg	62.5
Beef (boiled)	56.3
Chicken thighs (fried)	54.3
Beans (boiled)	40.6
#*Saman* (smoked)	39.6
Powdered milk	38.0
Snail (steamed)	34.3
Groundnut soup	31.9
Evaporated milk	25.0
Tilapia fingerlings (fried)	19.3

#Atlantic mackerel. ‡cow hide

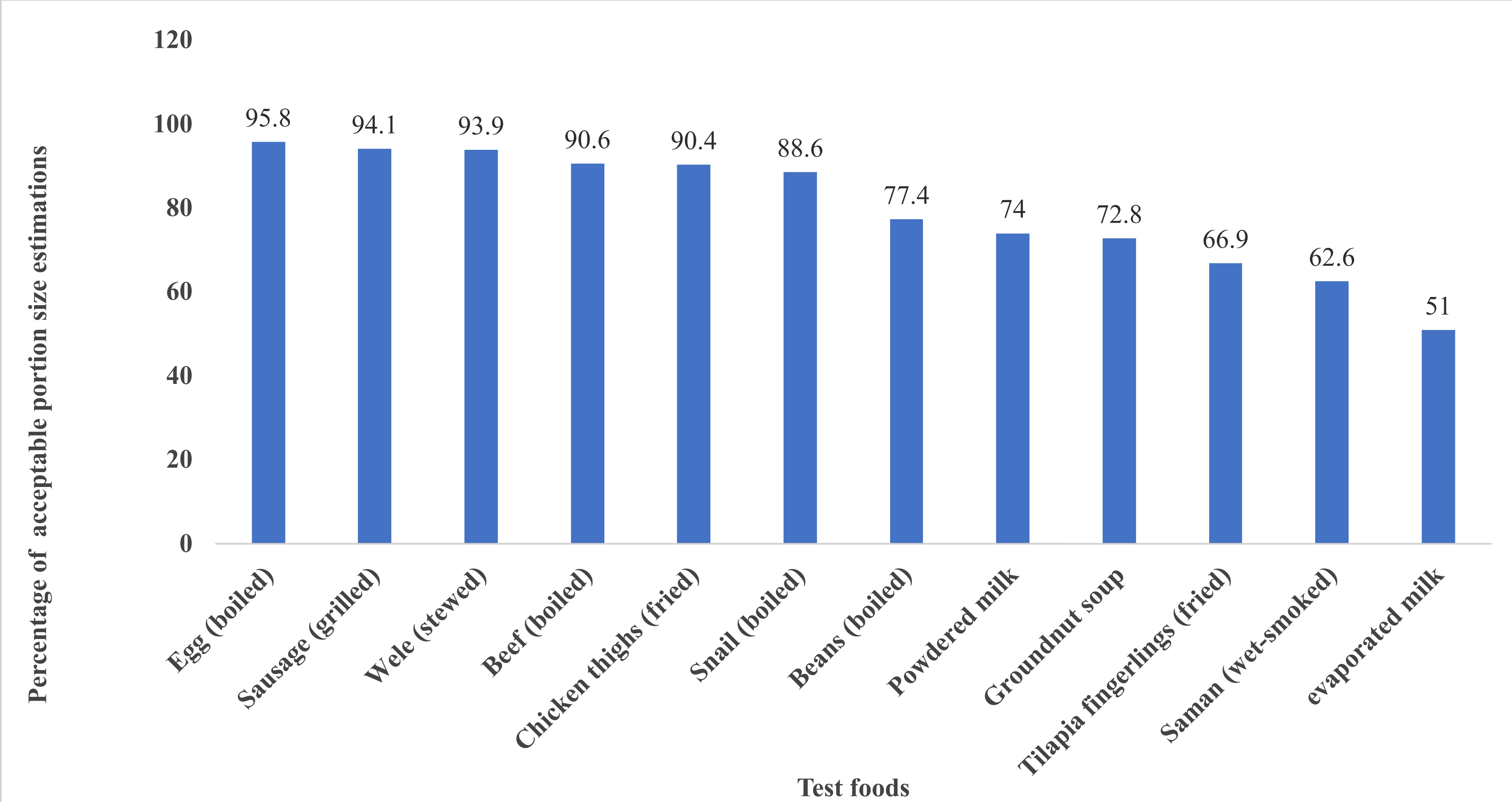


Fig 4.3: Proportion of acceptable portion size estimations for each test food

4.4.4.4 Estimation of different portions of the test foods

The proportion of accurate estimations made for different portions of each test food is shown in Table 4.8. The results are arranged (from column A to D) in increasing order of portion sizes presented for validation. Column A shows the accurate estimations made for the smallest portions presented during validation. This corresponded with a single portion (i.e. portion one) of all test food in the PFA except for fried tilapia fingerlings and groundnut soup for which the smallest portions presented were portion two in the PFA. Columns B and C are estimations for the two intermediate portions used in validation and those of column D are the largest (please see footnote to Table 4.8 for details).

Significant differences were noted in the number of accurate estimations for different portion sizes of each test food. The percentage of accurate estimations for all twelve test foods decreased with increasing size of the two intermediate portions (columns B and C), and then for most foods, increased again for the largest portion (column D). Accurate portion size estimations for boiled egg and smoked salmon were more when the smallest or largest portion (which were also the smallest and largest portions of the two foods in the photo series) was presented (boiled egg: 70.1% and 69.3%; smoked *saman*:69.3% and 75.6%). For evaporated milk and snail, accuracy decreased with increasing portion size. Among all the food portions evaluated, portion 5 of smoked *saman* was the least accurately estimated (2.4%). Portion 1 of snail scored the highest proportion of accurate estimations (92.1%).

Table 4.8: Proportion of accurate estimations for different portions of the test foods

Food	% Accurate estimations per portion size[1]				P-value
	A (Smallest portion evaluated)	B (Smallest intermediate portion evaluated)	C (Largest intermediate portion evaluate)	D (Largest portion evaluated)	
Beans (boiled)	66.1	53.5	15.7	26.8	<0.001*
Beef (boiled)	47.2	55.9	37.8	84.3	<0.001*
Chicken thigh (fried)	44.1	64.6	29.9	78.7	<0.001*
Boiled egg	70.1	48	-	69.3	<0.001*
Evaporated milk	52.8	24.4	12.6	10.2	<0.001*
Fried tilapia fingerlings	13.4	31.5	18.9	13.4	<0.001*
Groundnut soup	34.6	26	19.7	47.2	<0.001*
Powdered milk	81.1	26	15.7	29.1	<0.001*
Smoked *saman* (Atlantic mackerel)	69.3	11	2.4	75.6	<0.001*
Sausage (grilled)	84.3	90.6	87.4	89.8	0.003*
Snail (boiled)	92.1	31.5	11	2.4	<0.001*
Wele (cowhide; stewed)	80.3	57.5	66.1	89	<0.001*

*Chi square test of independence significant at $p \leq 0.05$

[1] A: smallest portion size presented for evaluation (portion 1 for all foods except tilapia fingerlings (portion 2) and groundnut soup (portion 2).
B: smallest intermediate portion presented for evaluation (portion 2 for all foods except fried tilapia fingerlings (portion 3), groundnut soup (portion 4) and smoked *saman* (Atlantic mackerel) (portion 3).
C: largest intermediate portion presented for evaluation (portion 3 for all foods except beans (portion 5), fried tilapia fingerlings (portion 5), groundnut soup (portion 7) and smoked *saman* (Atlantic mackerel) (portion 5).
D: largest portion size presented for evaluation (portion 4 for all foods except beans (portion 7), egg (portion 3), fried tilapia fingerlings (portion 7), groundnut soup (portion 8) and smoked *saman* (Atlantic mackerel) (portion 6).

Table 4.9 shows the proportion of acceptable estimations made for the different portion sizes of test foods. Except for sausage (p=0.440), the number of acceptable portion size estimations differed significantly for different portions of food, ranging from 14.2 % (largest intermediate portion of smoked *saman*) to 100 % (intermediate boiled egg portion). More than 60% of portion size estimations for the smallest portions of each test food were acceptable. Acceptable estimations for the smallest intermediate portion of evaporated milk and groundnut soup were below 60 % (54.3 and 52.8 % respectively). Among the largest intermediate portions tested, beans (53.5%), evaporated milk (48.8%) and fried tilapia fingerlings (48%) had the lowest proportion of acceptable estimations. The largest portion of evaporated milk scored 35.4% in this regard.

Table 4.9: Proportion of acceptable estimations for different portions of the test foods

	Smallest portion evaluated[1]	Smallest intermediate portion evaluated[2]	Largest intermediate portion evaluated[3]	Largest portion evaluated[4]	P-value
Beans (boiled)	89.8	90.6	53.5	75.6	<0.001*
Beef (boiled)	83.5	88.2	96.1	94.5	0.002*
Chicken thigh (fried)	82.7	89.8	99.2	89.8	<0.001*
Boiled egg	92.9	100	-	94.5	0.013*
Evaporated milk	67.7	54.3	48.8	35.4	<0.001*
Fried tilapia fingerlings	71.7	60.6	48	87.4	0.001*
Groundnut soup	76.4	52.8	92.1	70.1	<0.001*
Powdered milk	87.4	85	62.2	61.4	<0.001*
saman (smoked)	80.3	78.7	14.2	77.2	<0.001*
Sausage(grilled)	91.3	94.5	96.1	94.5	0.440
Snail (boiled)	93.7	81.1	83.5	96.1	<0.001*
Wele (cowhide; stewed)	92.9	87.4	97.6	97.6	<0.001*

*Chi square test of independence significant at $p \leq 0.05$

[1]Smallest portion size presented for evaluation (portion 1 for all foods except fried tilapia fingerlings (portion 2) and groundnut soup (portion 2).

[2]Smallest intermediate portion presented for evaluation (portion 2 for all foods except fried tilapia fingerlings (portion 3), groundnut soup (portion 4) and *saman* (Atlantic mackerel) (portion 3).

[3]Largest intermediate portion presented for evaluation (portion 3 for all foods except beans (portion 5), fried tilapia fingerlings (portion 5), groundnut soup (portion 7) and *saman* (Atlantic mackerel) (portion 5).

[4]Largest portion size presented for evaluation (portion 4 for all foods except beans (portion 7), egg (portion 3), fried tilapia fingerlings (portion 7), groundnut soup (portion 8) and smoked *saman* (Atlantic mackerel) (portion 6).

4.4.4.5 Differences in portion size estimations made by male and female participants

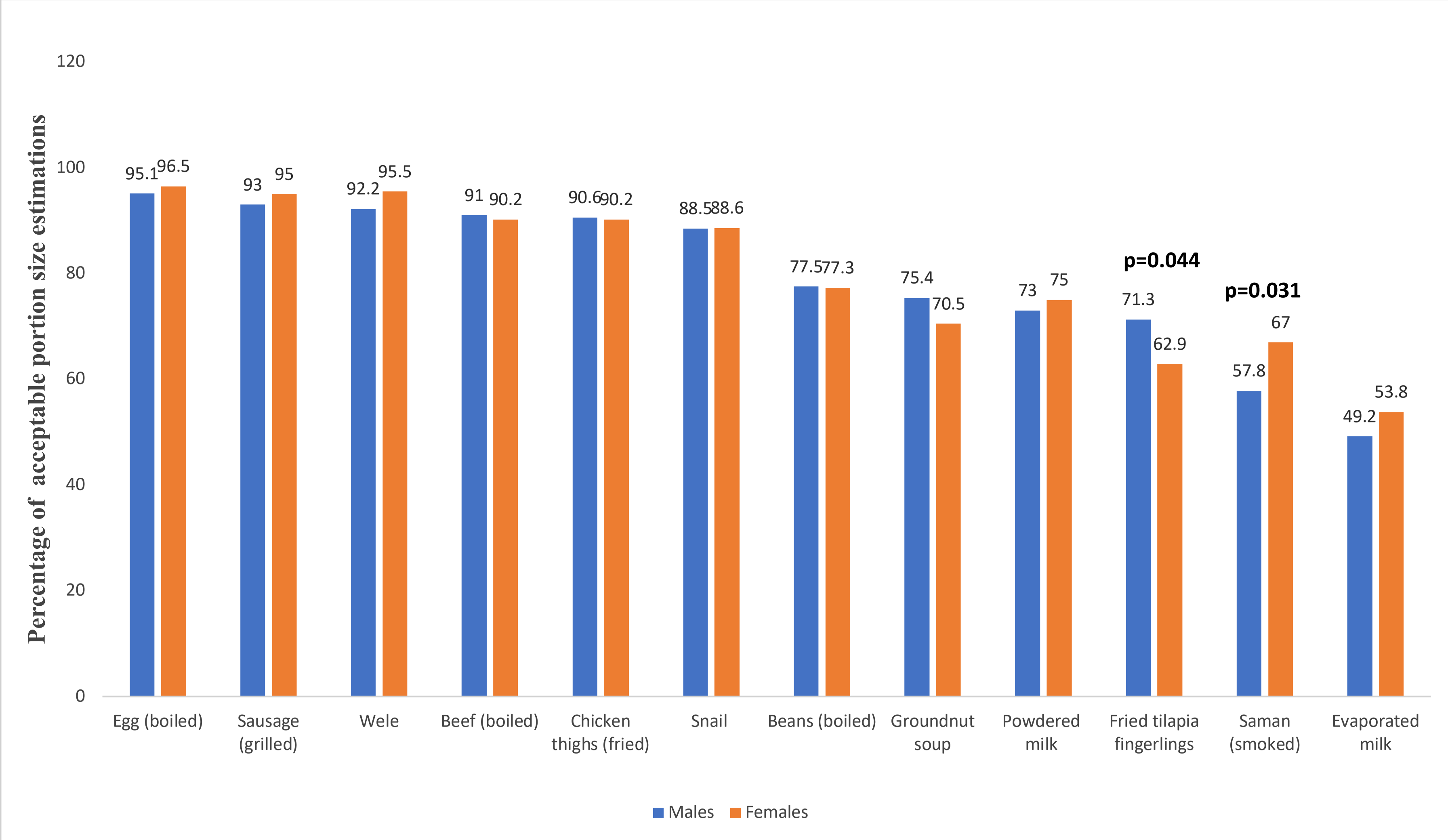
The proportion of accurate (Table 4.10) and acceptable (Fig 4.4) estimations of portion size were compared between male and female participants. Accurate portion size estimations made by males ranged from 20.5% (fried tilapia fingerlings) to 84.8% (sausage). Among female participants, it ranged from 18.2 % (fried tilapia fingerlings) to 90.9% (sausage). Female participants made more accurate portion size estimations for beans, beef, boiled egg, powdered milk, smoked *saman*, grilled sausage and *wele*, compared to their male counterparts. However more of the estimations made by males for chicken thighs, evaporated milk, fried tilapia fingerlings, groundnut soup and snail were accurate. There was no evidence that these differences were statistically significant ($p>0.05$ in all cases) (Table 4.10).

In terms of acceptable portion size estimations, significant gender difference was found only in the estimation of fried tilapia fingerlings ($p=0.044$) and smoked *saman* ($p=0.031$) (Fig 4.4). In the case of fried tilapia fingerlings, more of the portion size estimations of male participants were acceptable (71.3%) than those of the females (62.9%). The opposite was true for smoked *saman*, for which 67% of the estimates by female participants were acceptable compared to 57.8% for males.

Table 4.10: Proportion of accurate portion size estimations according to gender

Food	% Accurate estimations within gender		p-value*
	Males	Females	
Beans (boiled)	38.5	42.4	0.788
Beef (boiled)	55.3	57.2	0.931
Chicken thighs (fried)	54.5	54.2	0.972
Egg (boiled)	62.3	62.6	0.184
Evaporated milk	26.2	23.9	0.365
Fried tilapia fingerlings	20.5	18.2	0.282
Groundnut soup	33.6	30.3	0.272
Powdered milk	37.7	38.3	0.893
Saman (smoked)	36.5	42.4	0.110
Sausage (grilled)	84.8	90.9	0.184
Snail (boiled)	36.5	32.2	0.766
Wele (stewed)	71.7	74.6	0.233

#Atlantic mackerel; ‡*cow* hide *Chi square test of independence significant at $p \leq 0.05$



Chi square test of independence significant at $p \leq 0.05$

Fig. 4.4: Proportion of acceptable portion size estimations according to gender

4.4.4.6 Differences in portion size estimations according to age groups

Three age categories (less than 30 years old; 30 to 44 years; 45 to 64 years) were created for comparison of age-related differences in accurate (Table 4.11) and acceptable (Table 4.12) portion-size estimations. Notably, none of the cross-sectional study participants in the >64 years age bracket gave permission to be contacted for the validation. As a result, elderly persons in that age group were not represented in this phase of the study.

Compared to the other age groups, significantly more powdered milk portion size estimations made by participants in the < 30 years age group were accurate ($p = 0.026$) (Table 4.11). Even though some differences were noted for a number of food items besides powdered milk, no other evidence of statistical significance was found for any of those. For example, it was observed that participants in the 45 to 64 years age group made both the highest (88.5% for sausage) and lowest (13.5 % for tilapia fingerlings) proportion of accurate estimations but these were not significantly different from those made by other age groups for those same foods.

Table 4.11: Proportion of accurate portion size estimations according to age groups

Food	% Accurate estimation within age group			p-value
	<30 years	30-44 years	45-64 years	
Beans (boiled)	40.1	42.4	38.5	0.853
Beef (boiled)	57.4	53.5	57.7	0.169
Chicken thighs (fried)	53.2	57.6	51.9	0.349
Egg (boiled)	66.2	54.6	61.5	0.091
Evaporated milk	25.3	24.3	25	0.944
Fried tilapia fingerlings	18.6	22.9	13.5	0.552
Groundnut soup	34.0	25.0	38.5	0.166
Powdered milk	38.8	37.5	34.6	0.026*
#*Saman* (smoked)	41.0	38.9	32.7	0.478
Sausage (grilled)	87.8	88.2	88.5	0.791
Snail (boiled)	35.6	30.6	36.5	0.478
‡*Wele* (stewed)	73.4	71.5	76.9	0.900

#Atlantic mackerel; ‡*cow* hide

*Chi square test of independence significant at $p \leq 0.05$

Differences in the proportions of acceptable portion size estimations pertaining to age are presented in Table 4.12. The lowest proportion of acceptable estimations observed was for evaporated milk. Among the three age groups, that of the 45-64 years group was the lowest (46.2%) but did not differ from the other two (p= 0.692). The < 30 years age group made a higher number of acceptable portion size estimations for snail, beans, groundnut soup, fried tilapia fingerlings, smoked *saman* and evaporated milk than the other groups but none of these were significantly different from those of the other age groups (p>0.05 in all cases).

There was however a significant age-group difference in acceptable portion size estimations made for powdered milk. The 45-64 years group made a significantly higher proportion of acceptable estimates while the 30 to 44 years group made the lowest (p= 0.012).

Table 4.12: Proportion of acceptable portion size estimations according to age groups

Food	% of acceptable estimations within age group			p-value
	<30 years	**30-44 years**	**45-64 years**	
Egg (boiled)	95.7	97.2	92.3	0.421
Sausage (grilled)	94.6	92.4	96.2	0.524
‡*Wele* (stewed)	94.2	93.1	94.2	0.883
Chicken thighs (fried)	91.0	91.0	84.6	0.335
Beef (boiled)	90.1	91.7	90.4	0.863
Snail (boiled)	87.8	91.0	86.5	0.547
Beans (boiled)	78.2	76.4	75.0	0.831
Powdered milk	76.6	65.3	82.7	0.012*
Groundnut soup	76.0	67.4	69.2	0.131
Fried tilapia fingerlings	67.9	66.7	61.5	0.659
#*Saman* (smoked)	63.5	61.8	59.6	0.846
Evaporated milk	52.6	51.4	46.2	0.692

#Atlantic mackerel; ‡*cow* hide *Chi square test of independence significant at $p \leq 0.05$

4.4.4.7 Differences in portion size estimations according to BMI categories

Among all BMI categories, the highest proportion of accurate portion size estimates were made by obese participants for beans, beef, chicken, boiled egg, fried tilapia fingerlings, sausage and *wele* (Table 4.13). The percentage of accurate estimations for fried tilapia (p= 0.015) and *wele* (p=0.024) were the only ones that differed significantly between participants of different BMI levels. There was no other evidence of statistically significant differences.

Table 4.13: Proportion of accurate portion size estimations according to BMI categories

Food	% Accurate estimation within BMI categories				p-value
	Underweight	Normal weight	Overweight	Obese	
Beans (boiled)	25	40.2	41.4	45.8	0.564
Beef (boiled)	43.8	57	54.3	60.4	0.158
Chicken thighs (fried)	37.5	52.4	57.8	64.6	0.419
Egg (boiled)	41.7	65.4	52.9	72.2	0.186
Evaporated milk	43.8	24.1	21.6	33.3	0.353
Fried tilapia fingerlings	18.8	18.9	17.2	27.1	0.015*
Groundnut soup	43.8	32	29.3	33.3	0.805
Powdered milk	37.5	38.1	37.5	37.5	0.494
#*Saman* (smoked)	43.8	39.3	37.9	43.8	0.930
Sausage (grilled)	87.5	88.1	86.2	91.7	0.382
Snail (boiled)	25	34.5	35.3	33.3	0.383
‡*Wele* (stewed)	56.3	71.6	77.6	79.2	0.024*

#Atlantic mackerel; ‡*cow* hide *Chi square test of independence significant at p ≤ 0.05

Percentage of acceptable estimations made by participants in each BMI category is presented in Table 4.14 below. All portion size estimations by the obese group for beef, boiled egg and *wele* were acceptable (i.e. 100%). No distal estimations were made for chicken thigh, boiled egg and sausage by the underweight group. For all the test foods, no statistically significant differences were observed in portion size estimations across the different BMI categories (Table 4.14).

Table 4.14: Proportion of acceptable portion size estimations according to BMI categories

Food	% of acceptable estimations within BMI categories				P-value
	Underweight	Normal weight	Overweight	Obese	
Beans (boiled)	56.3	76.8	81.9	77.1	0.139
Beef (boiled)	87.5	88.7	92.2	100	0.077
Chicken thighs (fried)	100	89.3	90.5	93.8	0.433
Egg (boiled)	100	95.9	93.1	100	0.297
Evaporated milk	62.5	52.1	48.3	52.1	0.725
Fried tilapia fingerlings	81.3	64.3	69.8	72.9	0.296
Groundnut soup	75	72	71.6	81.3	0.576
Powdered milk	56.3	72.9	80.2	72.9	0.160
[#]*Saman* (smoked)	68.8	63.7	58.6	62.5	0.748
Sausage (grilled)	100	95.1	91.4	91.7	0.299
Snail (boiled)	75	86.9	94	91.7	0.054
[‡]*Wele* (stewed)	100	93.3	92.2	100	0.177

[#]Atlantic mackerel; [‡]*cow* hide [*]Chi square test of independence significant at $p \leq 0.05$

4.4.4.8 Differences in portion size estimations according to educational backgrounds

Table 4.15 below shows the proportion of accurate estimations made by participants with different educational backgrounds. Participants who had a tertiary education background made the highest proportion of accurate estimations for beans, beef, fried chicken thighs, boiled egg, powdered milk, *saman*, sausage and *wele*. Differences between participants of different educational levels in accurate estimations of fried chicken thighs (p =0.003), fried tilapia fingerlings (p= 0.008), and *wele* (p=0.046) were statistically significant (Table 4.15). For fried chicken thighs, the proportion of accurate estimations increased with increasing education level. The trend was not so clear for fried tilapia fingerlings and *wele*. Regarding fried tilapia fingerlings, an increase was observed from the no formal education group to the secondary school level group. Accurate estimations for the tertiary group were lower than that of the secondary school level but higher than the two other groups. Accurate estimation of *wele* which was lower for the primary school level group as compared with participants with no formal education, increased across the other two educational levels.

Table 4.15: Proportion of accurate portion size estimations according to educational levels

food	% Accurate estimations per educational level				p-value
	None	Primary	Secondary	Tertiary	
Beans (boiled)	35.4	36.5	39.5	45.4	0.664
Beef (boiled)	47.9	51.9	56.3	60.5	0.190
Chicken thighs (fried)	43.8	50	53.9	59.9	0.003*
Egg (boiled)	52.8	56.4	64.1	64.9	0.091
Evaporated milk	14.6	26.9	26.6	25	0.194
Fried tilapia fingerlings	10.4	19.2	20.7	19.7	0.008*
Groundnut soup	27.1	34.6	31.6	32.9	0.149
Powdered milk	35.4	26.9	38.7	41.4	0.220
#*Saman* (smoked)	41.7	30.8	39.5	42.1	0.574
Sausage (grilled)	87.5	88.5	87.1	89.5	0.679
Snail (boiled)	29.2	38.5	34	34.9	0.908
‡*Wele* (stewed)	66.7	55.8	75	78.3	0.046*

#Atlantic mackerel; ‡*cow* hide *Chi square test of independence significant at p ≤ 0.05

Acceptable portion size estimates for fried chicken thighs ($p<0.001$) and fried tilapia fingerlings ($p<0.001$) increased steadily with increasing educational level. Almost the same trend was observed for beef and boiled egg, except that the proportion of accurate beef estimations was higher for participants with no formal education compared with those who had primary education. Accurate boiled egg estimations were also higher among those with primary school level education compared with the secondary school level group. These results are presented in Table 4.16.

Table 4.16: Proportion of acceptable portion size estimations according to educational status

Food	% Acceptable estimations per educational level				p-value
	None	Primary	Secondary	Tertiary	
Beans (boiled)	75	69.2	75.8	83.6	0.121
Beef (boiled)	85.4	82.7	90.6	94.7	0.039*
Chicken thighs (fried)	77.1	78.8	92.6	94.7	<0.001*
Egg (boiled)	86.1	97.4	95.3	99.1	0.008*
Evaporated milk	54.2	57.7	53.5	45.4	0.306
Fried tilapia fingerlings	43.8	65.4	65.6	77	<0.001*
Groundnut soup	66.7	65.4	72.3	78.3	0.194
Powdered milk	77.1	63.5	72.7	78.9	0.144
#*Saman* (smoked)	68.8	53.8	63.3	62.5	0.470
Sausage (grilled)	97.9	92.3	94.1	93.4	0.640
Snail (boiled)	87.5	84.6	88.7	90.1	0.746
‡*Wele* (stewed)	91.7	90.4	94.1	95.4	0.540

*Chi square test of independence significant at $p \leq 0.05$

4.4.4.9 Summary of accurate and acceptable portion size estimations made during validation

In Table 4.17 below, the proportions of all accurate and acceptable estimations made during the validation are presented according to sex, age group, BMI, educational background and size of portions displayed. As shown, portion size estimation was associated with educational level and the size of food portions but not sex, age group or BMI. Participants with tertiary level education made significantly more accurate portion size estimations than the other groups. The proportion of acceptable estimations by those with more years of education (i.e. tertiary and secondary level education) were higher than for their counterparts who had no formal education or only primary level education. Among all the portion size options evaluated, accurate estimations were highest for the smallest portions, followed by the largest portions, the smallest intermediate portion and finally the largest intermediate portion. Acceptable portion size estimations also followed a similar pattern.

Table 4.17: Proportion of overall accurate and acceptable estimations stratified by sex, age group, BMI, educational level and size of portions.

	Accurate estimations (%)	p-value	Acceptable estimations (%)	p-value

	Accurate[1]	Not accurate[2]		Acceptable[3]	Not acceptable[4]	
Sex						
Male	46.2	53.8	0.558	79.2	20.8	0.520
Female	46.9	53.1		79.9	20.1	
Age group						
<30 years	47.2	52.8	0.439	80.4	19.6	0.149
30-44 years	45.4	54.6		78.4	21.6	
45-64 years	46	54		77.9	22.1	
[5]BMI kg/m^2						
Underweight	42	58	0.60	79.8	20.2	0.222
Normal weight	46.4	53.6		78.9	21.1	
Overweight	45.6	54.4		80	20	
Obese	51.4	48.6		82.6	17.4	
Educational level						
None	40.8	59.2	<0.001*	75.7	24.3	<0.001*
Primary	40.8	59.2		73.8	26.2	
Secondary	20.4	79.6		79.6	20.4	
Tertiary	49.1	50.9		82.1	17.9	
Size of portion evaluated						
Smallest portion[6]	61.2	38.8	<0.001*	84.2	15.8	<0.001*
Smallest intermediate portion[7]	43.4	56.6		80.3	19.7	
Largest intermediate portion[8]	32.2	67.8		73.8	26.2	
Largest portion[9]	49.7	50.3		80.0	20.0	

*Chi square test of independence significant at $p \leq 0.05$

[1]proportion of correct/exact estimations [2]proportion of adjacent and distal estimations [3]proportion of correct and adjacent estimations

[4]proportion of distal estimations

[5]WHO classification (World Health Organization, 2000)

[6]smallest portion size presented for evaluation (portion 1 for all foods except tilapia fingerlings (portion 2) and groundnut soup (portion 2).

[7]smallest intermediate portion presented for evaluation (portion 2 for all foods except fried tilapia fingerlings (portion 3), groundnut soup (portion 4) and smoked *saman* (Atlantic mackerel) (portion 3).

[8]largest intermediate portion presented for evaluation (portion 3 for all foods except beans (portion 5), fried tilapia fingerlings (portion 5), groundnut soup (portion 7) and smoked *saman* (Atlantic mackerel) (portion 5).

[9]largest portion size presented for evaluation (portion 4 for all foods except beans (portion 7), egg (portion 3), fried tilapia fingerlings (portion 7), groundnut soup (portion 8) and *saman* (Atlantic mackerel) (portion 6).

CHAPTER FIVE

5.0 DISCUSSIONS

5.1 The cross-sectional study

The main objective of this three-part study was to develop and validate a photographic food atlas with portion sizes of commonly consumed animal and plant protein source foods. In the first part, which is the descriptive cross-sectional study, commonly consumed protein source foods were identified from 3-day 24-hour dietary recall data of eight hundred and thirty-four study participants.

5.1.1 Characteristics of participants in the cross-sectional study

Male participants who completed the study protocol for the cross-sectional survey were slightly overrepresented (50.9% vs 49.1% females). This gender distribution deviates somewhat from the 2010 census-derived national estimates of 48.8% male and 51.2% female (Ghana Statistical Service, 2013b). Forty-five percent (45%) of participants were Akan, 22.9% Ga-Dangme and 18.3 % Ewe as compared to 39.7 %, 27.4% and 20.1% respectively in the Greater Accra region (Ghana Statistical Service, 2013a). In terms of religion, adherents of the Christian religion form the majority in the country (83.2%) while Moslems make up 11.9%. Similar to the national statistics, study participants who professed Christianity and Islam were 89.2 % and 8.2% respectively.

Similar to the pattern found in national and regional data (for Greater Accra) (Ghana Health Service, 2018), the proportion of female participants who had never received any formal education was higher than males. As observed nationally (Ghana Statistical Service, 2014b), fewer of the females had attained secondary or tertiary education This gender disparity in educational background may be part of the reason why unemployment was higher among female participants. Males also dominated the formal sector and skilled work. The trading sector however had far more females (31.3%) than males (12.4%) and is reflective of what pertains in urban Ghana with more females (43.1%) than males (17.2%) engaged in this sector (Ghana Statistical Service, 2014b).

According to the anthropometric profile, 43.9 % of all participants were overweight or obese (mean BMI of the overall sample was 25.1kg/m^2). In a recently published meta-analysis, Ofori-Asenso *et al*. (2016) estimated the prevalence of overweight and obesity in 48,966 adult Ghanaians from 43 studies across the country. The observation of overweight and obesity in this present study was lower than their estimated 55.2% for the Greater Accra Region, but close to the 43% overweight or obesity they found at the national level. These results bring to light, the global increase (Chooi *et al*., 2019) that has also been noted among the general Ghanaian population over the years (Agyemang *et al*., 2015).

More female participants than males in this study were overweight or obese. This too aligns with the current global trend (Chooi *et al*., 2019, Garawi *et al*., 2014, Agyemang *et al*., 2015). Several explanations have been ascribed for the comparatively higher rates of overweight and obesity in females. Biologically, females have a higher percentage of body fat. There is evidence too that women's role in reproduction also predisposes them to more weight gain (Newby *et al*., 2005, Brooks and Maklakov, 2010). Restrictions on women's behavior in some cultures limit their involvement in physical activity, thereby promoting sedentarism and weight gain. A study conducted in an African township in Cape Town noted that women's role as decision makers with respect to household food spending made them more prone to obesity (Case and Menendez, 2009).

5.1.2 Common protein foods consumed

Reported intake of animal source protein foods by participants was higher than plant sources. This is not entirely surprising in the light of the fact that GAMA is a rapidly growing metropolis marked by continued and rapid urbanization (Owusu, 2015). Such growth increases are known to be accompanied by a rise in per capita income which may translate into increases in animal protein intake (Staatz *et al*., 2017). The balance of essential amino acids in a protein food determines its quality. In this respect, animal sources are generally superior to plant protein sources. More animal source foods may therefore be indicative of improved diet quality. Still, when compared to other economies, especially more advanced ones, intake of animal source foods in our environment is low. According to comprehensive 2015 global estimations, Sub-Saharan Africa had the lowest intake of animal protein (Reedy *et al*., 2019).

Fish was the predominant of animal protein source of choice among participants. On average, fish accounts for about 60% of total animal protein consumed and 22% of household food expenditures in Ghana (USDA, 2019). In this study, different mackerel and tuna species were found to be more common. The two have long been established as among the most preferred along the Ghanaian coast (Heinbuch, 1994). They are also more affordable (USDA-GAIN, 2009, Onumah *et al*., 2020). Smoking was the prevalent method by which fish reported by participants had been processed. Around 60% of fish in Ghana is smoked (USDA, 2019). In an early survey of animal protein sources among rural and urban populations in Ghana, it was noted that wet hot-smoked fish is liked for the succulent mouthfeel imparted by its high fat content, and dry smoked fish for the distinct flavour which consumers find highly acceptable, as well as its longer shelf-life (Heinbuch, 1994). The main dry smoked fishes observed in this study were *amane* (herrings), *adwene* (catfish) and anchovies (*abobi/ keta school boys and nsesaawa and*). Fried fish was the next most common after smoked fish. Kenkey, a ubiquitous and well patronized food originating with the Ga people [who are the indigenous people of GAMA] is traditionally eaten with fried fish and grinded pepper.

Salted, fermented and sun-dried fish (collectively referred to as fermented fish) were consumed by 6.6 % (*Koobi*), 2.3% (kako) and 0.1% (*momone*) of participants respectively. A plausible explanation for the low figures is that though these are quite popular, they are most often used for their flavour enhancing properties (especially *momone*) (Anihouvi *et al*., 2012) and not as main protein sources in a meal. This corroborates a recent assertion by Aboagye *et al*. (2020) that by virtue of the quantities used by consumers, fermented fish are not a significant source of protein.

In comparison to the variety of fish available on the market, those reported in the cross-sectional study was somewhat limited. The many occasions when participants were unable to indicate the name of fish they ate cannot be discounted as a probable cause of this observation. As mentioned in the results, on 39.6% of the occasions when they ate fish, participants did not know the name of the fish. Likely then, those fishes whose names participants successfully identified are indeed those most common or well known to them. An example of the later is Atlantic mackerel (also called chub mackerel and locally known as '*saman*' (Edwards *et al*., 2001). Smoked *saman* (consumed by approximately 36% of participants) was the commonest fish identified by name.

Poultry and poultry products were the second most common protein group after fish. Over 95% of the total consumption frequency from this group were reports of chicken and chicken eggs. Poultry products available on the market include a large proportion of imported chicken products such as whole chicken, sausage, gizzards, wings, thighs and other pre-cut parts (Netherlands Enterprise Agency, 2019). Almost 60% (n=436) of participants ate chicken egg reported as boiled, fried or egg stew. Eggs are comparatively low-cost but good source of protein, essential fatty acids, antioxidants, vitamins, and minerals. But due to its high cholesterol content, egg consumption has for years been associated with an increased risk of stroke and heart disease. This led to recommendations to limit intake, especially in persons who have an elevated CVD risk (Clayton and Kern, 2017). Even though the controversy on dietary cholesterol is not yet quite settled, accumulation of some contrary evidence in recent years led to the removal of its restriction in diet from several nutritional guidelines (Alexander *et al*., 2016, McNamara, 2015). Focus has shifted from single nutrients to healthy dietary patterns for optimum cardiovascular health (Van Horn *et al*., 2016). In Ghana, a national egg campaign was launched in 2018 by stakeholders including the National Association of Poultry Farmers, Ghana Health Service and Ministry of Food and Agriculture (MOFA) to emphasize the health benefits of egg consumption and drive the hitherto low consumption levels up (Joy Online, 2018). Another possible contributory factor is the increase in vendors who sell bread and fried egg with hot beverages and *indomie* (noodles) with eggs.

It is reported that though guinea fowl, turkey, ostrich and other poultry are also available in Ghana, consumption of chicken and chicken products particularly in urban areas, far exceeds these (Netherlands Enterprise Agency, 2019). This pattern was observed in this study. Turkey and guinea fowl which were the only two other poultry reported were consumed by less than 1% of participants. Sausage was consumed by nearly 7 % (n=50). A challenge encountered though was the inability of some participants to distinguish the particular animal source of the sausage eaten. This happened with more than half of those who reported sausage consumption. Grilled sausage/sausage kebabs are available as pork, beef or chicken sausages, all of which appear similar in size (whether of chicken, beef or pork origin, the sausages grilled at kebab stands are larger than the smaller chicken sausages which are usually fried or steamed) and often in colour too. By anecdotal evidence, street vendors who grill sausages are mostly Moslems and it stands to reason that they sell beef or chicken sausage only. The difference between the two sausages is not immediately obvious and unless a consumer specifically inquires, they may not be able to tell one from the other. Grilled pork sausages are easier to identify since they are mostly sold at pork joints or at stands that are labelled accordingly. It is also possible that the low numbers observed is because patronage of sausage which is highly popular among both rural and urban Ghanaian children (Antwi, 2017) is not as high among adults. The latter, if true, is actually beneficial. Sausages on the Ghanaian market have been found to contain high levels of nitrite. For instance, samples of 6 different sausage brands of mixed origin (i.e. chicken, beef and pork) analysed by Duah *et al*. (2019) were above the legal limits. In the long term, this has serious implications for the risk of colorectal cancer and other adverse health effects associated with nitrite toxicity. For similar reasons, the low intake frequency seen for corned beef, the only canned meat product reported by participants, is positive.

The legume group ranked third on the list of commonly consumed protein foods. In terms of both consumption frequency and number of individuals who reported consumption, groundnut soup, a very common soup in Ghana and other West African countries (Meng *et al*., 2018a, Meng *et al*., 2018b) was first on the list. Boiled or roasted groundnuts was the third most common. Groundnuts and groundnut-based foods are a key part of diet and major source of plant protein and energy in West Africa (Asibuo *et al*., 2008, Eshun, 2013, Jolly *et al*., 2008). For instance, Ene-Obong *et al*. (2013) reported that over 70% of the population of a nation-wide survey in Nigeria ate groundnuts on a daily basis. Also, groundnut sauce was one of six sauces deemed important in the diet of children in Burkina Faso (Avallone *et al*., 2008). In Ghana, Meng *et al*. (2018a) found that groundnuts and groundnut products are consumed by a large proportion of urban dwellers. Indeed, boiled and roasted groundnuts are well liked snack foods and widely available from street vendors. Palava sauce and beans which came in second and fourth place respectively are also popular choices in the country (Agble *et al*., 2009). Koose, a deep-fried bean cake made from thick cowpea paste (Apea-Bah *et al*., 2017) was the fifth most common legume food and was consumed by one-fifth (i.e. 20.9%) of all participants. It originated with Moslems in Northern Ghana (Nout, 1996) but is now eaten all over the country customarily with the spicy millet porridge, Hausa Koko. The popularity of beans, koose and other cowpea products underscore the fact that cowpeas have long been recognized as an acceptable and comparatively affordable protein source (Sefa-Dedeh and Yiadom-Farye, 1988).

Items in the meat and meat products group placed fourth in the ranking of commonly consumed protein source foods. The American Meat Science Association has a very broad definition for meat: 'skeletal muscle and its associated tissue (including nerves, connective tissue, blood vessels, skin, fat and bones) and edible offal derived from mammals, avian, and aquatic species deemed as safe and suitable for human consumption' (Boler and Woerner, 2017). Fish, poultry and wild game are not part of the USDA definition (USDA, 2017). Ohene-Adjei and Bediako (2017) explained that in Ghana, red blood and an endoskeleton are the features of species from which 'true meat' is obtained and even so, choices of animal species are subject to ethnicity. According to the author, local perception of meat places brain tissue, offal and bone as supplemental meats, while invertebrates (e.g. snails) are recognized as valuable sources of animal protein but not true meat. In this present study, foods were grouped into the meat and meat products category on the basis of the USDA definition with the exception that bush meat which is part of wild game was included. Beef was most common in the group; it was eaten by nearly 43% of all participants. Furthermore, over half (approximately 52.2%) of the reported consumption frequency from the meat group referred to beef. Beef was often cooked in soups, stews and as kebabs. Next to beef, *wele* (cow hide) was most common. The dietary recall showed that participants ate *wele* with *waakye* or in okro stew or soup.

Goatmeat placed third. If *wele* is discounted, the trend of meat consumption found among study participants is similar to what pertains at the national level with goatmeat placing second and bushmeat being the least consumed (Osei-Asare and Eghan, 2014). The low frequency of bushmeat consumption confirms recent reports of declined intake among the population. Bush meat (game) is a relatively expensive luxury food item in urban areas (McNamara *et al*., 2019) and so does not form a regular part of protein sources for most households. There are also reports of changing preference among the younger generation. In a study of the influence of non-wealth factors on bushmeat intake in four West African countries, it was found that consumption of bushmeat among young persons, particularly in urban areas was low (Luiselli *et al*., 2019). The mean age of participants in this present study was 34.1 ± 11.9 and falls within this category. Also important is the influence of increased public awareness created by radio and other news media, of disease risks such as Ebola that is associated with bushmeat consumption (Kuukyi *et al*., 2014).

The prevalence of snail consumption was low (0.6 % of total frequency of protein source food intake). Snail has a favorable nutritional profile besides the protein content. Ghosh *et al*. (2017) found a polyunsaturated to monounsaturated fatty acid ratio of 1.08 and considerable amounts of minerals. Some persons by virtue of their ethnic background and cultural beliefs avoid snail altogether. But snail is largely a delicacy often in high demand in Greater Accra (Nyoagbe *et al*., 2016). In view of this, rather than being the result of non-preference, the high cost of snail may be the reason for the seemingly low consumption.

It is widely held that milk and milk products do not contribute substantially to dietary intake of Ghanaians. The incidence of lactose intolerance among some adult Ghanaians has been cited as a contributory factor (Otchere and Okantah, 2001). There are also concerns about unhygienic production and retail conditions especially with regard to fresh milk and fresh milk products (Gidiglo, 2014, Kunadu *et al*., 2019). In fact, there is little indication that the highly unhygienic conditions surrounding local production of milk as described by Whitby (1968) has changed and Ghanaian consumers have been noted to perceive fresh milk as both unhygienic and inferior (Aidoo *et al*., 2009). Against this background, it was not surprising that no reports of fresh milk were noted in this study. Intake from the milk group had a frequency of 11.7% of the total protein food consumption but the majority of this was from evaporated milk which is typically consumed in small amounts. The ideal brand by Nestle was the most popular. In fact, interviewers had to clarify when a person said they consumed ‘ideal’ because the name is ubiquitous with evaporated milk. Such clarification showed up the use of a number of other brands on the market. These were captured as guide photographs in the atlas. Other products reported, namely flavoured ice cream, yoghurt, local cheese (*wagashi*) and *brukina* (fermented milk and millet), have all been observed in prior studies (Aidoo *et al*., 2009, Kunadu *et al*., 2019). Skimmed milk and low-fat milk were the least consumed in the group.

5.2 Characteristics of the photographic food atlas

Due to variations in dietary patterns, photographic food atlases must represent the most important foods consumed locally instead of simply adapting what is used in another country (Korkalo *et al*., 2013). The final atlas contains fifty-four commonly consumed animal and plant protein foods. The criteria by which these foods were selected was that they had been consumed by at least 1 % of the sample. The reasoning was that in this way, as many as possible of the variety of plant and animal source foods consumed would be captured. The low cut-off also allowed inclusion of the different forms in which commonly consumed foods were taken, e.g. groundnut paste (starkly different in presentation from its source, groundnuts) which was consumed as a bread spread by 1.3 % of total participants. Setting a cut-off value to rank commonly consumed foods on the basis of a minimum number of consumers is an accepted practice (Faber *et al*., 2013). Other options that have been used in research are an all-inclusive approach when there is not much dietary variety (Mbhenyane *et al*., 2005) or using only the highest ranked foods within a predetermined limit (Labadarios *et al*., 2005).

The fifty-four foods depicted in the atlas include various fried, steamed and grilled fishes and meat; soup, paste and sauces; milk and milk products of different consistencies (liquid, powdered, solids, gruel). The physical properties of the foods represent the range of what is consumed in the population. Nelson and Haraldsdottir (1998b) described a number of characteristics by which different foods must be assessed in order to make an estimation of portion size. Palava sauce and beans (boiled or stewed) fall within the category of gravy and sauces for which both area and depth of food spreading across the plate is needed. A respondent must judge the depth of groundnut soup (wet food served in a bowl) which hides much of the soup from view. Laughing cow cheese was the only wedge-shaped item. Unlike other wedge items such as pies, pizza and wedge-shaped cuts of cake, for which judgement of area and depth of the wedge is required, the size of a wedge of laughing cow cheese is constant. This implies that beyond identification, perhaps a respondent need only recall the number of wedges consumed. With respect to the local cheese *wagashi*, the area and thickness of slice is important for estimation. Powdered milk was presented as a loose mound or heap on a side plate. Again, such characteristics require assessment of area and depth of the mound. A majority of the foods in the atlas are in the 'discrete pieces of different sizes' category (Nelson and Haraldsdottir, 1998b). They are found within the fish, poultry and meat groups and are generally irregular-shaped. The volume i.e. area and depth help to estimate the portion size of such foods.

Food pictures in the atlas are arranged in five groups which appear in decreasing order of the total number of times that items within the group had been reported: fish, poultry and poultry products, legumes, meat and meat products, milk and milk products. Individual items within each group are arranged in alphabetical order for ease of use. Portions in some of the photo series are arranged in ascending order of size while others are in decreasing order of to minimize automatic choice of a particular portion size. As observed by Nelson and Haraldsdottir (1998b), while a random order of photos will be best in this regard, respondent burden will be increased. Further negative consequences can be deduced from such a situation: dietary interviews will be needlessly prolonged; respondent fatigue will set in and they may become less corporative. Ultimately, accuracy of their responses will be affected and the motive for using the portion size aid defeated.

A majority of foods presented in the atlas are serial photographs of eight, six, or four portions. Photographic series with fewer photographs may be faster to use and less burdensome to respondents. But there is evidence that more, not less photographs improve accuracy of portion size estimation. Subar *et al*. (2010) for example, noted that more accurate estimations were made with eight-portion photographs than with four-portion ones. Although the difference was not statistically significant and the team used digital computer-based images, similar observations had been reported in an earlier study with printed photos (Nelson *et al*., 1994). In that study Nelson and his colleagues observed that using a single portion photograph consistently led to higher errors than when eight-photo series was used. Based on this and later results (Nelson *et al*., 1996), it was suggested that photo series with four to eight pictures enable the best estimations of portion size (Nelson and Haraldsdottir, 1998c).

The photographs of evaporated milk portions in clear glass were captured vertically so the depth of content could be easily gauged. All other food photographs in this study were taken at an angle of 45-degree. This angle is widely used and accepted as best, to represent 'the view of a person of average height, sitting at a table and looking at a plate of food on the table in front of him' (Jayawardena and Herath, 2017, Turconi *et al*., 2005, Schnefke *et al*., 2019, Bouchoucha *et al*., 2016, Lazarte *et al*., 2012, Smith *et al*., 2010). Photographs were formatted to A7 size (6 cm by 8 cm) to fit the maximum of 8 pictures per A4 page. In addition to serial photographs, the atlas contains some guide photographs of different brands or categories of some food items and range photographs that show some foods in the different sizes typically found (Jayawardena and Herath, 2017). The dimension used for range and guide photographs was slightly bigger (7.5 cm by 10 cm) (Amougou *et al*., 2016).

Portion size of foods in this study was determined in tandem with Boateng (2014) who produced and validated a photographic atlas of common carbohydrate foods in Accra. In the case of those foods that were purchased from food vendors, the smallest portion sold was taken as the initial portion from which other portions were obtained. Other sources used were the Food Weights/Handy/Measures booklet by Owusu *et al*. (1995), food exchange lists of local foods in Nigeria (Fadupin, 2009), and exchange list for meal planning (Krause and Raymond, 2008).

However, information on portion sizes commonly consumed is best obtained from population-based nutritional surveys which include weighed food intake data to avoid the limitations of household measures and food models (Nelson and Haraldsdottir, 1998c). The National Diet and Nutrition Survey (NDNS) of the United Kingdom is an excellent example of such. The survey includes a randomly selected and nationally representative sample, detailed food consumption data based on 7 days weighed food records and other information on health and lifestyle (Lee, 1993, Ashwell *et al*., 2006, Pryer *et al*., 1997). Seasonal differences are also accounted for in the NDNS.

Admittedly, the resource requirements for such high-quality surveys is beyond the reach of many, particularly in developing countries. Therefore, other means have been employed by various researchers in the absence of such data. Portion sizes in the photographic food atlas for the United Arab Emirates was partly based on the UK Food Atlas (Al Marzooqi *et al*., 2015). The disadvantage of this method is highlighted by Sharma *et al*. (2002), who found very large differences in the average portion sizes of the British African Caribbean and British white population, showing that ethnic-specific portion sizes are essential.

Tueni *et al*. (2012) surveyed 50 adult Lebanese volunteers from whom they inferred medium portions which were taken to represent the average portion size consumed by the general population. Small and large portions were subsequently calculated from the medium portion. In developing the food atlas for use in the Southern Nepal plains, reference portions and increments were chosen by asking the opinion of some members of a community in the plains about typical, small and large portions (Harris-Fry *et al*., 2016). The portions were then weighed and used for the atlas. Portion sizes in the Ecuadorian photographic food atlas were determined by an 'expert committee in Ecuadorian cuisine' (Villena-Esponera *et al*., 2019). Food items included in the food photography manual of Tunisia were selected on the basis of the findings from some epidemiological studies in the country. (Bouchoucha *et al*., 2016). The report however did not mention how the small, medium and large food portions presented in the manual were deduced.

The interval between portions in a photo series is important for accurate estimation of portion size. If the weight interval is too low, the portions will be difficult to differentiate. On the other hand, large weight intervals will result in large differences in estimated and actual weight. If that happens under real-life circumstances, then choosing the correct photograph (i.e. the portion closest to what a respondent actually consumed) will still result in large differences between estimated and actual weight of food consumed and this will affect nutrient calculations and deductions made from it (Biltoft-Jensen *et al*., 2018). This has been seen to happen with margarine, butter and other fat spreads that are eaten in small portions, where fat and hence energy calculations were overestimated (Biltoft-Jensen *et al*., 2018). In this study, subsequent portions were obtained by equal increments of a single portion to minimize such errors and ensure visual difference between photographs (Biltoft-Jensen *et al*., 2018, Nelson *et al*., 1994, Subar *et al*., 2010, Foster *et al*., 2008).

Regarding the number and portions in the range and guide photos, this depended on information inferred from the cross-sectional survey as well as what was found on the open market. For example, dry smoked fishes were obtained from the Tuesday market at Korle-Gonno in Accra. The Tuesday market is an important regional market where dry smoked fishes are brought in from other parts of Ghana and West Africa for wholesale and retail (Heinbuch, 1994). Buying from there allowed the opportunity to obtain samples in all the range of sizes typically available. Wet-smoked fishes were obtained from fishmongers in Chorkor for the same reasons.

All photographs in the atlas produced in this present study are colour-printed. Though Nelson *et al*. (1994), saw 'only a very small but significantly higher mean percentage difference' with the use of colour photographs compared to black-and-white ones, they noted that colour pictures held the attention of respondents better. Colour pictures may reduce boredom during dietary assessment interviews and facilitate easier recognition and identification of a food. Of course, an atlas in full colour will likely be more expensive to produce. A majority of photographic food atlases, including France's 'Portions Alimentaires' and the UK 'Food Portion Sizes: A photographic Atlas' (Nelson and Haraldsdottir, 1998b) are all in colour. Other examples are the atlases referred by Tueni *et al*. (2012), Lombard *et al*. (2013), Amougou *et al*. (2016), Foster *et al*. (2017), Mathews *et al*. (2018), Valanou *et al*. (2018) and Nichelle *et al*. (2019). Another recent example is the Kenyan photographic food atlas that was developed for adolescents (Anono *et al*., 2018).

5.3 Validation of the photographic food atlas

In this study, the accuracy of using the developed photographic atlas of common animal and plant protein sources was validated through the visual perception method. By this method, participants compared plated pre-weighed food portions with the portion sizes depicted in the photographs, then indicated which photograph best corresponded with that portion on the plate. Twelve food items from the atlas were chosen for the validation study. These represented the most commonly consumed foods identified from the survey. For equal representation, the top two foods from each protein group was included. The decision to include fried tilapia fingerlings was informed by two things. Firstly, frying was the next most frequent method after smoking by which fish consumed by participants had been prepared. Secondly, tilapia fingerlings were the most frequently mentioned fried fish which participants identified by name. Previous mention has been made of the fact that participants in some instances could simply not place the name the fish they had eaten. Altogether, the twelve validation test foods also represented the various forms (including cooking methods) in which the animal and plant protein foods are consumed. In terms of the specific portions chosen for the validation, random selection of four portion sizes from all the available portions (boiled egg had only three) in the respective photo series ensured a non-biased representation. Similarly, assignment of the selected portions to each table was randomized. The proportion of correct or adjacent portion size estimations made by participants who piloted the validation procedure was high (79.3%) and ranged from 54.5% for evaporated milk to 98% for boiled egg. These results were considered satisfactory and the study proceeded to the main validation bar a few minor changes to the questionnaire as already detailed in Chapter 3.

5.3.1 Overall proportion of accurate and acceptable portion size estimations

Overall, 47% of the 5969 portion size estimations made by participants in the main validation study were correct. Higher correct estimations have been reported in some studies including 50% by (Ovaskainen *et al*., 2008), 52% in the validation of a PFA of common carbohydrate foods consumed in Accra (Boateng, 2014), 66% by Villena-Esponera *et al*. (2019) and 77% by Amougou *et al*. (2016). Others such as Nichelle *et al*. (2019) and Biltoft-Jensen *et al*. (2018) detected lower proportions of correct estimates than the current study (36 and 42% respectively). The closest to what was found in this current study was observed in a validation of a photographic seafood portion guide (Mathews *et al*., 2018). The proportion of correct estimations in that study was 46 %.

In the literature, accuracy is sometimes also measured as the proportion of both correct ***and*** close to correct estimations; though with varying definitions of what constitutes 'close to correct'. According to Almiron-Roig *et al*. (2017), most authors report accuracy rates of >60 % by this definition. In this study, adjacent estimations that differed by one portion more or less than the correct one were deemed as close to the correct estimation. Eighty percent (80%) of the portion size estimations in the current study fell within this category This is near the 83% noted by Olafsdottir *et al*. (2016) for protein-rich foods in Iceland. They considered estimations of ± 25% from the actual weight as acceptable. In the study by Venter *et al*. (2000) estimates within 10% of the actual weight were described as accurate and this applied to 68% of the 2959 portion estimations. Valanou *et al*. (2018) saw 97 % correct or adjacent portion size estimations while Mathews *et al*. (2018) observed 91% correct estimations within +/-2 oz (portions in the atlas were in increments of 2 oz i.e. 56.7 g). Sometimes accuracy is also expressed in terms of the relative (Szenczi-Cseh *et al*., 2017, Olafsdottir *et al*., 2016) or absolute (Subar *et al*., 2010) differences between estimated and actual weight of test foods. However, by virtue of the approach used in the current study, comparison with such results is not possible.

Since perfect precision in portion size estimation is impractical (Hernandez *et al*., 2006), universal guidelines for acceptable limits of accuracy is important. Unfortunately, there are no such guidelines as yet (Szenczi-Cseh *et al*., 2017, Naska *et al*., 2016, Bernal-Orozco *et al*., 2013). Therefore, the results were considered acceptable if the proportion of correct and adjacent estimation was not less than 50% (Villena-Esponera *et al*., 2019, Valanou *et al*., 2018, Ovaskainen *et al*., 2008). As a reminder, portion size estimations in the study were evaluated in two ways. Accuracy/accurate estimation was measured by the proportion of exactly correct estimations. On the other hand, acceptability/acceptable estimation refers to the proportion of correct and adjacent estimations. As explained earlier, estimations of one portion more (+1) or less (-1) than the correct one (i.e. picking the portion picture directly above or below the one which depicts the correct portion) were defined as adjacent.

Some foods were better estimated with the food photographs than others. This is indicated by the statistically significant differences in accurate and acceptable estimations. The proportion of accurate estimations were high (above 50%) for sausage, *wele*, boiled egg, beef and fried chicken thighs and low (below 50%) for all the amorphous foods. That of powdered milk, groundnut soup and evaporated milk were all below 40% (38, 31.9 and 25% respectively) and for boiled beans, almost 41%. These low figures contrast those observed by Boateng (2014) for amorphous carbohydrate foods commonly consumed in Accra. Apart from waakye, all other amorphous foods that were evaluated (chocolate drink, boiled rice, sugar corn porridge and *gari*) in that study had correct estimations of between 50.8 to 57%. This was attributed to familiarity due to the quantities and frequency with which these items are consumed. Low accuracy with waakye estimations was explained as being the result of unfamiliar presentation (waakye is usually purchased from street vendors who sell them in leaves or in clear plastic bags and not on flat white dinner plates as used in the study). The results in this current study however reflect the observations by several other studies concerning amorphous foods. For example, in a study conducted among adult Cameroonians, Amougou *et al*. (2016) found a significantly lower proportion of correctly estimated amorphous foods as compared to other foods.

There are other reports of the difficulty in portion size estimation of amorphous foods (Flax *et al*., 2019, Subar *et al*., 2010, Huybregts *et al*., 2007, Venter *et al*., 2000) including even among nutrition professionals in training (Howes *et al*., 2017). Amorphous foods take the shape of whatever utensil they are served in and perception of depth is required to correctly assess the portion size. Two-dimensional photographs are limited in the extent to which for example, the depth of soup in an opaque bowl (such as the groundnut soup in this study) can be well captured. Rumbak *et al*. (2019) also ascribed the errors they found in estimation of amorphous foods to this.

In the case of evaporated milk, photographs were taken vertically to clearly show the depth of content and give the impression of a life size image (Jayawardena and Herath, 2017). Yet milk was second from the bottom in terms of accuracy and though acceptability of the estimations were good (51%), it was the lowest among all the test foods. Use of life-size images has yielded mixed results on its effect on accurate estimation. To elucidate, Korkalo *et al*. (2013) saw an increase in the proportion of incorrect estimations when life size images were used, while Harris-Fry *et al*. (2016) noted that inaccurate estimations rather increased. Thoradeniya *et al*. (2012) on the other hand, reported that overall, life-size pictures did not make a difference than when small pictures were used.

As previously discussed, unlike carbohydrate foods or even other protein source foods, intake of milk and milk products among the Ghanaian populace is rather low. This is not only in terms of the number of consumers and frequency of consumption, but also the quantities consumed. This is also a possible explanation for the high proportion of incorrect milk portion size estimations. Another factor that could have influenced estimation of both evaporated milk and milk powder is the mode of presentation which may have been unfamiliar to participants. In both the photo series and during validation, powdered milk was presented on a saucer and evaporated milk, in a glass. Nowadays, milk manufactures have employed several new small packages designed to break bulk and make powdered and evaporated milk products more convenient to use. These single-unit packages, some of which are displayed in the atlas as guide photos might have been easier to evaluate. In view of the manner in which milk is commonly consumed in the country, powdered milk in larger packages is likely to be scooped directly into whatever food it is to be consumed with. The same can be said for evaporated milk which may be poured directly from its package or onto a spoon. In the case of popular street foods which might be taken with milk (e.g. *Hausa koko,* a spicy millet porridge; *asaana*, a malted maize drink; brewed tea and coffee), it is the vendor who usually adds milk if requested and consumers may not be able to relate the quantity poured beyond perhaps [for highly observant consumers], the number of spoons the vendor put in.

Milk on food is difficult to estimate even among persons from a milk eating culture (Foster *et al.*, 2017). A possible solution for our local context may be to present each portion of milk in a fixed amount of a popular food such as *Hausa koko* and/or others that would provide a good colour contrast for the milk. This would have to be repeated for different portions of the porridge. A respondent will then first indicate which portion of porridge represents what they ate. The progressive change in colour as milk quantity increases/decreases in each fixed portion of food may be a better presentation for milk estimation. This is somewhat similar to what Nelson *et al.*

(1996) described for a sub-study on descriptors of milk portion sizes. Participants who had consumed cornflakes with milk were asked to state the quantity they added in a number of ways including as 'damp', 'normal' or 'drowned'.

Surprisingly, the proportions of accurate estimation for smoked *saman* and fried tilapia fingerlings which are both solid foods, was low. That of the fried tilapia fingerlings was the lowest among all the twelve test foods. Regarding smoked *saman*, the reasons for the unexpected observation may have something to do with the shape of the portions displayed, in relation to that in the photo series. The weight of each portion of test food used for validation were matched to the corresponding portion in the photo series. This is in fact easier to do with the amorphous foods than whole-piece smoked *saman* which needed to be subdivided to obtain the appropriate weight for each portion. The subdivision was done with the aim to obtain the required weight for each portion in just one block instead of several small pieces, thereby avoiding as much as possible, the visual illusion associated with estimation of cut food (i.e. the tendency to overestimate a food portion that has been cut up and seems voluminous compared to a block of the same food with similar weight (Wada *et al*., 2007).

This was successfully done only after several attempts, by which time the final portions though similar in weight to the corresponding portions depicted in the photo series, did not always exactly the shape. It has been shown that respondents have difficulty when the shape of a food in the photo series differs from what is displayed (Lillegaard *et al*., 2005, Vilela *et al*., 2018) or what they are accustomed to (Flax *et al*., 2019). Rather than being a flaw on this study, this inadvertently demonstrates the challenges that can be expected when the photos are used under real-life circumstances where the shape of what a respondent ate may differ from those portrayed. Notwithstanding all this, 62% of the portion size estimations of smoked *saman* was acceptable.

Turning to the fried tilapia fingerlings, again discrepancies in appearance of actual portions displayed and those in the photo series very likely played a role in the low proportions of accurate estimations. In this case though, it seems that the challenge to participants lay in the way the fingerlings were arranged on the plate. During food presentation for photography, fried tilapia fingerlings were not deliberately stacked nor spread on the plates. However, they do appear slightly stacked in the photos whereas the samples displayed for the validation might have progressively spread out as time went by. As demonstrated by Szocs and Lefebvre (2017), the portion size of food that is stacked up vertically on a plate is perceived differently than when the same amount is spread horizontally across the plate. When viewed from the top as happens with food in a plate on a dining table, horizontally arranged food seems larger. In the present study, there were far more adjacent overestimations for fried tilapia fingerlings (42%, the highest among all the test foods) than underestimations (5.1%), giving further credence to this explanation. Accuracy of estimations may improve if the portions of fried tilapia fingerlings are packaged in clear plastic bags. The fish is popularly sold by kenkey vendors who sometimes bag it this way. After the consumer makes a choice, the rubber is torn open to pour the fish onto a plate.

5.3.2 Gender and estimation of portion size

In this study, no association was noted between gender and accurate estimation of portion sizes. The proportion of acceptable estimations made for fried tilapia fingerlings was higher among male participants while that for smoked *saman* was higher among females. However, these differences disappeared when individual foods were controlled for and the proportion of acceptable and unacceptable portion size estimations was stratified by gender (p=0.52). There are mixed reports in the literature concerning the influence of gender on portion size estimation. Like the current study, a number of studies concluded that males and females did not differ in the accuracy with which they estimate portion sizes (Venter *et al*., 2000, De Souza *et al*., 2016, Villena-Esponera *et al*., 2019). On the other hand, Yuhas *et al*. (1989), Nelson *et al*. (1996) and Almiron-Roig *et al*. (2013) reported gender differences. Boateng (2014) also concluded that more of the female respondents correctly estimated portion size of carbohydrate foods. The role traditionally associated with the female gender in Ghanaian society, vis a vis food purchase and preparation were cited as a reason for their better perception of portion size. In this study, that assumption did not come into play for the protein source foods evaluated.

5.3.3 Age and estimation of portion size

When the test foods were considered individually, participants in the less than 30 years age group made a higher proportion of correct estimations for powdered milk than those in the 45-64 years bracket. Also, the highest proportion of acceptable portion size estimates made for powdered milk was by those in the 45 to 64 years old bracket. But, this did not reflect when age-group differences in overall accurate and acceptable estimations were assessed (p=0.439 and 0.149 respectively). These results do not agree with that of Szenczi-Cseh *et al*. (2017) and other researchers who detected significant age influences on estimation with the use of food photographs (Nelson *et al*., 1996, Foster *et al*., 2006). But like the current study, there are researchers who did find substantial evidence of such difference. Turconi *et al*. (2005) for example, concluded that portion sizes chosen from a set of photographs by 448 male and females (6-60 years old) who made a total of 9075 estimations, was independent of age. Also, Timon *et al*. (2018) found similar errors with estimation by both older and younger adults and therefore could not conclude with certainty that one group was more accurate. These results notwithstanding, given the reasonable possibility that usual portions of younger children differ substantially from that of adults, it will be expedient to pretest food photographs that were developed for use with adults, to determine their appropriateness for dietary assessment of such youngsters.

5.3.4 Body mass index and portion size estimation

Body mass index was identified as one of the 'potentially important confounders' in the use of photographs as a portion size estimation aid (Nelson *et al*., 1996). This is because obese persons may consume larger than average portions which they may feel pressured to under-report (Wehling and Lusher, 2017). When it comes to accurate identification of portion sizes with the aid of food photographs, there are opposing findings about the association with BMI. Some studies in this area did not expressly explore association between BMI and accuracy of portion estimation (Venter *et al*., 2000, Subar *et al*., 2010, De Keyzer *et al*., 2011, Amougou *et al*., 2016). Others (e.g. Ovaskainen *et al*. (2008) and Villena-Esponera *et al*. (2019)) did not find any association between the two factors. In this current study, obese participants made the highest proportion of correct estimations for fried tilapia fingerlings and *wele*. Furthermore, acceptable estimations of snail by the overweight group was higher than any other BMI group though not statistically significant. None of these differences impacted on overall proportions of accurate and acceptable estimations. This was evident in the fact that though the obese group made higher proportions of overall accurate and acceptable estimations, no statistically significant differences were noted between the different BMI categories (accurate estimations p=0.6; acceptable estimations p= 0.222). Therefore, in this study, selection of accurate and acceptable portion sizes was independent of participants' BMI.

5.3.5 Educational level and portion size estimation

In their guidelines for design and analysis of portion size validation studies, Nelson and Haraldsdottir (1998a) suggested that the perception and conceptualization skills necessary in the use of photographs for portion size estimation is influenced by educational level. The assumption is that a higher level or more years of schooling translate to better perception and conceptualization skills and hence more accuracy in portion size estimation. In the present study, there was evidence to this effect. Specifically, those with a tertiary education background made a significantly higher proportion of correct estimations than the others. The same observation was made with the proportion of acceptable estimations, showing that their estimations were the least distal. It was interesting to note, though difficult to explain, that participants with no formal education and those with only primary schooling both made higher proportions of correct estimations when compared to participants with secondary school background. In the study by Huybregts *et al*. (2007) among women in Burkina Faso, those who attended school were more likely to make correct estimations with food photographs. In Argentina, the percentage of correct assessments was marginally higher for adult participants with a university degree as compared to those with only primary education (López *et al*., 2006). Nichelle *et al*. (2019) also reported that compared to participants with more than 12 years study, those who had less than 12 years of education found it harder to quantify portions. This was however in connection with food photographs uploaded on a tablet so digital literacy skills may have influenced the outcome.

On the contrary, no significant differences were seen in the proportion of correct estimations between adults of different education levels in a South African study (Venter *et al*., 2000). There are other studies also in which no evidence of association of educational level and correct portion estimation was found (Ovaskainen *et al*., 2008, Naska *et al*., 2016).

5.3.6 Influence of food portion size on accurate estimation

As already highlighted by the results chapter, there were significant differences in the proportions of accurate estimations assessed for each test food. When estimations were stratified according to the size of portions, the analysis showed that the proportion of accurate estimations for the smallest portions was significantly higher than for all the other portions. This concurs with early reports that the ability of individuals to accurately gauge portion size generally decreases as portion size increases (Young and Nestle, 1995). It agrees too with previous findings by Huybregts *et al*. (2007) who validated food photographs among 257 15-45-year-old rural Burkinabe women. They detected that the correct picture was chosen more often when smaller portions were served. The reports of Boateng (2014), Rumbak *et al*. (2019) and Biltoft-Jensen *et al*. (2018) also corroborate this. In addition to general difficulties with perception of large portions, Trolle *et al*. (2013) suggested that this trend may be the result of a reluctance by respondents to select photographs of the largest portions especially when they did not personally plate the food.

Unlike Ovaskainen *et al*. (2008) and Trolle *et al*. (2013) who further noted that intermediate portions were more accurately assessed than the largest portions displayed, the largest portions in this current study were more accurately estimated than intermediate portions. In fact, the intermediate portions presented the greatest challenge to participants as shown by the significantly lower accurate estimations and higher distal estimations made in estimating those portions. The two extreme portions presented during validation coincided with the smallest and largest portions of a majority those food as depicted in the atlas. Participants could thus make an error in only one direction: the smallest portion could only be overestimated and the largest portion could only be underestimated. But with the intermediate portions, incorrect estimation could be made in both directions. The implication of this in practise is that while smaller or larger food portions are more likely to be correctly estimated with the use of a photographic food atlas is used, further probing may be necessary when respondents indicate that an intermediate portion represents what they consumed.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Fifty-four commonly consumed animal and plant source foods were identified in this study. When the protein source foods were ranked on the basis of consumption frequency, foods in the fish and seafoods (34.6%), poultry and poultry products (21.3%), and legume (18.8%) groups topped the list and together constituted 74.7% of total protein food consumption occasions. A photographic food atlas with portion sizes was created for the 54 protein source foods. It consists of 62 sets of photo series comprising serial pictures of foods plated in various portions as well as photographs of some protein foods in the range of sizes and varieties/brands typically available on the market. Twelve most commonly consumed protein foods were evaluated during validation of the atlas by the visual perception method. There was evidence that portion size estimation was associated with participants' educational background as well as the portion size options displayed. However, portion size estimation was independent of sex, age group and BMI.

Total of 47 % of the portion size estimations made with the atlas were exactly correct and 33% were adjacent. Therefore, overall, 80% matched the criteria for acceptable estimations. Based on these results, the atlas produced is a potentially useful visual tool for portion size estimation of animal and plant protein source foods in the Ghanaian diet.

6.2 Recommendations

6.2.1 Recommendations for further studies

The following recommendations are made in light of this study:

1. The difficulty encountered with portion size estimation of amorphous foods was confirmed in this study. In view of this, further research is recommended to explore innovative methods to deal with this challenge and achieve the maximum accuracy possible for estimation of such foods.
2. Future studies should be designed to include a test of the applicability of the atlas as part of a dietary assessment such as 24-hour recall where not only perception, but also memory and conceptualization are required for accurate estimations.
3. Research is also needed to assess how the atlas will affect estimation of food and nutrient intake in comparison with household measures. Weighed food records must be included as a reference measure in such studies (Nelson and Haraldsdottir, 1998a).
4. Further work is required to include other components of the Ghanaian diet besides carbohydrate and protein foods, so that a complete photographic atlas can be available. Thereafter, the atlas will need to be adapted to adequately reflect the diversity of diet across other regions in the country.
5. There are currently no portion size estimation aids purposely designed to improve the quality of dietary assessment in young Ghanaian children. Future studies are therefore needed to fill this gap.

6.2.2 Recommendations for policy

A concerted effort with all stakeholders including the Ghana Academy of Nutrition and Dietetics, CSIR-Food Research Institute, Ministry of Food and Agriculture, Ministry of Health, Ghana Health Service, Ghana Standards authority and others is urgently required to:

1. Establish standard serving sizes for Ghanaian foods and adopt standard volumes for household cooking and eating utensils.
2. Compile a comprehensive national food and nutrient intake data comparable to that of the National Diet and Nutrition Survey of the UK and based on weighed food records from a nationally representative sample to provide robust information on food intake, portion sizes and more. These will help to improve the quality and relevance of nutrition-related research in the country.

6.3 Contributions to knowledge

- This study has resulted in the first photographic food atlas to be developed and validated for common protein source foods in the Ghanaian diet. It offers the prospect for standardizing portion size estimation in clinical practice, teaching, research and nutrition education in Ghana.
- The different characteristics of the foods chosen for validation of the atlas (i.e. amorphous foods, small pieces, single-unit foods and irregular shapes) presented the opportunity to identify and document the peculiar challenges with portion size estimation of such foods in the Ghanaian context. It has also contributed to the general body of evidence concerning the difficulties encountered with portion size estimation of amorphous foods.

- Findings from this study support and contribute additional evidence to previous reports about the association of respondent characteristics, specifically gender, age, BMI and educational background, with accuracy of portion size estimations when food photographs are used.
- The study has contributed to the body of literature about current dietary patterns in the country by documenting evidence on the common protein foods consumed.

6.4 Limitations

1. Information on protein source food consumption was derived from 24-hour dietary recall interviews. The method is subject to recall bias as it relies solely on the respondent to provide information about what they have eaten in the past 24 hours.
2. Only a limited number of the food items in the atlas were included in validation. Considering other food items will make it possible to identify any photo series that may need modification to enhance portion size assessment with the tool.
3. Similar to other studies of visual perception, validation was conducted under what some authors term 'laboratory conditions' where the test foods were predefined and largely identical in appearance to the photo series. In most cases this does not represent a realistic use of the atlas (except in the context where it is used to teach individuals how to identify specific food portions in relation to some treatment goal), and can lead to better results than what may be seen in real life. Nevertheless, such ideal conditions make it easy to identify any problems with the photo series itself, so that these can be rectified before the tool is evaluated under more realistic circumstances. In this way, visual perception studies like this current study are imperative.

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APPENDIX 1: ETHICAL CLEARANCE

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

Ref. No.: EPRC/APRIL/2019

APRIL 13, 2019

Anna Dedei Kuevi
Dept. of Nutrition and Dietetics
SBAHS.
Korle-Bu

ETHICAL CLEARANCE
Protocol Identification Number: ***CHS-Et/M.8 – 4.7/2018-2019***

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

The College of Health Sciences Ethical and Protocol Review Committee (EPRC) at its 28 March, 2019 full board meeting reviewed and approved your research protocol.

Title of Protocol: "The Development of a photographic food atlas with portion sizes of commonly consumed animal and plant protein sources foods"

Principal Investigator: **Anna Dedei Kuevi**

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 APRIL 15, 2020.

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, Dept. of Nutrition and Dietetics

APPENDIX 2: PARTICIPANT INFORMATION SHEET AND CONSENT FORM

DEPARTMENT OF NUTRITION AND DIETETICS
SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA

Title of study: "The Development of a Photographic food atlas of commonly consumed animal and plant protein source foods in Accra."

Anna Kuevi, a PhD student in the School of Biomedical and Allied Health Sciences, Department of Nutrition and Dietetics, Prof. Matilda Steiner-Asiedu, Dean of the College of Basic Sciences and Dr. Matilda Asante, Head of Department of Nutrition and Dietetics, are conducting a research titled 'Photographic food atlas of commonly consumed animal and plant protein source foods in Accra'. The aim of the study is to obtain information on common animal and plant protein source foods (e.g. meat, fish, eggs, groundnuts and other protein-rich foods) consumed in the Greater Accra Metropolitan Area, and to create a photographic atlas of these foods.

You are invited to participate in this study. This study is not expected to cause any medical or social risk to you. All the information obtained from you will be kept strictly confidential and any reports from the research will not include your name or any other information which can be used to identify you. Since your participation is entirely voluntary, you can decide to withdraw at any point without any penalties or consequences. Please address any questions, concerns or complaints you may have to the researcher or research advisors:

Anna Kuevi on telephone number: 020-467-9353 email: adkuevi@chs.edu.gh
Prof. Matilda Steiner-Asiedu on telephone number: 0541260704 email- tillysteiner@gmail.com
Dr. Matilda Asante on telephone number: 0540683892: email- matildaasante@chs.edu.gh

Informed consent form

I ………………………………………………….. understand that my participation in this study is strictly voluntary and I may withdraw at any time without prejudice. I understand that the aim of this study is to collect information on common protein foods eaten in Accra and to create a validated photographic atlas of these foods. I also understand that any information about me that is collected during this study will be kept strictly confident and that only the researchers will have access to information. I understand that at the conclusion of this study all records will be destroyed. I am aware that I will not be waiving my or any legal or human rights by agreeing to take part in this research. My signature below verifies that I am 18 years of age or older, in good mental and physical condition, and that I agree to and understand the conditions listed above.

--------------------------------------- ---------------------------------------

Participant's Signature   Date

--------------------------------------- ---------------------------------------

Witness's Signature   Date

APPENDIX 3: DATA COLLECTION FORM

Participant code/ID: ____

PART 1: SOCIO-DEMOGRAPHIC BACKGROUND INFORMATION

1.1 Gender (1)Male (2)Female [ ]

1.2 How old were you at your last birthday? __________

1.3 Highest Educational level completed [ ]

(1) No formal education (2)Primary (3)Junior high school
(4)Senior high school (5)Tertiary 1-3 years(Diploma/certificate/professional)
(6)Tertiary 4 years or more (Degree/Postgraduate/professional)
(7) Other (please specify) ____

1.4 Occupation……………………………………………………………………

1.5 Which one of these best describes your tribal origin? [ ]

(1) Akan (4) Upper West (Lobi/Wale/Dagaari/Sissala etc.)

(2) Ga/Ga-Adangbe (5) Upper East (Frafra/Mamprusi/Kussasi etc.)

(3) Ewe (6) Northern (Dagomba/Gonga/ Kokomba/Nanumba etc.)

(7) Other (please specify)____

1.6 Marital Status [ ]

(1) Married/Cohabiting (2) Separated (3) Divorced (4) Never married (5) Widowed

1.7 Religion

(1) Christian (2) Muslim (3)Traditionalist

(4) Other (Please specify) ____________________________________

1.8 Will you like to be part of the validation process?

(1)Yes (2)No

1.9 Physical measurements

Height (cm)	
Weight (kg)	
Waist circumference (cm)	
Hip circumference (cm)	
Waist-to-hip ratio	

Contact:

APPENDIX 4A: DIETARY RECORD FORMS

Time and Type of meal	Description of food (write each food on a different line)	*Amount	Food preparer

*Household measure, weight or volume

APPENDIX 4B: SAMPLE DIETARY RECORD FORM

Time and Type of meal	Description of food (write each food on a different line)	*Amount	Food preparer
7.40 am Breakfast	*Hausa koko*	3 soup ladles full	Bought
	White sugar	2 tablespoons	Bought
	Evaporated milk (peak milk)	2 teaspoons full	Bought
	Roasted groundnut	1 small tin tomato full	Bought
	Koose	1 large egg size	Bought
1pm Lunch	Beans	2 soup ladles full	bought
	Palm oil	2 teaspoons full	
	Grinded red pepper	2 teaspoons full	
	Fried ripe plantain	6 matchboxes	
7.25 pm Supper	*Akple*	3 medium orange size	Daughter
	Okro soup	2 soup ladles full	Wife
	Keta school boys	3 tablespoons	
	Beef (no bone)	2 matchbox sizes	Bought
	wele	1 matchbox size	bought
7pm snack	Coca cola (regular)	1 bottle (330 ml)	bought

*Household measure, weight or volume

APPENDIX 5A: RECIPE BOOK

ID number……………………….
Gender………………………………
Age ………………………………….
Phone number ……………………………………..

The purpose of the recipe booklet

This form is provided for you to record the recipes you use to prepare the listed protein foods given to you. Please record the way you always prepare the food. You do not have to change anything. The information is only for research and will not be used against you in any way at all. Thank you very much for participating!

How to use the booklet:

- Begin each recipe on a new page. You can use as many pages as necessary.
- Describe the quantity of all ingredients in weight if possible, or with any of the agreed household measures. This must be done after it has been prepared (that is: peeled, chopped, trimmed etc.) for cooking.
- Describe in detail all the steps you take to cook the food. Do not forget the preparations you make before you put the food on fire to cook.
- Wherever applicable, please indicate the time spent in cooking each ingredient.

A sample of how to record your recipes is shown on the next page.

Example of recorded recipe

Please enter each ingredient on a new line and each recipe on a new page. **Dish: Palava sauce**	
Ingredient list	**Weight (g) / handy measure**
Kontomire	2 Olonka chopped
Agushie	2 small tin tomato size
Onions	4 large egg sized
Tomatoes	10 small tangerine size
Kpakpo shito	5 small pieces
Ginger	½ matchbox size
Abedru	½ small tin tomato size
Momoni	1 small Maggi cube size
Smoked *saman*	2 medium fishes
Salt	To taste
Palm oil	1 stew ladle

Method	**Preparation time (minutes)**
Wash the chopped kontomire in salt water and blanch with very little water (1 stew ladle of water).	Approximately 2 minutes
Chop onions and tomatoes in small pieces	
Grind kpakpo shito, ginger and abedru together.	
Wash and soak agushie in water (5-10 minutes) then blend with a little water.	
Put saucepan on fire, pour in palm oil and add momoni.	1 stew ladle full
Add the chopped onions and the grinded kpakpo shito, ginger and abedru and leave to simmer. Stir occasionally.	Approximately 1 minute
Add chopped tomatoes and leave to simmer. Stir occasionally.	Approximately 3 minutes
Clean smoked saman and break each into 6 small pieces. Add to the sauce on fire and allow to simmer. Stir occasionally.	Approximately 5 minutes
Shake the blended agushie to mix well then pour into the sauce. Cover pan and leave to simmer.	Approximately 5 minutes
Stir in blanched kontomire to sauce. Leave to cook and stir occasionally. Add salt to taste.	Approximately 8-10 minutes

Please indicate each ingredient on a new line and start every recipe on a new page. **Dish:**	
Ingredient list	**Weight (g) / household measure**

Method

APPENDIX 5B: RECIPES OF SOME PROTEIN SOURCE FOODS AND DISHES

BOILED BEANS

Ingredients	**Quantity**
Cow peas (e.g. black-eyed beans)	1 margarine tin (about 450g)
Salt	To taste
Kanwe (saltpeter)	½ the size of 4g bouillon cube
Water	1.5 litres

Pick stones, sticks and other foreign objects from the beans and soak in water for an hour. To cook, wash and drain the bean into the saucepan for cooking. Add the water and allow to boil. Add saltpeter and continue cooking until the beans is soft and the water thickens. Add salt to taste. *Participant*

BEANS STEW

Ingredient	**Quantity**
Beans (Niger)	1 margarine cup
Tomatoes	4 large
Onion	2 medium orange sizes
Amane (smoked herring)	5 middle finger sizes
Red and green	8 small pieces
Smoked *saman* (Atlantic mackerel)	75 g
Koobi	½ matchbox size
Palm oil	60 ml

Wash and soak beans overnight. Discard the water and wash. Put in a saucepan with fresh water to boil. Boil until beans is tender but still firm and the water has reduced. Wash *amane* and *saman*. Wash and grind pepper and tomatoes. Wash and slice onions. Pour the palm oil in a saucepan and put on fire. Wash and add koobi. Stir and add sliced onions and grinded tomato mix. Let it cook for 10 minutes and add *amane*. Break *saman* into small pieces and add. Stir the stew and leave to simmer. Add cooked beans to the stew and leave on fire for 10 minutes.

ROASTED GROUNDNUT

Ingredients	**Quantity**
Fresh groundnuts	1 olonka
Ada salt (coarse salt)	1/3rd of empty 160 g milk tin (about 60 g)
Water	2 litres
Sea sand	

Remove all spoilt nuts and foreign materials from the fresh groundnuts and set aside. Put the salt and water in a saucepan and allow it to boil. Pour the sorted groundnut into it and cover the saucepan. The water should be enough to just cover the groundnuts. As soon as it starts to boil again, take if off the fire and drain it. Spread groundnuts out flat to dry. Put traditional frying pan on fire to heat the sea sand. Put in the dry groundnuts and stir regularly until it is ready. When it is cooked, the groundnut can easily be peeled. Remove the pan from the fire pour the mixture into a sieve to separate the groundnut. Allow it to cool and store in an airtight container or plastic bag. *Vendor*.

GROUNDNUT SOUP

Ingredients	Quantity
Groundnut paste	450 g
Tomato paste	40 g
Fresh tomato	3 medium orange sizes
Onion	3 medium orange sizes
Kpakpo shito (grinded)	¼ cup
Ginger (grinded)	1 tablespoon
Garlic (grinded)	2 cloves
Beef	1 kilos
Maggi shrimp cube	One small tablet (4 g)
Salt	To taste

Mash the groundnut paste with water and blend to a smooth puree. Pour the mixture into a saucepan on fire and boil for about 20 minutes while stirring regularly till oil appears on top of it. Meanwhile, peel ginger, onions and garlic then wash and blend together with the pepper. Wash and cut beef into desired chunks then season with the blended spices, maggi and salt. Add the whole fresh tomatoes to the seasoned beef and steam. After about 20 minutes pour the groundnut paste mixture into it, add enough water (about 7 cups) and leave soup to simmer while stirring occasionally. Remove the tomatoes, mash and pour into the soup. Add more water to the thickness desired. Allow soup to continue cooking until ready. *Participant*

EGG STEW

Ingredients	**Quantity**
Fresh tomatoes	5 medium (290g when cleaned, deseeded and chopped)
onions	1.5 medium (121 g when cleaned and chopped)
Kpakpo shito (scotch bonnet pepper)	8 small pieces (about 7g)
Garlic	2 cloves (10 g when peeled and chopped)
Curry powder	1 tablespoon
Soya bean oil	80 ml
Fresh eggs	4 medium
Onga stew seasoning	5g
Salt	To taste

Wash tomatoes, remove seeds and chop. Clean and chop onions. Grind kpakpo shito and garlic. In a saucepan, heat cooking oil and put in the chopped onions. Stir for a minute and add grinded kpapko shito and garlic. Stir and add chopped fresh tomatoes. Lower the heat and allow to simmer. Break eggs into a bowl, add curry powder and beat. Pour eggs into stew. Cover the saucepan, lower heat and leave to cook. After 6-7 minutes, remove lid and stir. Add onga seasoning and cook for 10 minutes. *Participant*.

FRIED FISH

Ingredients	**Quantity**
Red fish (Sea bream), kpanla (Horse mackerel)	
or any fresh fish of choice	1 kg
Salt	To taste
Frytol (Vegetable oil)	

Remove the scale and gills of the fish and cut the tails. If the fishes are big, cut them up into two or more pieces as desired. You can also make one or two slashes on both sides of the fish. Wash the fish in clean water and drain. Add some salt to taste then toss to ensure that the salt mixes well. Leave it for about 20 minutes. When you are ready to fry, put some vegetable oil in a frying pan. The oil should be enough to almost cover the fish. Put in a few slices of onion to deodorize the oil. Remove the onions when they start turning brown and put the fish into the heated oil. Fry the fish for about 6 to 8 minutes (depending on the size or thickness of the fish) on each side until well cooked. Remove and place in a colander to drain excess oil. If you like, after removing the onions from the oil, you can put in a small amount of flour (about 1 tablespoon) to prevent the fish from sticking to the frying pan. *Participant.*

PALAVA SAUCE

Ingredients	**Quantity**
Fresh chopped *kontomire* (cocoyam leaves)	1 olonka (slightly pressed)
Agushie (melon seeds)	2 empty tin tomato size (210 g can)
Smoked *Odaa* (Big eye Tuna)	1 palm size

Salt	To taste
Fresh tomatoes	5 medium tangerine size
Onions (peeled and chopped)	3 medium tangerine size
Garlic (peeled)	4 cloves
Ginger	2 small maggi cube size
Kpakpo shito (scotch bonnet pepper)	10 small pieces
Palm oil	One and half small tin tomato full
Abeduru (solanum)	2 tablespoons
Momoni (salted and fermented fish condiment)	I small maggi cube size

Wash and soak *agushie* in a little water to cover it. Wash the chopped *kontomire* very well in salty water. Drain, place in a covered saucepan and put on low heat for one minute. Take it off the fire and set aside. Meanwhile, wash and then blend together one onion and all the ginger, pepper, garlic and *abeduru* with a little oil (1 small tin tomato can full). Wash and chop the fresh tomatoes as well as the other two onions. Drain and then blend the agushie with a little water (about 1 small tin tomato can full). Remove bones from the smoked *odaa*, wash and break into middle-finger pieces. Pour palm oil into a saucepan and place on medium heat. Wash *momoni* and put in the oil. Use a ladle to break the *momoni* and spread it evenly in the palm oil. Add the chopped onions and stir for minute. Add the smoked fish, pour in the blended spices and allow to cook for about 10 minutes. Stir the sauce once a while so that it will not stick to the bottom of the saucepan. Add the chopped tomatoes and allow to cook for another 5 minutes. Pour the blended agushie into the sauce, cover and leave to simmer. After 5 minutes, stir the sauce again and put in the *kontomire*. Stir and add salt to taste. Allow everything to cook on low heat until ready. *Participant*

APPENDIX 6: EVALUATION FORM FOR PILOT VALIDATION

Participant ID:…………. **Gender:** (1) Male (2) Female Age:

Education: 1: none | 2: primary | 3: JHS/SHS | 4: Tertiary | 5: Other

Weight (kg)……….. **Height** (m)……….. **BMI** (kg/m^2)……….

Food	Coded Portion Displayed	Selected Coded Portion from Photo Atlas	**For official use only**	
			Corresponding code of selected food	Estimation*
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)
				(1) (2) (3) (4)

*1 Correct estimation (CE); 2 Under estimation (UE); 3 Over estimation (OE); 4 Distal estimation (DE)

APPENDIX 7: EVALUATION FORM FOR MAIN VALIDATION

Department of Nutrition and Dietetics
School of Biomedical and Allied Health Sciences
University of Ghana

Participant ID:………… **Gender:** (1) Male (2) Female Age:

Education: 1: none | 2: primary | 3: JHS/SHS | 4: Tertiary | 5: Other

Weight (kg)………… **Height** (m)………… **BMI** (kg/m^2)……….

TABLE 1

Food item	Coded Portion Displayed	Selected Coded Portion from Photo Atlas	For official use only	
			[1] CCPIPA	[2]Estimation
Beans (boiled)	V817			(1) (2) (3) (4)
Beef (boiled)	V114			(1) (2) (3) (4)
Chicken thighs (fried)	V131			(1) (2) (3) (4)
Egg (boiled)	V473			(1) (2) (3) (4)
Evaporated milk	V638			(1) (2) (3) (4)
Tilapia fingerlings (fried)	V478			(1) (2) (3) (4)
Groundnut soup	V732			(1) (2) (3) (4)
Powdered milk	V586			(1) (2) (3) (4)
Saman	V716			(1) (2) (3) (4)
Sausage (grilled)	V116			(1) (2) (3) (4)
Snail (boiled)	V821			(1) (2) (3) (4)
Wele	V774			(1) (2) (3) (4)

[1]CCPIPA: Corresponding Coded Portion in Photo Atlas
[2]Correct estimation (CE); 2 Under estimation (UE); 3 Over estimation (OE); 4 Distal estimation (DE)

TABLE 2

Food item	Coded Portion Displayed	Selected Coded Portion from Photo Atlas	**For official use only**	
			CCPIPA	Estimation*
Beans (boiled)	V912			(1) (2) (3) (4)
Beef (boiled)	V738			(1) (2) (3) (4)
Chicken thighs (fried)	V372			(1) (2) (3) (4)
Egg (boiled)	V287			(1) (2) (3) (4)
Evaporated milk	V532			(1) (2) (3) (4)
Tilapia fingerlings (fried)	V324			(1) (2) (3) (4)
Groundnut soup	V937			(1) (2) (3) (4)
Powdered milk	V714			(1) (2) (3) (4)
Saman	V477			(1) (2) (3) (4)
Sausage (grilled)	V279			(1) (2) (3) (4)
Snail (boiled)	V489			(1) (2) (3) (4)
Wele	V922			(1) (2) (3) (4)

TABLE 3

Food item	Coded Portion Displayed	Selected Coded Portion from Photo Atlas	**For official use only**	
			CCPIPA	Estimation*
Beans (boiled)	V696			(1) (2) (3) (4)
Beef (boiled)	V894			(1) (2) (3) (4)
Chicken thighs (fried)	V294			(1) (2) (3) (4)
Egg (boiled)	V571			(1) (2) (3) (4)
Evaporated milk	V316			(1) (2) (3) (4)
Tilapia fingerlings (fried)	V117			(1) (2) (3) (4)
Groundnut soup	V737			(1) (2) (3) (4)
Powdered milk	V918			(1) (2) (3) (4)
Saman	V873			(1) (2) (3) (4)
Sausage (grilled)	V789			(1) (2) (3) (4)
Snail (boiled)	V833			(1) (2) (3) (4)
Wele	V457			(1) (2) (3) (4)

TABLE 4

Food item	Coded Portion Displayed	Selected Coded Portion from Photo Atlas	**For official use only**	
			CCPIPA	Estimation*
Beans (boiled)	V786			(1) (2) (3) (4)
Beef (boiled)	V886			(1) (2) (3) (4)
Chicken thighs (fried)	V595			(1) (2) (3) (4)
Boiled Egg	V526			(1) (2) (3) (4)
Evaporated milk	V113			(1) (2) (3) (4)
Tilapia fingerlings (fried)	V635			(1) (2) (3) (4)
Groundnut soup	V391			(1) (2) (3) (4)
Powdered milk	V947			(1) (2) (3) (4)
Saman	V949			(1) (2) (3) (4)
Sausage (grilled)	V924			(1) (2) (3) (4)
Snail (boiled)	V412			(1) (2) (3) (4)
Wele	V688			(1) (2) (3) (4)

APPENDIX 8: PLATED PROTEIN FOOD PORTIONS AND CORRESPONDING CODES USED DURING VALIDATION

Food item	Portions (codes presented)			
Beans (boiled)	1 (V817)	7 (V912)	5 (V696)	2 (V786)
Beef (steamed boneless)	3 (V114)	1 (V738)	4 (V894)	2 (V886)
Chicken thighs (fried)	4 (V131)	2 (V372)	3 (V294)	1 (V595)
Egg (boiled)	3 (V473)	-	1 (V571)	2 (V526)
Evaporated milk	1 (V638)	3 (V532)	2 (V316)	4 (V113)
Tilapia fingerlings (fried)	3 (V478)	5 (V324)	7 (V117)	2 (V635)
Groundnut soup	2 (V732)	8 (V937)	4 (V737)	7 (V391)
Powdered milk	2 (V586)	3 (V714)	4 (V918)	1 (V947)
Saman (wet hot smoked)	1 (V716)	3 (V477)	6 (V873)	5 (V949)
Sausage (grilled)	1 (V116)	4 (V279)	2 (V789)	3 (V924)
Snail (boiled)	2 (V821)	1 (V489)	4 (V833)	3 (V412)
Wele	3 (V774)	1 (V922)	4 (V457)	2 (V688)

APPENDIX 9: CODES AND WEIGHT OF FOOD PORTIONS IN THE ATLAS

	Code	Portions (g)							
Food		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Anchovies (*Abobi/keta school boys)* sun dried	KSB00	27	54	81	108	135	162	-	-
Atlantic mackerel *(Saman)* smoked	SSM00	32	64	96	128	160	192	-	-
Beans (boiled)	BB00	70	140	210	280	350	420	490	560
Beans stew	BS00	63	126	189	252	315	378	441	504
Beef boneless (fried)	BFf00	28	56	84	112	-	-	-	-
Beef boneless (steamed/boiled)	BFS00	15	30	60	90	-	-	-	-
Brukina[1]	BRK00	250 ml	500 ml	-	-	-	-	-	-
Cassava fish (fried)	CFf00	34	68	102	136	170	204	238	272
Cassava fish (steamed)	CFb00	38	76	114	152	190	228	266	304
Catfish (*Adwene)* smoked (different sizes)	ADWi00	22	89	141	262	-	-	-	-
Catfish (*Adwene)* smoked	ADWii00	20	40	60	80	-	-	-	-
Chicken drumstick (fried, different sizes)	CDf00	45	59	104	127	-	-	-	-
Chicken sausage (fried) (no. of units)	CSf00	32 (1)	64 (2)	96 (3)	128 (4)	160 (5)	192 (6)	224 (7)	256 (8)
Chicken thigh (fried)	CTf00	25	50	75	100	-	-	-	-

APPENDIX 9 CONT.

	Code	Portions (g)							
Food		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Chicken wing (drumette, fried)	CWfi00	25	50	-	-	-	-	-	-
Chicken wing (wingette, fried)	CWfii00	25	50	75	100	-	-	-	-
Corned beef	CNB00	29	58	87	116	145	174	203	232
Cow feet (steamed/boiled, deboned)	CFT00	20	40	60	80	-	-	-	-
Cow tripe (boiled)	CTR00	10	20	30	40	50	60	-	-
Crab (steamed/boiled. Different sizes)	CRB00	4	7	12	16	22	33	65	-
Egg (boiled. Different sizes)	BEG00	40	48	58	-	-	-	-	-
Egg, fried (no. of eggs)[2]	FEG00	43 (1)	86 (2)	127(3)	174(4)	-	-	-	-
Egg stew	EGS00	63	126	189	252	315	378	441	504
Evaporated milk[3]	EMi00	5 ml	10 ml	15 ml	20 ml	25 ml	30 ml	35 ml	40 ml
Evaporated milk[3]	EMii00	15 ml	30 ml	45 ml	60 ml	75 ml	90 ml	105 ml	120 ml
Frigate mackerel *(Okpoku)* smoked	OKP00	33	66	99	132	165	198	231	264
Gizzard (fried)	GZD00	23	46	69	92	115	138	161	184
Goat meat (steamed/boiled)	GTB00	30	60	90	120	-	-	-	-

APPENDIX 9 CONT.

	Code	Portions (g)							
Food		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Groundnut (roasted) (no. of units)	GNR00	24 (1)	48 (2)	72 (3)	96 (4)	120 (5)	144 (6)	168 (7)	192 (8)
Groundnut paste	GNP00	17	34	51	68	-	-	-	-
Groundnut soup	GNS00	95	190	285	380	475	570	665	760
Groundnut unshelled, boiled (~78g shelled nuts)	GNB00	130	260	390	520	-	-	-	-
Herrings *(Amane)* dry smoked	HERi00	53	106	159	212	-	-	-	-
Herrings (amane) dry smoked (different sizes)	HERii00	5	3	10	12	15	-	-	-
Horse mackerel *(Kpanla)* fried	KPA00	34	68	102	136	170	204	238	272
Kako[4]	KAK00	35	70	-	-	-	-	-	-
Koobi[4]	KBI00	12	24	36	48	-	-	-	-
Koose	KOS00	24	48	72	96	120	144	-	-
Laughing cow cheese	LCC00	15	-	-	-	-	-	-	-
Non-dairy creamer (range of sizes)	N-DCr00	20	40	250	-	-	-	-	-
Odaa (Big eye Tuna) smoked	SMT00	20	40	60	80	100	120	-	-
Palava sauce	PLVs00	64	128	192	256	320	384	448	512
Pig feet (boiled)	PFB00	50	100	150	200	-	-	-	-

APPENDIX 9 CONT.

	Code	Portions (g)							
Food		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Powdered milk	PWMi00	3	6	9	12	15	18	21	24
Powdered milk	PWMii00	7	14	21	28	35	42	-	-
Red fish (Sea bream) fried	RFF00	27	54	81	108	135	162	189	216
Red fish (Sea bream) steamed	RFS00	28	56	84	112	140	168	196	224
Sausage (beef) grilled (no. of units)	SG00	106 (1)	214(2)	315(3)	418(4)	-	-	-	-
Shrimp (fried)	SHRf00	32	64	96	128	160	192	224	256
Snail (boiled. Different sizes)	SNL00	12	21	35	47	87	-	-	-
Tilapia (grilled) (different sizes)	TPG00	210	341	488	506	-	-	-	-
Tilapia fingerlings (fried)	TPf00	21	42	63	84	105	126	147	168
Waagashi	WAG00	50	100	150	200	-	-	-	-
Wele	WE00	32	64	96	128	-	-	-	-

[1,3]Portions of evaporated milk and brukina are measured in ml.
[2]Medium eggs
[4]*Kako* and *koobi* were weighed after steaming.

APPENDIX 10A: WEIGHT, HOUSEHOLD MEASURES AND MACRONUTRIENT COMPOSITION OF SINGLE PORTIONS OF SOME ANIMAL AND PROTEIN SOURCE FOODS

Food	Portion one (g)	Household measure[#]	Kcal	Protein (g)	Fat (g)	CHO (g)
Anchovies (*Abobi/keta school boys)* sun dried	27	125g sardine tin (loosely packed)	83.16	15.80	14.71	0
Atlantic mackerel *(Saman)* smoked	32	1 matchbox	65.6	5.95	4.44	0
Beans (boiled)	70	1 stew ladle	100.1	4.34	3.99	12.67
Beans stew	63	1 stew ladle	137.89	5.61	6.40	15.53
Beef boneless, lean (fried)	28	1 matchbox				
Beef boneless, lean (steamed/boiled)	15	½ matchbox	40.95	3.81	2.73	0
Brukina (250ml)^	273	½ water sachet	376.74	16.65	12.29	49.96
Catfish (*Adwene)* smoked	20	1 matchbox	21	3.69	0.57	0
Chicken drumstick (fried)	45	~2 matchboxes	90.9	12.15	4.5	0.05
Chicken thigh (fried)	25	1 matchbox	71.75	6	5.25	0.08
Chicken wing (fried)	25	1 matchbox	63.25	6.5	4	0
Corned beef	29	1 tablespoon	60.32	4.99	4	1
Cow tripe (boiled)	10	1 matchbox	11.8	1.68	0.56	0
Crab (steamed/boiled)	4		4.6	0.95	0.06	0
Egg (boiled)	40	1 small egg	62	5.03	4.24	0.45
Egg (fried)	43	1 small egg	84.28	5.86	6.58	0.38
Egg stew	63	1 stew ladle	136.16	3.27	13.28	1.49
Gizzard (fried)	23	3 pieces	35.42	6.99	0.62	0
Goat meat (steamed/boiled)	30	1 matchbox	42.90	8.13	0.91	0
Groundnut (roasted)	24	3 tablespoons	140.4	5.68	11.92	5.16
Groundnut paste	17	1 tablespoon	101.83	4.24	8.89	3.13
Groundnut soup	95	1 soup ladle	154.17	6.18	11.80	8.76
Groundnut unshelled, boiled (~78g shelled nuts)	130		247.5	10.4	17.1	16.5
Herrings *(Amane)* dry smoked	53	160 g milk tin (loosely packed)	107.59	12.21	6.14	0

Koose	24	Medium egg size	66.24	2.68	3.30	6.84
Laughing cow cheese	15	1 piece	37	1.1	3.2	1.1
Non-dairy creamer	20	Small sachet	101.43	0.6	6.8	9.56
Odaa (Big eye Tuna) smoked	20	1 matchbox	26.4	5.64	0.26	0
Palava sauce	64	1 stew ladle	115	4.77	9.31	5.08
Powdered milk	6	1 tablespoon	29.76	1.58	1.60	2.31
Red fish (Sea bream) fried	27	1 matchbox	74.52	8.69	4.05	0.24
Shrimp (fried)	32	½ cup	77.44	6.84	3.93	3.67
Snail (boiled)	12		16.56	3.02	0.06	1.00
Tilapia (grilled)	210		234.15	49.56	3.99	0
Waagashi	50		201.50	12.54	16.57	0.64
Wele^^	32	1 matchbox	43.49	10.61	0.12	0

Sources: Eyeson and Ankrah (1975); Armah *et al.* (2008); Vincent *et al.* (2020); NutritionValue.org

^Debrah (2017).

^^Maduforo (2016).

CHO- carbohydrate

Stew ladle = ¼ cup; soup ladle = ½ cup; tablespoon = 15 ml; teaspoon =5 ml; 1 cup= 250 ml; ½ cup = 125 ml; ½ water sachet= 250 ml; matchbox= 4.5x3x1 cm.

APPENDIX 10B: WEIGHT AND MACRONUTRIENT COMPOSITION OF FLAVOURED ICE CREAM, POWDERED MILK AND SOYA MILK BRANDS DEPICTED IN THE PHOTOGRAPHIC ATLAS

Flavoured ice cream (FLIC00) *	**Net content**	**Kcal**	**Protein (g)**	**Fat (g)**	**CHO (g)**
FanYogo strawberry flavoured skimmed yoghurt	145ml packet	81.03	1.84	2.85	11.58
FanYogo strawberry flavoured skimmed yoghurt (Special independence edition)	110ml packet	61.49	1.39	2.16	8.79
FanYogo cocopine coconut and pineapple flavoured skimmed yoghurt	180ml packet	100.92	2.28	3.42	14.38
FanYogo mango passion flavoured skimmed yoghurt	180ml packet	100.92	2.28	3.42	14.38
FanYogo funky banana (Banana and strawberry flavoured skimmed yoghurt)	180ml packet	100.92	2.28	3.42	14.38
SuperYogo lemon flavoured skimmed yoghurt	180ml packet	94.91	2.75	3.65	12.68
SuperYogo sweet and plain skimmed yoghurt	180ml packet	94.91	2.75	3.65	12.68
FanIce vanilla ice cream	145ml packet	168.73	1.60	8.27	19.57
FanChoco chocolate flavoured ice cream	145ml packet	71.72	2.02	1.75	11.12
Evaporated milk sachets (EMS00)	**Net weight content**	**Kcal**	**Protein (g)**	**Fat (g)**	**CHO (g)**
Peak filled evaporated milk, low cholesterol (green label)	30 g sachet	46.5	2.22	2.4	3.57
Peak full cream unsweetened evaporated milk	30 g sachet	48	2.41	2.69	3.50
Nestle Ideal original full cream evaporated milk	29 g sachet	47	2.4	2.6	3.5
Powdered milk sachets (PWMS00)					
Cowbell instant filled milk powder	26 g sachet	134.42	6.11	7.67	10.22
Cowbell instant filled milk powder	14 g sachet	72.38	3.29	4.13	5.50
Miksi instant filled milk powder	26 g sachet	131.3	5.2	7.8	10.14
Miksi instant filled milk powder	14 g sachet	70.7	2.8	4.2	5.46
Peak green instant milk powder with vegetable fat	25g sachet	128	6	7.4	9.5
Nestle Ideal dairy delight	26 g sachet	127	4.7	6.8	12
Soya milk (SYA00)	**Net content**	**Kcal**	**Protein (g)**	**Fat (g)**	**CHO (g)**
Vita milk	125ml (Tetra Pak)	104	3.2	4.5	12.6
Vita milk	250ml (Tetra Pak)	207	6.5	9	25.3
Vita milk	300ml (bottle)	252	9	6	33

Source: calculated from nutritional information on package labels. *100 ml of ice cream ~ 63.4g. CHO- carbohydrate

APPENDIX 10C: MACRONUTRIENT COMPOSITION OF EVAPORATED MILK BRANDS DEPICTED IN THE PHOTOGRAPHIC ATLAS

	Teaspoon (5ml)				Tablespoon (15ml)			
Evaporated milk brand (EMC00)	**Kcal**	**Protein (g)**	**Fat (g)**	**CHO (g)**	**Kcal**	**Protein (g)**	**Fat (g)**	**CHO (g)**
Nestle Ideal original full cream evaporated milk	8.83	0.45	0.48	0.65	26.50	1.35	1.45	1.95
Nestle Ideal value creamer (red label)	7.33	0.27	0.43	0.63	22.00	0.80	1.30	1.90
Nestle Ideal balance (green label)	7.50	0.37	0.43	0.55	22.50	1.10	1.30	1.65
Peak Green low cholesterol filled evaporated milk	7.30	0.43	0.35	0.52	21.90	1.28	1.04	1.55
Lele evaporated filled milk	6.97	0.23	0.34	0.73	20.91	0.70	1.02	2.19
Nestle Carnation tea creamer	7.33	0.27	0.43	0.63	22.00	0.80	1.30	1.90
Luna Popular filled evaporated milk	7.68	0.32	0.42	0.53	23.04	0.95	1.26	1.60

Source: calculated from nutritional information on package labels.
CHO- carbohydrate

APPENDIX 10D: MACRONUTRIENT COMPOSITION OF CANNED SARDINE AND MACKEREL BRANDS DEPICTED IN THE PHOTOGRAPHIC ATLAS

Canned sardines (CSD00)	***Drained weight (g)**	**Kcal**	**Protein (g)**	**Fat (g)**	**Carbohydrate (g)**
****Generic**					
Sardines	90	215.1	22.32	13.95	0
*****Brands**					
Lele (125 g can)	90	201.6	22.86	12.06	0
Titus (125 g can)	90	224.30	23.00	14.70	0
Laser (125 g can)	90	185.00	17.00	11.30	0
Joom (125 g can)	90	196.20	20.70	12.60	<0.1
Belma (125 g can)	88	202.2	19.9	13.62	0
Anny (125 g can)	90	137.7	23.04	4.77	0.54
Festiva (125 g can)	90	260	23	18	0
Ena pa (125 g can)	90	N/A	N/A	N/A	N/A
Canned Mackerel in tomato sauce (CMAC00)					
Geisha mackerel (155g can)	85	127.5	17	5.67	0
Rosalinda mackerel (155g can)	85	127.5	17	5.67	0
Ena pa mackerel (self-opening 155g red can)	85	127.5	17	5.67	0
Ena pa Jack mackerel (425g can)	235	352.5	47	15.67	0
Obaapa (155g can)	90	105	9	7.5	1.5
Lele (155g can)	85	127.5	17	5.67	0
Ena pa (155g green can)	85	127.5	17	5.67	0
Ena pa Jack mackerel (200 g red can)	110	165	22	7.33	0

Source: calculated from nutritional information on package labels.

*Oil/ sauce drained.

** General. Not branded (source: Vincent *et al*., 2020).

*** Specific brands in guide photographs.

APPENDIX 11: FREQUENCY OF CONSUMPTION AND INDIVIDUALS WHO REPORTED CONSUMPTION OF PROTEIN SOURCE FOODS

APPENDIX 11A: PROFILE OF FISH AND SEAFOODS CONSUMED

	No. of times reported	% of total protein food reports[1]	% of total fish reports[2]	No. of individuals who reported consumption	
				n[3]	%[4]
Fried fish (not named)	542	9.2	26.6	350	47.2
Saman (Atlantic mackerel)	332	5.6	16.3	269	36.3
Tuna	245	4.2	12.0	189	25.5
Amane (Herring)	134	2.3	6.6	105	14.2
Steamed fish (not named)	137	2.3	6.7	105	14.2
Tilapia	94	1.6	4.6	83	11.2
Smoked fish (not named)	128	2.2	6.3	76	10.2
Canned sardines	78	1.3	3.8	70	9.4
Red fish (Sea bream)	81	1.4	4.0	65	8.8
Kpanla (Horse mackerel)	55	0.9	2.7	49	6.6
Koobi	32	0.5	1.6	27	3.6
Crab	28	0.5	1.4	27	3.6
Okpoku (Frigate mackerel)	33	0.6	1.6	26	3.5
Kako	18	0.3	0.9	17	2.3
Adwene (Catfish)	15	0.3	0.7	15	2.0
Canned mackeral	15	0.3	0.7	15	2.0
Cassava fish	17	0.3	0.8	13	1.8
Anchovies (*Abobi/keta school boys, nsesaawa*,)	12	0.2	0.6	12	1.6
Shrimps	13	0.2	0.6	12	1.6
Canned tuna flakes	6	0.1	0.3	5	0.7
Odaa (Big eye Tuna)	6	0.1	0.3	5	0.7
Adode (Oyster)	8	0.1	0.4	5	0.7
Antele (Atlantic bumper)	2	0.0	0.1	2	0.3
Saflo (West African Spanish mackerel)	2	0.0	0.1	2	0.3
Buebue (Burrito)	1	0.0	0.0	1	0.1
One man thousand (West African pygmy herring)	1	0.0	0.0	1	0.1
Momoni	1	0.0	0.0	1	0.1
Octopus	1	0.0	0.0	1	0.1
Prawns	1	0.0	0.0	1	0.1

[1]Number of times food was reported ÷ total number of protein food reports (i.e. 5894). [2]Number of times food was reported ÷ total number of times food in the group was reported. [3]Number of individuals who ate food. [4]Number of individuals who ate food item ÷ total sample (i.e..742)

APPENDIX 11B: PROFILE OF POULTRY AND POULTRY PRODUCTS CONSUMED BY STUDY PARTICIPANTS

	No. of times reported	% of total protein food reports[1]	% of total poultry Reports[2]	No. of individuals who reported consumption	
				n[3]	%[4]
Chicken	457	7.8	36.4	542	73.0
Egg	747	12.7	59.5	436	58.8
Gizzard	32	0.5	2.5	31	4.2
Chicken sausage	12	0.2	1.0	11	1.5
Turkey	7	0.1	0.6	6	0.8
Guinea fowl	1	0.0	0.1	1	0.1

[1]Number of times food was reported ÷ total number of protein food reports (i.e. 5894). [2]Number of times food was reported ÷ total number of times food in the group was reported. [3]Number of individuals who ate food. [4]Number of individuals who ate food item ÷ total sample (i.e..742)

APPENDIX 11C: PROFILE OF LEGUMES CONSUMED BY STUDY PARTICIPANTS

	No. of times reported	% of total protein food reports[1]	% of total legume reports[2]	No. of individuals who reported consumption	
				n[3]	%[4]
Groundnut soup	283	4.8	25.5	223	30.1
Beans	184	3.1	16.6	163	22.0
Groundnut	186	3.2	16.8	158	21.3
Palava sauce	186	3.2	16.8	157	21.2
Koose	177	3.0	15.9	155	20.9
Tom brown	39	0.7	3.5	43	5.8
Soya milk	9	0.2	0.8	8	1.1
Agushie stew	19	0.3	1.7	7	0.9
Bambara beans	7	0.1	0.6	7	0.9
Baked beans	8	0.1	0.7	6	0.8
Agushie soup	4	0.1	0.4	3	0.4
Almond milk	5	0.1	0.5	2	0.3
Groundnut cake	2	0.0	0.2	2	0.3
Tofu	1	0.0	0.1	1	0.1

[1]Number of times food was reported ÷ total number of protein food reports (i.e. 5894). [2]Number of times food was reported ÷ total number of times food in the group was reported. [3]Number of individuals who ate food. [4]Number of individuals who ate food item ÷ total sample (i.e..742)

APPENDIX 11D: PROFILE OF MEATS CONSUMED BY STUDY PARTICIPANTS

	No. of times reported	% of total protein food reports[1]	% of total meat reports[2]	No. of individuals who reported consumption	
				n[3]	%[4]
Beef	418	7.1	52.2	317	42.7
Wele	152	2.6	19.0	126	17.0
Goat meat	77	1.3	9.6	70	9.4
[5]Sausage	38	0.6	4.7	29	3.9
Snail	38	0.6	4.7	27	3.6
Corned beef	28	0.5	3.5	25	3.4
Pork	22	0.4	2.7	17	2.3
Offals	14	0.2	1.7	13	1.8
Cow feet	8	0.1	1.0	8	1.1
Bush meat	2	0.0	0.3	2	0.3
Bacon	1	0.0	0.1	1	0.1
Dog meat	1	0.0	0.1	1	0.1
Mutton	1	0.0	0.1	1	0.1
Beef sausage	1	0.0	0.1	1	0.1

[1]Number of times food was reported ÷ total number of protein food reports (i.e. 5894). [2]Number of times food was reported ÷ total number of times food in the group was reported. [3]Number of individuals who ate food. [4]Number of individuals who ate food item ÷ total sample (i.e..742)
[5]Unspecified meat source.

APPENDIX 11E: PROFILE OF MILK AND MILK PRODUCTS CONSUMED BY STUDY PARTICIPANTS

	No. of times reported	% of total protein food reports[1]	% of total milk reports[2]	No. of individuals who reported consumption	
				n[3]	%[4]
Evaporated milk	449	7.6	65.2	331	44.6
Powdered milk	103	1.7	14.9	84	11.3
Flavored ice cream	78	1.3	11.3	73	9.8
Brukina	19	0.3	2.8	18	2.4
Non-diary milk	17	0.3	2.5	15	2.0
Cheese	13	0.2	1.9	11	1.5
Yoghurt	4	0.1	0.6	4	0.5
Condensed milk	3	0.1	0.4	3	0.4
Low-fat milk	2	0.0	0.3	1	0.1
Skimmed milk	1	0.0	0.1	1	0.1

[1]Number of times food was reported ÷ total number of protein food reports (i.e. 5894). [2]Number of times food was reported ÷ total number of times food in the group was reported. [3]Number of individuals who ate food. [4]Number of individuals who ate food item ÷ total sample (i.e..742)

APPENDIX 12: DAPA-TOOLKIT

KING'S College LONDON University of London

24-HOUR RECALL INSTRUCTIONS

OBTAINING A 24-HOUR RECALL

The 24-hour recall aims to provide a complete record of all food and drink eaten on the previous day between midnight and midnight. The time element is important, as there may be respondents who work shifts or that have unusual time schedules meaning that their dietary patterns are not typical.

The 24-hour recall is collected in three phases (Triple Pass):

1. **A quick list of foods eaten or drunk.**

Respondents are asked to report everything that they had to eat or drink on the previous day between midnight and midnight. This recall session is not interrupted. At the end of the recall, respondents are invited to add any additional items not initially recalled.

2. **Collection of detailed information concerning the items in the quick list.**

For each item of food or drink, respondents are asked to provide additional detail.

a) The time at which the food or drink was consumed.
b) A full description of the food or drink, including brand name where available.
c) Any foods likely to be eaten in combination e.g. milk in coffee
d) Recipes and other combinations of foods e.g. sandwiches
e) The quantity consumed, based on household measures, photographs of different portion sizes of foods or weights.
f) Any leftovers or second helpings.

3. **A recall review in which respondents are given an opportunity to provide additional information and for the interviewer to prompt for information about foods or drink not mentioned.**

The interviewer reviews all the food eaten and drunk in chronological order, prompts for any additional eating or drinking occasions or foods/drink possibly consumed and clarifies any ambiguities regarding type of food eaten or portion size. Finally the interviewer asks the respondent to name the place where each food or drink item was consumed. All of the information gathered is recorded by the interviewer on the record sheet in the booklet called <u>Food Consumption Record: Individual 24-hour recall</u>.

The 24-hour recall protocol

In order to standardise the 24-hour recall method, you need to follow the protocol. This is a separate document called Protocol for the Completion of a Food Consumption Record: Individual 24-hour recall. This provides full details to enable you to carry out the recall, including exactly what to say, the order in which the recall should be carried out, the information you need to collect and when to refer to other materials such as prompt cards. **It is very important that the protocol is followed at every interview, even when you feel confident with the method.**

The 24-hour questions – collection of some additional information at the end of the recall

When the 24-hr recall has been completed, respondents are asked questions regarding drinking water and dietary supplements (this includes vitamin, mineral and sports supplements). If they have taken any dietary supplements, you need to record the name and brand directly from the container e.g. Superdrug Multivitamins and zinc. In addition, if the strength of the supplement is specified on the front of the container, you need to record this e.g. Boots Vitamin C 500mg. 'Nutritionally complete' supplements, which tend to be used as meal replacements e.g. Slimfast, Ensure, should be recorded on the record sheet.
Respondents are also asked whether or not the day recalled was typical of their usual food consumption, or if it was unusual or restricted in any way and if so for what reason.
Please note, some of the questions in this section are for you to answer.

The Interviewer feedback questionnaire

Finally, there is an interviewer evaluation to be filled in by you as soon as possible after each 24-hour recall interview. It is very important, as it gives an indication of how complete or accurate you feel the information given by the respondent is.

Food coding

Every item of food and drink recorded during the 24-hour recall has to be coded by you. Coding is not done as part of the interview but as a separate exercise afterwards. It is vital to code the previous 24-hour recall before visiting the respondent for the next interview. This is so that you can gather any extra information needed or resolve any queries as early as possible. Do not to leave all the coding of the 24-hour recalls until the end. Instructions on allocating food and portion codes can be found in the document 24-hr Recall Coding Instructions.

LOGISTICS

Each respondent will be asked to provide four 24-hour recalls; with the third being conducted by telephone where appropriate.

Within the household

In some households you will be required to conduct 24-hour recalls with two people. Within the limits of cultural constraints and social sensitivity, where there are two adults we would prefer these to be conducted separately. However, where a respondent is not sure of the full details of the food he/she ate it will be necessary to refer to someone else in the house for clarification.

Home interviews

You should aim to sit opposite the respondent. When you are probing for details of foods consumed and their brand names, respondents may offer to show you items from their food store. This is very useful in identifying exactly what has been consumed. Make a note during the recall so that you can collect all the information at the end rather than disrupting the interview by the respondent repeatedly going into the kitchen. You should copy down full details of the product, in terms of name, brand name and specific type (where appropriate) e.g. *"I can't believe it's not butter", 70% vegetable fat spread or Tesco's High Juice, no added sugar, blackcurrant and apple.*

Telephone interviews

If you feel that a telephone recall is appropriate, then after conducting the second 24-hour recall in person, you should inform the respondent that you will telephone some time within the next few days to conduct a further 24-hour recall. Do not inform them as to exactly when you will be telephoning. Leave the Food Atlas and copies of cards 1 and 2 with them for use during the telephone 24-hour recall. During the telephone recall or before leaving after completing the second 24-hour recall you will need to arrange a time to visit to do the fourth and final 24-hour recall in person.

If you do not feel that a telephone recall is appropriate (e.g. because the respondent is elderly and/or had difficulty using the food atlas at the personal recalls), you should arrange a time to do the third recall in person.

Interviewing children

A parent/carer should be present at the 24-hour recalls carried out on children under 16 years of age. Telephone interviews, if not conducted with the parent/carer should similarly be conducted with a parent/carer near at hand. With very young children (under 5), the parent/carer will provide all the information. With slightly older children (between 5 and 12) the majority of the information given will still come from the parent/carer, with the child perhaps making some additions. Older children (of 12 years and over) will themselves be very knowledgeable about their own diets and will be able to provide much of the information required.

At the beginning of the interview it is important to establish expectations regarding the degree of participation of the parent/carer. Based on your assessment of the child's capabilities (probably largely related to age) you should either ask the child to provide you with the majority of the information and the parent/carer to fill in the gaps or vice versa. Where the child is old enough, you should seek his/her agreement with statements or additions made by the parent/carer.

There will be occasions when the parent/carer is unable to provide sufficient information e.g. young children have eaten at a friend's or relative's house. If you feel there are gaps in the recall, please make a note of this in your feedback.

Be wary of young children (12 years and younger) estimating the amount they had to eat. They invariably overestimate. Confirm portion sizes with the parent/carer.

DESCRIPTION OF FOOD AND DRINK

In general the following information is required:

BOX 1

- What **type** of food or drink was it?
- **How was it bought**? – fresh, canned, frozen, dehydrated etc?
- Was the item smoked or not e.g. ham, bacon etc.
- Was it homemade – if so – what were the ingredients?
- How was it **cooked** – boiled, poached, fried etc?
- If it was cooked in fat, fat was used in pastry or cakes or any other dish, or if any fat was added to e.g. a sandwich or baked potato, what sort of fat or oil was used?
- If it was a dried / dehydrated product e.g. hot chocolate was it reconstituted using water, milk (specify type e.g. skimmed, semi-skimmed, whole) or both? etc
- Was the item **coated** before cooking? E.g. flour, batter, egg, breadcrumbs
- Was it unsweetened, or sweetened with sugar or artificial sweeteners e.g. Candarel?
- Was it low or reduced fat / low or reduced calorie?

This is not a comprehensive list, but offers a guide as to the type of information required.

Prompts and probing
All of the information is collected with a series of neutral prompts to encourage recall. You should ask **neutral questions** which do not encourage a specific response.

So, for individual foods, you should not say specifically "was that boiled or fried?" but "how was that cooked?" For additional foods, you should not presuppose consumption of foods in specific combinations, for example you should say, "what else did you have with that?" rather than "did you have butter on your potatoes?"

However, where initial neutral prompts do not lead to further information it may be necessary to list a series of specific options e.g. "was that boiled, fried, roasted, grilled etc?" Always list the options.

Where foods come in different varieties e.g. low fat, low calorie, caffeine free etc, always refer to the "standard" variety first as well as the low fat/low calorie variety i.e. "so was that standard or diet coke?"

Food Description Prompt Sheet for Interviewers

For many foods, there is a certain amount of detail that should be collected in addition to that specified in ***Box 1*** on the previous page. These foods can be found on the separate Food Description Prompt Sheet for Interviewers. The foods are arranged in alphabetical order along with the information that is required.

Commonly Consumed Additional Food Prompts

Included in the Food Description Prompt Sheet for Interviewers is a table called Commonly Consumed Additional Food Prompts. This lists foods frequently eaten in combination with other foods e.g. sugar on cereal, butter on potatoes, jam on toast. Use this list to probe for foods that a respondent may forget.

Usual eating habits

In the CAPI interview, you will obtain some information regarding the respondent's usual eating habits. You can transcribe this information into the front of the 24-hour recall booklet. This can then be referred to during the recall thereby reducing the burden on both interviewer and respondent when asking about frequently consumed foods such as tea, coffee and bread.

For example, if the respondent says they had tea, you can ask, *"Was that your usual tea?"* If they say yes, you need to confirm the eating habits details with them *"Your usual tea is a cup of weak tea with a dash of whole milk and no sugar. Is that what you had?"* Then you can record 'tea, usual' on the recall.

If it is not the respondent's usual tea (often the case if it is drunk outside the home), you must probe as normal i.e. strength of tea, any milk or sugar etc.

Evidence of probing

Recording on the record sheet where you have probed helps clear up ambiguities that may arise when it comes to coding a particular food or drink.

- If a respondent does NOT eat something typically eaten in combination with another food or they break their usual eating habit e.g. they have toast, but no spread, record "no spread" on the recall to indicate that you have probed for that food.
- For foods where low fat or low calorie varieties are available as well as "standard" versions e.g. yoghurts, soft drinks etc, if the respondent has the "standard" version, record "standard" on the recall to show that you have probed for the different types.
- If you have probed and the respondent does not know or cannot remember exactly what they had to eat or drink, indicate this by recording **P -** on the recall (this stands for a negative response when probed).

School meals

When collecting information about children's school lunch, initially follow the same procedures as for any other meal. However, if a child eats a dish that is a recipe, it is important to confirm with the school the exact recipe name of the dish. Young children will not always call a dish by its correct name e.g. cottage pie may be called shepherds pie.

In addition, young children, where the parent/carer usually recalls the food eaten, may find it difficult to remember some, if not most, of what they had to eat at school and how much. If this is the case you should try to obtain menu information from the school as quickly as possible. You should use this information to prompt the child as soon after the recall as possible, ideally the same day or day after. Whenever possible, this additional prompting for school meals can be done with the child/parent over the telephone rather than as an extra visit. If the child still cannot remember or you are concerned about the accuracy of the detail recalled, mention this in your feedback questionnaire including the name of the school.

Meals on Wheels
Descriptions of the components of the meal (for example mashed potato, carrots and chicken breast etc) and details on portion sizes and leftovers using the food atlas or household measures should be obtained from the respondent. Councils employ private catering companies to provide meals on wheels. Please obtain the name and telephone number of the catering company that provided the meals, this will the help the nutrition team at KCL with any queries. You should be able to get this information from the respondent as they will usually be given a menu with the company name etc on it.

Recipes
For homemade dishes, for example beef stew, you should write 'beef stew, recipe [number]' against this entry under food description on the record sheet. Then, on the recipe sheets, you need to record the following information:

- List of ingredients
  Record details about the ingredients in the same way you would if the food was eaten on its own. For example, if tomatoes were used, were they fresh or tinned. If oil was used, what type? If meat, what animal and what cut?
  Probe for ingredients they might have forgotten e.g. water, oil, herbs, spices
- Amounts of ingredients
  This can be in household measures, weights or using photographs in the food atlas (see Estimation of Portion Size)
- Cooking method
  Record some brief information on how the dish was prepared and cooked. This can sometimes elicit extra or forgotten detail. So if the respondent says they fried something, remember to ask if it was in oil and the type used. If they stewed or boiled a dish, remember to ask about how much water they used. If they mashed a potato, did they use any milk or spread?

If another member of the household prepared the dish, you should try and get the relevant information from them.

Ethnic foods
When collecting information about ethnic foods it is important to obtain as much information about a food/recipe that is 'unusual'. It is important to check the spelling of the names of ethnic foods as many have unusual spellings and/or alternative names. For example, okra (a vegetable grown in South America, West Indies and India; used in soups and stews) is also called lady's finger; 'moong' beans are also spelt 'mung' beans. Therefore, you should ask for packets or containers (if available) to check the spelling if you or the respondent are not sure. There is also a list of common South Asian foods/dishes at the end of the Food Description Prompt Sheet for Interviewers to help with this.

Composite dishes
When a food is composed of several different foods e.g. a sandwich or a salad these should be recorded separately. For example, a sandwich would be split into bread, spread and filling. The individual components and the amount of each component should be recorded on a separate line under 'description of food or drink' on the record sheet.

Takeaway foods and fast foods

If the respondent consumes takeaway or fast foods, wherever possible, in addition to other information collected please record the name and address of the food outlet and the price of the item. This will help the nutrition team at KCL with any queries.

Food and drink consumed over a long period of time

The respondent may eat or drink something over an extended period of time such as sipping a litre of water throughout the day, or a few glasses of wine over an evening. If it is too difficult to separate specific amounts consumed at specific times, you can record the time period and the amount consumed over that period e.g. 13:00 – 16:00, ½ litre of bottled water.

Underreporting

When asking people to report what they have had to eat and drink, many people tend to report less than they have actually consumed. This is why we use the triple pass 24 hour recall protocol and allow lots of opportunities for prompting respondents. Underreporting is particularly common in:

- Young white men
- Asian women
- Overweight respondents

BRAND NAME

Where possible, you need to ask the respondent for the brand name of foods they have consumed e.g. Heinz baked beans, Kellogg's Cornflakes etc. If the respondent does not remember at first request, you may be able to get this information if the items are in their food store e.g. cupboard or fridge. This should be left until the end of the recall. Avoid repeatedly interrupting the recall by asking the respondent to go into the kitchen.

ESTIMATION OF PORTION SIZE

At the beginning of the interview the respondent is introduced to the process involved in the 24-hour recall and told that they will be asked to provide details of what they have eaten, and to give an estimate of the amount that they ate (portion size).

A portion size can be described in terms of:

- photographs in the food atlas
- household measures (e.g. one level teaspoon of sugar, 1 kit kat (2 sticks)
- weights (e.g. a 420g tin of baked beans, 125 g pot of yoghurt)

For the majority of respondents the photographs in the food atlas provide the most accurate estimate of portion size and should be used whenever possible.

However, some respondents such as the very young or elderly, find the photographs in the food atlas difficult to use and household measures or packages should be used as an alternative.

If the respondent has packaging with a weight on, ask to see the package as this will help with identification of the precise type of food and the size. Do NOT let respondents guess weights.

Use of food atlas

The Photographic Food Atlas contains 78 sets of photographs of portion sizes of a wide range of foods. It also provides additional guide photographs for other foods that come in defined portion sizes e.g. bread rolls and also photographs of a variety of household measures e.g. mugs, glasses etc. Some of the photographs show the food in more than one form e.g. Cheddar cheese on page 24 – a slice, square and grated pile of cheese are present on each plate. The slice, square and grated pile of cheese each have the same weight so the respondent still only needs to select one photograph. For the Yorkshire pudding on page 12 – the total weight of the two individual round puddings in each photograph is equal to the weight of the rectangular slice of Yorkshire pudding.

The respondent is asked to select the photograph in the food atlas which most closely resembles the amount that they ate. To help the respondent select the most appropriate photograph there is a full size photograph of the plates and bowl that were used in the photographs. This can be found in the front inside flap of the food atlas. The appropriate photograph of the plate or bowl should be visible while the respondent makes their selection.

Not all foods appear in the atlas, particularly those eaten by people from ethnic groups, so you will need to use household measures instead.

Spoon size

If a respondent describes the amount they had to eat in spoonfuls, it is important to determine the size of the spoon. Often respondents will say they used a tablespoon when what they actually used was a dessertspoon. To clarify the size of the spoon you should show the respondent the picture of a life size tablespoon, dessertspoon and teaspoon. This can be found in the front inside flap of the food atlas.

DO NOT use the photographs on page G20 of the food atlas. They are not life-size and cause confusion for many respondents.

Equivalent foods

As mentioned before, the atlas cannot be used for every food but, as it is a more accurate estimate of portion size than household measures, it should be used whenever possible. It may also be used for equivalent foods, that is a food of sufficiently similar shape and/or consistency. For example the photograph of meat curry with sauce on page 72 can be used for any type of meat, chicken or fish curry with sauce. Similarly the photographs of tins at the back of the book can be used for other tinned foods. In the front of the food atlas you will find a list of 'equivalent foods' which tells you other foods for which you can use the photos in the food atlas.

You should NOT use the photographs of one type of food to represent another unless it is on the equivalent foods list. For example, you would not use the photographs of fruit cake on page 8 for sponge cake (similarly, you would not use the photographs of sponge cake on page 11 for fruit cake).

Leftovers
After the respondent has selected a photograph it is important to remember to ask them whether they ate the whole portion. If not, it is necessary to find out what proportion was left and enter that in the 'leftovers' column. Again, amounts can be estimated using the food atlas, household measures or weights.

Second helpings
Second servings should be recorded in the following way. Record food or drink on a separate line of the record sheet under 'Description of food or drink' (in order to be able to see that it was a second helping) with the portion size (using the food atlas or household measures) of the second helping recorded in the 'amount' column.

PLACE NAME

Finally, the respondent is given a card (CARD 1) and asked to select a place name for each eating and drinking occasion. In some cases, it is important to ascertain the source of food, as well as the place. For example, the place "Home" appears on the card four times (options A-D), but each time, the source of the food or drink is different:
A) Home, from their own food supply
B) Home, a take-away brought in e.g. fish and chips
C) Home, other food brought in, that they had to pay for e.g. meals on wheels (NOT takeaway)
D) Home, other food brought in that was free e.g. a family member bringing round a cake.
When respondents are selecting a place name they should pick the place first. Only if there is more than one option for that place name, should they then pick a source.

APPENDIX 13: SAMPLE PAGES FROM THE PHOTOGRAPHIC FOOD ATLAS OF ANIMAL AND PLANT PROTEIN SOURCE FOODS




PHOTOGRAPHIC ATLAS OF COMMON ANIMAL AND PLANT PROTEIN SOURCE FOODS IN THE GREATER ACCRA METROPOLITAN AREA




Table of contents

3

Glossary of some local foods

Brukina: A local yogurt-cereal snack. It is made from fermented milk, sugar and boiled millet.

Beans: All types of small dry cowpeas e.g. red kidney, white, brown, black eyed etc. are locally called beans. Boiled beans with gari, palm oil and fried ripe plantain ('red red') are the favourite of many. Beans is also popularly cooked with rice and sorghum leaves (waakye) or pre-boiled and then used for beans stew.

Kako: Hard dried fermented salted fish. Kako is processed from such fish as sharks, skates and rays.

Koobi: Salted fermented tilapia.

Koose: A spicy deep-fried beans cake.

Palava sauce: A popular sauce prepared with cocoyam leaves and agushie i.e. melon (*Cucumeropsis manii*) seeds. The sauce is commonly eaten with boiled rice or *ampesi* (i.e. boiled plantain, yam, cocoyam or other root tubers of choice).

Waagashi: A local cheese similar to cream cheese. For milk to coagulate, *Calotropis procera* leaf extract is used. *Waagashi* is sliced and fried to be eaten as a snack with powdered pepper. Some also use it in place of meat/fish in stew.

Wele: Singed cowhide. *Wele* is popular in tomato stew that is eaten with waakye and in okro stew/soup.

17

KSB001

KSB002

KSB003

KSB004

KSB005

KSB006

23

ADWi001

ADWi002

ADWi003

ADWi004

24

ADWii001

ADWii002

ADWii003

ADWii004

30

KAK001

KAK002

32

SMT001

SMT002

SMT003

SMT004

SMT005

SMT006

39

43

CWfii001

CWfii002

45

FEG001

FEG002

FEG003

FEG004

47

GZD001

GZD002

GZD003

GZD004

GZD005

GZD006

GZD007

GZD008

51

GNP001

GNP002

GNP003

GNP004

52

54

KOS001

KOS002

KOS003

KOS004

KOS005

KOS006

55

PLV001

PLV002

PLV003

PLV004

PLV005

PLV006

PLV007

PLV008

56

LEFT TO RIGHT: Vita milk (250ml Tetra Pak); Vita milk (300ml bottle); Vita milk (125ml Tetra Pak)

58

63

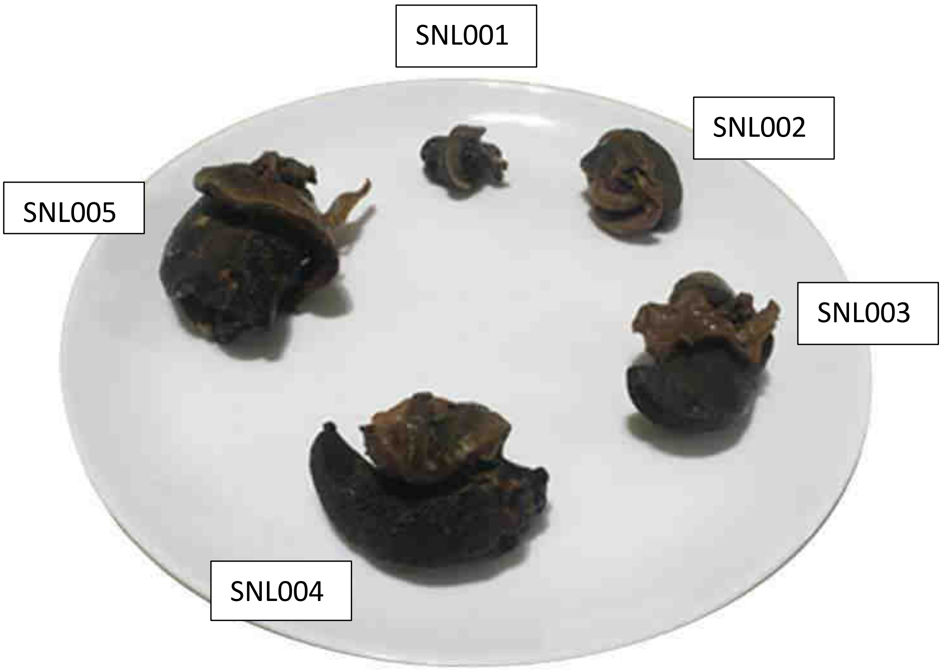
PFB001

PFB002

PFB003

PFB004

64



66

67

BRK001

BRK002

68

EMi001

EMi002

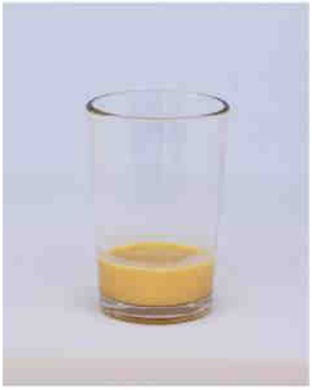
EMi003

EMi004

EMi005

EMi006

EMi007



EMi008

73

LCC00

76

PWMi001

PWMi002

PWMi003

PWMi004

PWMi005

PWMi006

PWMi007

PWMi008

78

WAG001

WAG002

WAG003

WAG004