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VALIDITY AND REPRODUCIBILITY OF A FOOD FREQUENCY QUESTIONNAIRE AMONG LEBANESE ADULTS FOR THE ASSESSMENT OF ENERGY AND NUTRIENT INTAKE

by
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AN ABSTRACT OF THE THESIS OF

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Title: Validity and Reproducibility of a Semi quantitative Food Frequency Questionnaire among Lebanese Adults for the Assessment of Energy and Nutrients Intake

Scientific Background: Diet is a major modifiable risk factor in the etiology of chronic diseases. Dietary assessment is a critical step in the evaluation of diet-disease association and the formulation of recommendations for dietary interventions. Limited validated tools exist for the assessment of dietary intake of adults in the Middle East and North Africa Region. As for Lebanon, to our knowledge, there exists no valid long-term dietary assessment tool for Lebanese adults aged 18-65 years.

Objectives: The aim of this study is to examine the validity and reliability of a food frequency questionnaire (FFQ) for the assessment of dietary intake among Lebanese adults.

Methods: Healthy Lebanese faculty and staff members of both genders, aged between 18 and 65 years, were recruited from various faculties and offices at the American University of Beirut, Lebanon (n=120). Participants completed the FFQ twice, during a one-year interval. Within each of the four seasons of this one year, three 24-hour recalls (24-HR) representing two weekdays and one weekend were collected. Estimation of energy and nutrients' intake was conducted using Nutritionist Pro software. For validity, dietary intake data collected via the FFQ was compared to the mean of repeated 24 hr recalls (MPRs). Percent difference in means, Spearman's rank correlations and Bland-Altman plots were used to assess the validity of the developed FFQ. Intraclass Correlation Coefficient (ICC), weighted kappa (κ w) and same and adjacent percent agreement were used to evaluate the FFQ's reproducibility. Statistical Package for Social Sciences (SPSS) was used in the analysis and a $p<0.05$ indicated significance.

Results: Out of the 120 adults, 110 completed the study (dropout rate: 8.3%). The mean (±SD) age of subjects 41.28±9.88 years for males and 34.81±7.70 for females. Spearman's correlation coefficients (r) for the association of the FFQ and mean 24-HR for the validity ranged from 0.239 for 'alpha-carotene' ($p<0.05$) to 0.694 for 'energy' ($p<0.01$). Bland-Altman's Limits of agreements (LoA) showed acceptable agreement between the FFQ and the mean of MPRs in estimating portions for most nutrients where most data points in the Bland-Altman plots lied between the, closer to the middle horizontal line. Larger differences between the FFQ mean 24 HR were observed for most nutrients at higher intake. As for the reliability, ICC was calculated between FFQ-

1 and FFQ-2. It ranged from 0.31 for ‘cobalamin’ ($p<0.01$) to 1.00 for ‘sodium’ ($p<0.01$). The κ w values and their agreement ranged from 0.25 “fair” for ‘carbohydrate % contribution to total energy’ to 0.82 “almost perfect” for ‘protein’ intake. The average percent agreement between FFQ-1 and FFQ-2 in ranking participants into the same or adjacent quartiles was 87.12%, highest for ‘protein’ (100%) and lowest for ‘fat % contribution to total energy’ (73.6 %).

Conclusion: The study’s findings demonstrated that the developed FFQ is a valid and reliable instrument for the assessment of energy, macronutrients and most micronutrient intake among Lebanese adults. After validation, this questionnaire will not only serve for the assessment of dietary intake among Lebanese adults, but it can also be adapted by researchers in neighboring countries possessing dietary patterns similar to those in Lebanon.

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ABBREVIATIONS

AUB	American University of Beirut
AUBMC	American University of Beirut Medical Center
24-HR	24-hour dietary recall
AUB	American University of Beirut
BMI	Body mass index
β	beta regression slope
CITI	Collaborative Institutional Training Initiative
cm	Centimeter
DFE	Dietary Folate Equivalents
DHQ	Diet history questionnaire
DR	Dietary record
EMR	Eastern Mediterranean Region
FFQ	Food frequency questionnaire
FFQ-1	The first administration of the Food Frequency Questionnaire
FFQ-2	The second administration of the Food Frequency Questionnaire
g	gram
ICC	Intraclass correlation coefficient
IPAQ	International Physical Activity Questionnaire
IRB	Institutional Review Board
IU	International Unit
κ w	Weighted Kappa
Kcalories	Kilocalories
Kg	Kilograms
LoA	Limits of agreement

µg	micrograms
MPR	Multiple Pass Food Recall
mg	milligram
m^2	square meter
NCD	Non-Communicable Diseases
RE	Retinol Equivalent
SD	Standard Deviation
SDG	Sustainable development goal
SES	Socioeconomic status
SPSS	Statistical Package for Social Sciences
USA	United States of America
USD	United States Dollar
USDA	United States Department of Agriculture
vs	versus
WHO	World Health Organization
RE	Retinol Equivalent

CHAPTER I

INTRODUCTION

A. General Overview

Diet is a leading factor in the rising obesity rates which in turn is a major risk for non-communicable diseases (NCD) (Lim & Park, 2018; Swinburn et al., 2009). Dietary assessment methods are used to assess the diet-disease link and using minimally valid tools in epidemiologic studies attenuates this link. (Day, McKeown, Wong, Welch, & Bingham, 2001). Therefore, using reproducible and valid dietary assessment methods ameliorates the assessment of the diet-disease association since the tool accurately measures the aspect of the diet it is intended to measure. The dietary assessment methods that are most commonly used in research are dietary record (DR), 24-hour recall (24-HR) and food frequency questionnaire (FFQ) (Shim, Oh, & Kim, 2014). The latter is the most commonly used method in epidemiological studies secondary to their low cost, ease of administration and their ability to estimate long-term dietary intake (Henríquez-Sánchez et al., 2009; W. Willett, 2012). The use of FFQs in epidemiological studies permits comparing average nutrient intake of different groups, ranking individuals within a group and measuring absolute levels of nutrient intake (Aydemir, 2002; Illner et al., 2012).

Validating dietary assessment methods is of great importance to avoid systematic biases in epidemiological studies; and this is done through comparing it to a superior method, with independent sources of measurement errors, which is the dietary record in the case of FFQ validation. However, in many contexts, using 24-HR as a reference method is more appropriate since it necessitates less motivation and literacy

than the dietary records (W. Willett, 2012).

Since there are remarkable variations in the dietary intake across different age groups in the same geographic population, it is important to develop FFQs that are tailored to each population and further to each age group pertinent to that population. Several FFQs have been developed and validated to be used in epidemiological studies to assess the dietary intake of adult populations in several countries like the United States of America (USA), several European regions, Kingdom of Saudi Arabia and Iran (Bijani et al., 2018; Gosadi et al., 2017; Marshall et al., 2016; F. E. Thompson et al., 2008). In 2016, the Nutrition and Dietetics department at the American University of Beirut (AUB) developed and validated a FFQ for Lebanese children population (Moghames et al., 2016a); however, up to date and to our knowledge; no validated FFQ exists for the assessment of dietary intake among Lebanese adults.

B. Objectives

The main aim of this study was to validate a semi quantitative food frequency questionnaire (SQFFQ) that is culturally specific and suitable for the assessment of dietary intake among Lebanese adults. The objectives, therefore, were to:

1- Develop a culturally specific FFQ that includes a comprehensive list of foods frequently consumed by the Lebanese adults.
2- Assess the relative validity of the developed FFQ in the measurement of energy, macronutrients and several micronutrient intake as compared to the mean of repeated 24-HRs over the period of 12 months in addition to season-specific correlations.

3- Determine the repeatability of the developed FFQ after 12 months following the primary administration.

CHAPTER II

LITERATURE REVIEW

A. Malnutrition

Weight is a major determinant of the health status of the immune, metabolic, reproductive, and musculoskeletal systems (Haslam & James, 2005). It is one of the indicators of malnutrition which can be defined as a disease state brought about by either undernutrition due to inadequate intake of energy and other nutrients or overnutrition due to excessive intake of energy and other nutrients (Ge & Chang, 2001).

1. Undernutrition

There are four main forms of undernutrition worldwide, namely protein-energy malnutrition, iron deficiency and anaemias, vitamin A deficiency and iodine deficiency disorders (Stephenson, Latham, & Ottesen, 2000). Undernutrition is accountable for 35% of the 9.2 million child deaths yearly (Khan & Bhutta, 2010).

The need for relieving the global undernutrition has been emphasized in the United Nations' Sustainable Development Goals (SDGs), a group of global targets for enhancing the economic and social welfare of the world's poorest countries (SDGs, 2015).

The concern is not solely having access to food and calories. Although many people have access to calories, they suffer from micronutrients deficiency. This condition is referred to as "hidden hunger" which brings about negative, sometimes chronic, implications on health (Burchi, Fanzo, & Frison, 2011). Despite that poor

nutrition is a global burden, obesity has become an epidemic in several regions of the world (Wang & Lobstein, 2006).

2. Obesity

a. The Global Stand on Obesity

Albeit hunger remains a burden in several developing countries in Africa, Asia and Latin America, excessive body fat is currently a considerable cause of deteriorated quality of life and preventable mortality in many affluent countries and in the urban populations of developing countries (Haslam & James, 2005; Sullivan, 2011).

The United Nations' third SDG emphasized the need to ensure healthy lives and improve the well-being at all ages (SDGs, 2015). Since obesity entails major adverse effects on healthy lives and overall well-being, policy actions to develop and implement public health strategies to prevent obesity have been created mainly in developed countries (Chan & Woo, 2010).

These policy actions mainly target the food, physical activity and the socioeconomic environments to directly influence eating and physical activity behaviors. This also necessitates support of health services and clinical interventions (Chan & Woo, 2010). One example of an effective policy action in this regard was the taxation of sugar sweetened beverages which was associated with a decrease in BMI in the USA (Cabrera Escobar, Veerman, Tollman, Bertram, & Hofman, 2013). However, policy- based strategies alone are not enough since they are faced by a lot of obstacles. Individual lifestyle changes are also important for combating the obesity epidemic (Chan & Woo, 2010).

b. Prevalence of Obesity

In 2016, the World Health Organization (WHO) announced that the overweight prevalence among adults, 18 years and older, reached 1.9 billion adults among which 650 million were obese. This indicated that the global obesity has almost tripled since 1975 (Organization., 2015). Also, it is expected that the number of overweight and obese adults will rise to 1.35 billion and 573 million, respectively, by 2030 (Huang & Hu, 2015). As for the Eastern Mediterranean Region (EMR), a recent review indicated that the estimated average prevalence of adult overweight and obesity reached as high as 27% and 24%, respectively (L. Nasreddine, Ayoub, & Al Jawaldeh, 2018). Obesity prevalence was noted to be higher among women as compared with men which is consistent with the figures seen worldwide (Lim & Park, 2018; L. Nasreddine et al., 2018).

c. Implications of Obesity

Obesity is a disease that is associated with increased risk of non-communicable diseases (NCDs) (Lim & Park, 2018). Excess body weight is an independent risk factor for cardiovascular disease, cancer and musculoskeletal disorders, and is associated with high medical and social costs (Haslam & James, 2005). Even in non-obese populations, abdominal obesity is associated with increased risk of type 2 diabetes and cardiometabolic disease (Balkau et al., 2008).

B. Determinants of Obesity

Studies on the determinants and correlates of obesity commenced more than 50 years ago (Bray, Barry, & Mothon, 1970). The aetiology of obesity goes beyond being

simply an imbalance between energy intake and energy output (Alzaman & Ali, 2016). In fact, a set of actors contribute to the development of overweight and obesity with the commonly attributed determinants in the web of causations being genetic predisposition, environmental factors, physical activity and dietary intake (Jelassi, Ben Miled, Bellamine Ben Saoud, & Demongeot, 2016).

1. Genetic Predisposition

Scientific evidence from genetic epidemiological studies suggested that genetic factors play a huge role in the development of obesity, given that 50%–80% of variation in body mass index (BMI) can be accredited to heritability (Wardle, Carnell, Haworth, & Plomin, 2008). Genetic studies done on BMI have mainly concentrated on how average BMI changes with polygenic risk scores (Abadi et al., 2017). Also, results of a very recent study, which analyzed data from 12,346 participants; suggested that genes distinctly influence the weight rank of individuals at different sections of the BMI distribution. This implies that heavier individuals at higher BMI percentiles are more likely to be responsive to obesity genetic risks than lighter individuals falling at lower percentiles (Wehby, 2018). Genetic predisposition is; however, not enough to determine individuals' body weight (Jelassi et al., 2016).

2. Environmental Factors and Physical Activity

Besides genetic predisposition, several environmental factors are also correlated with the onset of obesity. The digital and industrial revolutions incited economic growth, urbanization and trade that have fuelled macro-societal changes which in turn have endorsed nutrition transition to a less healthy diet. These changes corroded the

environment quality rendering it an obesogenic one which can be defined as “any characteristic that acts as a barrier to maintaining a healthy weight” (Kirk, Penney, & McHugh, 2010; Sullivan, 2011). Furthermore, the transition has been aggravated by other social changes such as high socio-economic status and sedentarity in several parts of the world including the EMR leading to high prevalence rates of obesity (Alzaman & Ali, 2016; L. Nasreddine et al., 2018; Sullivan, 2011).

Physical activity is also an important determinant along with genetic and environmental factors. As aforementioned, energy balance comprises two major components: energy intake and energy expenditure. The latter is mainly determined by physical activity whose effect on obesity has been intensively investigated in studies among which some have suggested that a physically active lifestyle is correlated with a 40% attenuation in the genetic predisposition to increased BMI (Li et al., 2010).

For instance, the results of a cross sectional study that assessed 24,871 individuals in China revealed a significant positive association between physical activity and lower prevalence of obesity (O. Lee, Lee, Lee, & Kim, 2016). Also, analyzing longitudinal data from 1989 to 2011 in China showed that physical inactivity secondary to engaging in sedentary habits was positively associated with higher weight gain in both adults and children (Zhang, 2017). Similarly, reports from the Middle East region propose that most of this geographical area’s populations lead a lifestyle that hinders an adequate level of physical activity (Yammine, 2017). Not only physical activity, but also dietary intake constitutes a direct determinant of weight status.

3. Dietary Intake

The sedentarity in the prevailing obesogenic environment is coupled with the availability of relatively cheap, as compared to healthy food; and the rising supply of highly palatable, handy and energy-dense foods. These factors all together contribute to the escalating trends of the incidence and prevalence of obesity (Du & Eskens, 2010). Moreover, some dietary patterns increase the risk of obesity including less frequent eating, skipping breakfast and eating meals away from home. Large cross-sectional and prospective cohort studies found a clear positive correlation between consumption of fast food and weight gain (Du & Eskens, 2010; Jelassi et al., 2016). Individuals who consume more fast foods usually have a higher intake of energy, fat, and soft drinks, and a lower intake of dietary fibre, fruits and vegetables. This increases their overall energy intake and the risk for obesity (Bowman & Vinyard, 2004).

C. Assessment of Dietary Intake

Despite its numerous determinants, diet remains a leading factor in the rising obesity rates (Swinburn et al., 2009). In attempt to combat the obesity epidemic through developing and implementing effective population-based strategies; the link between diet and obesity needs to be thoroughly assessed (Chan & Woo, 2010).

Diet is also a major lifestyle-related determinant of numerous chronic diseases. Cancer incidence was found to be reduced by one-third secondary to positive changes in dietary habits (Doll & Peto, 1981). Cardiovascular disease risk prediction was made possible thanks to dietary information (Baik, Cho, Kim, & Shin, 2013) and a low risk of all-cause mortality was associated with the consumption of a nutrient-dense diet (Streppel et al., 2014).

The estimation of dietary intake involves the assembly of information on the frequency and quantity of foods consumed and the calculation of energy intake, nutrients and probably other constituents of foods (Biro, Hulshof, Ovesen, & Cruz, 2002). Estimating a sample of the population's nutrient intake is a real challenge for nutrition research and one of the most convenient methods for estimating dietary and nutrients consumption is the administration of dietary assessment methods (Serra-Majem et al., 2009).

Dietary intake measurement is mainly conducted for comparing different groups' average nutrient intake, ranking individuals within a group, and assessing usual intake of individuals (R. Lee & Neiman, 2007).

1. Dietary Assessment Methods

The collection of dietary information can be done at 3 different levels: the individual, the household and the population level (Immink et al., 2009). Individual-level dietary assessment methods, in large population studies, can be crudely divided into prospective or retrospective. The retrospective methods involve the recalling of nutrient intake of subjects over a defined past time. The retrospective methods comprise 24-HRs, FFQs and diet history questionnaires (DHQ). On the other hand, prospective methods involve the subjects' reporting of their dietary intake after or at the same time of dietary consumption. The prospective methods include the food record and observed chemical analysis of duplicated diets (Immink et al., 2009).

Both retrospective and prospective methods can be done either by self-report or by the help of a trained interviewer (Shim et al., 2014). The latter requires that the interviewer be knowledgeable about foods present in the marketplace and about

preparation techniques for both regional and ethnic foods. The 24-HR, DR and FFQ are the most widely used in nutritional epidemiological research (Shim et al., 2014).

a. 24-Hour Recall

The 24-hour recall (24-HR) is an interview carried out for collecting information about the foods and beverages that were eaten and drank by the interviewed subject over the past 24 hours. Although it can be self-reported, 24-HR is best performed by a trained and skilled dietary interviewer who should possess competency in asking the proper sequence of open-ended neutral questions and in probing on forgotten foods, methods of food preparation, composite dishes' ingredients, commercial products' brand names in addition to supplemental intake (Frances E. Thompson & Subar, 2013). 24-HR is commonly carried out in person or over the telephone. The latter is mainly used to conserve the element of surprise to avoid any dietary changes due to being aware of the time of the interview. The subject is usually the interviewee; however, the caretaker would be the interviewee in case the subject is mentally incapacitated adult or a child (W Willett, 1998). Since reporting the dietary intake of a single day may not represent the individual's overall usual dietary intake, multiple 24-hours including weekdays and weekends are conducted and their data are averaged together (Block, 1982; Trabulsi & Schoeller, 2001).

24-HR has several advantages among which is relying on short-term memory. Also, it can collect detailed qualitative information concerning the consumed food (Trabulsi & Schoeller, 2001). It is rapid, cheap, non-intrusive and is light on the subject, especially if coupled with choices of practical food portions (Biro et al., 2002). Moreover, literacy is not a requisite for conducting this method which doesn't exert

heavy burden on the subject. This makes it very likely that the subject agreeing to participate represents the general population; which renders this method ideal for use in several populations (Frances E. Thompson & Subar, 2013). Despite the above-listed strengthens, 24-HR has some limitations that need to be considered.

Among the drawbacks of this method is the fact that no subject has perfect knowledge and memory of their intake of foods and beverages. Due to the reliance of this method on the subject's memory, intra-individual variation from one day to another may increase the daily fluctuations. This renders a single 24-hour recall an unreliable indicator of an individual's usual intake. Preferably, a trained interviewer needs to conduct multiple 24-HRs to make up for the inter-day variations for the ultimate intake estimation (McPherson, Hoelscher, Alexander, Scanlon, & Serdula, 2000; W Willett, 1998). To attenuate some of the limitations of using 24-HR, the United States Department of Agriculture (USDA) developed the Multiple Pass Food Recall (MPR) (Moshfegh et al., 2008; Raper, Perloff, Ingwersen, Steinfeldt, & Anand, 2004).

i. The Multiple Pass Food Recall (MPR)

The MPR is a valid dietary assessment technique that comprises 5 steps which allows the revision of intake more than once to retrieve forgotten foods and eating occasions. First, a "quick list" where the subjects, without interruption, list all the foods and beverages they have consumed over the past 24 hours. Second, the subject is reminded by the interviewer of a forgotten food list usually missed out in 24-hour recall reporting. Third, the interviewer asks the subject about the time and meal of the reported foods. Fourth, the interviewer probes in a detailed cycle about the foods and beverages eaten so details about portion sizes, way of preparation, brand names and

supplemental intake are collected. Fifth, a final probe for the whole 24-hour recall is done (Blanton, Moshfegh, Baer, & Kretsch, 2006). A good estimate of an individual's usual nutrient intake can be provided by several MPRs conducted on an individual over various seasons (R. Lee & Neiman, 2007).

b. Dietary Record

The dietary record (DR) approach involves that the subjects record the foods and beverages, the amounts of each item consumed (weighed or estimated by using visual portion size pictures/household cooking measurements), the time the food was consumed, and specific ingredients used in mixed dishes. Recording is done over either one or several consecutive days that represent weekdays and weekends. For optimal accuracy, the recording should be done at the time of the meal to avoid dependence on memory. Accurate information on food consumed during recording period times can be provided by the DR mainly since it does not require relying on the subject's memory (Trabulsi & Schoeller, 2001).

To fill out the DR; however, subjects are required to be intensively trained on recording, to have high literacy and high motivation. The latter requirements may not be feasible for a wide sector of the population which can render the sample nonrepresentative of the general population. Since this method is considered burdensome on subjects, the quality of the information recorded tends to drop with four or more days of recording (Frances E. Thompson & Subar, 2013). Moreover, since recording complex dishes can be difficult on subjects, they may change their dietary habits to ease the reporting (Watson, Collins, Sibbritt, Dibley, & Garg, 2009) or may falsely report "healthier foods" hence increasing social desirability reporting bias (Bliss,

2004; Trabulsi & Schoeller, 2001). Furthermore, several non-consecutive, random days representing different seasons are needed to arrive at useful estimates for the DRs to be correctly representative of usual intake (R. Lee & Neiman, 2007).

24-HR and DR are rarely used for dietary intake estimation in large scale epidemiological research secondary due to the high effort needed to collect and process multiple days of recalls or food records (W Willett, 1998). Alternatively, these methods are used to assess mean intake among smaller groups and in FFQs' validation studies. FFQs are currently the leading method for large-scale intake estimation (W. Willett, 2012).

c. Food Frequency Questionnaire

Food frequency questionnaires are developed to measure average long-term diet instead of providing short-term intake precise estimate (W. Willett, 2012). As compared to the 24- HR and the DR, the FFQ enables a much longer recall of food intake over the preceding few months or year.

i. Types of Food Frequency Questionnaires

Three different types of food frequency questionnaires exist depending on the way portion size information is collected. For qualitative food frequency questionnaires, no portion size information is collected. As for SQFFQs, the frequency of intake regarding standard portion size for each food listed ought to be reported by the respondent. Quantitative food frequency questionnaires ask the respondents to report portion size information (Sempos, 1992).

The SQFFQ is the mostly used version of this dietary assessment method

(Sempos, 1992). This is due to several reasons. First, they can estimate nutrients unlike qualitative FFQs. Second, SQFFQs can be self-administered in 15-20 minutes unlike lengthy interviews of quantitative FFQs. Third, self-administered SQFFQs can be used to assess the intake of large sample sizes as in cohort studies since they can be electronically delivered to the respondents (Sempos, 1992). Despite the numerous strengths of using FFQs, some limitations of this methodology exist. The quantification of portions and/or frequencies may be inaccurate with FFQ administration as it involves a long recall period (Illner et al., 2012).

2. The Importance of Validated Dietary Assessment Tools

Poor compliance and weak accuracy in the data collected is noted with using dietary assessment tools validated in other contexts. Consequently, developing dietary assessment tools specific to the target population are needed to properly assess the dietary intake of that population. To be culturally sensitive and agreeing with the basic food culture, validation of dietary assessment methods is better done by region (Torheim et al., 2001).

Using low validity dietary assessment methods in epidemiologic studies highly weakens nutritional intake- disease link; a problem referred to as regression dilution. For this reason, the use of valid dietary assessment tools is highly recommended for better association between nutritional intake and disease (Day et al., 2001).

a. Implementation in Research

Using a reproducible, valid, cheap, and unburdensome dietary assessment method is essential in research situations. They can also provide a satisfactory

estimation of long-term dietary intake given that a central feature of dietary intake states that an underlying consistent dietary pattern superimposes the day to day variations in intake (W. Willett, 2012). This fundamental rule is one the reasons why FFQ is the most commonly used dietary assessment method in epidemiological studies (Henríquez-Sánchez et al., 2009; W. Willett, 2012).

D. The Food Frequency Questionnaire

1. FFQs in Research

a. The Application of FFQs in Research

Using FFQs in epidemiological studies enables comparing average nutrient intake of different groups, ranking individuals within a group as well as estimating absolute levels of nutrient intake (Aydemir, 2002; Illner et al., 2012). Ranking individuals by relative levels of nutrient intake permits epidemiologists to evaluate etiological hypotheses and interactions. The FFQ comprises a list of foods for which the respondent is required to specify how often he/she eats from each as in x times per day/per week/per month or rarely/never (Janet Cade, Rachel Thompson, Victoria Burley, & Daniel Warm, 2002). Foods with similar nutritional qualities are grouped together for ease of use. FFQ lists can range from 40 to 200 food items and FFQs with longer lists were found to be more valid than shorter ones (W. Willett, 2012). Assessing nutrient intake among specific ethnic groups is more likely enhanced with using FFQs including ethnic foods pertaining to that group (Khokhar et al., 2009).

b. The FFQ as an Assessment Tool in Nutritional Research

Currently, the food frequency questionnaire is considered the most practicable and cost-effective method for collecting comprehensive dietary data in large-scale epidemiological studies (W. C. Willett & Hu, 2006). Methods that involve frequencies are considered useful in epidemiological studies since they can be used reliably among large study populations (Block, 1982; Subar, 2004). Hence, since FFQs can measure habitual intake, they can be useful for the estimation of the link between nutrient intake and disease and predict the health of both individuals and groups (W Willett, 1998) .

For all the previously mentioned advantages, mainly translation to nutrients, reflection of seasonal variation and ease of administration; FFQs have been more widely used in research than 24-HRs and DRs (M. Livingstone & Robson, 2000; Welch, Luben, Khaw, & Bingham, 2005). Hence, it may be beneficial to sacrifice specific dietary intake of few days for favor of cruder intake information on dietary intake over a longer period. This is especially advantageous when correlating dietary intake to long-latent diseases such as Non Communicable Diseases (W. Willett, 2012) .

After collecting the FFQ data, the reported foods are all summed up then multiplied by portion size, by intake frequency and by nutrient content per portion to estimate a daily intake of nutrients (Bliss, 2004).

2. Validity and Reproducibility

Accurately measuring diet aspect for which it has been developed to measure is referred to as validity which is an important aspect when using FFQs. Using invalid dietary assessment tools can result in incorrect information which can falsify the association between nutritional intake and diseases (Cade, Burley, Warm, Thompson, & Margetts, 2004). Validating FFQs against more detailed and accurate dietary intake

assessment methods ‘gold standard’ render them suitable for the assessment of long-term dietary intake at the food groups, macronutrient and micronutrient levels. This “gold standard”, although never perfect, is superior to the tool to be validated (Janet Cade et al., 2002; W Willett, 1998). Besides validity, reliability is another important trait of FFQs.

Another important aspect of a FFQ is whether it can produce reproducible results. The term reliability, in this context, refers to getting the same questionnaire measurement upon more than one administration at different times to the same person, especially knowing that no identical conditions exist on repeated measures (W. Willett, 2012) .

a. The Use of Reference Dietary Assessment Methods for Validation

Since there is no absolute truth in dietary assessment and no perfect assessment method exists, the measurement errors pertinent to the two methods to be compared should be as independent as possible. The reference dietary assessment method with the most uncorrelated error sources with the FFQ is the dietary record (W. Willett, 2012). Therefore, when deciding on a reference method to validate a FFQ, the first choice is ideally dietary records; however, dietary records are very demanding from the subjects, are likely to affect their actual diet and require high literacy and motivation for cooperation. Hence, the 24-HR is recommended for use when there are limited subjects’ literacy and cooperation even though this method, like FFQ, relies on memory and may involve distorted estimations of portion sizes of reported consumed foods and beverages (Hebert et al., 1999).

3. Available Validated FFQs for Adults

Over the past 15 years, several FFQs aiming at assessing the dietary patterns of numerous populations were developed and validated in different countries like USA, Colombia, Brazil, Jamaica, India, Turkey and several European regions (Bautista, Herrán, & Pryer, 2005; Gunes et al., 2015; Hebert et al., 1999; Sichieri & Everhart, 1998; F. E. Thompson et al., 2008; Torheim et al., 2001). In some countries, several FFQs are developed for the various populations like adults, children less than 5 years of age and children less than 10 years of age which emphasizes the high importance of tailoring FFQs that are specific to different population studies (Araujo, Yokoo, & Pereira, 2010; Fumagalli, Monteiro, Sartorelli, Vieira, & Bianchi, 2008; Mendes et al., 2011)

In the Middle East and North Africa region, FFQs were developed and validated for adults in countries like the Islamic Republic of Iran and the Kingdom of Saudi Arabia (Bijani et al., 2018; Gosadi et al., 2017; Malekshah et al., 2006). However, other countries like United Arab Emirates and Kuwait have developed culture-specific food frequency questionnaires that still need to be validated (Dehghan et al., 2005). In Lebanon, a FFQ was designed and validated to assess the dietary intake of Lebanese children; however, no valid FFQ specific to Lebanese adults exists to date (Moghames et al., 2016a).

a. Methodological Comparisons in Published FFQ Validation Studies

A summary of a sample of FFQ validation studies is depicted in Table 2.1. Overall, the studies included in Table 2.1 had a wide range of 60-966 adults enrolled. Three out of seven of the studies had a population less than 100 participants (Bautista et

al., 2005; Hebert et al., 1999; Sichieri & Everhart, 1998), and three studies had a number of participants between 100 and 200 (Bijani et al., 2018; Gosadi et al., 2017; Gunes et al., 2015) and the study that interviewed a large number of participants is the one conducted in a big nation, i.e. the USA (F. E. Thompson et al., 2008).

Of the seven studies summarized in Table 2.1, six used 24-hour recalls as a reference method to validate the FFQ. The number of days for the 24-hour recalls was two days in 3 out of 7 of the studies. While two studies validated the FFQ against four 24-hour recalls, only one study used one 24- hour recall (Bautista et al., 2005).

Cade et al. conducted a more formal review of 227 FFQ validation studies and found that 75% of the 227 FFQ validation studies of these 227 validation studies were validated against another dietary assessment method (Cade et al., 2004). The studies that utilized 24-HR as a reference method to validate their FFQ used 1 to 28 days of recall with a mode of one day (Table 2.1).

Table 2.1. Comparing Methodology of Globally Published FFQs Validated for Adults.

Reference	Questionnaires compared	Population
(F. E. Thompson et al., 2008)	124-item FFQ vs two consecutive 24-HRs	966 American adults (mean age of 66 years)
(Bautista et al., 2005)	60-item FFQ vs 7 days of weighed intake registry (7-WIR)	97 Colombian adults (20–40 years old)
(Gunes et al., 2015)	229-item FFQ vs four 24-HRs	120 Turkish adults (mean age 50 years)
(Hebert et al., 1999)	92-item FFQ vs two 24-HRs	60 Indian adults (mean age 33.7 years)
(Sichieri & Everhart, 1998)	61-item FFQ vs four 24-HRs	94 Brazilian adults
(Bijani et al., 2018)	138-item FFQ two 24-HRs	200 men and women of 68 years mean age
(Gosadi et al., 2017)	140-item FFQ vs one 24-HR	183 Saudi students studying at King Saud University in the Kingdom of Saudi Arabia

CHAPTER III

METHODS

A. Study Design and Sample Size

This was an observational cross-sectional study designed for the aims of developing, validating and testing the reproducibility of a Food Frequency Questionnaire (FFQ) against 12 Multiple Pass Food Recalls (MPRs) in a sample of Lebanese adults aged 18 – 65 years.

B. Ethics Approval

The study proposal was reviewed by the Institutional Review Board (IRB) of the Social and Behavioral Sciences at AUB and was given approval for a period of two years starting June 2016. A written consent form (Appendix I) was completed by each participant announcing his/her willingness to participate in the research project. The privacy and confidentiality of participants was conserved by designating random identifiers to the questionnaires and the MPRs to ensure subjects' anonymity. All consent forms, questionnaires and MPRs were stored in locked cabinets to which investigators had exclusive access to.

C. Study Participants

The study population in this research study is adults working in various faculties and offices at AUB. Eligible individuals who proved to meet the inclusion and exclusion criteria and who agreed to take part in this study signed a written consent form.

Inclusion criteria:

- Holding the Lebanese nationality or residing in Lebanon for more than 10 years
- Able to speak the Arabic language
- Aged between 18 and 65 years

Exclusion criteria:

- Students
- Non-Arabic speaking individuals
- Pregnant or breastfeeding women
- Individuals with chronic health conditions that require dietary modifications such as those diagnosed with eating disorders, diabetes, renal diseases, liver diseases, etc (Appendix III).

As for the sample size; for FFQ validation studies, it is considered appropriate to work on a sample size between 100 and 200 participants (WC. Willett, 1998). The dropout rate was at 4% according to a recent validation study conducted among a similar population (Moghames et al., 2016b). Thus, to account for potential dropout rates, a sample size of 120 individuals was recruited. This sample size has the potential to elevate the statistical power of the study, especially with the presence of intra- and inter- variability in dietary intake within and between participants respectively.

D. Study Protocol

Each participant was enrolled in this study for a total of 12 months which entailed 14 face-to-face interviews that took place in a private setting at AUB where participants were recruited. This private setting was either the participants' office or

NFSC department, room 520 (Clinical Research room) where the interviews took place. During the first interview, a socio-demographic questionnaire was conducted in addition to a lifestyle questionnaire and the first FFQ (FFQ-1). Also, in the first visit; anthropometric measurements of each participant were taken and recorded.

During each of the four seasons, all participants were approached to schedule face-to-face interviews at AUB to collect three random MPRs. The MPRs represented two weekdays and one weekend day per season, for a total of 12 days of MPRs. After 12 months, the participants were re-contacted for a face-to-face interview at AUB upon which the second FFQ (FFQ-2) was administered (Fig. 3.1). The seasons are defined as spring (March-May), summer (June-August), fall (September-November) and winter (December-February). Since non-compliance can bias the validation analyses, participants who fill out less than two MPRs per season or fail to complete both FFQs were considered as non-compliant and their data were excluded from the study analysis.

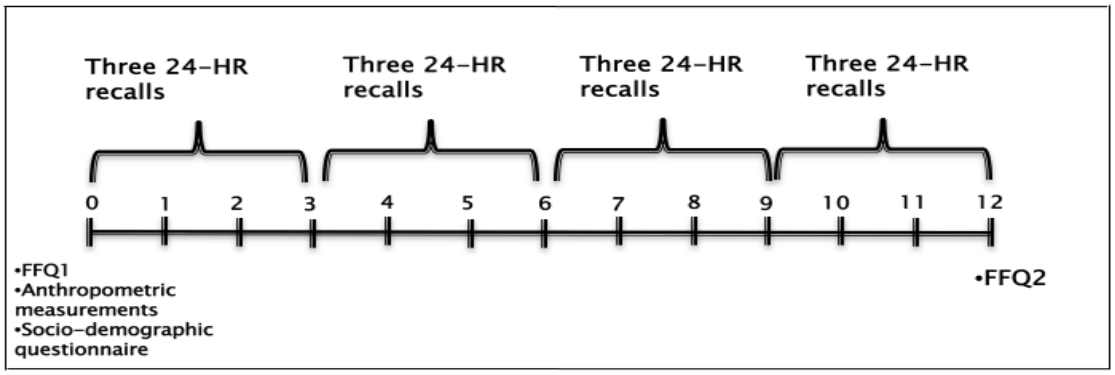


Figure 3.1. Schematic Representation of the Study Protocol for Data Collection for the Validation of a Developed FFQ for the Assessment of Dietary Intake Among Lebanese Adults.

E. Recruitment Strategy

Participants were invited to the study via several methods from verbal announcements during departmental or office general meetings to using flyers distributed everywhere on campus. In addition, flyers were posted in the entrance of all academic faculties and departments at AUB, student and staff cafeteria, post office and physical plant. The posting of flyers took place in coordination with the administration of each of these academic/administrative units. Serious efforts were made to recruit a study population from across all departments and offices at AUB. A trained research assistant certified by the Collaborative Institutional Training Initiative (CITI) for ethical research conduct contacted interested faculty and staff members for briefing them about the purpose of the study, assuring their qualification, and finally recruiting them in the study (Fig. 3.2).

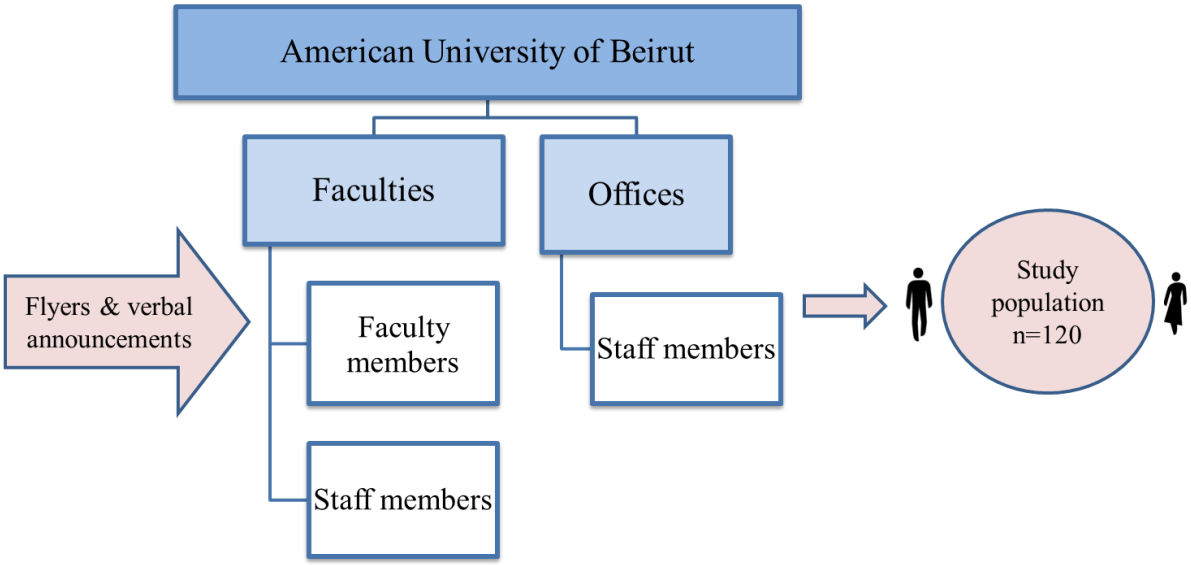


Figure 3.2. Strategy Adapted to Recruit Participants in the Study Validating a FFQ Among Lebanese Adults.

F. Data Collection

1. Socio-Demographic Questionnaire

The socio-demographic questionnaire included information about the participant's age, gender, education, marital status, occupation, and crowding index (Appendix IV).

2. Lifestyle Questionnaire

The lifestyle questionnaire inquired into the smoking and physical activity habits of the participants (Appendix IV).

- Current and past smoking habits (cigarettes, narghile, and cigars) were assessed. The number of cigarettes or cigars smoked per day, week, or month were reported. As for the use of narghile, the duration of smoking was evaluated by the number of minutes per day, week, or month.
- Physical activity habits were assessed using questions and scoring methods set by the Arabic version of the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003).

3. Anthropometric Assessment

Anthropometric measurements of participants were obtained using standardized techniques and calibrated equipment. The weight scale (SECA 877) and stadiometer (SECA 213) were used to measure weight (kg) and height (cm), respectively. Before measuring the weight, study subjects were requested to take off their shoes and as much outerwear as possible. Participants were weighed to the nearest 0.1 kg. As for their heights, they were measured to the nearest 0.1 cm with the subjects barefoot. Then

Body mass index (BMI) was calculated as weight (kg)/height (m^2). All measurements were conducted in duplicates and the averages were used (Appendix IV).

4. Dietary Intake Assessment

a. Development of the FFQ

A 4-page semi-quantitative FFQ was designed to assess the dietary intake per energy and nutrients among adults in Lebanon. The FFQ includes three sections: the food list, the portion size, and the frequency response (Appendix V).

i. Food List

To compile the food list, the following approaches were adopted: 1) A review of 24-HRs (n=200) previously collected in a sample of Lebanese adults as part of a national study conducted in Lebanon (Lara Nasreddine et al., 2012). Frequently cited (>5%) food items were included in the food list of the developed FFQ; 2) The developed food list was reviewed by a panel of experts which included licensed dietitians and a gastroenterologist, who are familiar with the common dietary habits among Lebanese adults; 3) A convenience sample of 30 adults who is similar in characteristics to the target population checked the food items list to examine if the food list is clear, comprehensive, and culturally convenient; 4) The food list was also compared to previously published FFQs, mainly FFQs validated in the region. Food items were listed using generic names and, in several cases, foods with similar nutritional characteristics/culinary use were assembled together for lucidity and ease of conduction.

The FFQ food list was composed of 94 food items categorized into 23 food groups:

Cereals and Cereals-Based Products – Pasta and Other Cereals – Potatoes and Potato Based Products – Vegetables – Fruits – Fresh Fruit Juices – Meat (Cured meat, meat, offals) – Poultry – Eggs– Fish and Seafood – Pulses –Nuts and Seeds – Milk and Dairy Products – Yogurt and Yogurt Based Products – Pizza and Pies – Mixed Dishes (vegetable based dishes) – Fats and Oils (Added on breads, Used in frying) – Sugar and Sugar Derivatives – Cakes and Pastries – Honey, Jam, Molasses, Pudding, Ice cream and Halawah – Alcoholic Beverages – Non- Alcoholic Beverages– Miscellaneous.

ii. Portion Sizes

As for portion size, subjects were given the option to express the portion size in terms of common household measurements (teaspoons, tablespoons, and cups) as well as standardized food portions for customary sized food items common in the Lebanese market. A standard two-dimensional (2-D) food portion visual chart was utilized to assist in quantifying the reference portion size. This chart has been developed by Nutrition Consulting Enterprises and validated for use amongst adults aged 20 to 70+ years as part of the Framingham Heart Study, especially for telephone dietary interviewing (Posner et al., 1992).

iii. Frequency

The participant's food intake frequency was indicated by how many times per day, week, or month he/she has consumed each food item during the previous year. The frequency of intake of foods seldom or never consumed was also indicated. In addition,

the amounts of fruits and foods whose intake varies throughout the year, such as ice cream and hot beverage, was seasonally adjusted, if applicable.

b. Administration of Dietary Assessment Methods

i. Food Frequency Questionnaires

During the interview for the FFQ data collection, the research assistants questioned the participants about their consumption of each food item over the past 12 months. If the item was consumed, the usual portion size intake and the frequency of the food consumed was noted down. The developed FFQ also includes an open-ended section in which the participants can indicate their intake of further foods or beverages that they routinely consume at least once a week and that are not included in the FFQ's food list.

ii. 24-Hour Recalls

In most cases, twelve 24-HRs were collected per participant, divided into sets of three 24-HRs per season (Appendix X). The 24-HRs were collected using the Multiple Pass Food Recall (MPR) 5-step approach, developed by the United States Department of Agriculture (USDA) (Moshfegh et al., 2008). The steps to collect the 24-HRs using the MPR approach include 1) quick food list recall, 2) forgotten food list probe 3) time and occasion at which foods were consumed, 4) detailed overall cycle and 5) final probe review of the consumed foods. The research assistants asked about information related to the time of intake of each food item, the type of food consumed, its portion size, preparation methods and the brand of the foods/ beverages/ supplements consumed. The participants were not informed of the day of the MPRs' interviews ahead of time,

therefore, they were contacted on the same day of the encounter for them to maintain their usual unbiased food intake to avoid getting socially desirable answers. The intake estimates as measured by the twelve MPRs were used as reference methods to validate the FFQ.

The administration of both the FFQs and MPRs was done by trained research assistants. This is favorable since nutritional assessment necessitates specialist training and correlation coefficients were reported to be higher for interviewer-based FFQs when compared with self-administered ones (Cade et al., 2004). Self-administered FFQs require accurate preparation, pre-testing and high literacy skills and encouragement. Self-administered FFQs may also be associated with a high number of incomplete answers which may lead to an increased exclusion rate (JE. Cade, R. Thompson, V. Burley, & D. Warm, 2002). In addition, it was made sure that same in-person approach in data collection was used to reduce potential bias from use of in-person versus phone administration of both FFQs and 24-HRs.

A 2D food portion visual chart (Appendix VIII) was used in both the MPRs and FFQs data collection to aid participants in estimating the exact portion size they consumed. This chart has been validated for use with adult men and women 20 to 70+ years of age as part of the Framingham Heart Study especially for the use of telephone dietary interviewing (Posner et al., 1992). Standardized portion sizes were also used for specific foods such as breads, potatoes, eggs, tuna cans, chocolate bars, croissants, chips bags and manakich, to name a few.

G. Data Analysis

1. Analysis of Food Items into Energy and Nutrients

As for the FFQ nutrients intake, the frequency per day of each food item consumed was multiplied by its portion size to calculate the total amount in grams of food intake per day, and consequently the total energy, macronutrients and micronutrients consumed per day (Bingham et al., 1994).

Food items collected from the MPR were analysed using the Nutritionist Pro software (version 1.2, 2002, First Data Bank, Nutritionist Pro, San Bruno, CA). Nutritionist Pro software uses a nutrient database from the Continuing Survey of Food Intake of Individuals released in 2002 (Spencer, Elon, Hertzberg, Stein, & Frank, 2005). Lebanese composite dishes recipes using single food items from the USDA database were added to the Nutritionist Pro software, in order to cover Lebanese traditional foods commonly consumed among our target population. All food items from Nutritionist Pro software were extracted into an excel sheet and were given a code like the codes used in the FFQ. For each subject, the average amount of energy and macronutrients and micronutrients were calculated. After that, information obtained were extracted with others into SPSS for analysis.

Statistical data analysis was done to assess the validity and reproducibility of the FFQ by energy, the macronutrients (carbohydrates, sugar, proteins, fats, cholesterol, saturated fat, polyunsaturated fats, monounsaturated fat and dietary fibers) and selected micronutrients namely the minerals sodium, potassium, calcium, iron, phosphorous, magnesium, zinc, and manganese and the vitamins/vitamin precursors vitamin A (RE), vitamin C, vitamin D, thiamin, riboflavin, niacin, pyridoxine, folate, cobalamin, biotin, beta-carotene, alpha-carotene, alpha- tocopherol and alpha- carotene.

2. Statistical Analysis

Statistical analysis was done using Statistical Package for Social Sciences 19.0 (SPSS for Windows, Version 19.0, Chicago: SPSS Inc.).

Means and standard deviations were calculated for all continuous variables in the socio-demographic and anthropometric questionnaire. On the other hand, categorical variables were taken as frequencies. Validity and reliability statistics were performed on percent energy intake and total amount of nutrients consumed per day.

a. Validity Statistics

i. Mean Difference and Correlation Coefficients

Mean of the FFQ-2 and the MPRs were calculated. Mean difference of the two methods (FFQ-2 minus the mean of the MPRs) was also calculated as was the percent mean difference $\left(\frac{FFQ2-mean\ MPRs}{mean\ \ MPRs} \times 100\right)$ for energy and nutrients' intake.

Despite it is useful to compare means of both methods, providing data on the associations between the intake measured by the 2 methods is also important (W Willett, 1998). Spearman's correlation coefficient and agreement between FFQ-2 and MPRs were calculated to validate this FFQ since correlation coefficients were the most commonly used statistical method in 168 (83%) of validation studies (Janet Cade et al., 2002). Individuals can be ranked similarly by Spearman's **c**orrelation coefficients which measure the strength and direction of the association between two different measurements at individual level (Verger et al., 2017). Spearman's **c**orrelation coefficients were computed for energy and nutrients' estimates between the FFQ and the MPRs. To identify associations between dietary intake with health and disease, a correlation coefficient approved for validity ranges should not be below 0.3 or 0.4

(Janet Cade et al., 2002). The strength of relation between the two methods, but not the agreement, can be measured by correlation coefficients (r) (Bland & Altman, 1986). To better assess agreement between the two methods, the Bland-Altman statistical method was used.

ii. Bland-Altman Method

It is important to measure the agreement between a new assessment technique and an established one across the range of intake in order to compare both methods (Bland & Altman, 1986). A review of 210 agreement studies found that the Bland-Altman method was used in 85 % of the studies as an agreement measure (Zaki, Bulgiba, Ismail, & Ismail, 2012). Bland-Altman method is used to assess whether the difference between the methods is the same across range of intake, and whether the extent of agreement differs for high intake compared with low intake (Cade et al., 2004). The differences between observations on the same subject were used by Bland-Altman method which enables graphically plotting them against the average of both methods per subject. The Bland-Altman method also helps determine if there is any bias (systematic difference) between compared methods, and the extent of agreement of the two administrations (Limits of agreement LoA) (Cade et al., 2004).

The use of the LoAs allows the assessment of the extent of agreement'/disagreement of the two methods. Wide limits indicate the presence of an overall bias (Bountziouka & B Panagiotakos, 2010).

The LoAs are two values that 95% of the differences between the two methods should lie between. LoAs are calculated as:

$mean\ difference - 1.96 \times\ 2\ standard\ deviation$ and $mean\ difference + 1.96 \times$

$2\ standard\ deviation$. A p value less than 0.05 was considered statistically significant.

b. Reproducibility Statistics

i. Intraclass Correlation Coefficient

The Intraclass Correlation Coefficient (ICC) is used to describe the degree of resemblance between units in the same group. The ICC differs from other correlation coefficients in that it allows the analysis of data structured as groups, rather than data structured as paired ones. ICC estimates the differences between the two administrations of the FFQ within the subjects and not those among the observers (Bountziouka & B Panagiotakos, 2010). However, using solely the ICC is not enough since it ignores ordering variances and instead treats the two administered FFQs (1, 2) as two random instruments rather than specific methods (Zaki et al., 2012). Hence, weighted kappa statistic was used.

ii. Kappa Test

The Kappa test is used to measure the agreement between two or more observers in assigning the data into different categories. In the present study, weighted Kappa (κ w) was administered instead of Kappa to see the degree of closeness and difference of the ratings of the two methods. κ w was used to examine how well the FFQ-1 can categorize individuals into quartiles of the energy and nutrients' intake when compared with the FFQ-2. According to Landis & Koch (1977), Kappa values were classified for strength of agreement according to the following ranges: 0.21 to 0.40 are considered fair, 0.41 to 0.60 moderate, 0.61 to 0.80 substantial and 0.81-1 almost perfect (Landis &

Koch, 1977).

Percent agreement was calculated as quartiles:

number of subjects in quartiles 1-1,1-2 + number of subjects in quartile 2-1,2-2,2-3 + number of subjects in quartile 3-2,3-3,3-4 + number of subjects in quartiles 4-3,4-4 / n=110.

H. List of Variables Used in the Analysis

Variables of interest for the present analysis were derived from the first visit, the MPRs and the FFQs. Description of variables used in this study is shown in Table 3.1.

Table 3.1. List of Variables Used in the Analysis

Variable	Type	Description/Coding
Socio-demographic variables		
participant's age (years)	Continuous	
participant's age (years)	Categorical	1= 23-30 years 2= 31-40 years 3= 41-50 years 4= ≥ 51 years
Sex of the participant	Categorical	1=Male 2=Female
BMI	Categorical	1= <18.5 Underweight 2= 18.5-24.9 Normal 3= 25-29.9 Overweight 4= 30-34.9 Obesity class1 5= ≥35 Obesity class 2
Governorate	Categorical	1=Beirut 2=Mount Lebanon 3=South 4=Nabatiyeh 5=North 6=Bekaa
Marital status of the participant	Categorical	1=single 2=married 3=widowed 4=divorced
Educational level of the participant	Categorical	1=no schooling

		2=primary school 3=intermediate school 4=high school 5=technical diploma 6=university degree
Specialized in health-related major	Categorical	1=Yes 2=No 3=Not applicable
Occupation	Categorical	1=Academic, full time 2=Academic, part time 3=Non-academic, full time 4=Non-academic, part time 5=other
Crowding Index	Categorical	1=≥1 2=<1
Do you own the house you currently live in?	Categorical	1=Yes 2=No
How many cars does your household own?	Categorical	0=0 1=1 2=2 3= ≥3
Monthly Income	Categorical	1=<600,000L.L 2=600,000-999,999 L.L 3=1,000,000-1,499,000L.L 4=1,500,000-1,999,000L.L 5=2,000,000-2,499,000L.L 6=2,500,000-2,999,000L.L 7=>3,000,000 L.L

CHAPTER IV

RESULTS

A. Descriptive Characteristics of Study Participants

The number of participants who consented to participate in the study was 120 subjects; however, 10 subjects dropped out hence 110 participants completed the study as depicted in Table 4.1. The main reasons for drop outs were either that subjects were so hard to reach which hindered completing a minimum of two MPRs, or left AUB or American University of Beirut Medical Center (AUBMC) institution during the one year study period hence were no longer eligible to stay in the study, or were not very cooperative in terms of arranging a meeting with the research assistants. Table 4.1 describes the socio-demographic characteristics of the study population. Of the 110 Lebanese adults participating in the study, 67 (60.9 %) were males and 43 (39.1%) were females. The age of the participants ranged between 18 and 65 years among which 43% are below the age of 35 years. Of the participants, 72.7 % were either overweight or obese and 76.4 % of the participants reached an educational level of high school and above. Of the participants, 31.8 % worked in health-related jobs and 85.4 % were non-academic AUB/AUBMC staff members. The crowding index was greater than 1 for 52.7 % of the participants and 68.2 % of the subjects owned the house they were residing. All the participants owned at least one car in their household and only 15.5 % owned three or more cars. The total monthly income of the participants exceeded 2000 USD for half of them.

As related to lifestyle practices, 54.5 % of the participants reported to be smokers with an average mean of 10.99 ± 1.01 years of smoking. For physical activity, results showed that 23.6 % of the participants were engaged in low intensity physical activity while only 10.9 % reported to perform high intensity physical activity and more than half had a moderate intensity physical activity (Table 4.1). There were notable differences between females and males with respect to sociodemographic characteristics. The mean age of the females was less than that of males; more males were in the overweight and the obesity ranges while males reported to be more physically active than females (Table 4.1). The percentage of males who smoked was greater than that of females. Compared to males, females had both higher academic achievements and higher household incomes.

Table 4.1. Socio-Demographic Characteristics and Lifestyle Characteristics of the Study Population by Gender[a]

Variables	**n(%)**			
Socio-demographic variables	Total n=110	Males N=67 Mean ±SE	Females N=43 Mean ±SE	Significance[b]
Age (years)	38.75± 0.91	41.28±9.88	34.81± 7.70	**P=0.000**
Age categorized				
<35 years	43 (39.1)	19(28.4%)	٢٤(55.8)	X^2=11.120
35-45 years	34 (30.9)	21 (31.3)	13 (30.2)	**P=0.004**
>45 years	33 (30.0)	27 (40.3)	6 (14)	
BMI (kg/m^2)				
18.5-24.9 Normal	30 (27.3)	6 (9)	24 (55.8)	X^2=29.058,
25.0-29.9 overweight	44 (40)	33 (49.3)	11 (25.6)	**P=0.000**
≥30 obese	36 (32.7)	28 (41.8)	8 (18.6)	
Governorate				
Beirut	49 (44.5)	24 (35.8)	25 (58.1)	X^2=5.281,
Outside Beirut	61 (55.5)	43 (64.2)	18 (41.9)	**P=0.022**
Marital status				
Single, Widowed, Divorced	47 (42.7)	20 (29.9)	27 (62.8)	X^2=11.613,
Married	63 (57.3)	47 (70.1)	16 (37.2)	**P=0.001**
Education level				
Up to intermediate school	26 (23.6)	22 (32.8)	4 (9.3)	X^2= 16.437

High school	15(13.6)	13(19.4)	2(4.7)	**P=0.000**
University/technical diploma	69(62.7)	32(47.8)	37(86.0)	
Specialized in health related major (medicine, public health, nutrition, pharmacy, etc.)				
Yes	35 (31.8)	19 (28.4)	16 (37.2)	X^2=2.689, P=0.261
No	74 (67.3)	48 (71.6)	26 (60.5)	
Not applicable	1 (0.9)	0(0)	1 (2.3)	
Occupation				
Academic	16 (14.5)	5 (7.5)	11 (25.6)	X^2=6.917, **P=0.009**
Non- Academic	94 (85.5)	62 (92.5)	32 (74.4)	
Crowding Index (CI)				
<1	52 (47.3)	28 (41.8)	24 (55.8)	X^2=2.066, **P=0.151**
≥1	58 (52.7)	39 (58.2)	19 (44.2)	
Do you own the house you currently live in?				
Yes	75 (68.2)	44 (65.7)	31(72.1)	X^2=0.498, **P=0.480**
No	35 (31.8)	23 (34.3)	12 (27.9)	
How many cars does your household own?				
≤1	58 (52.7)	43 (64.2)	15 (34.9)	X^2=9.027, **P=0.011**
2	35 (31.8)	16 (23.9)	19 (44.2)	
≥3	17 (15.5)	8 (11.9)	9 (20.9)	
Total monthly income?				
Below 3,000,000LL (2000$)	55 (50.0)	41 (61.2)	14 (32.6)	X^2= 8.591, **P=0.003**
Above 3,000,000LL (2,000$)	55 (50.0)	26 (38.8)	29 (67.4)	
Lifestyle practices –smoking				
Current smoker				
Yes	60 (54.5)	44 (65.7)	16 (37.2)	**P=0.003**
No	50 (45.5)	23 (34.3)	27 (62.8)	
How long have you been a smoker (Years)n=60	10.99±1.01	11.38±7.99	9.94±7.27	**P= 0.532**
Lifestyle practices –Physical Activity				
Low- intensity activity	26(23.6)	12 (17.9)	14 (32.6)	X^2=3.413, **P=0.181**
moderate- intensity activity	72 (65.5)	48 (71.6)	24 (55.8)	
high- intensity activity	12 (10.9)	7 (10.4)	5 (11.6)	

[a] Categorical variables are reported as N(%): frequency and percentage within column; continuous variables are reported as Mean ± SD. SD: Standard deviation.

[b] Significant differences between males and females; p value was derived from chi-square for categorical variables and from independent t test for continuous variables.

BMI: body mass index (kg/m^2)

18.5-24.9 Normal, 25.0-29.9 Overweight, ≥30 Obese

SE: standard error

CI: Crowding Index

B. Relative Validity of the Questionnaire (Comparison with the Mean of 8-12 MPRs)

Table 4.2 reports the mean, mean difference and percent mean difference of energy and nutrients' intake estimated by FFQ-2 and the average of the 8-12 MPRs. The mean caloric intake for the adults enrolled in the study sample measured by FFQ-2 was found to be ٢٣٨٥.٧١±٩٩٣.٦٥ kcal. On the other hand, the mean caloric intake of 8-12 MPRs across the study sample was ٢٠٢٥.٠٢±٦٥٧.٢٧ kcal. Therefore, the mean difference between the estimations from the two methods was ٣٦٠.٦٩±٦٨٥.٨٣ kcal with a percent mean difference of ١٩.٦٦ %. The same variables were calculated for a list of selected nutrients depicted in Table 4.2.

A positive percent mean difference indicated an overestimation while a negative percent difference implied that the FFQ underestimated nutrient intake as compared to the MPRs. The results indicated that the FFQ overestimated the intake of all macronutrients with a wide range between 82.12 % and 2.4% for total fat and protein intake respectively. As for micronutrients, the FFQ overestimated 17 out of 22 studied micronutrients. Among the overestimated micronutrients, vitamin C was overestimated by the highest percentage of 254.76% while calcium was the least overestimated by 4.5%. The intake of only few nutrients were underestimated by FFQ as compared with the mean of the MPRs; namely the macronutrients cholesterol (%) and saturated fats and the micronutrients vitamin A (RE), sodium, beta-carotene, alpha-carotene, riboflavin, niacin and cobalamin.

Table 4.2. Intake of Energy and Nutrients According to FFQ-2 and the Mean of MPRs for Comparative Validity

Nutrient	Mean FFQ-2 ± SD	Mean MPR ± SD	Mean difference ± SD	Percent mean difference (%)
Energy (Kcalories)	٢٣٨٥.٧١±٩٩٣.٦٥	٢٠٢٥.٠٢±٦٥٧.٢٧	٣٦٠.٦٩±٦٨٥.٨٣	١٩.٦٦±٣٦.٤١
Protein (%)	٣.٧٨±١.٠٩	٣.٧٤±٠.٨١	٠.٠٣٥±٠.٩٦	٢.٤±٢٦.٠٣
Proteins (g)	88.96±40.81	74.50±26.18	14.46±33.31	22.10±46.69
Carbohydrate (%)	١٢.٢٦±٣.٥٥	10.90±1.63	1.36±3.07	12.71±28.60
Carbohydrate (g)	285.58±127.19	218.37±71.64	67.21±100.61	33.71±51.46
Fat, Total (%)	5.03±1.61	4.57±0.79	0.45±1.43	10.37±32.35
Fat, Total (g)	116.67±53.76	90.10±27.99	25.68±47.39	82.12±124.33
Cholesterol (%)	10.66±7.50	11.65±6.35	-1.0±5.80	-1.0±47.07
Cholesterol (mg)	249.47±178.88	233.27±144.11	16.20±137.86	18.46±70.33
Saturated Fat (%)	1.02±0.37	1.18±0.24	-0.17±0.36	-12.55±30.28
Saturated Fat (g)	20.08±12.77	23.62±7.81	0.46±12.24	7.16±54.05
Monounsaturated Fat (%)	1.79±0.67	1.73±0.45	0.060±0.60	5.22±34.04
Monounsaturated Fat (g)	41.87±21.36	34.38±12.42	7.50±17.77	24.57±52.39
Polyunsaturated Fat (%)	1.20±0.47	1.01±0.23	0.19±0.42	20.15±41.03
Polyunsaturated Fat (g)	28.20±14.10	20.05±6.71	8.15±12.75	43.08±63.79
Dietary Fiber, Total (g)	24.13±11.22	18.26±6.63	5.88±9.06	2.90±12.03
Sugar, Total (%)	3.89±1.95	3.62±1.37	0.27±1.70	10.28±50.83
Sugar, Total (g)	88.90±52.32	70.81±27.37	18.10±45.73	31.19±74.28
Sodium (mg)	2264.85±1095.82	2460.02±776.84	-195.17±846.54	-8.27±31.58
Potassium (mg)	3062.19±1313.76	2415.47±762.57	646.72±1091.29	30.48±47.59
Vitamin A (RE)	525.74±415.34	1015.73±633.92	-489.98±648.12	-35.59±44.84
Beta-Carotene (µg)	1985.63±1205.87	3657.73±2149.02	-1672.10±2097.41	-10.39±16.28
Alpha-Carotene (µg)	76.98±45.16	425.47±499.81	-348.49±492.42	-143.67±223.59
Vitamin C (mg)	250.89±99.40	81.20±35.11	169.70±94.83	254.76±172.11
Calcium (mg)	811.0±375.36	791.62±260.48	19.38±327.57	4.50±41.36
Iron (mg)	15.60±6.67	12.78±4.82	2.82±5.90	28.82±50.47
Vitamin D (µg)	2.12±1.96	1.29±1.11	0.83±1.48	141.28±317.0
Alpha-Tocopherol (mg)	14.25±7.23	10.25±4.25	4.0±6.12	8.16±15.20
Thiamin (mg)	1.37±0.57	1.27±0.47	0.10±0.42	11.86±36.0
Riboflavin (mg)	1.55±0.73	1.78±1.00	-0.23±0.95	-0.78±47.36
Niacin (mg)	22.30±11.43	60.60±84.33	-38.30±82.82	-8.80±62.21
Pyridoxine (Vitamin B6) (mg)	1.95±1.00	1.57±0.59	0.38±0.84	32.70±62.57

Folate (Total) (µg)	395.52±185.0	318.0±111.67	76.66±155.01	29.60±53.13
Folate (DFE)	422.23±201.81	323.20±114.11	99.04±167.30	28.81±51.98
Cobalamin (Vitamin B12) (µg)	4.36±3.39	5.27±5.57	-0.91±6.0	-37.88±128.87
Biotin (µg)	17.32±9.86	15.41±6.94	1.91±8.65	19.82±62.27
Phosphorus (mg)	1503.39±750.00	992.52±355.45	510.90±661.70	56.81±70.02
Magnesium (mg)	331.78±129.70	278.91±89.19	52.87±101.51	22.24±41.14
Zinc (mg)	12.72±5.87	9.20±3.47	3.52±4.97	44.98±61.74
Manganese (mg)	4.07±1.72	3.57±2.20	0.48±2.19	22.89±44.22

Table 4.3 shows the correlation coefficients for comparative validity between FFQ-2 and the mean of 8-12 MPRs. Spearman's correlation coefficients for energy macronutrients and selected micronutrients were statistically significant. The values of Spearman's correlation coefficients for energy and macronutrients ranged from 0.370 for percent saturated fat ($p<0.01$) to 0.694 for total energy intake ($p<0.01$). Spearman's correlation coefficient values for the micronutrients ranged from 0.239 for alpha-carotene ($p<0.05$) to 0.672 for sodium ($p<0.01$). Energy and all assessed nutrients except for cobalamin, alpha_carotene and vitamin C showed a Spearman's correlation coefficient ≥ 0.3.

Table 4.3. Spearman's Correlation Coefficients for Energy and Nutrients Intake Obtained Using FFQ-2 and the Average of MPRs for Comparative Validity

Nutrient	Spearman's r
Energy (kcalories)	0.694**
Protein (%)	0.406**
Protein (g)	0.616**
Carbohydrate (%)	0.456**
Carbohydrate (g)	0.581**
Fat, Total (%)	0.460**
Fat, Total (g)	0.565**
Cholesterol (%)	0.482**

Cholesterol (mg)	0.579**
Saturated Fat (%)	0.370**
Saturated Fat (g)	0.453**
Monounsaturated Fat (%)	0.474**
Monounsaturated Fat (g)	0.629**
Polyunsaturated Fat (%)	0.510*
Polyunsaturated Fat (g)	0.578**
Dietary Fiber, Total (g)	0.610**
Sugar, Total (%)	0.560**
Sugar, Total (g)	0.497**
Sodium (mg)	0.672**
Potassium (mg)	0.559**
Vitamin A (RE)	0.357**
Beta-Carotene (μg)	0.309**
Alpha-Carotene (μg)	0.239*
Vitamin C (mg)	0.333**
Calcium (mg)	0.564**
Iron (mg)	0.590**
Vitamin D (μg)	0.527**
Alpha-Tocopherol (mg)	0.605**
Thiamin (mg)	0.654**
Riboflavin (mg)	0.555**
Niacin (mg)	0.441**
Pyridoxine (Vitamin B6) (mg)	0.400**
Folate (Total) (μg)	0.560**
Folate (DFE)	0.585**
Cobalamin (Vitamin B12) (μg)	0.273**
Biotin (μg)	0.562**
Phosphorus (mg)	0.546**
Magnesium (mg)	0.635**
Zinc (mg)	0.559**
Manganese (mg)	0.642**

** P value < 0.05; ** P value < 0.01*

The mean difference, 95% limits of agreement (LoA), slope and confidence intervals for energy and assessed nutrients are presented in Table 4.4. Mean agreement/difference indicates how well the FFQ and MPRs agree on average. The LoAs provide information on the degree of errors between methods, the direction of the bias between methods and whether the bias is constant across levels of intake (Bland & Altman, 1986). For example, LoAs of -1010.97 kcal to 1732.35 kcal suggests that 95% of the differences in energy intake between FFQ-2 and mean of MPRs lie within this range (Table 4.4).

Agreement consistency was examined across the range of intake for energy each of the studied nutrients. This was done through estimating the regression slope of differences (β) between the FFQ and mean of the 8-12 MPRs summarized in Table 4.4. This method regressed the average of the FFQ and the MPRs on their differences (Bland & Altman, 1999). For energy and macronutrients, the slopes ranged between 0.277 for cholesterol (mg) and 0.727 for polyunsaturated fatty acid (g). As for the assessed micronutrients, the regression slope ranged between -0.998 for vitamin D (µg) and 0.793 for vitamin C (mg). The signs of the slopes indicate the directions of the regression lines and whether the nutrient is overestimated or underestimated by the FFQ as compared with the mean of the MPRs. Findings show that all the resulting slopes of the regressions lines were positive for energy and the majority of the nutrients (all except for beta-carotene, alfa-carotene, vitamin D, niacin, riboflavin and manganese), suggesting that there is at least a considerable fraction of the study participants who overestimate their dietary intake on the FFQ relative to the mean of the MPRs.

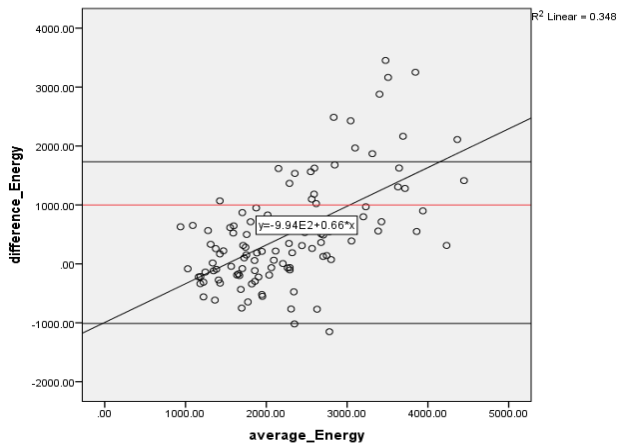
Table 4.4. Mean Difference, 95% Limits of Agreement (LoA) and Regression Slope of Differences of FFQ-2 Against the Mean of 8-12 MPRs for Energy and Nutrient Intake for Assessment of Relative Validity.

Nutrient	Mean Difference	95% LoA[a]		Beta / Slope[b]	Intercept	P value[c]	Confidence Interval[d]
Energy (Kcalories)	360.6855	-1010.97	1732.35	0.526	-673.55	0.000	0.324,0.614
Protein (%)	0.0351	-1.89	1.960	0.327	-1.386	0.000	0.169,0.586
Protein (g)	14.46	-3.20	4.72	0.491	-30.137	0.000	0.361,0.730
Carbohydrate (%)	1.364	-4.781	7.51	0.706	-9.573	0.000	0.764,1.126
Carbohydrate (g)	67.21	-134.008	268.428	0.609	-104.067	0.000	0.511,0.849
Fat, Total (%)	0.4548	-2.40	3.31	0.658	-3.866	0.000	0.703,1.097
Fat, Total (g)	25.68	-69.10	120.45	0.622	-60.069	0.000	0.628,1.024
Cholesterol (%)	-0.982	-12.50	10.54	0.219	-3.205	0.022	0.030,0.369
Cholesterol (mg)	16.1966	-259.51	291.91	0.277	-46.465	0.003	0.088,0.431
Saturated Fat (%)	-0.1659	-0.88	0.55	0.431	-0.830	0.000	0.363,0.845
Saturated Fat (g)	0.46	-24.02	24.94	0.483	-15.870	0.000	0.448,0.921
Monounsaturated Fat (%)	0.0609	-1.14	1.26	0.411	-0.838	0.000	0.295,0.727
Monounsaturated Fat (g)	7.4944	-28.05	43.03	0.565	-17.949	0.000	0.481,0.853
Polyunsaturated Fat (%)	0.1939	-0.64	1.03	0.662	-0.814	0.000	0.713-1.106
Polyunsaturated Fat (g)	8.1532	-17.34	33.64	0.727	-14.854	0.000	0.782,1.126
Dietary Fiber, Total (g)	5.8799	-12.25	24.01	0.563	-7.612	0.000	0.459,0.815
Sugar, Total (%)	0.2727	-3.13	3.68	0.388	-1.437	0.000	0.249,0.661
Sugar, Total (g)	18.0952	-73.37	109.56	0.622	-46.946	0.000	0.619,1.010
Sodium (mg)	-195.17	-1888.25	1497.91	0.415	-1171.11	0.000	0.240,0.586
Potassium (mg)	646.7169	-1535.86	2829.29	0.567	-1184.12	0.000	0.483,0.854
Vitamin A (RE)	-489.9849	-1786.22	806.25	0.415	-4.80	0.000	-0.893,-0.366
Beta-Carotene (μg)	-1672.1007	-10670.53	7326.33	-0.542	633.249	0.000	-1.059,-0.575
Alpha-Carotene (μg)	-348.4861	-1333.33	636.36	-0.984	128.100	0.000	-1.962,-1.833
Vitamin C (mg)	169.6890	-19.97	359.35	0.793	-47.308	0.000	1.115,1.499
Calcium (mg)	19.3759	-635.77	674.52	0.400	-358.032	0.000	0.265-0.677
Iron (mg)	2.8208	-8.96	14.61	0.361	-3.189	0.000	0.215-0.632
Vitamin D (μg)	-46.7330	-133.04	39.57	-0.998	1.281	0.000	-1.908,-1.860
Alpha-Tocopherol (mg)	3.9998	-8.24	16.24	0.551	-4.127	0.000	0.472,0.855
Thiamin (mg)	0.1048	-0.74	0.95	0.244	-0.180	0.010	0.052,0.380
Riboflavin (mg)	-0.2331	-2.12	1.66	-0.341	0.490	0.000	-0.664,-0.206
Niacin (mg)	-38.3027	-203.95	127.34	-0.965	37.597	0.000	-1.926,-1.737
Pyridoxine (Vitamin B6) (mg)	0.3844	-1.49	2.26	0.510	-0.869	0.000	0.484,0.942
Folate (Total) (μg)	76.6624	-233.35	386.67	0.533	-146.757	0.000	0.437,0.817
Folate (DFE)	99.0395	-235.55	433.63	0.587	-160.728	0.000	0.514,0.880
Cobalamin (Vitamin B12) (μg)	-0.9059	-12.88	11.07	0.465	2.924	0.000	-1.084,-0.506
Biotin (μg)	1.9128	-15.39	19.22	0.386	-5.527	0.000	0.247,0.662
Phosphorus (mg)	510.8686	-812.53	1834.27	0.680	-647.399	0.000	0.737,1.119
Magnesium (mg)	52.8724	-150.14	255.89	0.441	-85.088	0.000	0.276,0.627
Zinc (mg)	3.5170	-6.41	13.45	0.547	-3.684	0.000	0.465,0.849
Manganese (mg)	0.4845	-3.90	4.867	-0.263	1.828	0.005	-0.596,-0.106

[a] LoA determined as mean difference ± 2×standard deviation of the differences
[b] Slope of the average of methods regressed on difference between methods
[c] Statistical significance of β
[d] Confidence interval of β

To thoroughly estimate agreement between the FFQ and the MPRs, Bland-Altman method of plotting the mean difference between FFQ-2 and the mean of the 8-12 MPRs for energy and nutrients' intake was used (Appendix IX). In the Bland-Altman plots, linear regression analysis showed a significant upward trend of the difference between the estimates of FFQ-2 and the mean of MPRs with increased intake of energy and all assessed nutrients except for those of beta-carotene, alpha-carotene, riboflavin, niacin, vitamin D and manganese (Appendix IX). Fig. 4.1 shows the Bland-Altman plots for energy, protein, carbohydrates, fats, sugar, vitamin C, iron, vitamin D, beta-carotene, alpha tocopherol, and dietary fiber intake. These plots show that the regression lines were positive for these nutrients, except for vitamin D and beta-carotene, indicating the overestimation of their intake by the FFQ. However, most of the values lie between the 95% LoAs and near the mean difference line and similar results were observed for the other assessed nutrients (Appendix IX).

The figures in Appendix X show the Bland-Altman plots for the population stratified by gender. The plots revealed comparability in the direction of the regression lines, the clustering of values around the bias line (mean difference line) and between the 95% LoAs for energy and most nutrients. Differences in agreement between females and males were only shown with respect to the intake of protein, cholesterol and sodium where the regression lines show an upward trend for males and a downward trend for females for these three nutrients (Appendix X). It is important to note that results showed that there is no statistical significant difference between the means of the number of MPRs completed by males and females (t-test p value=0.951) with means ± SDs of 10.52±1.005 and 10.53±1.099 for males and females respectively.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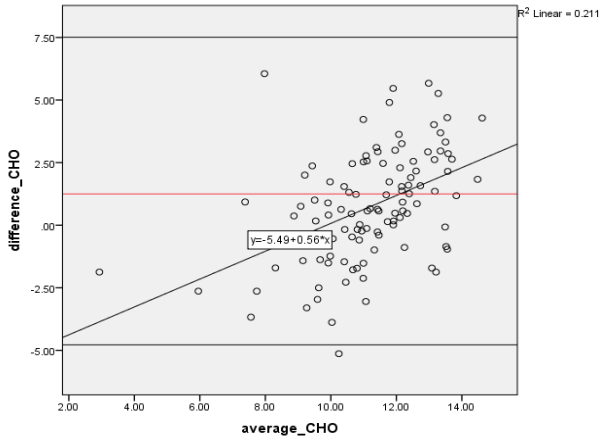
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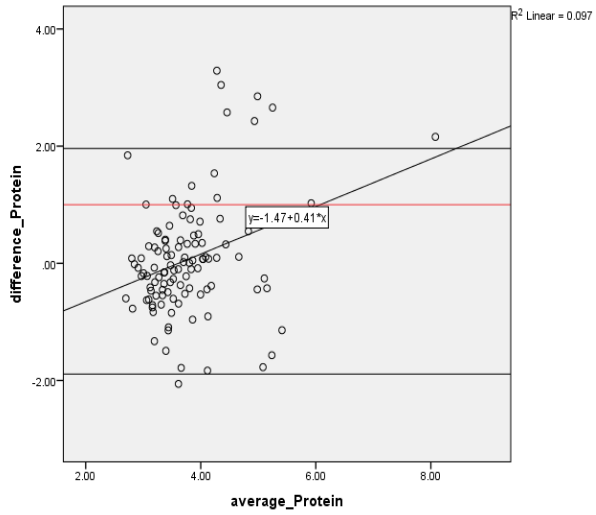
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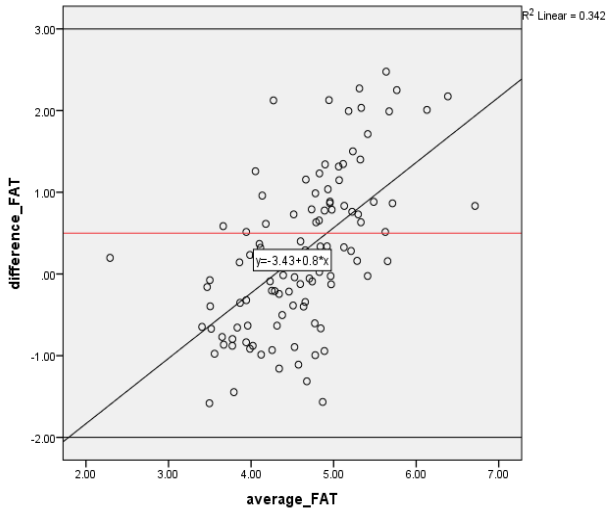
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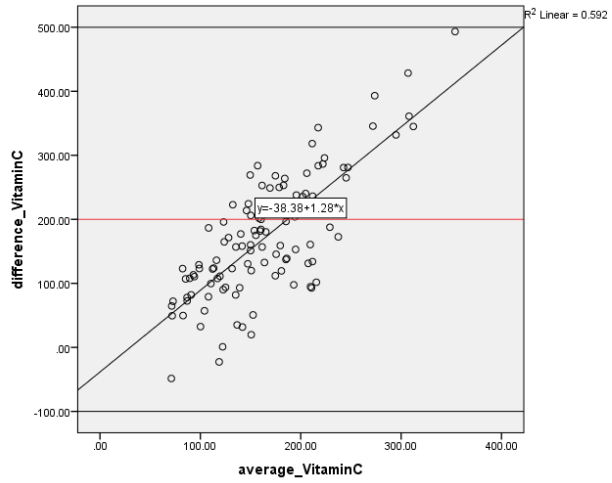
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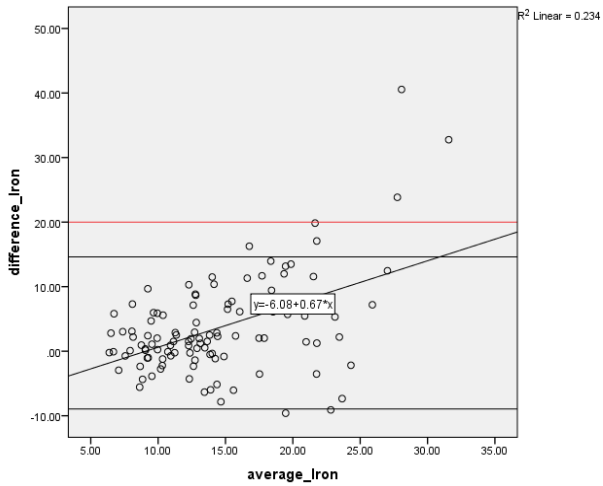
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average_Iron

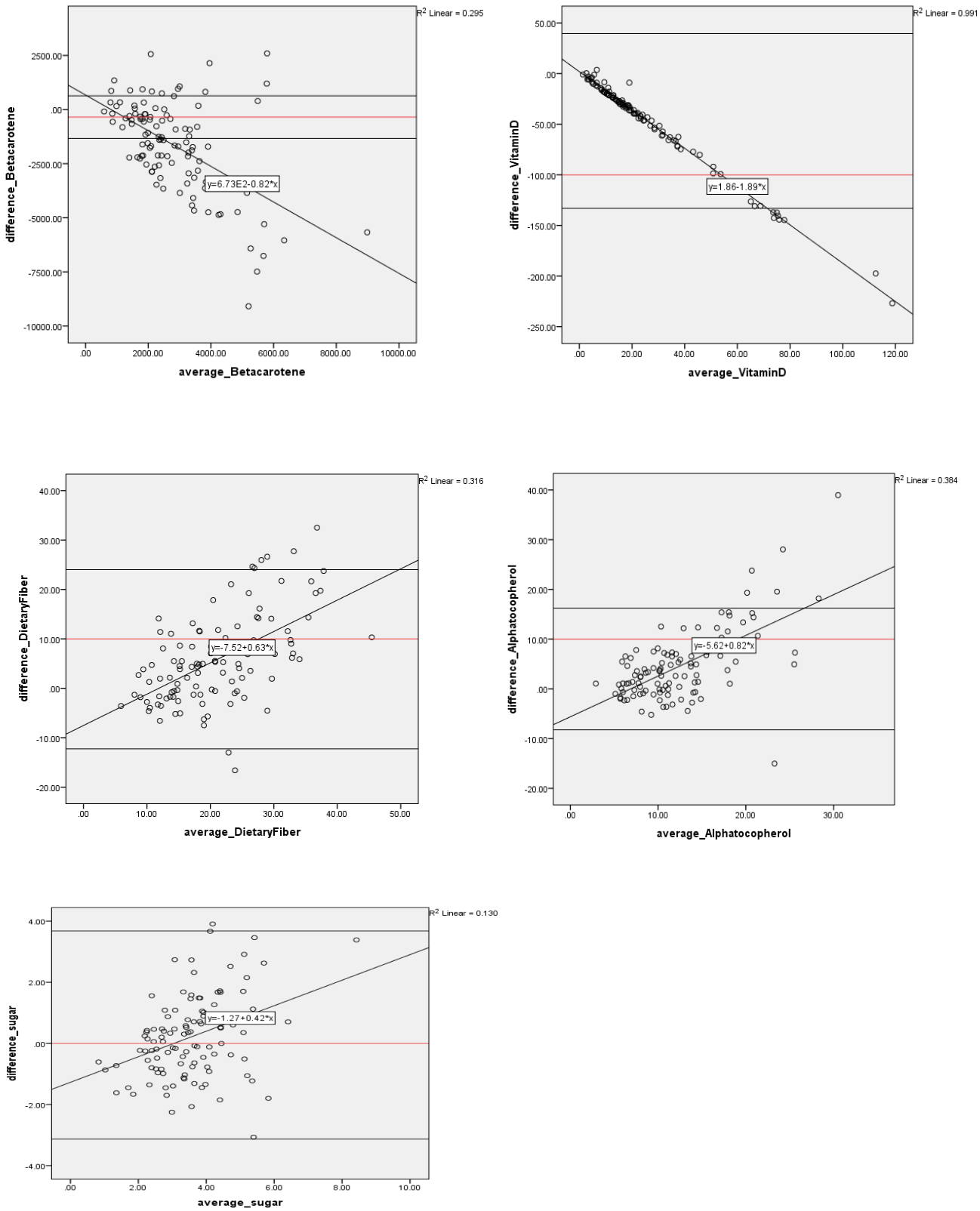

Figure 4.1. Bland-Altman charts for energy, protein, carbohydrates, fats, sugar, vitamin C, iron, vitamin D, beta-carotene, alpha tocopherol, and dietary fiber predicted by the FFQ and mean of MPRs.

C. Relative Reproducibility of the Questionnaire (Comparison Between FFQ-1 and FFQ-2)

The Intraclass Correlation Coefficient (ICC) was computed for FFQ-1 and FFQ-2 to assess the reproducibility of the FFQ and the results are displayed in Table 4. 5. An ICC score greater than 0.5 was found for most nutrients and all scores were statistically significant except for that of vitamin A (RE). The correlation range for reliability of the FFQ was found to range from 0.305 for cobalamin (μg); $p<0.05$, to 1.000 for sodium (mg); $p<0.01$. The values of ICC for energy and energy adjusted macronutrients ranged from 0.373; $p<0.05$, for cholesterol to 0.849 for total energy intake; $p<0.01$.

Table 4.5. Intraclass Correlation Coefficients (ICC) for Energy and Nutrients Intake Obtained Using FFQ-1 and the FFQ-2 for Comparative Reliability.

Nutrients	Mean FFQ-1 ± S.D	Mean FFQ-2 ± S.D	ICC
Energy (Kcalories)	2935.30±1433.64	2511.82±1145.12	0.849 **
Protein (%)	3.88±0.81	3.81±1.03	0.381*
Protein (g)	113.46±60.04	96.99±56.81	0.795**
Carbohydrate (%)	11.92±2.11	11.54±2.54	0.559**
Carbohydrate (g)	351.12±182.72	258.96±135.70	0.767**
Fat, Total (%)	4.72±1.06	4.73±1.05	0.658**
Fat, Total (g)	135.63±67.64	116.32±54.76	0.726**
Cholesterol (%)	12.21±10.41	11.78±10.23	0.373*
Cholesterol (mg)	348.02±297.80	314.94±371.62	0.600**
Saturated Fat (%)	0.96±0.24	0.97±0.28	0.573**
Saturated Fat (g)	28.34±15.84	24.68±14.20	0.765**
Monounsaturated Fat (%)	1.73±0.50	1.71±0.51	0.735**
Monounsaturated Fat (g)	49.10±24.49	42.38±21.99	0.796**
Polyunsaturated Fat (%)	1.07±0.32	1.15±0.36	0.520**
Polyunsaturated Fat (g)	30.89±16.65	28.27±15.03	0.730**
Dietary Fiber, Total (g)	27.83±13.13	24.06±11.24	0.765**
Sugar, Total (%)	3.66±1.25	3.66±1.55	0.683**
Sugar, Total (g)	106.03±61.48	88.76±52.64	0.766**
Sodium (mg)	3185.46±1675.93	2418.29±1268.80	1.000**
Potassium (mg)	3707.06±1715.08	3146.56±1421.48	0.817**
Vitamin A (RE)	697.44±778.52	588.85±682.55	0.211
Beta-Carotene (μg)	2328.52±1317.35	1981.08±1214.09	0.403**
Alpha-Carotene (μg)	93.41±59.92	77.71±46.88	0.461**
Vitamin C (mg)	273.51±122.02	251.10±99.67	0.745**
Calcium (mg)	1012.19±490.49	840.01±421.70	0.736**
Iron (mg)	19.18±9.26	16.24±8.02	0.795**
Vitamin D (μg)	2.55±1.92	2.31±2.38	0.706**

Alpha-Tocopherol (mg)	16.27±8.70	14.75±8.24	0.690**
Thiamin (mg)	1.76±0.85	1.45±0.56	0.770**
Riboflavin (mg)	1.93±0.93	1.65±0.94	0.705**
Niacin (mg)	27.44±15.23	23.33±13.33	0.781**
Pyridoxine (Vitamin B6) (mg)	2.46±1.38	2.03±1.18	0.616**
Folate (Total) (μg)	468.52±223.64	404.85±197.62	0.771**
Folate (DFE)	507.93±255.77	433.25±215.18	0.748**
Cobalamin (Vitamin B12) (μg)	7.22±9.42	5.65±8.72	0.305*
Biotin (μg)	19.91±12.37	18.88±13.98	0.745**
Phosphorus (mg)	1770.65±805.13	1503.39±749.10	0.810**
Magnesium (mg)	402.03±173.41	344.61±147.84	0.795**
Zinc (mg)	16.59±10.03	14.07±9.97	0.666**
Manganese (mg)	5.00±2.35	4.18±1.86	0.726**

* P value < 0.05; ** P value < 0.01

The reproducibility analysis results using Kappa agreement between the two administrations of the FFQ are presented in Table 4.6. To compare nutrient data classification into tertiles, the kappa test was used. The κ w values and their agreement rank for energy and macronutrient intake ranged from 0.25 ranked “fair” for percent carbohydrate intake adjusted for energy to 0.82 a rank of “almost perfect” for protein. For most nutrients, the weighted kappa relations were ranked “moderate”. The weighted kappa values for the studied micronutrients ranged between 0.353 for beta carotene (fair agreement) to 0.565 for potassium (moderate agreement).

Also, for reproducibility, the percent of individuals correctly classified into the same and adjacent tertile varied from 73.6% (total fat %) to as high as 100% (protein intake). As for the micronutrients, the same and adjacent percent agreement ranged from 80.91 % for alpha-carotene (μg) to 93.64% for both potassium and phosphorous. For most nutrients, the FFQ was able to correctly classify subjects into the same and adjacent tertile greater than 73.6 % of the time.

Table 4.6. Values of Agreement between the Two Methods (FFQ-1 and FFQ-2) As Measured by the Weighted Kappa Statistic and Same and Adjacent Percent Agreement Results for Energy and Nutrients Intake for Comparative Reliability.

Nutrients	Weighted kappa	Confidence Interval	Same and Adjacent Percent agreement (%)	Rank*
Energy (Kcalories)	0.570	(0.475,0.665)	94.55	Moderate
Protein (%)	0.816	(0.749,0.882)	100	Almost perfect
Protein (g)	0.546	(0.439,0.652)	91.82	Moderate
Carbohydrate (%)	0.249	(0.111,0.387)	76.36	Fair
Carbohydrate (g)	0.531	(0.421,0.641)	90.91	Moderate
Fat, Total (%)	0.293	(0.164,0.422)	73.6	Fair
Fat, Total (g)	0.487	(0.376,0.599)	90	Moderate
Cholesterol (%)	0.316	(0.190,0.442)	80	Fair
Cholesterol (mg)	0.446	(0.323,0.569)	85.45	Moderate
Saturated Fat (%)	0.301	(0.164,0.438)	80	Fair
Saturated Fat (g)	0.560	(0.460,0.661)	95.45	Moderate
Monounsaturated Fat (%)	0.321	(0.194,0.447)	81.82	Fair
Monounsaturated Fat (g)	0.472	(0.365,0.580)	90.00	Moderate
Polyunsaturated Fat (%)	0.291	(0.167,0.416)	80.91	Fair
Polyunsaturated Fat (g)	0.399	(0.274,0.525)	81.82	Fair
Dietary Fiber, Total (g)	0.516	(0.402,0.631)	87.27	Moderate
Sugar, Total (%)	0.368	(0.236,0.499)	81.82	Fair
Sugar, Total (g)	0.563	(0.452,0.673)	90.00	Moderate
Sodium (mg)	0.502	(0.399,0.605)	91.82	Moderate
Potassium (mg)	0.565	(0.465,0.666)	93.64	Moderate
Vitamin A (RE)	0.389	(0.263,0.516)	83.64	Fair
Beta-Carotene (μg)	0.353	(0.232,0.474)	83.64	Fair
Alpha-Carotene (μg)	0.370	(0.246,0.493)	80.91	Fair
Vitamin C (mg)	0.494	(0.378,0.611)	87.27	Moderate
Calcium (mg)	0.457	(0.333,0.580)	85.45	Moderate
Iron (mg)	0.471	(0.362,0.580)	90.00	Moderate
Vitamin D (μg)	0.486	(0.367,0.604)	89.09	Moderate
Alpha-Tocopherol (mg)	0.372	(0.251,0.493)	83.64	Fair
Thiamin (mg)	0.522	(0.413,0.631)	90.00	Moderate
Riboflavin (mg)	0.466	(0.358,0.574)	91.82	Moderate
Niacin (mg)	0.413	(0.303,0.524)	90.00	Moderate
Pyridoxine (Vitamin B6) (mg)	0.505	(0.392,0.619)	90.00	Moderate
Folate (Total) (μg)	0.471	(0.350,0.592)	85.45	Moderate
Folate (DFE)	0.442	(0.321,0.563)	85.45	Moderate
Cobalamin (Vitamin B12) (μg)	0.458	(0.331,0.584)	88.18	Moderate
Biotin (μg)	0.396	(0.269,0.523)	83.64	Fair
Phosphorus (mg)	0.516	(0.412,0.621)	93.64	Moderate
Magnesium (mg)	0.480	(0.375,0.586)	90.91	Moderate
Zinc (mg)	0.495	(0.385,0.605)	88.18	Moderate
Manganese (mg)	0.461	(0.338,0.583)	83.64	Moderate

**(Landis & Koch, 1977)*

CHAPTER V

DISCUSSION

A. Major Findings of the Study

To our knowledge, the present study presents the first Arabic FFQ to be validated among Lebanese adults. The use of this FFQ will assist in the assessment of adult Lebanese dietary intake in epidemiological studies and will aid in the understanding of the diet-disease link (Shim et al., 2014). The validity of this FFQ was assessed by comparing it to 8-12 MPRs in a sample of Lebanese adults and its reproducibility was evaluated through the administration of the FFQ to the same subjects twice during an interval of one year. The results suggested that this FFQ which was tailored to assess the intake of Lebanese adults is both valid and reliable. Being validated in the same population it was intended to be used in renders the greatest chance for valid and reliable findings (Sharma, 2011; Teufel, 1997). The major finding of this study is that the developed FFQ is a valid and reliable tool for assessing energy, macronutrients and numerous micronutrients in Lebanese adult population.

B. Major Findings on Validity of the FFQ

To assess the FFQ validity, the mean differences between intake of energy, macronutrients, and micronutrients were compared between the FFQ and the mean of 8-12 MPRs. Spearman's correlation coefficients and Bland-Altman statistics and plots were also obtained to evaluate the FFQ validity.

It is well known that when compared to 24-HRs and dietary records**,** FFQs have

the tendency to overestimate nutrient intake (Kabagambe et al., 2001; Rimm et al., 1992). In the present study's FFQ, energy intake was overestimated by ٣٦٠.٦٩ kcalories (Table 4.2). All macronutrients were overestimated with a wide range between 82.12 % and 2.4% for total fat and protein intake respectively. Among the energy and macronutrients intake, only cholesterol and saturated fat intake were underestimated by the FFQ when compared with the mean of the 8-12 MPRs. As for overestimated micronutrients, which were 17/22 studied micronutrients, vitamin C was overestimated by the highest percentage of 254.76% while calcium was the least overestimated by 4.5% (Table 4.2).

As aforementioned, FFQs are known to provide estimates higher than the reference method which makes the overestimation of this study and those in literature predictable. The overestimation reflected by FFQs when compared to dietary recalls might be due to potential underestimation of dietary recall and to potential misjudgement by FFQ brought about the long period of recall of the FFQ which is usually one year (Fernández-Ballart et al., 2010). Such an overestimation might also be due to the large number of foods listed under each food group in the FFQ and due to inaccurate reporting of consumption frequency and/or the amount of foods commonly consumed (Bohlscheid-Thomas, Hoting, Boeing, & Wahrendorf, 1997; Hunter et al., 1988). This tendency of overestimation of the FFQ was also noticed in most of the validation studies in literature shown in Table 5.1 (Araujo et al., 2010; Athanasiadou et al., 2016; Bautista et al., 2005; Bijani et al., 2018; Collins et al., 2014; Fumagalli et al., 2008; Gunes et al., 2015; Hebert et al., 1999; Jackson et al., 2001; Knudsen et al., 2016; Steinemann et al., 2017; Torheim et al., 2001; Watson et al., 2009; Yuan et al., 2017). Results also showed that few nutrients assessed were underestimated by the FFQ

extrapolations when compared to the MPRs. For the macronutrients, only cholesterol (%) and saturated fat intake were underestimated of those of the MPRs by 1% and 12.55 % respectively. More variations were noticed with micronutrients with underestimation ranging from -0.78 % for riboflavin to 143.69 % for alfa-carotene. Micronutrients on average were underestimated by 35.05% and they were namely vitamin A (RE), sodium, beta-carotene, alpha-carotene, riboflavin, niacin and cobalamin.

To describe the strength and direction of the correlation between FFQ estimates for energy and the selected nutrients and those of the MPRs, Spearman's correlation coefficients were obtained (Table 4.2). It is suggested that correlation need to be at least 0.3 or 0.4 to detect associations between diet and disease (Janet Cade et al., 2002). In the present study, results showed that the Spearman's correlation coefficients between the FFQ and the mean of the MPRs ranged between 0.24 and 0.70 with an overall average of 0.52. The average of the correlations for the energy and macronutrients was 0.52 and for the assessed micronutrients was 0.51. More specifically, Spearman's correlation coefficients were 0.37 for percent saturated fat intake and 0.70 for percent total energy intake. The extreme results for micronutrients were close to those of the macronutrients, 0.24 for alfa carotene and 0.67 for sodium (Table 4.3). The Spearman's correlation coefficients were all positive and above 0.24 which suggests an overall positive moderate correlation between the FFQ and the mean of the MPRs.

According to Bland and Altman (1986), it is not ideal to use correlation coefficients to analyze agreement between methods. Correlation coefficients measure the strength of a relation between two variables rather than the actual agreement between them. For instance, if the intake of a nutrient from one measurement is double that of its intake from the other measurement; this would result in a high correlation

coefficient and a strong relation between the two methods. However, the two methods might poorly agree in assessing the intake of this nutrient. Correlations show the relation between methods, and it is less likely that two methods measuring the same aspect not be related (Bland & Altman, 1986). In the present study, the FFQ was designed to quantify the absolute level of intake, which cannot be accomplished by correlations, rather than to rank individuals according to nutrient intake which makes using correlations inadequate.

Besides mean difference and correlations, Bland-Altman's method was applied to data in the present study to summarize the difference between energy and nutrients' intake across a range of intake and provide a measure of the average relative to the difference of energy and nutrients' intake between the FFQ and the mean of the MPRs (Appendix IX). This enabled to identify whether the developed FFQ presented errors (over or under-estimations) and whether these errors appeared at different levels of intake (Bland & Altman, 1986). In the Bland-Altman plots, linear regression analysis revealed a significant upward trend of the difference between the estimates of FFQ-2 and the mean of MPRs as related to intake of energy and all studied nutrients except for those of beta-carotene, alpha-carotene, riboflavin, niacin, vitamin D and manganese (Appendix IX). This implies that at lower levels of intake of energy and nutrients (except for beta-carotene, alpha-carotene, riboflavin, niacin, vitamin D and manganese), the estimates of FFQ better agreed with those of the mean of MPRs as compared with higher intake. Extreme or outlying observations are also shown by the Bland-Altman plots and they were checked among energy and nutrients to examine whether it is the same subject. The checking revealed heterogeneity in the subjects' that outliers pertained to.

Bland-Altman plots of energy and several nutrients are included in Fig. 4.1. It was noticed that the regression line showed upward trend for energy, protein, carbohydrates, fats, sugar, vitamin C, iron, alpha tocopherol, and dietary fiber indicating better agreement between the FFQ and the MPRs' estimates at lower intake levels than at higher intake (Fig. 4.1). In other words, at higher intake of energy, protein, carbohydrates, fats, sugar, vitamin C, iron, alpha tocopherol, and dietary fiber (from MPRs), the FFQ tends to overestimate intake. Nevertheless, most of the values lie between the 95% LoAs and close to the bias line i.e. mean difference horizontal line, implying a low magnitude of error in the FFQ's estimation. Similar results were observed for the other assessed nutrients which indicated an overestimation trend by the FFQ (Appendix IX)

Besides the plots for the entire study population, the figures in Appendix X show the plots for the population stratified by gender. The plots show differences in agreement between females and males as related to the intake of only few nutrients mainly protein, cholesterol, and sodium where the regression lines show an upward trend for males and a downward trend for females. This suggests that at higher protein, cholesterol and sodium intake there is a sizable fraction of the male participants, contrary to females, who overestimated protein, cholesterol and sodium intake on FFQ-2 relative to the mean of the MPRs (Appendix IX). Knowing that there is no significant difference between the number of MPRs completed by males and females, comparing the plots of the study population stratified by gender for energy and most of the nutrients assessed, the regression lines' direction, the distribution of the values around the bias line and between the 95% LoAs (most values lied between the LoAs), were very comparable between females and males (Appendix X).

This general overestimation of the FFQ revealed by the Bland-Altman plots coincides with the results of the mean difference. The Bland-Altman plots point to relevant comparability of estimates of energy and nutrients obtained by the FFQ and those from repeated MPRs which would unlikely cause systematic biases (Appendix IX).

1. Comparison with other validation studies

Several studies have validated FFQs for use in adult populations in many countries worldwide. Comparing validity across studies between the test FFQ and the gold standard is not an easy task due to the presence of differences in study populations, methodologies, nutrient analysis data and between-individual variations. Table 5.1 presents a comparison between the present study's findings and those of other FFQ validation studies. Most of the published FFQ validation studies included in Table 5.1 observed correlation coefficients in the association between the test FFQ and the gold standard (s) of 0.20-0.77 (Araujo et al., 2010; Athanasiadou et al., 2016; Bautista et al., 2005; Bijani et al., 2018; Gunes et al., 2015; Hebert et al., 1999; Jackson et al., 2001; Malekshah et al., 2006; Sichieri & Everhart, 1998; Steinemann et al., 2017; Torheim et al., 2001). Fumagalli et al. and Watson et al. observed correlation coefficients as low as 0.021 (fiber) and 0.09 (retinol) respectively as shown in Table 5.1 (Fumagalli et al., 2008; Watson et al., 2009).

As for the reference methods used to validate the test FFQs, the present study and 15 out of the 16 studies included in Table 5.1 assessed the relative validity of the test FFQ by comparing it to only one kind of subjective dietary assessment method. i.e. either regular DRs, weighed intake registry or 24-HRs. Of the 16 presented studies,

eight used 24-HRs as a gold standard to validate their FFQs. Five of the studies used DR and the remaining used weighed intake registry (Table 5.1). Yuan et al. used either DR or 24-HR as gold standards and the results showed that Spearman's correlation coefficients after adjusting for within-person variations were 0.63 for the DR and 0.62 for the 24-HRs which are almost the same for both dietary assessment methods (Yuan et al., 2017).

When compared to Bautista et al., the study with the highest correlation coefficients (0.46-0.71) among the assessed studies that used DR or weighed registry intake as reference methods in Table 5.1, the present study's findings showed higher correlation coefficients for magnesium, iron and thiamin (Bautista et al., 2005). Also, this study had higher correlation coefficients than most of the validation studies that compared their test FFQs to DRs or weight intake registries (Table 5.1).

As for the 8 studies that used 24-HR as a reference method to validate the test FFQs, only two studies, Jackson et al. and Malekshah et al.; used 12 24-HRs while the remaining six studies used only six 24-HRs. Knowing that the present study's participants completed 8-12 24-HRs, gives an added value to the study design. Furthermore, when comparing the correlation coefficients of this study (0.24-0.70) to the validation studies that used 24-HR as a reference method, it was noticed that they were higher than those in three of the studies, namely Gunes et al., Malekshah et al. and Sicheiri et al. and approximate to those of the other studies (Table 5.1). Moreover, Hebert et al. study which used 24-HR as a reference method and which observed the highest Spearman's correlation coefficients (0.45-0.90) among the studies shown in Table 5.1 obtained less correlation that the present study as related to intake of both fiber (0.55 vs 0.61) and vitamin C (0.45 vs 0.564) (Hebert et al., 1999).

Therefore, compared with other validation studies of varying methods and results, the present study's results were found to be similar to those from validation studies that utilized either food records or 24 hour recalls as the reference method.

C. Findings on the Reliability of the FFQ

The FFQ was administered a second time, one year after the first administration, to the same subjects to test for the FFQ's reproducibility. The time interval separating the two administrations was chosen to be no longer than one year so that to minimize potential temporal changes in subject's dietary intake and at the same time not too short to avoid participants recalling the answers of the first FFQ-1 when completing FFQ-2. ICC coefficients and kappa test were used to assess FFQ reliability. The ICC coefficients obtained from this study ranged between 0.37 and 0.85 for macronutrients and between 0.31 and 1.00 for micronutrients. ICC coefficients for energy and all nutrients were greater than 0.5 except for protein %, cholesterol %, beta-carotene, alpha-carotene, and cobalamin; which indicates high repeatability of the FFQ as the minimum correlation for an assessment tool to be considered reproducible is 0.5 (Table 4.5) (Janet Cade et al., 2002).

As shown in Table 5.1, the present validation study's ICC coefficients are comparable with those of most of studies that assessed FFQs' reproducibility (Athanasiadou et al., 2016; Collins et al., 2014; Hebert et al., 1999; Jackson et al., 2001).

To further assess the FFQ's reliability, the weighted kappa was calculated, and it is valuable in this analysis since unlike the ICC it gives a single value to represent agreement and adjusts for chance agreement and the degree of disagreement (Masson et

al., 2003). The weighted kappa observed from the present study ranged from fair to almost perfect agreement for macronutrients and from fair to moderate agreement for micronutrients with more than half of the overall nutrients having moderate agreement in FFQ-1 and FFQ-2 (Table 4.6) When comparing the present study FFQ's reliability with a recent FFQ that was tested for reliability by Athanasiadou et *al.* (2016), the former's weighted kappa values were higher for protein, total fat, cholesterol, potassium and manganese and comparable for the rest of the assessed nutrients (Athanasiadou et al., 2016).

As for the FFQ's ability to correctly classify individuals into the same and adjacent tertile, it correctly classified subjects into the same and adjacent tertile greater than 73.6 % of the time and more than 90% of the time for energy and the following nutrients: energy, protein, carbohydrates, total fat, saturated fat, monounsaturated fat, total sugar, sodium, potassium, iron, thiamin, riboflavin, niacin, pyridoxine, phosphorous, and magnesium (Table 4.6). The high values of percent agreement indicate significant agreement between the estimates of the FFQ and the mean of the 8-12 MPRs.

The nutrients that were with exceptionally poor agreement between the FFQ and the mean of MPRs and the two administrations of the FFQ in the present study; mainly cobalamin, vitamin A, alpha-carotene and beta-carotene were not consistently reported to stand out in other validation studies in literature (Athanasiadou et al., 2016; Collins et al., 2014; Hebert et al., 1999; Jackson et al., 2001).

In brief, the findings of this study suggested that this FFQ is valid and reproducible in ranking the energy and most nutrients intake of Lebanese adults and in reflecting their consumption among this population.

Table 5.1. Comparing Methodology and Correlation Ranges of Published FFQs Validated by Energy, Macronutrients and Micronutrients.

Author	Country	Study population	Dietary assessment	Parameters used	Main findings	The present study's main findings
Araujo et al., 2010	Brazil	169 adolescents from Rio de Janeiro, Brazil	FFQ vs 3 DR (2 weekdays and 1 weekend)	• Pearson correlation coefficients • Weighted kappa • Bland-Altman method	• Pearson correlation coefficients: 0.33 to 0.46 • Weighted kappa: 0.28 to 0.44	Spearman's correlation coefficients: 0.24-0.70 Bland-Altman LoAs and plots ICC: 0.31-1.00 Weighted kappa statistic: 0.25-0.82
Athanasiadou et al. 2016	Greece	179 pregnant women	FFQ vs two 24-HRs	• Cohen's d • Pearson correlation coefficients • Weighted kappa • Bland-Altman • ICC	• Cohen's d: Below 0.3 • Pearson correlation coefficients: 0.30-0.77 • Weighted kappa: 0.31-0.78 • ICC: 0.49-0.89	
Bautista et al. 2005	Colombia	97 20–40-year-old subjects	FFQ vs 7 weighed intake registry	• Spearman's rank correlation coefficients • Bland-Altman's LoA	• Spearman's rank correlation coefficients: 0.46 - 0.71 • Bland- Altman's LoA: 45% - 165%	
Bijani et al. 2018	Iran	200 men and women aged 60 years and older	FFQ vs two 24-HRs	• Pearson's correlation coefficients for nutrients • Bland-Altman plots • Pitman's tests	• Pearson correlation coefficients: 0.21 - 0.53 (males) 0.26 - 0.71 (females).	

Collins et al. 2013	Australia	97 Australian adults	FFQ vs 3 day weighed DR	• ICC	• ICC: 0.14-0.7	
Fumagalli et al. 2008	Brazil	151 public school healthy children aged 5- 10 years	FFQ and a 3 day DR	• Pearson's correlation coefficients • Kappa statistic	• Pearson's correlation coefficients: 0.021-0.69 • Kappa statistic: 0.046-0.285	
Gunes at al. 2015	Turkey	120 Caucasian adults aged 30-70 years	FFQ vs four 24-HRs	• Pearson correlation • Attenuation coefficient • Measures of agreement • Weighted kappa statistics • Bland-Altman plots	• Pearson correlation: 0.20-0.47 • Attenuation coefficient:0.044-0.611 • Weighted kappa statistics: 0.4-0.6	
Hebert et al. 1998	India	60 Indian adults	FFQ vs six 24-HRs	• Spearman's coefficient: • ICC	• Pearson correlation: 0.50-0.77 • Spearman's rank correlation coefficients: 0.45 - 0.90 • ICC: 0.73-0.75	
Jackson et al. 2001	Jamaica	73 adults	FFQ vs 12 24-HRs	• Pearson's correlations coefficients • ICC	• Pearson's correlations coefficients: 0.42-0.71 • ICC: 0.42-0.69	
Knudsen et al. 2015	Denmark	97 pregnant women aged 20-42 years	FFQ vs 4-day DR	• Pearson's correlation coefficients • De-attenuated coefficients • Bland-Altman plots	• Pearson's correlations coefficients: 0.08-0.63 • De-attenuated coefficients: 0.13-0.93	
Malekshah et al. 2006	Iran	131 subjects aged 35-65 years	FFQ vs 12 24-HRs	• Pearson's correlation coefficients	• Pearson's correlation coefficients :0.27-0.59	

Sicheiri et al. 1998	Brazil	88 staff and faculty members at the State University of Rio de Janeiro	FFQ vs four 24- HRs	• Pearson's correlation coefficients	• Pearson's correlation coefficients :0.18-0.55	
Steinemann et al. 2017	Switzerland	Fifty-six participants	FFQ vs 4-day weighed food record	• Spearman's correlation • Bland–Altman analysis • Wilcoxon rank sum tests	• Spearman's correlation: 0.27 - 0.55	
Torheim et al. 2001	Mali	75 participants from a rural region in Western Mali	FFQ vs 2-day combined weighed and recalled DR	• Spearman's correlation • Bland–Altman analysis • Wilcoxon rank sum tests	• Median Spearman's correlation coefficient: 0.40	
Yuan et al. 2017	United States of America	796 American females aged 45-80 years	FFQ vs two 7-day dietary records (7DDRs) or up to 4 automated self-administered 24-hour recalls (ASA24s)	• Spearman's correlation coefficients	• Spearman's correlation coefficients for FFQ vs 7DDRs: mean 0.53 • Spearman's correlation coefficients for FFQ vs ASA24s: 0.43 • Spearman's correlation coefficients after adjusting for within-person variations: 7DDRs (mean r = 0.63) and ASA24s (mean r = 0.62)	

Watson et al. 2009	Australia	101 students aged 9-16 years	FFQ vs four one-day assisted DR	• Spearman's and Pearson Correlations • Weighed Kappa statistics • Bland-Altman plots	• Pearson correlation: 0.13- 0.37 • Spearman's correlation coefficients: 0.09 - 0.35 • Weighed Kappa statistics: 0.09 (retinol) showing 'slight' agreement, to 0.36 (iron)	

D. Strengths, Limitations, and Potential Biases

1. Strengths of the Study

Several strengths of this study need to be noted. First, it comprised 8 to 12 MPRs administered over a period of 12 months; 3 recalls per season with two weekdays and one weekend for each season. This attenuated the daily and seasonal variations in our study population and rendered the results more representative of usual intake of the Lebanese adult population. Also, the number of 24-HRs completed is among the highest when comparing this study to other validation studies that used 24-HR as gold standard for validation (Table 5.1). Second, the FFQs and the MPRs were all performed by trained interviewers who are licensed dietitians which not only ensured adequate completion of the dietary assessment forms, but also assisted participants understand the process and reduced the misinterpretation of portion size intake and frequencies. Third, to aid subjects accurately quantify their dietary consumption; standardized portion sizes or 2 D food portion visual charts were utilized. Fourth, the multiple pass recall approach was used in completing the 24-HRs which may have helped reduce the limitations of using 24-HRs as a reference method (Moshfegh et al., 2008; Raper et al., 2004).

2. Limitations of the Study

The results of this study ought to be considered in light of a few limitations. It is important that the errors pertinent to the method being validated and the reference method be as independent from each other as possible (Knudsen et al., 2016). In the present study, the FFQ was validated by comparing it to 24-HRs which both share memory as a potential measurement error. The gold standard for validating FFQ is DRs since the latter does not depend on memory contrary to FFQs and 24-HRs. Hence, when compared with DRs, 24-HR cannot assess the exact validity and relative validity of a FFQ. However, previous attempts in epidemiological studies that were conducted in Lebanon have failed to use DRs as a reference method. This is due to that DRs require high literacy and high motivation which was faced with many obstacles in the Lebanese context. Since the gold standard should be culture-specific, the 24-HR was used as a reference method instead of DRs. This limitation was minimized by using the MPR approach which can dilute the memory bias since it uses the five probing stages.

Since the study was administered on a sample of adults mostly pertaining to higher academic level who would generally understand the charts used in data collection better than those of lower educational level and would tend to be more nutritionally aware which might have elevated the chance for increased validity and reliability results in the study sample.

Furthermore, the present validation study lacks a reference measure that is independent of self-reported intake unlike the case of 24-HR. An example of such an ideal reference to use in further examining the validity of the FFQ is a biomarker of dietary intake (Steinemann et al., 2017). Nonetheless, wider aspects of dietary intake

have no corresponding biomarkers to reflect them and using biomarkers to validate dietary assessment methods is costly (Knudsen et al., 2016).

Another limitation is the use of USDA's food and nutrient database as the primary reference database for analysing portion sizes. This was due to the lack of food composition data that is specific to Lebanese food composition databases. However, a food composition table specifically developed for Middle Eastern foods was used for analysis of traditional Lebanese dishes (Pellet & Shadarevian, 1970).

The observed moderate agreement between FFQ-2 and the mean of MPRs may be brought about by the following potential limitations: errors in estimation of portion size, the high day-to-day variability of dietary intake and limitations of recall ability (M. B. E. Livingstone, Robson, & Wallace, 2004).

3. Potential Biases in the Study and Ways Adopted to Minimize them

Considering the above limitations**,** some potential biases might be present which might affect the internal validity of the study. At the data collection level, the main biases that might be present are recall, memory, social desirability, and study effect biases. The main recall biases that this study might entail are overweight subjects tending to underestimate their dietary intake and subjects pertinent to lower socioeconomic status (SES) tending to over-report their intake mainly that of relatively expensive food like meat products. These potential recall biases were minimized by training the interviewers not to drill on answers and avoid asking leading questions. As for memory bias, it might be present in retrospective dietary assessment tools like FFQs and 24-HRs which were both used in this study. This bias was minimized by giving the interviewees sufficient time for adequate recall especially of long term memory as is the

case with FFQs completion. In addition, interviewers were thoroughly trained not to give any judgmental attitude throughout the interview which helped minimize social desirability bias of potentially giving answers that are perceived as desirable.

To minimize the study effect bias of changing dietary intake secondary to awareness of interview on the following day, the study subjects were not notified ahead of time of the exact day of the follow up and were contacted on the same day of the interview.

At the data entry level, data entry errors were minimized by extensively training the interviewers on data entry programs used, i.e. Microsoft Access and Nutritionist Pro, and biases were minimized by random checking of the data entry.

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

To our knowledge, this study is the first to validate a semi-quantitative FFQ developed to measure the energy and nutrients' intake among Lebanese adults. The present study's findings suggest that the 94-item FFQ developed in AUB Nutrition and Dietetics department provides valid and reliable measurements of habitual intake for energy, macronutrients, and most of the micronutrients studied among Lebanese adults aged 18-65 years over a period of one year. This suggests the appropriateness of using this FFQ for assessing the dietary patterns of Lebanese adults and ranking their energy and nutrients' intake in epidemiological studies. However, while this FFQ was valid for the overall dietary assessment of Lebanese adults; it had a limited capability to capture the specific intake of certain micronutrients. This coincides with Willet's conclusion that obtaining a valid assessment of some micronutrients requires a nutrient-specific food frequency questionnaire (W Willett, 1998**).** As for repeatability, this study's results point to a generally moderate reliability of the developed FFQ for the assessment of energy and the selected nutrients' intake. The obtained correlation ranges for validity (Spearman's correlation coefficients) and reliability (ICC) resembled those reported by other studies that validated FFQs specific to other populations (Table 5.1).

This culture-specific validated questionnaire will not only be a useful instrument for assessing dietary intake of Lebanese adults but will also serve as a resource that can be utilized by researchers of countries of geographical and cultural proximity to Lebanon. This FFQ is a relatively uncostly instrument that can be utilized in

investigating diet–disease associations, characterizing dietary patterns and intake, informing and evaluating nutrition interventions and conducting cross-country comparison studies. Since this FFQ can measure long-term dietary intake of the Lebanese adult population, this allows researchers to conduct studies that help track dietary changes among this population over time and to monitor nutrition transitions. The data from such studies can serve as guidelines for Lebanese policy makers to develop and implement policies that aid in the improvement of several dietary aspects pertinent to the Lebanese adult population.

As for future studies, the present study's results suggest the need for developing and validating micronutrient-specific FFQs for those micronutrients that are of special concern to Lebanese adults' well-being such as calcium, dietary vitamin D, iron. In addition, future research ought to include designing and validating a FFQ specific to the Lebanese older adults aged 65 years and above where findings of a recent cross-sectional study suggest the presence of statistically significant poor nutritional status among a sizable fraction of elderly Lebanese assessed by the Mini Nutritional Assessment (MNA) (HALLIT, SALAMEH, & BOULOS, 2018).

APPENDICES

APPENDIX I

PARTICIPANT CONSENT FORM (ENGLISH VERSION)

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RESEARCH CONSENT FORM, PROTOCOL #: NUT.FN.22

1. Title of Research
Validity and Reliability of a Food Frequency Questionnaire to Assess Dietary Intake among Lebanese adults.
2. Principal Investigator
Dr. Farah Naja, American University of Beirut
3. What is the purpose of this study?
The purpose of this study is to examine the validity and reliability of a Food Frequency Questionnaire (FFQ) for the assessment of dietary intake among Lebanese adults. Our goal is to compare the dietary intake data we collect via the FFQ to 24-hour dietary recalls (24-HRs) and blood biomarkers (carotenoid, tocopherols, and retinols). We aim to enroll 120 adults aged between 18 and 65 years old from various faculties and offices at the American University of Beirut (AUB) to participate in this study. This project is being sponsored by the URB at AUB and the University of Texas at Austin.
4. How will we recruit subjects like you?
Flyers will be posted on AUB campus. Subjects will be asked to indicate their interest in participating in the study by email or by phone. They will be invited to come to the research unit at the Nutrition and Food Sciences Department in AUB. A brief screening form will be filled to verify eligibility for the study. Subjects will be part of the study if they meet the inclusion and exclusion criteria. A total of 120 subjects will be recruited.
5. What will I do if I choose to be in this study?
In order to study dietary intake it is important that we be able to identify the kinds and amounts of foods and beverages that people are consuming and how they reflect in their blood biomarkers. Therefore, if you choose to participate in the study, we will conduct with you a total of 14 face-to-face interviews to collect the data. During the first interview, we will administer the sociodemographic and lifestyle questionnaires and the first FFQ, and a second FFQ will be administered one year later. After the first visit, blood collection for the analysis of the blood biomarker carotenoid, tocopherols, and retinols (in addition to the lipid profile) will be conducted at the American University of Beirut Medical Center (AUBMC), during the first season (15 ml) and the last season (15 ml) of the study period. Hence, only two blood samples will be collected (a total of 30 ml from both blood drawings). Within each of the four seasons of this one year, we will call you three times to set three meeting times with you in order to conduct three face-to-face interviews to complete the three 24-hour recalls (24-HRs) representing two weekdays and one weekend per season. We will then compare the dietary intake data we collected via the FFQ to the 24-HRs and the blood biomarkers (carotenoid, tocopherols, and retinols).

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6. How long will I be in the study?

We will administer our data collection questionnaires through 14 face-to-face interviews with a trained Research Assistant over a period of 12 months. The face to face interviews will take place at the participants' office (if applicable), or the subject will be invited to the NFSC department, room 520 (clinical research room).

7. What are the possible risks or discomforts?

There will be a tiny bit of discomfort during blood collection via venipuncture. There is always a slight chance for bruising, infection, pain or fainting when blood is collected. However, a certified phlebotomist at AUBMC will collect blood following the standard venipuncture techniques in the sitting position. Unforeseeable risks may arise during the study procedure. There is also a risk of breach of confidentiality. However, safeguards are in place as listed in the confidentiality section of this document.
Note that at the end of the study when all samples are analyzed, the researchers will share the test results with all participating subjects and will advise them to discuss the results with the subjects' family physician.

8. Are there any potential benefits?

There are no personal direct benefits for you if you participate in this project. However, your participation may help the research team at AUB develop and validate an FFQ which will be a useful tool in estimating dietary intake in a large sample size of this population and will fill a critical knowledge gap in the assessment of nutritional status of Lebanese adults, especially in the light of consistent documented associations between food intake and obesity as well as the influence of dietary intake on chronic disease risk.

9. Are there costs to me for participation?

You will receive a monetary compensation (15 USD) in cash on each day of blood withdrawal as a compensation for your waiting time and transportation.

10. Who can I contact if I have questions about the study?

If you have questions or concerns, or if you think the research has hurt you in any way, you can contact:
Dr. Farah Naja
Tel: 009611350000, ext: 4504
Email: fn14@aub.edu.lb

If you have questions about your rights as a volunteer, or you want to talk to someone outside the research team, please contact:
Biomedical Sciences Institutional Review Board
American University of Beirut, Lebanon
Tel: 00961 1 374374, ext: 5445
Email: irb@aub.edu.lb

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11. Will information about me and my participation be kept confidential?

Data collection will be conducted in a manner that preserves the confidentiality of all subjects and ensures that no breach of participants' privacy occurs. All the data will be collected, managed and stored by team members only. A random coded study ID will be assigned to each participant at the time of enrollment. This study ID will be used to identify all data collected. The study ID key will be contained in a password protected file on password protected computers accessible only to the investigators of the study, as well as the selected research team members involved in data entering, cleaning and coding. All hard copies will be stored in locked cabinets with access only to the investigators. The project's research records may be reviewed by the research team at Nutrition and Food Science department at AUB and University of Texas, Austin. Any published reference to the data obtained in this study will not make reference to any of your personal data in identifiable form.

_____**I ALLOW** the use of my collected information to be shared with collaborators.

_____**I DO NOT ALLOW** the use of my collected information to be shared with collaborators.

12. What are my rights if I take part in this study?

Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

13. Additional Choices

The analysis of collected blood samples will take place at the AUBMC laboratory (Beirut) and Craft Technologies Inc. (US). Leftover samples will be discarded according to institution policy. In case you consented for your leftover blood samples to be used for future research, they will be stored at the NFSC department.

- You may join this study even if you do not permit blood withdrawal. Please indicate your choice on the appropriate line below:

_____**I PERMIT** blood withdrawal.

_____**I DO NOT ALLOW** blood withdrawal.

- You may join this study even if you do not permit the storage and use of your left-over samples for future research. Please indicate your choice on the appropriate line below:

_____I **PERMIT** the storage and use of my left-over samples for future research.

_____I **PERMIT** the storage of my leftover samples but request to be contacted to seek permission of use for future research.

_____I **DO NOT ALLOW** storage or the use of my left-over samples for future research.

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- We would also like your permission to contact you about participating in future studies. You may still join this study even if you do not permit future contact beyond the study period. You may also change your mind about this choice. Please indicate your choice on the appropriate line below:

_____**YES**, you may contact me. Please provide us with your mobile number:

_____**NO**, you may **NOT** contact me.

Documentation of Informed Consent

I have had the opportunity to read this consent form and have the research study explained. I have had the opportunity to ask questions about the research study, and my questions have been answered. I am prepared to participate in the research study described above. I will be offered a copy of this consent form after I sign it.

Participant's Signature — Date / Time

Participant's Name

Researcher's Signature — Date / Time

Researcher's Name

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APPENDIX II

PARTICIPANT CONSENT FORM (ARABIC VERSION)

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AUB American University of Beirut
Faculty of Agricultural and Food Sciences

نموذج الموافقة على الاشتراك ببحث علمي، رقم البروتوكول: NUT.FN.22

1. عنوان البحث
تقييم دقّة إستمارة العادات الغذائية بين الراشدين اللبنانيين
2. الباحث الرئيسي
د. فرح نجا، الجامعة الأميريكيّة في بيروت
3. ما هدف هذا البحث؟
تهدف هذه الدراسة إلى النظر في صلاحية ودقة إستمارة العادات الغذائية لتقييمها بين الراشدين اللبنانيين. نرمي إلى مقارنة بيانات العادات الغذائية التي نجمعها من خلال الاستمارة بالمأكولات التي يتناولها الشخص في 24 ساعة الماضية وبالواصمات الحيوية في الدم (carotenoid, tocopherols, and retinols). نهدف إلى إشراك 120 راشداً بين عمر 18 و65 من عدة كليات ومكاتب في الجامعة الأميريكية في بيروت في هذه الدراسة. وهذا المشروع هو ممول من قبل مجلس الأبحاث الجامعي في الجامعة الأميريكية في بيروت وجامعة تكساس في أوستن.
4. كيف سيتمّ اختيار المشاركين في الدراسة؟
سيتم نشر الاعلان عن الدراسة في الجامعة الأميريكية في بيروت. يعبّر الأشخاص عن رغبتهم بالمشاركة من خلال البريد الاكتروني أوالاتصال الهاتفي. يطلب من هؤلاء الأشخاص زيارة قسم التغذية في الجامعة الأميريكية في بيروت، و تُملأ عندها استمارة لمعرفة اذا كان الشخص مخوّلاً للانضمام حسب شروط الدراسة. سيتم اختيار 120 أشخاص للمشاركة في هذه الدراسة.
5. ما الذي سيحدث اذا قررت المشاركة في هذا البحث؟
لدراسة العادات الغذائية، من المهمّ أن نستطيع تحديد أنواع وكميات المأكولات والمشروبات التي يتناولها الأشخاص وكيفية انعكاس ذلك في الواصمات الحيوية في الدم. لذا إذا قرّرت أن تشارك في الدراسة، سنجري معك 14 مقابلة وجهاً لوجه لجمع البيانات. خلال المقابلة الأولى، سنضع استمارات متعلّقة بأسلوب الحياة والعوامل الاجتماعية والديمغرافية واستمارة العادات الغذائية الأولى وبعد سنة نجري استمارة العادات الغذائية الثانية. بعد الزيارة الأولى، يتمّ سحب الدم لتحليل الواصمات الحيوية(carotenoid, tocopherols, and retinols) بالإضافة إلى نسبة الدهون في الدم في المركز الطبي في الجامعة الأميركية في بيروت خلال الفصل الأول (15 مل) والأخير (15 مل) من فترة الدراسة. لذا سيتمّ سحب عينات الدم مرتين فقط (مجموع 30 مل). في غضون كلّ من الفصول الأربعة لهذا العام، سنتّصل بك ثلاث مرات لتحديد ثلاثة لقاءات بغية إجراء ثلاث مقابلات وجهاً لوجه لإتمام رصد المأكولات التي يتناولها الشخص في الـ24 ساعة الماضية على ثلاث دفعات ويمتّل هذا يومين في الأسبوع وعطلة نهاية أسبوع واحدة في الفصل. كما سنقارن بيانات العادات الغذائية التي جمعناها عبر الاستمارة بالمأكولات التي تمّ تناولها خلال 24 ساعة وبالواصمات الحيوية (carotenoid, tocopherols, and retinols).

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Version Date: May 30, 2016

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11. ماذا سيحل بالمعلومات المجموعة عن المشتركين؟

سنحرص على حماية المعلومات المتعلقة بك واعتماد السرّيّة المطلقة. سوف نستخدم رمز للتعرف عليك في سجلاتنا بدلاً من استخدام اسمك. وسيتم مراقبة سجلاتك وقد يتم التدقيق بها من دون إنتهاك السرية.
سيتمّ حفظ نموذج الموافقة في خزانة مقفلة في مكتب الباحث الرئيسي، بينما سيتم حفظ الإستبيانات التي تمّ ملؤها في خزانة مقفلة في مكتب مخصص لهذا البحث. كما سيتمّ حفظ نسخ إلكترونية من البيانات والتأمين عليها بكلمة سريّة. سيتمكن فريق البحث في قسم التغذية في الجامعة الأميريكية في بيروت ، وفي جامعة تكساس في أوستن فقط الاطلاع على المعلومات الخاصة بك. لن نحدد هويتك في أي تقارير أو مطبوعات ناتجة عن هذا البحث.

_____ **أسمح** باستخدام المعلومات التي تم جمعها عني لمشاركتها مع باحثين آخرين.

_____ **لا أسمح** باستخدام المعلومات التي تم جمعها عني لمشاركتها مع باحثين آخرين.

12. ما هي حقوقك عند المشاركة في هذا البحث؟

يجب أن تدرك بأن مشاركتك في هذه الدراسة هي طوعية. لديك حرية قبول أو رفض المشاركة في هذه الدراسة من دون أي تأثير سلبي عليك ومن دون خسارة أي من المنافع التي تحقّ لك.

13. خيارات إضافية

يتم تحليل عينات الدم في مختبر الجامعة الأمريكية في بيروت وفي مختبر Craft Technologies Inc. في الولايات المتحدة الأمريكية. أما بقايا الدم، يتم التخلص منها وفقاً لسياسة المؤسستين. في حال سمحت للباحثين بحفظ بقايا من عينات الدم لتستخدم في أبحاث لاحقة، يتم تخزين هذه البقايا في قسم التغذية في الجامعة الأمريكية في بيروت.

- يمكنك الانضمام إلى هذه الدراسة حتى إذا كنت لا تسمحين لنا بسحب عينات الدم. يرجى الإشارة إلى اختيارك بعلامة على الخط المناسب أدناه :

_____ **أسمح** بسحب عينات الدم.

_____ **لا أسمح** بسحب عينات الدم.

- يمكنك الانضمام إلى هذه الدراسة حتى إذا كنت لا تسمح لنا بحفظ أو إستخدام بقايا من عينات الدم في أبحاث مقبلة. يرجى الإشارة إلى اختيارك بعلامة على الخط المناسب أدناه:

_____ **أسمح** بحفظ وإستخدام بقايا من عينات الدم في أبحاث مقبلة.

_____ **أسمح** بتخزين بقايا من عينات الدم لكن اطلب أن يتم الاتصال بي للتصريح بإذن لاستخدام هذه العينات في أبحاث مقبلة.

_____ **لا أسمح** بحفظ وإستخدام بقايا من عينات الدم في أبحاث مقبلة.

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6. كم من الوقت سيستغرق هذا البحث؟

ستتم استمارات جمع البيانات من خلال 14 مقابلة شخصية مع مساعد أبحاث مدرّب على فترة 12 شهراً. ستتم مقابلات البحث في مكتب المشارك (إن أمكن) أو يدعى المشارك إلى قسم التغذية في الجامعة الأمريكية في بيروت، غرفة 520 (غرفة البحوث).

7. هل يمكن لهذا البحث أن يضرّك؟

ليس هناك مخاطر متوقعة ناتجة عن مشاركتك في هذه الدّراسة. انما قد تشعر بالانزعاج لدى سحب عيّنة دم صغيرة عبر وخز الوريد وهناك احتمال الإصابة بالتهاب أو رضة أو وجع أو فقدان الوعي عندها. سيتولى اختصاصي في الفصد في المركز الطبي في الجامعة الأميركية في بيروت سحب الدم باتباع التقنية الصحيحة لأخذ عينة الدم ويكون المشارك في وضعية الجلوس. قد تنشأ مخاطر غير متوقعة أثناء إجراء الدراسة. كما هناك احتمال خسارة سرية المعلومات، لكن فريق البحث يتبع الإجراءات اللازمة من أجل حماية هذه السرية.
من المهم الملاحظة أنه في ختام الدراسة حيث يكون قد تم تحليل كل عينات الدم، سيقوم الباحثون بمشاركة نتائج التحاليل مع جميع المشاركين في البحث وينصحونهم بمناقشة النتائج مع طبيب العائلة.

8. هل يمكن لهذا البحث أن يفيدك؟

لا يقدم هذا البحث فوائد مباشرة لك. انما مشاركتك العامة في هذه الدراسة تساعدنا في جمع معلومات هامة وتصديق إستمارة العادات الغذائية التي قد تساعد في تقدير هذه العادات لدى عينة كبيرة من السكّان وستكون كفيلة بسدّ فجوة علمية أساسية في تقييم الوضع الغذائي للراشدين اللبنانيين، خصوصاً وسط روابط موثّقة ومتناسقة بين تناول الطعام والسمنة وتأثير العادات الغذائية على خطر الإصابة بأمراض مزمنة.

9. هل هناك تكلفة عند المشاركة في هذه الدراسة؟

يحصل المشارك على قيمة نقدية (15 دولار) في كل يوم سحب الدم لقاء وقت الانتظار وتكلفة النقل.

10. مع من يمكنك التحدث للاستفسار عن الدراسة؟

لطرح أية أسئلة أو مخاوف، أو إذا كنت تعتقد أن البحث أضرّ بك أو قد يضرّ بك، يمكنك التحدث مع:

د. فرح نجا، الجامعة الأميركيّة في بيروت
رقم الهاتف: 009611350000، الرقم الداخلي: 4504
البريد الإلكتروني: fn14@aub.edu.lb

إذا كان لديك أسئلة حول حقوقك كمشارك بالبحث، أو كنت ترغب في التحدث مع شخص من خارج فريق البحث، يرجى الإتصال ب:

مجلس لجنة الأخلاقيات للعلوم الطبية
الجامعة الأميركية في بيروت، لبنان
رقم الهاتف: 009611374374، الرقم الداخلي: 5445
البريد الإلكتروني: irb@aub.edu.lb

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- نود الحصول أيضاً على إذنك للاتصال بك من أجل المشاركة في دراسات مستقبلية. بامكانك الانضمام لهذه الدراسة حتى ولو لم تسمح بأن نتصل بك في المستقبل. كما ويمكنك أيضا أن تبدّل رأيك في هذا الموضوع. يرجى الإشارة إلى اختيارك بعلامة على الخط المناسب أدناه:

_____ **نعم، أوافق** على معاودة الإتصال بي. يرجى تزويدنا برقم هاتفك:_____

_____ **كلا، أرفض** معاودة الإتصال بي.

صفحة التوقيع للمشاركة

المشاركة

لقد قرأت وفهمت المعلومات أعلاه. أوافق طوعاً على الانضمام الى البحث المشروح في هذا النموذج. سوف أحصل على نسخة من هذا النموذج بعد توقيعي عليه .

الاسم الكامل للمشارك

توقيع المشارك **التاريخ**
الوقت

الاسم الكامل للشخص الحاصل على الموافقة

التوقيع **التاريخ**
الوقت

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APPENDIX III

SCREENING FORM PROTOCOL (ENGLISH VERSION)

Institutional Review Board
American University of Beirut

07 SEP 2016

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American University of Beirut
Faculty of Agricultural and Food Sciences

Screening Form. Protocol # NUT.FN.22

Date	Interviewer's Name	Location (Campus/Hospital)
|_|_|-|_|_|-|_|_| DD - MM - YY	_____	_____

For a participant to be eligible for the study "Validity and Reliability of FFQ to Assess Dietary Intake among Lebanese Adults", all inclusion criteria must be "YES", and all exclusion criteria must be "NO".

Inclusion criteria	**Yes**	**No**
1. Aged between 18 and 65 years at the time of enrollment		
2. Lebanese nationality or living in Lebanon for more than 10 years		
3. Able to speak and understand the Arabic language		
Exclusion criteria	**Yes**	**No**
1. Pregnant or breastfeeding woman		
2. Student		
3. Suffers from a chronic health condition that requires dietary modification (e.g. eating disorder, diabetes, renal or liver disease etc.)		

If applicable, what are the reasons for refusal to participate in the research project?

- _____
- _____

Version 1: Date: 1-06-16

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03 OCT 2016

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APPENDIX IV

SOCIO-DEMOGRAPHIC AND ANTHROPOMETRIC MEASUREMENTS' QUESTIONNAIRE (ENGLISH VERSION)

American University of Beirut
15 JUN 2016
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American University of Beirut
Faculty of Agricultural and Food Sciences

DATA COLLECTION FORM – VISIT 1

1	**Personal Information Questionnaire**		
1.1	**Interviewer's name**		
1.2	**Subject ID**	I__I__I__I	
1.3	**Date**	____/____/_____ dd/ mm/ yyyy	
1.4	**Name**		
1.5	**Department**		
1.6	**Telephone number**	**Mobile:** **Landline:**	**Best time to contact you?** ____:____ am/pm
1.7	**Email**		
1.8	**Address**		

*Please circle only **1 answer** in the below questions, unless otherwise indicated.*

2	**Sociodemographic Questionnaire**	
2.1	**Date of birth**	____/____/_____ dd/ mm/ yyyy
2.2	**Gender**	1. Male 2. Female
2.3	In which **area** of Lebanon do you live?	1. Beirut 2. Mount Lebanon 3. South 4. Nabatiyeh 5. North 6. Bekaa
2.4	**Marital status**	1. Single 2. Married 3. Widowed 4. Divorced
2.5	What is the highest **educational level** that you have achieved?	1. No schooling 2. Primary school 3. Intermediate school 4. High school 5. Technical diploma 6. University degree
2.6	Did you specialize in a **health-related major** (medicine, biology, public health, nutrition, pharmacy, etc.)	1. Yes 2. No 3. Not applicable

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	Skip if you did not receive a technical diploma or university degree.	
2.7	What is your **occupation**?	1. Academic, full-time 2. Academic, part-time 3. Non-academic, full-time 4. Non-academic, part-time 5. Other, please specify: _____
2.8	What is the total **number of individuals** living in your house? *Including relatives or family members that frequently live with you on a semi-permanent basis.*	I__I__I
2.9	How many **rooms** are there in your house? *Excluding the kitchen, bathrooms, hallways, garage, and open balconies.*	I__I__I
2.10	Do you and/or your husband **own the house** you currently live in?	1. Yes 2. No
2.11	How many **cars** does your household own? *This includes cars owned by yourself, your spouse and any of your children.*	I__I__I
2.12	What is the **total monthly income** of the family (L.L.)? *Including the sum of salaries of the couple, income coming from relatives, and income coming from renting a house, land, or other assets.*	1. Less than 600,000 (less than $ 400) 2. 600,001 – 999,999 ($401 – $666.9) 3. 1,000,000 – 1,499,000 ($ 667 – $999.9) 4. 1,500,000 – 1,999,000 ($ 1,000 - $1,332.9) 5. 2,000,000 – 2,499,000 ($ 1333 - $ 1,666.9) 6. 2,500,000 – 2,999,000 ($1,667 – $1,999.9) 7. Above 3,000,000 ($2,000)
3	**Lifestyle Practices – Smoking**	
3.1	Are you a **current smoker**?	1. Yes 2. No
3.2	How long have you been a smoker?	1. _____ months 2. _____ years 3. Not applicable
3.3	If yes, how many of the following **do** you usually smoke?	1. Cigarettes *(number of cigarettes)* a. _____ per day b. _____ per week c. _____ per month 2. Cigars *(number of cigars)* a. _____ per day b. _____ per week c. _____ per month 3. Narghili *(total number of minutes)* a. _____ per day b. _____ per week

		c. _____ per month
3.4	Are you a **past smoker**?	1. Yes 2. No
3.5	For **how long** did you smoke?	1. _____ months 2. _____ years 3. Not applicable
3.6	If yes, how many of the following **did** you usually smoke?	1. Cigarettes *(number of cigarettes)* a. _____ per day b. _____ per week c. _____ per month 2. Cigars *(number of cigars)* a. _____ per day b. _____ per week c. _____ per month 3. Narghili *(total number of minutes)* a. _____ per day b. _____ per week c. _____ per month
4	**Lifestyle Practices - Physical Activity *(during the past 7 days)*** Please think about the activities you do at work for more than 10 minutes, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. (IPAQ – short format (Craig *et al.*, 2003; [30])	
4.1	During the last 7 days, on how many days did you do **vigorous physical activities** like heavy lifting, digging, aerobics, or fast bicycling? *(Activities that make you breathe much harder than normal and that you did for at least 10 minutes at a time)*	1. I__I__I days per week 2. No vigorous physical activities *(Skip to question 4.3)*
4.2	If yes, **how much time** did you usually spend doing **vigorous** physical activities on one of those days?	1. _____ hours per day 2. _____ minutes per day 3. I don't know/ I'm not sure
4.3	During the last 7 days, on how many days did you do **moderate physical activities** like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.	1. I__I__I days per week 2. No moderate physical activities *(Skip to question 4.5)*
4.4	**How much time** did you usually spend doing **moderate** physical activities on one of those days?	1. _____ hours per day 2. _____ minutes per day 3. I don't know/ I'm not sure
4.5	Think about the time you spent **walking in the last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.	1. I__I__I days per week 2. No walking *(Skip to question 4.7)*
4.6	**How much time** did you usually spend **walking** on one of those days?	1. _____ hours per day 2. _____ minutes per day

		3. I don't know/ I'm not sure
4.7	The last question is about the time you spent **sitting** on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.	1. _____ hours per day 2. _____ minutes per day 3. I don't know/ I'm not sure
5	**Anthropometric Measurements**	
5.1	Weight	l__l__l__l.l__l kg
5.2	Height	l__l__l__l.l__l cm
6	**Supplement intake**	
6.1	Do take any vitamin / mineral / herbal supplements?	1. Yes, *please specify:*

Brand (eg; EuroFer)	**Type** (eg; Iron)	**Dose/pill** (eg:300 mg)	**Frequency** (eg: day)

2. No

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APPENDIX V

24-HR RECALL (ENGLISH VERSION)

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TWENTY-FOUR HOUR RECALL FORM

1	**Personal Information Questionnaire**	
1.1	**Interviewer's name**	
1.2	**Subject ID**	I__I__I__I
1.3	**Date**	____/____/_____ dd/ mm/ yyyy
1.4	**Day of the week**	

2. 24-hour recall

2.1 Please recall what you ate and drank the previous day from the time you woke up until the next morning. Please include recipes and brand names when necessary.

Time	Food eaten	Amount	Method of preparation

1

Time	Food eaten	Amount	Method of preparation

2.2 Was yesterday a usual day?

1. Yes
2. No, *please specify*: _____

APPENDIX VI

FOOD FREQUENCY QUESTIONNAIRE (ENGLISH VERSION)

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Food Frequency Questionnaire

1. **Food Frequency Questionnaire** - *Please think about your eating patterns* ***during the past year****. Please indicate your usual intake of each of the following food items per day, week, or month. Please be as precise as you can in your recall.*

CODE	FOOD ITEM	REFERENCE PORTION	USUAL PORTION	FREQUENCY
1	**CEREALS AND CEREAL-BASED PRODUCTS**			
1.1	White bread	1 large Arabic loaf/ 1 medium Arabic loaf/ 1 baguette		☐ D ☐ W ☐ M ☐ Never
1.2	Brown/whole wheat bread	1 large Arabic loaf/ 1 medium Arabic loaf/ 1 baguette		☐ D ☐ W ☐ M ☐ Never
1.3	Ka'ak products	1 finger sized		☐ D ☐ W ☐ M ☐ Never
1.4	Toast and crackers	1 regular toast		☐ D ☐ W ☐ M ☐ Never
1.5	Breakfast cereals, regular	Side A/ 1 small box		☐ D ☐ W ☐ M ☐ Never
1.6	Breakfast cereals, bran or whole grain	Side A/ 1 small box		☐ D ☐ W ☐ M ☐ Never
2	**PASTA AND OTHER CEREALS**			
2.1	Bulgur, cooked	Side A		☐ D ☐ W ☐ M ☐ Never
2.2	Pasta/noodles, cooked	Side A		☐ D ☐ W ☐ M ☐ Never
2.3	Rice and rice-products	Side A		☐ D ☐ W ☐ M ☐ Never
3	**POTATOES AND POTATO- BASED PRODUCTS**			
3.1	French Fries	Side A		☐ D ☐ W ☐ M ☐ Never
3.2	Potato	1 medium portion		☐ D ☐ W ☐ M ☐ Never
3.3	Potato chips, regular	S / M / L bag		☐ D ☐ W ☐ M ☐ Never
3.4	Potato chips, light	S / M / L bag		☐ D ☐ W ☐ M ☐ Never
4	**VEGETABLES**			
4.1	Vegetables, canned	Side A		☐ D ☐ W ☐ M ☐ Never
4.2	Vegetables, raw	Side A		☐ D ☐ W ☐ M ☐ Never
4.3	Salad, green	Side A		☐ D ☐ W ☐ M ☐ Never
5	**FRUITS**			
5.1	Fresh fruits	Side A/ 1 medium portion		☐ D ☐ W ☐ M ☐ Never
5.2	Canned fruits	Side A/ 1 medium portion		☐ D ☐ W ☐ M ☐ Never
5.3	Dried fruits	Side A		☐ D ☐ W ☐ M ☐ Never
5.4	Fruit-based desserts (cocktails)	Side A		☐ D ☐ W ☐ M ☐ Never
6	**FRUIT JUICES**			
6.1	Fruit Juices, Canned	Side A/ 1 regular (240 mL)		☐ D ☐ W ☐ M ☐ Never
6.2	Fruit Juices, Fresh	Side A		☐ D ☐ W ☐ M ☐ Never
7	**MEAT- Cured Meat**			
7.1	Cured meat, except ham (luncheon meat,	Side B/ Hotdog size/ Regular cured meat slice/		☐ D ☐ W ☐ M ☐ Never

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Food Frequency Questionnaire

	hotdog)			
7.2	Ham	Regular cured ham slice		□ D □ W □ M □ Never
7.3	Meat (beef), cooked, low fat	Side B		□ D □ W □ M □ Never
7.4	Meat (beef),cooked, medium - high fat	Side B		□ D □ W □ M □ Never
7.5	Meat (lamb), cooked, high fat	Side B		□ D □ W □ M □ Never
8	**MEAT- Offals**			
8.1	Organ meat (liver, heart, brain, etc.)	Side B		□ D □ W □ M □ Never
9	**MEAT- Poultry**			
9.1	Poultry	Leg/ thigh/ breast/ Side B		□ D □ W □ M □ Never
9.2	Poultry, breaded (nuggets, escalope)	Nuggets/ Side B		□ D □ W □ M □ Never
10	**MEAT- Eggs**			
10.1	Eggs, whole	1 egg		□ D □ W □ M □ Never
11	**MEAT- Fish and Seafood**			
11.1	Fish	Side B		□ D □ W □ M □ Never
11.2	Fish, canned with oil (tuna, sardines)	1 large can/ 1 small can		□ D □ W □ M □ Never
11.3	Fish, canned without oil (in water)	1 large can/ 1 small can		□ D □ W □ M □ Never
11.4	Shellfish	Shrimp: 1 medium Calamari: 1 medium Crab stick: 1 stick		□ D □ W □ M □ Never
12	**PULSES, NUTS AND SEEDS**			
12.1	Beans, Chickpeas, Fava Beans, Lentils	Side A		□ D □ W □ M □ Never
12.2	Nuts and seeds	Side A		□ D □ W □ M □ Never
12.3	Falafel	1 falafel piece		□ D □ W □ M □ Never
13	**MILK AND DAIRY PRODUCTS**			
13.1	Cheese (low fat / light/white)	1 square/triangular portion/ Side A or B		□ D □ W □ M □ Never
13.2	Cheese (high fat/yellow)	1 square/triangular portion/ Side A or B		□ D □ W □ M □ Never
13.3	Cheese (processed, creamy)	1 square/triangular portion/Side A or B		□ D □ W □ M □ Never
13.4	Full fat milk, milk-based beverages	Side A/ 1 carton of flavored milk		□ D □ W □ M □ Never
13.5	Low fat milk, milk-based beverages	Side A/ 1 carton of flavored milk		□ D □ W □ M □ Never
14	**YOGURT AND YOGURT- BASED PRODUCTS**			
14.1	Labneh, regular	Side A		□ D □ W □ M □ Never
14.2	Labneh, low fat and	Side A		□ D □ W □ M □ Never

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	skim (0-2%)			
14.3	Yogurt, regular	Side A/1 ayran bottle		□ D □ W □ M □ Never
14.4	Yogurt, light	Side A/1 ayran bottle		□ D □ W □ M □ Never
15	**PIZZAS AND PIES**			
15.1	Pies, 'Manaeesh'	1 large/ 1 bouchee		□ D □ W □ M □ Never
15.2	Pies, small (e.g.: fatayer, sambousek)	1 small		□ D □ W □ M □ Never
15.3	Pizza	Side A or B/ 1 small bouchee		□ D □ W □ M □ Never
16	**MIXED DISHES**			
16.1	Artichoke, eggplant, cauliflower cooked	Side A		□ D □ W □ M □ Never
16.2	Chicory, fried with onions	Side A		□ D □ W □ M □ Never
16.3	Eggplant, zucchini, cabbage, grape leaves (stuffed with rice & meat)	Side A/ 1 medium portion		□ D □ W □ M □ Never
16.4	Stew (Jews mallow, okra, peas, spinach) *without rice	Side A		□ D □ W □ M □ Never
17	**FATS AND OILS (ADDED ON BREADS)**			
17.1	Butter/ghee	Side A		□ D □ W □ M □ Never
17.2	Mayonnaise, regular	Side A		□ D □ W □ M □ Never
17.3	Olive oil	Side A		□ D □ W □ M □ Never
17.4	Tahini	Side A		□ D □ W □ M □ Never
17.5	Vegetable oil	Side A		□ D □ W □ M □ Never
17.6	Olives	1 medium olive		□ D □ W □ M □ Never
18	**FATS AND OILS (USED IN FRYING)**			
18.1	Butter/ghee	Side A		□ D □ W □ M □ Never
18.2	Olive oil	Side A		□ D □ W □ M □ Never
18.3	Vegetable ghee	Side A		□ D □ W □ M □ Never
18.4	Vegetable oil	Side A		□ D □ W □ M □ Never
19	**SUGAR AND SUGAR DERIVATIVES**			
19.1	Sugar	Side A		□ D □ W □ M □ Never
19.2	Candy	1 small		□ D □ W □ M □ Never
19.3	Chocolate	1 medium bar/ Side B		□ D □ W □ M □ Never
19.4	Chocolate spread	Side A		□ D □ W □ M □ Never
20	**CAKES AND PASTRIES**			
20.1	Cakes and pastries	Side B		□ D □ W □ M □ Never
20.2	Arabic sweets	Side B		□ D □ W □ M □ Never
20.3	Biscuits	Side B/ 1 medium		□ D □ W □ M □ Never
20.4	Croissant	Side B/ 1 large		□ D □ W □ M □ Never
20.5	Doughnuts	Side B/ 1 medium		□ D □ W □ M □ Never
21	**HONEY, JAM, MOLASSES AND HALAWAH**			

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21.1	Jam	Side A		□ D □ W □ M □ Never
21.2	Sugar derivatives (molasses, halawa, honey)	Side A		□ D □ W □ M □ Never
21.3	Ice cream, regular	1 scoop/ 1 stick		□ D □ W □ M □ Never
21.4	Ice cream, low fat	1 scoop/ 1 stick		□ D □ W □ M □ Never
21.5	Pudding, regular (custard, mhalabiye)	Side A/ 1 medium container		□ D □ W □ M □ Never
21.6	Pudding, low fat	Side A/ 1 medium container		□ D □ W □ M □ Never
22	**ALCOHOLIC BEVERAGES**			
22.1	Beer	Side A/ 1 bottle		□ D □ W □ M □ Never
22.2	Spirit drinks (whiskey, rum, vodka)	Side A/ 1 drink		□ D □ W □ M □ Never
22.3	Wine	Side A/ 1 glass		□ D □ W □ M □ Never
23	**NON-ALCOHOLIC BEVERAGES**			
23.1	Coffee instant, Nescafe, Turkish	Side A		□ D □ W □ M □ Never
23.2	Coffee creamer	Side A		□ D □ W □ M □ Never
23.3	Tea	Side A		□ D □ W □ M □ Never
23.4	De-caffeinated coffee or herbal tea	Side A		□ D □ W □ M □ Never
23.5	Energy & sports drink	Side A/ 1 can (330 mL)		□ D □ W □ M □ Never
23.6	Soda, regular	Side A/ 1 can (330 mL)		□ D □ W □ M □ Never
23.7	Soda, diet	Side A/ 1 can (330 mL)		□ D □ W □ M □ Never
23.8	Water	Side A/ 1 Liter		□ D □ W □ M □ Never
24	**MISCELLANEOUS**			
24.1	Ketchup	Side A		□ D □ W □ M □ Never
24.2	Mustard	Side A		□ D □ W □ M □ Never
24.3	Zaatar (thyme+sesame)	Side A		□ D □ W □ M □ Never
24.4	Pickles	1 M. cucumber/Side A		□ D □ W □ M □ Never

25 **Are there any other foods and/or beverages that were not mentioned above that you usually eat at least once per week?**

1. Yes, *please specify:*

Food/beverage	Serving size	Serving/ week

2. No

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APPENDIX VII

FOOD FREQUENCY QUESTIONNAIRE (ARABIC VERSION)

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إستبيان وتيرة إستهلاك الطعام

1. **إستبيان وتيرة إستهلاك الطعام**. يرجى منك التفكير بالنمط الغذائي الخاص بك الذي اتّبعته خلال **العام** الماضي. الرجاء تحديد الكمية المتناولة عادةً **في اليوم** أو **الأسبوع** أو **الشهر** لكل من المواد الغذائية التالية. الرجاء أن تكون أجوبتك دقيقة قدر المستطاع.

CODE	الطعام	مثال عن حجم الحصة	الحصّة الإعتيادية	وتيرة الإستهلاك
1	**الحبوب والمنتجات المرتكزة على الحبوب**			
1.1	خبز أبيض	رغيف خبز عربي كبير/ رغيف خبز عربي وسط/ خبز فرنجي (baguette)		يوم □ أسبوع □ شهر □ أبداً □
1.2	خبز أسمر/ قمحة كاملة	رغيف خبز عربي كبير/ رغيف خبز عربي وسط/ خبز فرنجي (baguette)		يوم □ أسبوع □ شهر □ أبداً □
1.3	منتوجات الكعك	كعك بحجم الاصبع		يوم □ أسبوع □ شهر □ أبداً □
1.4	توست وكراكرز	توست وسط		يوم □ أسبوع □ شهر □ أبداً □
1.5	حبوب الفطور العادية	Side A/ علبة صغيرة		يوم □ أسبوع □ شهر □ أبداً □
1.6	حبوب الفطور المصنوعة من النخالة أو الحبوب الكاملة	Side A/ علبة صغيرة		يوم □ أسبوع □ شهر □ أبداً □
2	**المعكرونة والحبوب الأخرى**			
2.1	برغل، مطبوخ	Side A		يوم □ أسبوع □ شهر □ أبداً □
2.2	معكرونة/نودلز، مسلوقة	Side A		يوم □ أسبوع □ شهر □ أبداً □
2.3	الأرز والمنتجات المرتكزة على الأرز	Side A		يوم □ أسبوع □ شهر □ أبداً □

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3	البطاطا ومنتجاتها			
3.1	بطاطا مقلية	Side A		يوم □ أسبوع □ شهر □ أبداً □
3.2	بطاطا	حصّة واحدة وسط		يوم □ أسبوع □ شهر □ أبداً □
3.3	رقائق البطاطا، عادي	كيس S / M / L		يوم □ أسبوع □ شهر □ أبداً □
3.4	رقائق البطاطا، لايت	كيس S / M / L		يوم □ أسبوع □ شهر □ أبداً □
4	الخضار			
4.1	خضار معلّبة	Side A		يوم □ أسبوع □ شهر □ أبداً □
4.2	خضار، نيئة	Side A		يوم □ أسبوع □ شهر □ أبداً □
4.3	سلطة، خضراء	Side A		يوم □ أسبوع □ شهر □ أبداً □
5	الفاكهة			
5.1	الفاكهة الطازجة	حصة وسط/ Side A		يوم □ أسبوع □ شهر □ أبداً □
5.2	الفاكهة المعلّبة	حصة وسط/ Side A		يوم □ أسبوع □ شهر □ أبداً □
5.3	الفاكهة المجفّفة	Side A		يوم □ أسبوع □ شهر □ أبداً □
5.4	الحلويات المُعدّة من الفاكهة	Side A		يوم □ أسبوع □ شهر □ أبداً □
6	عصائر الفاكهة			
6.1	عصائر الفاكهة المعلّبة	Side A/ مل 240علبة عصير		يوم □ أسبوع □ شهر □ أبداً □
6.2	عصائر الفاكهة الطازجة	Side A		يوم □ أسبوع □ شهر □ أبداً □
7	اللحوم – اللحوم الباردة والمعلّبة			
7.1	لحوم باردة باستثناء لحم الخنزير (مرتديلا - hotdog)	Side B/ حجم اللحوم الباردة الوسط/ حجم hotdog		يوم □ أسبوع □ شهر □ أبداً □
7.2	لحم خنزير - Ham	حجم اللحوم الباردة الوسط		يوم □ أسبوع □ شهر □ أبداً □
7.3	لحم (بقر)، مطبوخ، قليل الدهون	Side B		يوم □ أسبوع □ شهر □ أبداً □

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7.4	لحم (بقر)، مطبوخ، معتدل/غني الدهون	Side B		يوم □ أسبوع □ شهر □ أبداً □
7.5	لحم (غنم)، مطبوخ، غني بالدهون	Side B		يوم □ أسبوع □ شهر □ أبداً □
8	**اللحوم – لحوم الأعضاء**			
8.1	لحوم الأعضاء	Side B		يوم □ أسبوع □ شهر □ أبداً □
9	**اللحوم – الدواجن**			
9.1	دواجن، ذات لحم	ساق/فخذ/صدر Side B		يوم □ أسبوع □ شهر □ أبداً □
9.2	دواجن، مغلّفة بالطحين أو الكعك (nuggets - escalope)	حجم Nuggets/ Side B		يوم □ أسبوع □ شهر □ أبداً □
10	**اللحوم – البيض**			
10.1	بيضة كاملة	بيضة واحدة		يوم □ أسبوع □ شهر □ أبداً □
11	**اللحوم – الأسماك وثمار البحر**			
11.1	الأسماك	Side B		يوم □ أسبوع □ شهر □ أبداً □
11.2	الأسماك المعلّبة بالزيت (تونة - سردين)	تنكة كبيرة/ تنكة صغيرة		يوم □ أسبوع □ شهر □ أبداً □
11.3	الأسماك المعلّبة من غير زيت (معلب بالماء)	تنكة كبيرة/ تنكة صغيرة		يوم □ أسبوع □ شهر □ أبداً □
11.4	ثمار البحر	قريدس: 1 وسط كالماري: 1 وسط كراب: 1 أصبع		يوم □ أسبوع □ شهر □ أبداً □
12	**بقول، مكسّرات، وبذور**			
12.1	فاصوليا، حمّص، فول، عدس، بذور	Side A		يوم □ أسبوع □ شهر □ أبداً □
12.2	مكسّرات	Side A		يوم □ أسبوع □ شهر □ أبداً □
12.3	فلافل	1 وسط فلافل		يوم □ أسبوع □ شهر □ أبداً □

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13	**الحليب ومنتجاته**			
13.1	جبن (قليل الدسم/لايت/بيضاء)	حصة واحدة = مثلث/مربع Side A or B		يوم □ أسبوع □ شهر □ أبداً □
13.2	جبن (غني بالدسم/صفراء)	حصة واحدة = مثلث/مربع Side A or B		يوم □ أسبوع □ شهر □ أبداً □
13.3	جبن (مصنّع-كريمه)	حصة واحدة = مثلث/مربع Side A or B		يوم □ أسبوع □ شهر □ أبداً □
13.4	الحليب ومشروبات الحليب الكاملة الدسم	Side A/ كرتونة حليب وسط		يوم □ أسبوع □ شهر □ أبداً □
13.5	الحليب ومشروبات الحليب القليلة/الخالية الدسم	Side A/ كرتونة حليب وسط		يوم □ أسبوع □ شهر □ أبداً □
14	**اللبن ومنتجاته**			
14.1	لبنه، عادي	Side A		يوم □ أسبوع □ شهر □ أبداً □
14.2	لبنه، لايت/ خالية الدسم	Side A		يوم □ أسبوع □ شهر □ أبداً □
14.3	لبن، عادي - كامل الدسم	Side A/ عبوة عيران		يوم □ أسبوع □ شهر □ أبداً □
14.4	لبن، خفيف أو خالي من الدسم	Side A/ عبوة عيران		يوم □ أسبوع □ شهر □ أبداً □
15	**البيتزا والفطائر**			
15.1	مناقيش	منقوشة كبيرة / bouchee صغيرة		يوم □ أسبوع □ شهر □ أبداً □
15.2	معجّنات، حجم صغير	حصة صغيرة		يوم □ أسبوع □ شهر □ أبداً □
15.3	بيتزا	Side A or Side B / bouchee صغيرة		يوم □ أسبوع □ شهر □ أبداً □
16	**الأطباق**			

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16.1	أرضي شوكي، باذنجان، قرنبيط مطبوخ	Side A		يوم □ أسبوع □ شهر □ أبداً □
16.2	هندبة، مقليّة مع البصل	Side A		يوم □ أسبوع □ شهر □ أبداً □
16.3	باذنجان، كوسى، ملفوف، ورق عنب *محشي بالأرز واللحم	Side A/ كوسى وسط 1		يوم □ أسبوع □ شهر □ أبداً □
16.4	يخنة (ملوخيّة، بامية، بازلاء، سبانخ) * دون رز	Side A		يوم □ أسبوع □ شهر □ أبداً □
17	الدهون والزيوت (المُضافة إلى الخبز، السلطات، الخ)			
17.1	زبدة/سمنه	Side A		يوم □ أسبوع □ شهر □ أبداً □
17.2	مايونيز، عادي	Side A		يوم □ أسبوع □ شهر □ أبداً □
17.3	زيت زيتون	Side A		يوم □ أسبوع □ شهر □ أبداً □
17.4	طحينة	Side A		يوم □ أسبوع □ شهر □ أبداً □
17.5	زيت نباتي	Side A		يوم □ أسبوع □ شهر □ أبداً □
17.6	زيتون	وسط زيتون 1		يوم □ أسبوع □ شهر □ أبداً □
18	الدهون والزيوت (المُستخدمة للقلي)			
18.1	زبدة/سمنه	Side A		يوم □ أسبوع □ شهر □ أبداً □
18.2	زيت زيتون	Side A		يوم □ أسبوع □ شهر □ أبداً □
18.3	سمن نباتي	Side A		يوم □ أسبوع □ شهر □ أبداً □
18.4	زيت نباتي	Side A		يوم □ أسبوع □ شهر □ أبداً □
19	السكّر ومشتقّاته			
19.1	سكّر	Side A		يوم □ أسبوع □ شهر □ أبداً □
19.2	سكاكر	حصة سكاكر صغيرة		يوم □ أسبوع □ شهر □ أبداً □
19.2	شوكولا	حصة شوكولا وسط/ Side B		يوم □ أسبوع □ شهر □ أبداً □

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19.3	كريمة شوكولا (chocolate spread)	Side A		يوم □ أسبوع □ شهر □ أبداً □
20	**الكيكات والحلويات**			
20.1	كيك	Side B		يوم □ أسبوع □ شهر □ أبداً □
20.2	حلويات عربيّة	Side B		يوم □ أسبوع □ شهر □ أبداً □
20.3	بسكويت	Side B/ وسط 1		يوم □ أسبوع □ شهر □ أبداً □
20.4	كرواسان	Side B/ كبيرة 1		يوم □ أسبوع □ شهر □ أبداً □
20.5	كعك الدونتس	Side B/ وسط 1		يوم □ أسبوع □ شهر □ أبداً □
21	**عسل، مربّى، دبس وحلاوة**			
21.1	مربّى	Side A		يوم □ أسبوع □ شهر □ أبداً □
21.2	مشتقّات السكّر (دبس، حلاوة، عسل)	Side A		يوم □ أسبوع □ شهر □ أبداً □
21.3	بوظة، عادي	1 scoop/ 1 stick		يوم □ أسبوع □ شهر □ أبداً □
21.4	بوظة، قليلة الدسم	1 scoop/ 1 stick		يوم □ أسبوع □ شهر □ أبداً □
21.5	بودنغ، عادي (كسترد- مهلبية)	Side A		يوم □ أسبوع □ شهر □ أبداً □
21.6	بودنغ، قليل الدسم	Side A		يوم □ أسبوع □ شهر □ أبداً □
22	**المشروبات الكحولية**			
22.1	بيرة	Side A		يوم □ أسبوع □ شهر □ أبداً □
22.2	المشروبات الكحولية من غير النبيذ، باستثناء البيرة (ويسكي، رم، فودكا)	Side A		يوم □ أسبوع □ شهر □ أبداً □

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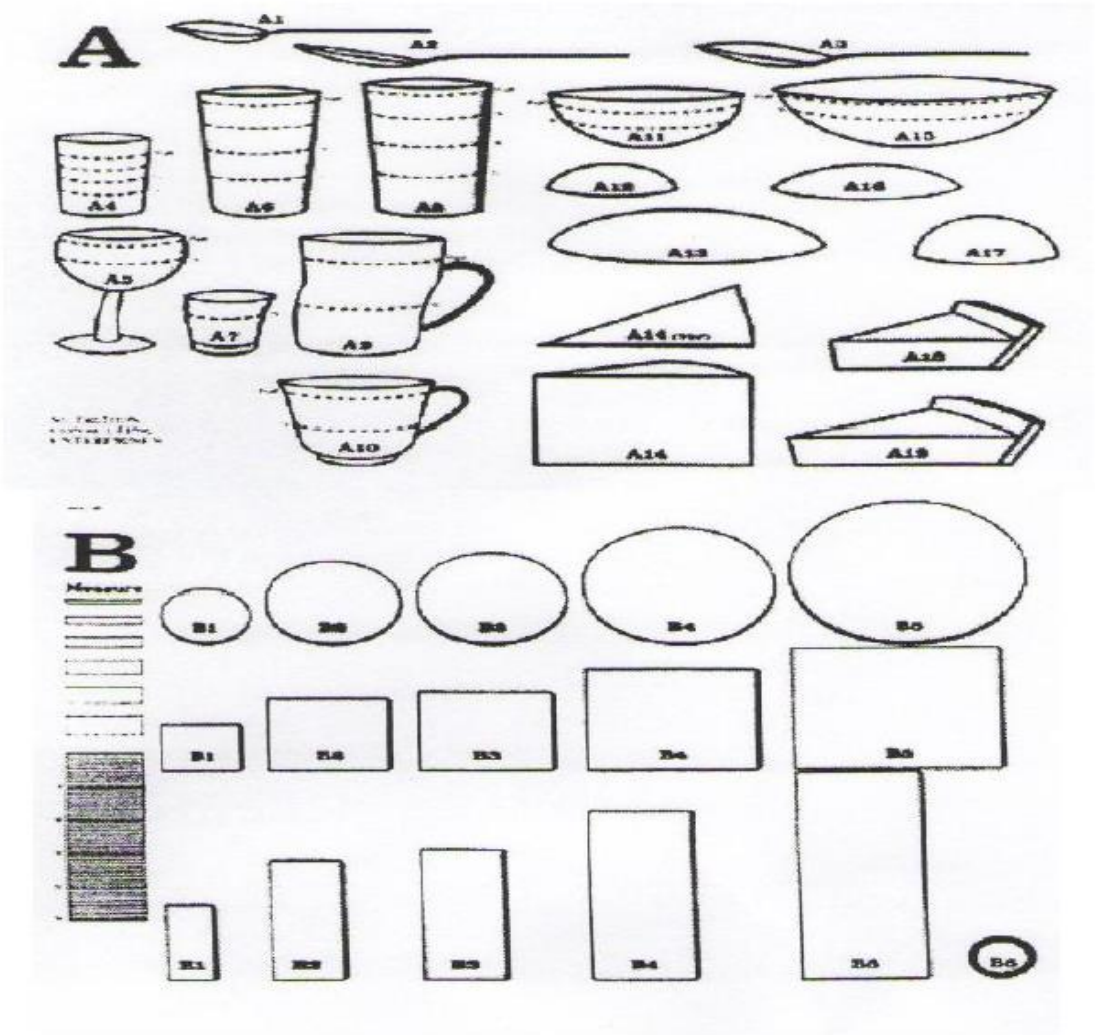
APPENDIX VIII

THE 2-D PORTION SIZE FOOD VISUAL POSTER
(NOT TO SCALE)

FOOD PORTION SIZE ILLUSTRATION



The above figure is a miniature of a poster that shows the real size of food portions (length: 60 cm, width: 48 cm)

Reference: Millen B and Morgan JL. The 2D Food Portion Visual. Farmingham, MA: Nutrition Consulting Entreprises, 1996

APPENDIX IX

BLAND ALTMAN PLOTS

Fig.1. Bland-Altman plot of energy intake as predicted by the FFQ-2 and mean of 8-12 MPRs

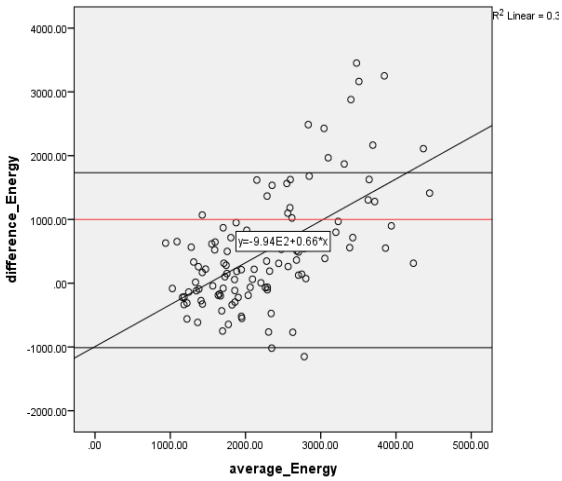


Fig.3. Bland-Altman plot of protein intake as predicted by the FFQ-2 and mean of 8-12 MPRs

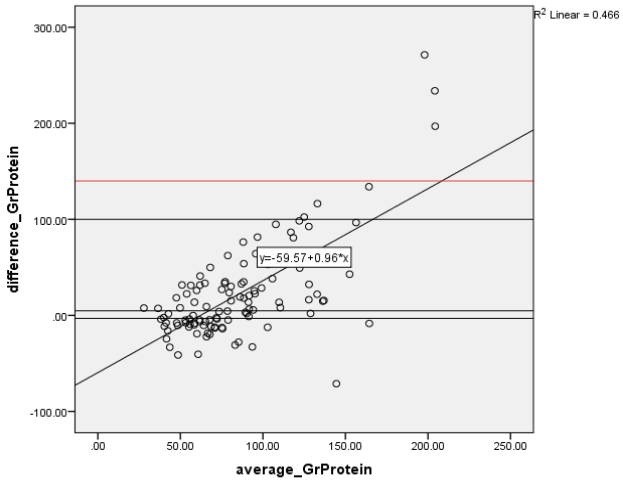


Fig.2. Bland-Altman plot of percent protein intake as predicted by the FFQ-2 and mean of 8-12 MPRs

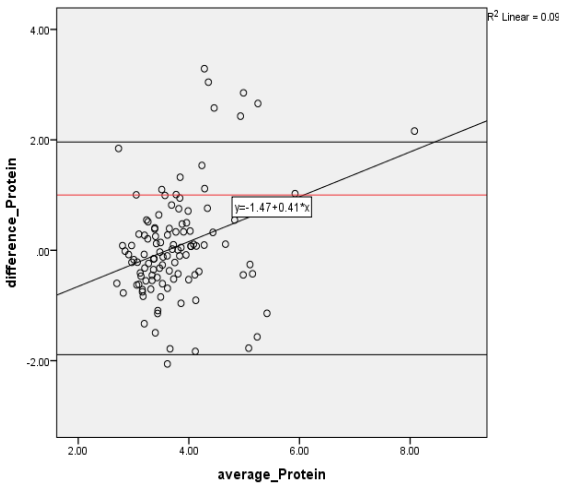


Fig.4. Bland-Altman plot of percent carbohydrate intake as predicted by the FFQ-2 and mean of 8-12 MPRs

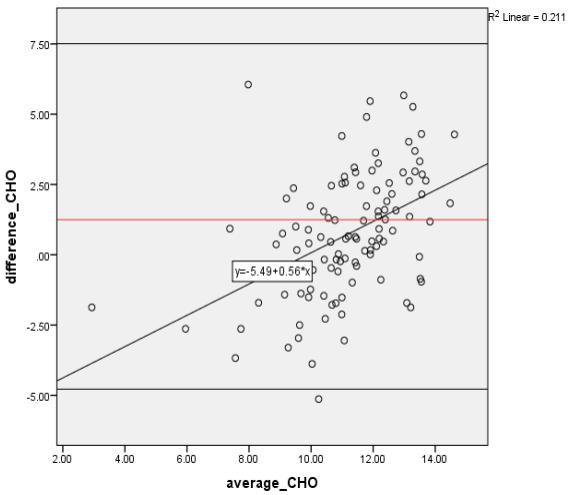


Fig.5. Bland-Altman plot of carbohydrate intake as predicted by the FFQ-2 and mean of 8-12 MPRs

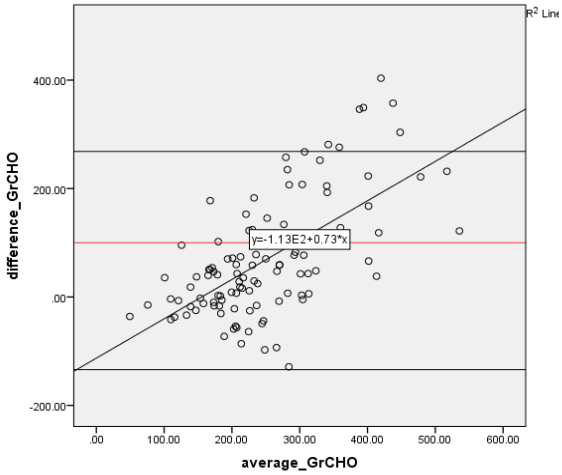


Fig.7. Bland-Altman plot of fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

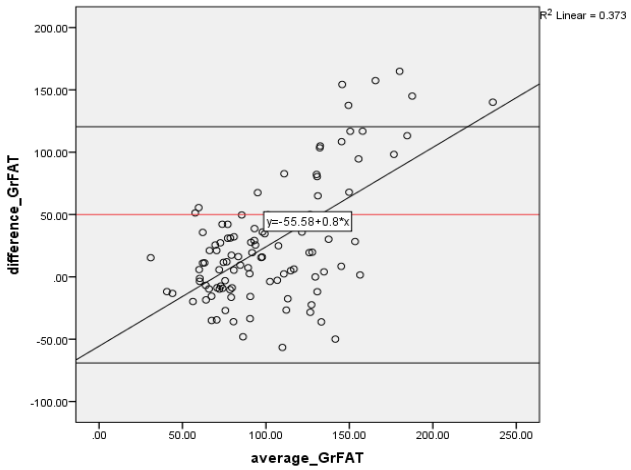


Fig.6. Bland-Altman plot of percent fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

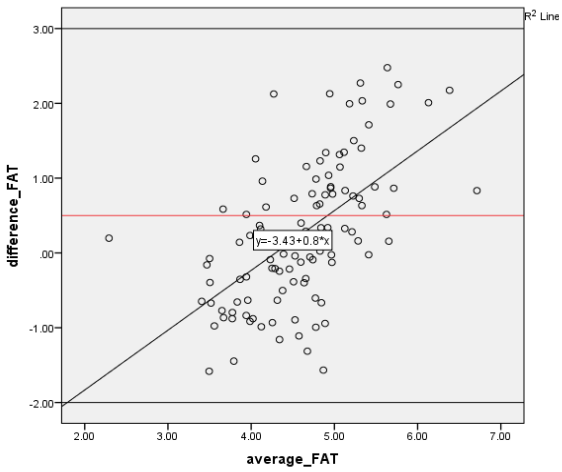


Fig.8. Bland-Altman plot of percent cholesterol intake as predicted by the FFQ-2 and mean of 8-12 MPRs

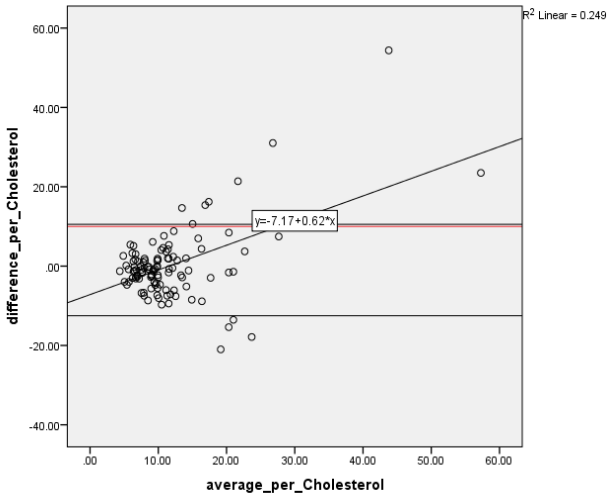


Fig.9. Bland-Altman plot of cholesterol intake as predicted by the FFQ-2 and mean of 8-12 MPRs

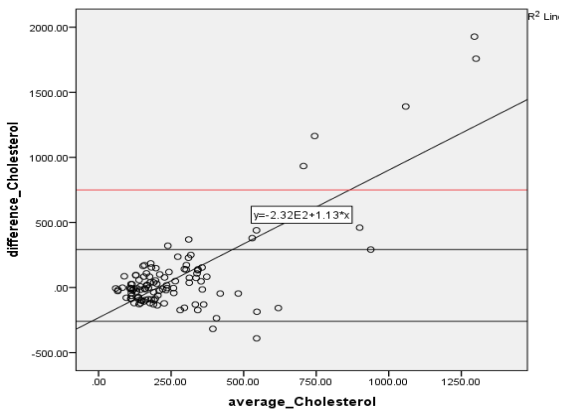


Fig.10. Bland-Altman plot of percent saturated fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

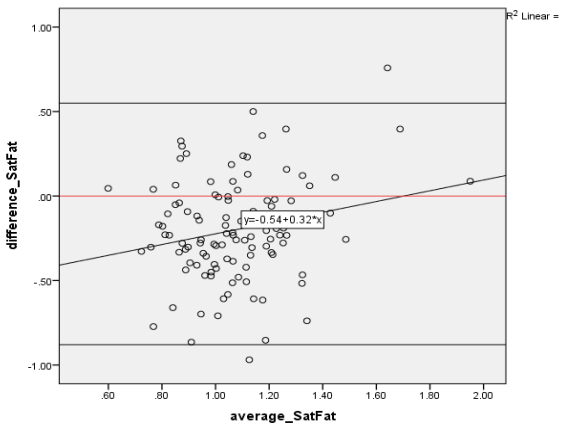


Fig.11. Bland-Altman plot of saturated fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

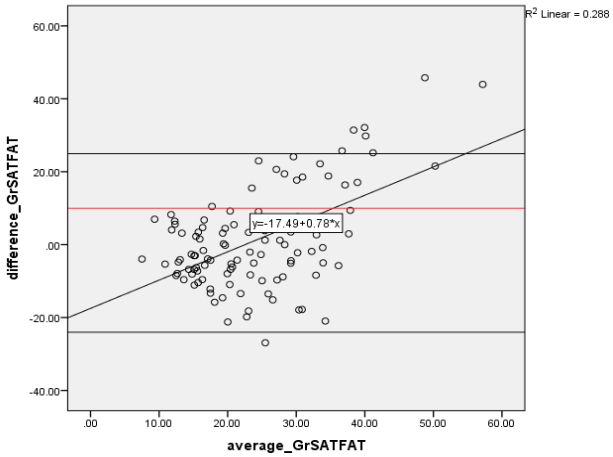


Fig.12. Bland-Altman plot of percent monounsaturated fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

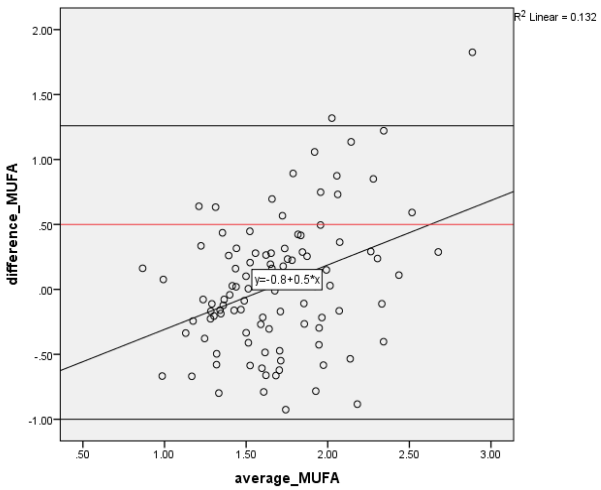


Fig.13. Bland-Altman plot of monounsaturated fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

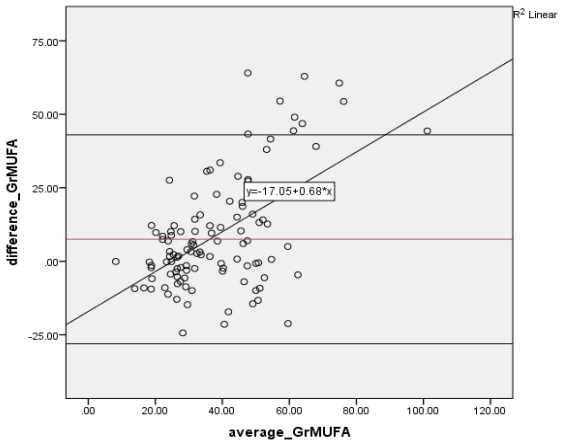


Fig.15. Bland-Altman plot of polyunsaturated fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

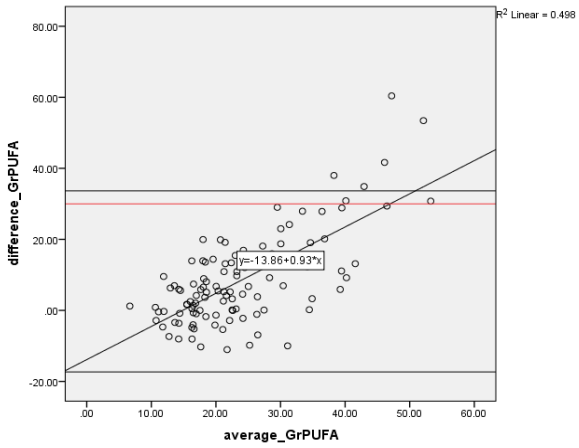


Fig.14. Bland-Altman plot of percent polyunsaturated fat intake as predicted by the FFQ-2 and mean of 8-12 MPRs

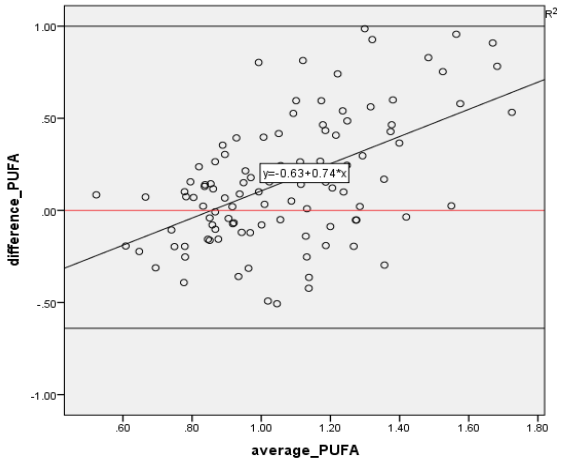


Fig.16. Bland-Altman plot of sodium intake as predicted by the FFQ-2 and mean of 8-12 MPRs

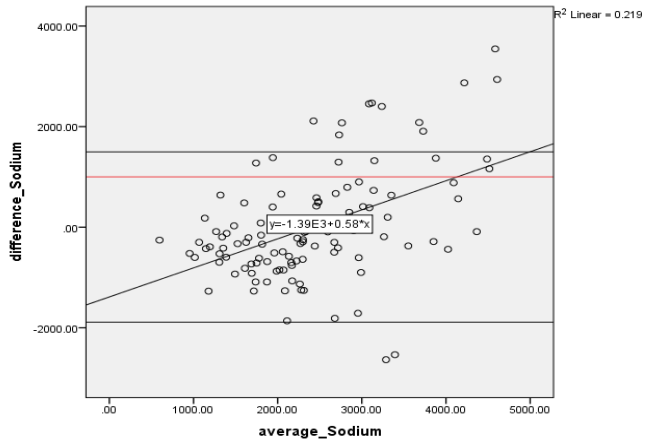


Fig.17. Bland-Altman plot of potassium intake as predicted by the FFQ-2 and mean of 8-12 MPRs

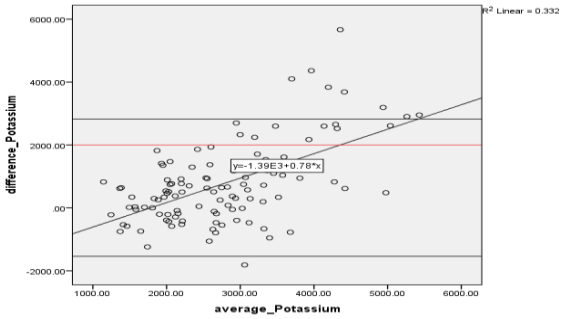


Fig.18. Bland-Altman plot of vitamin A (RE) intake as predicted by the FFQ-2 and mean of 8-12 MPRs

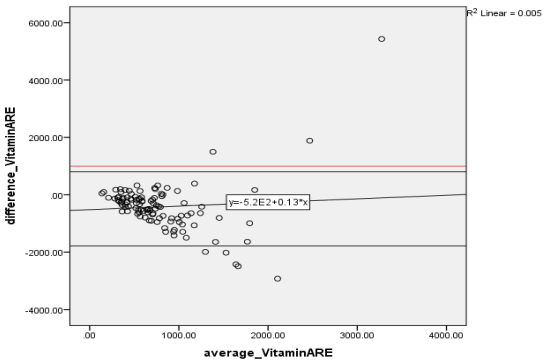


Fig.20. Bland-Altman plot of beta-carotene intake as predicted by the FFQ-2 and mean of 8-12 MPRs

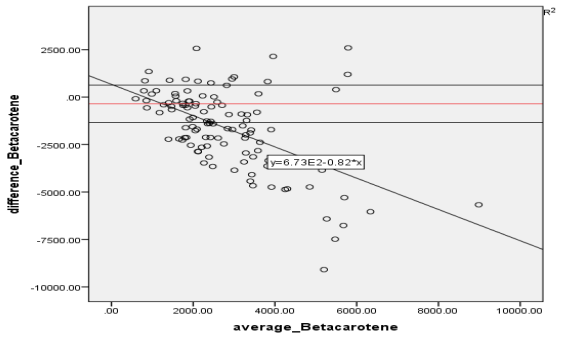


Fig.21. Bland-Altman plot of alpha-carotene intake as predicted by the FFQ-2 and mean of 8-12 MPRs

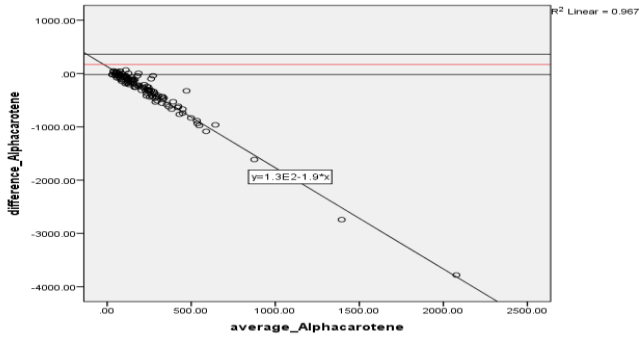


Fig.22. Bland-Altman plot of vitamin C intake as predicted by the FFQ-2 and mean of 8-12 MPRs

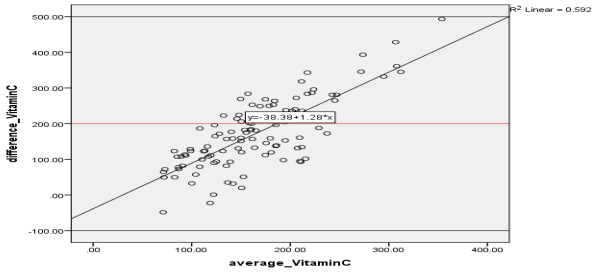


Fig.23. Bland-Altman plot of calcium intake as predicted by the FFQ-2 and mean of 8-12 MPRs

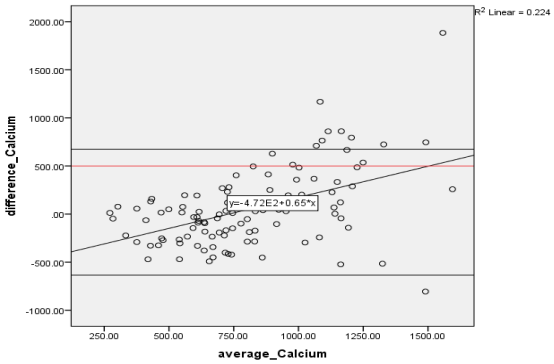


Fig.24. Bland-Altman plot of iron intake as predicted by the FFQ-2 and mean of 8-12 MPRs

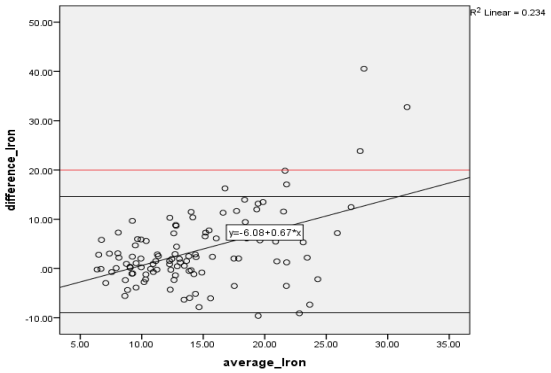


Fig.25. Bland-Altman plot of vitamin D intake as predicted by the FFQ-2 and mean of 8-12 MPRs

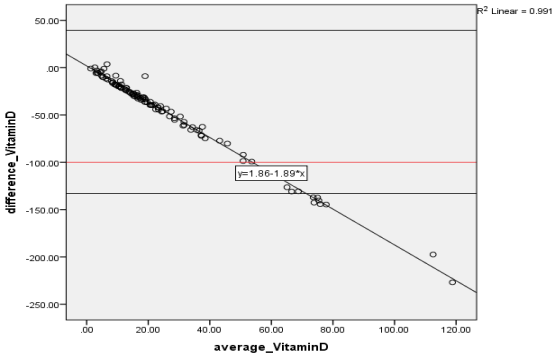


Fig.26. Bland-Altman plot of alpha-tocopherol intake as predicted by the FFQ-2 and mean of 8-12 MPRs

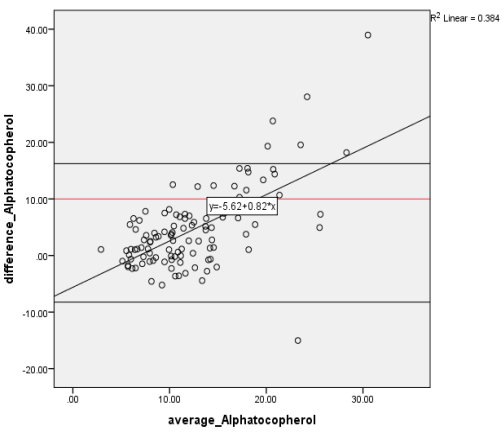


Fig.27. Bland-Altman plot of thiamin intake as predicted by the FFQ-2 and mean of 8-12 MPRs

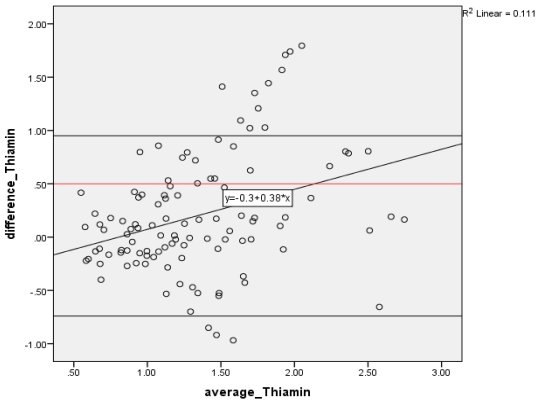


Fig.28. Bland-Altman plot of riboflavin intake as predicted by the FFQ-2 and mean of 8-12 MPRs

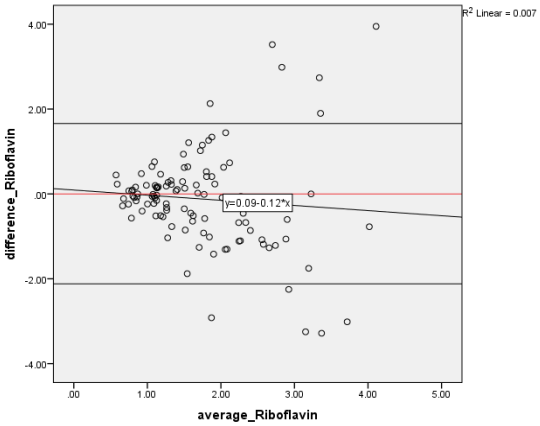


Fig.29. Bland-Altman plot of niacin intake as predicted by the FFQ-2 and mean of 8-12 MPRs

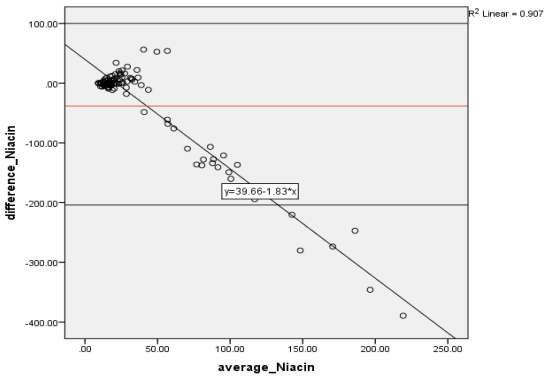


Fig.30. Bland-Altman plot of pyridoxine intake as predicted by the FFQ-2 and mean of 8-12 MPRs

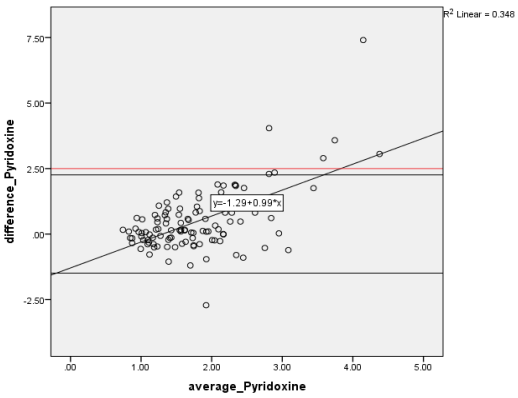


Fig.31. Bland-Altman plot of folate (mcg) intake as predicted by the FFQ-2 and mean of 8-12 MPRs

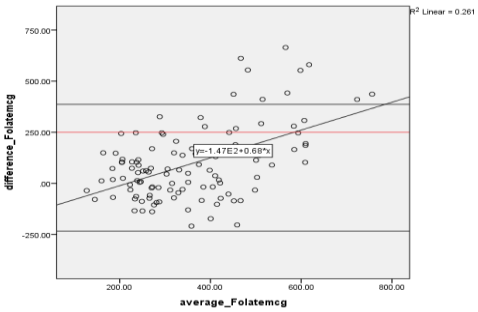


Fig.32. Bland-Altman plot of folate (DFE) intake as predicted by the FFQ-2 and mean of 8-12 MPRs

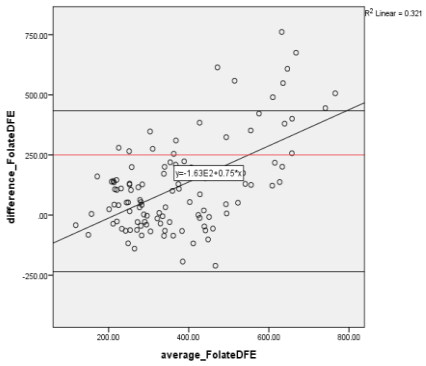


Fig.33. Bland-Altman plot of cobalamin intake as predicted by the FFQ-2 and mean of 8-12 MPRs

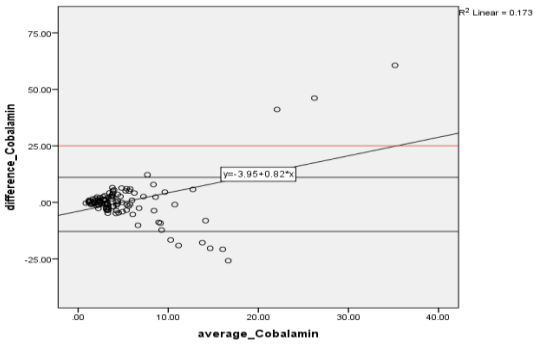


Fig.34. Bland-Altman plot of phosphorous intake as predicted by the FFQ-2 and mean of 8-12 MPRs

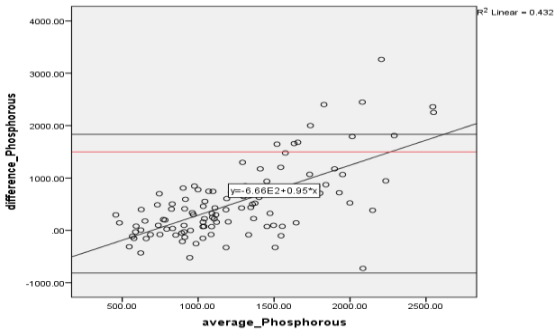


Fig.35. Bland-Altman plot of biotin intake as predicted by the FFQ-2 and mean of 8-12 MPRs

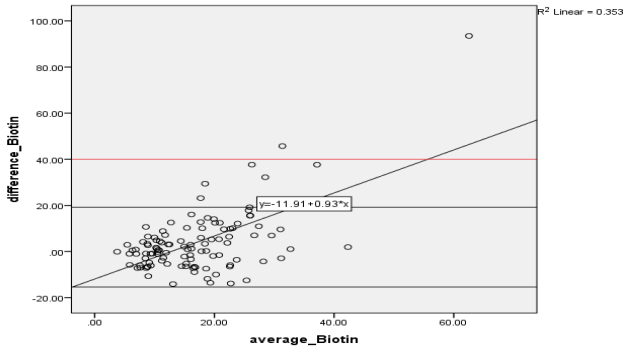


Fig.37. Bland-Altman plot of magnesium intake as predicted by the FFQ-2 and mean of 8-12 MPRs

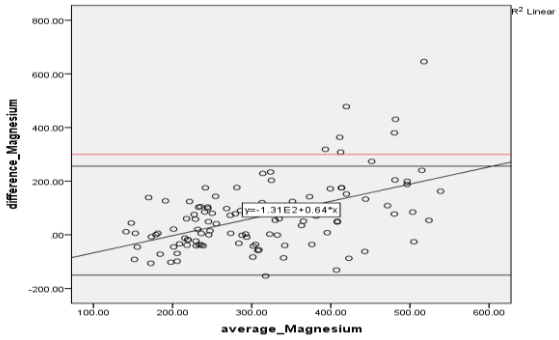


Fig.38. Bland-Altman plot of zinc intake as predicted by the FFQ-2 and mean of 8-12 MPRs

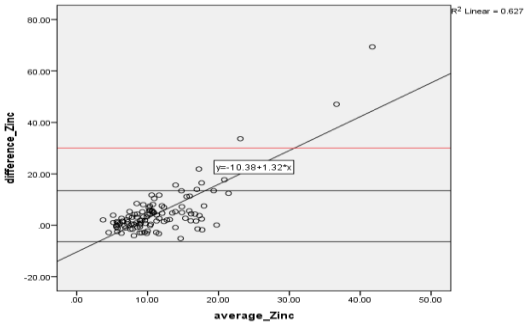


Fig.39. Bland-Altman plot of manganese intake as predicted by the FFQ-2 and mean of 8-12 MPRs

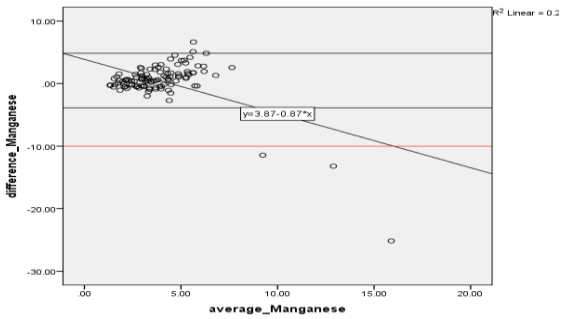


Fig.40. Bland-Altman plot of dietary fiber intake as predicted by the FFQ-2 and mean of 8-12 MPRs

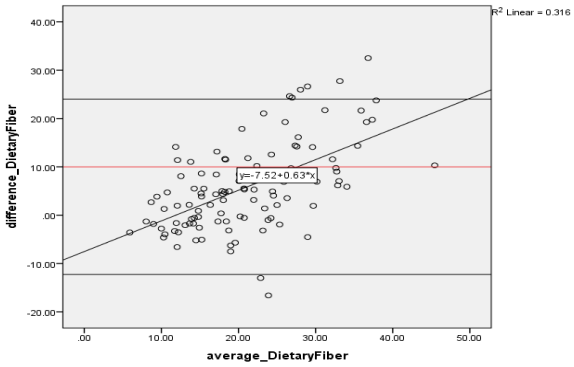


Fig.41. Bland-Altman plot of percent sugar intake as predicted by the FFQ-2 and mean of 8-12 MPRs

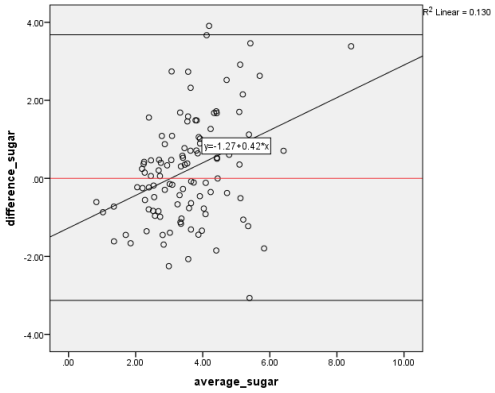
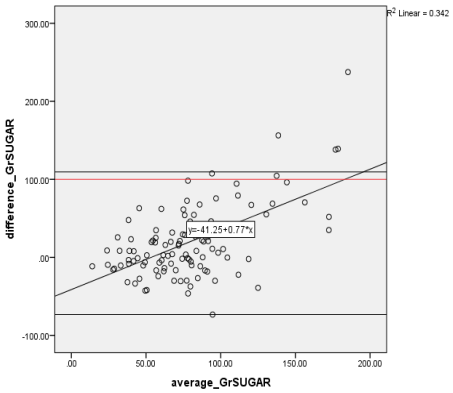


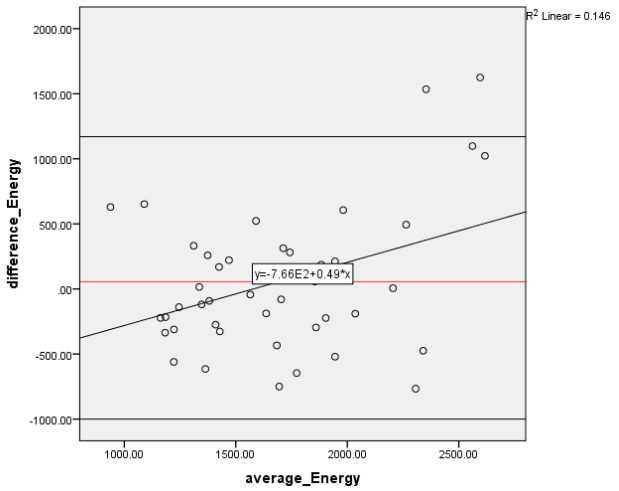
Fig.42. Bland-Altman plot of sugar intake as predicted by the FFQ-2 and mean of 8-12 MPRs

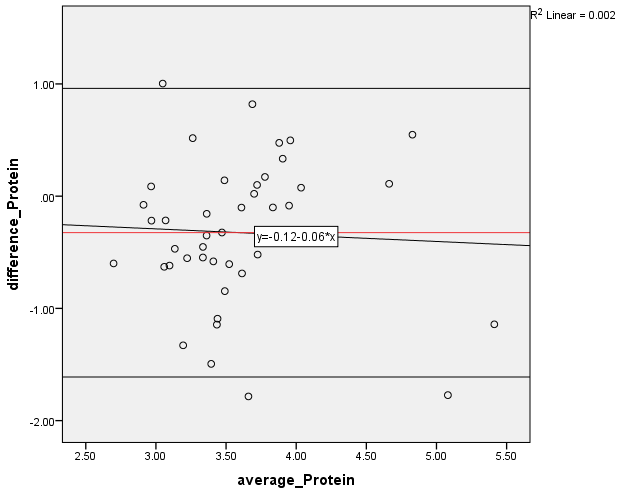


APPENDIX X

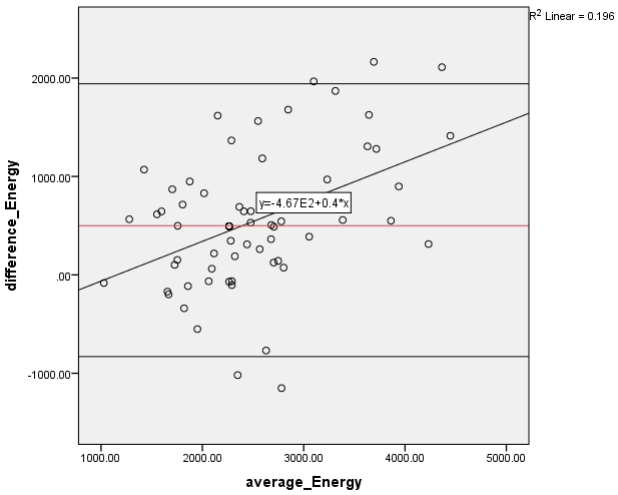
BLAND ALTMAN PLOTS STRATIFIED BY GENDER

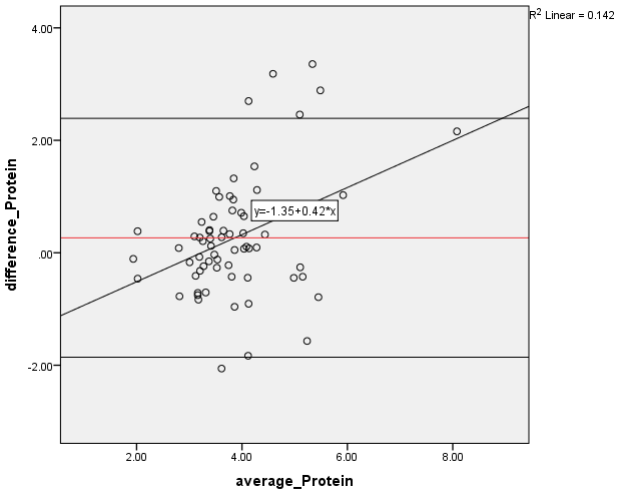
Bland Altman for Females

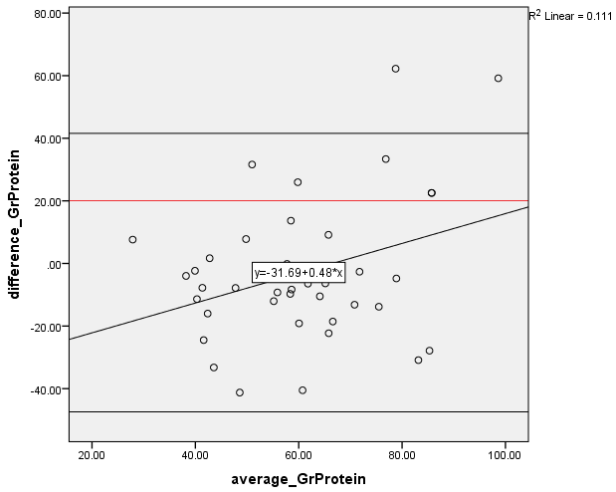


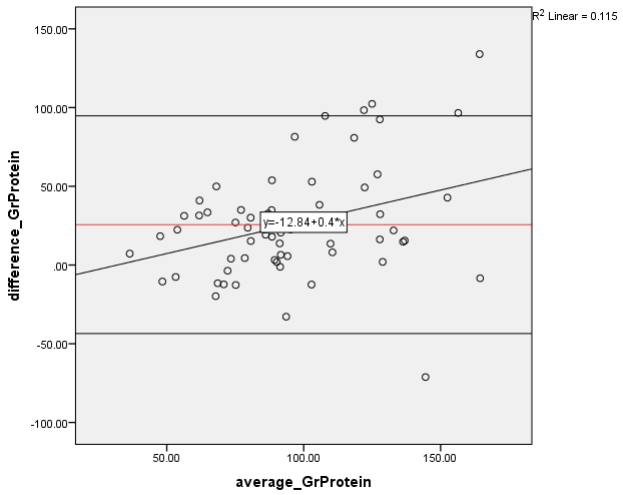


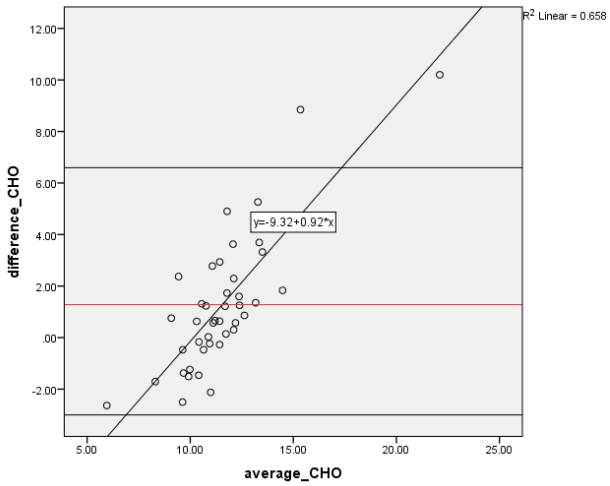
Bland Altman Plots for Males

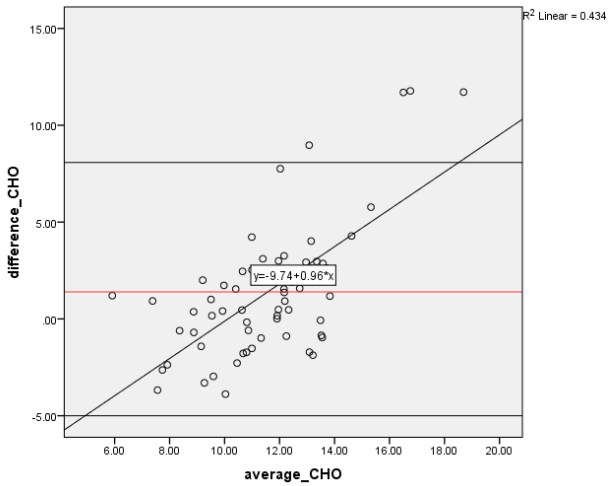


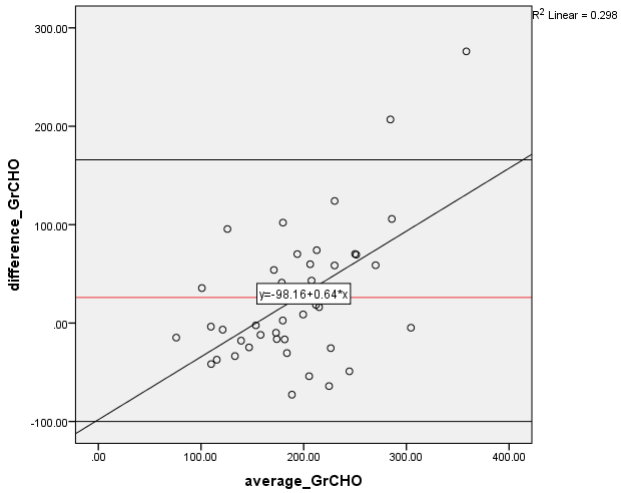


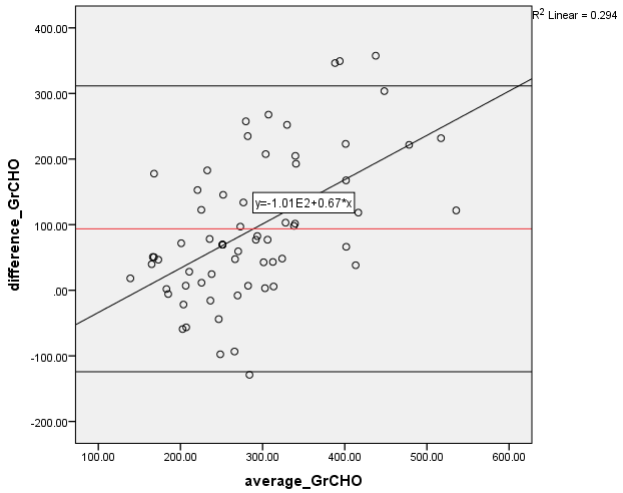

R2 Linear = 0.111
y=-31.69+0.48*x
difference_GrProtein
average_GrProtein

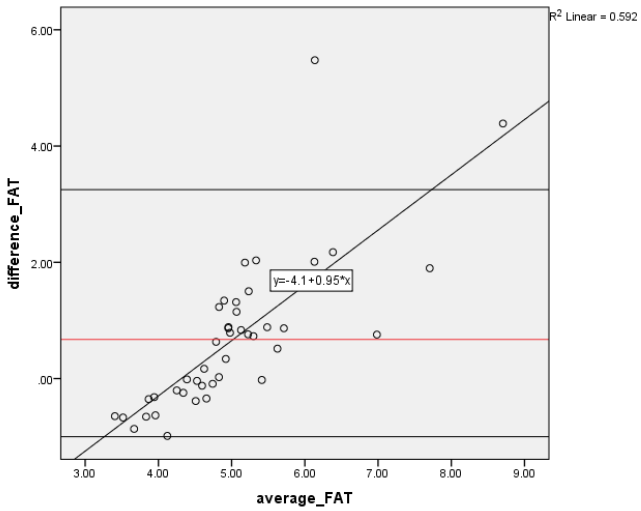

R2 Linear = 0.115
y=-12.84+0.4*x
difference_GrProtein
average_GrProtein

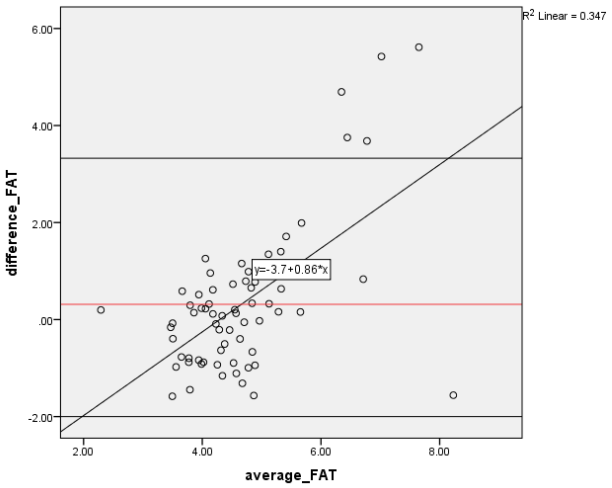

R2 Linear = 0.658
y=-9.32+0.92*x
difference_CHO
average_CHO

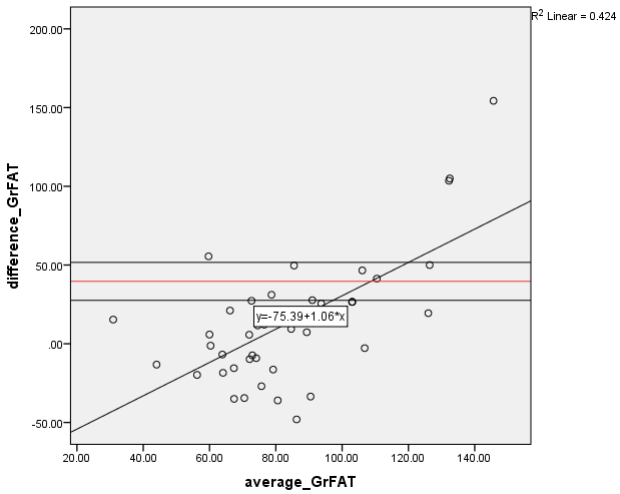

R2 Linear = 0.434
y=-9.74+0.96*x
difference_CHO
average_CHO

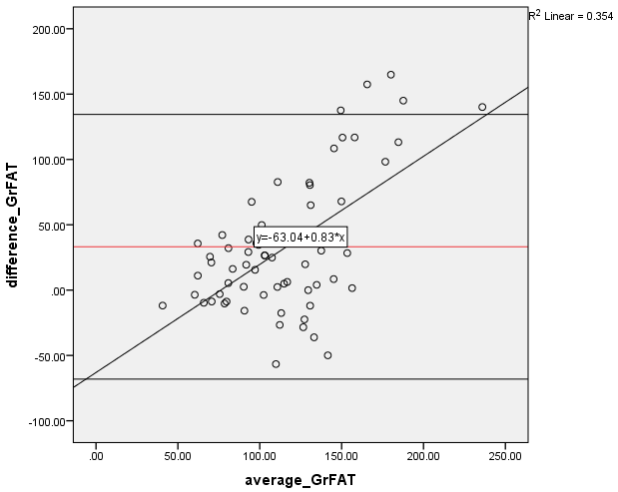

R2 Linear = 0.298
y=-98.16+0.64*x
difference_GrCHO
average_GrCHO

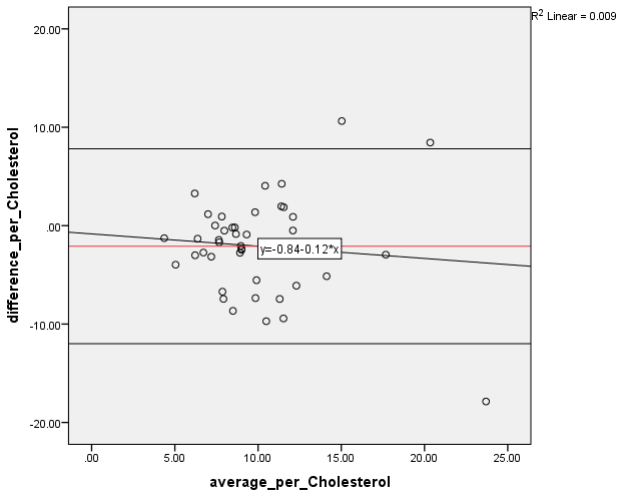

R2 Linear = 0.294
y=-1.01E2+0.67*x
difference_GrCHO
average_GrCHO

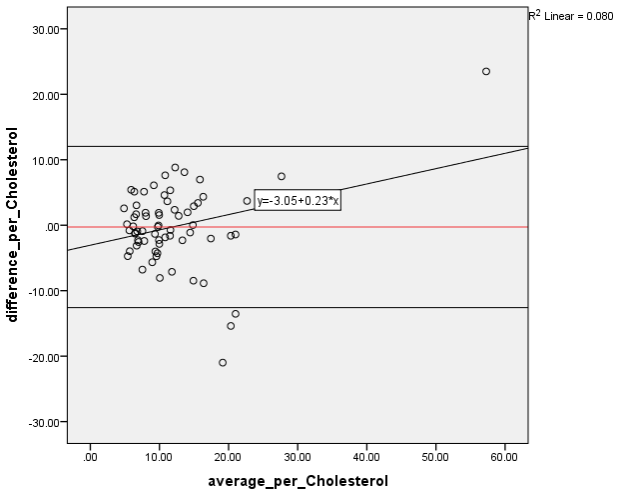

R² Linear = 0.592
y=-4.1+0.95*x
difference_FAT
average_FAT

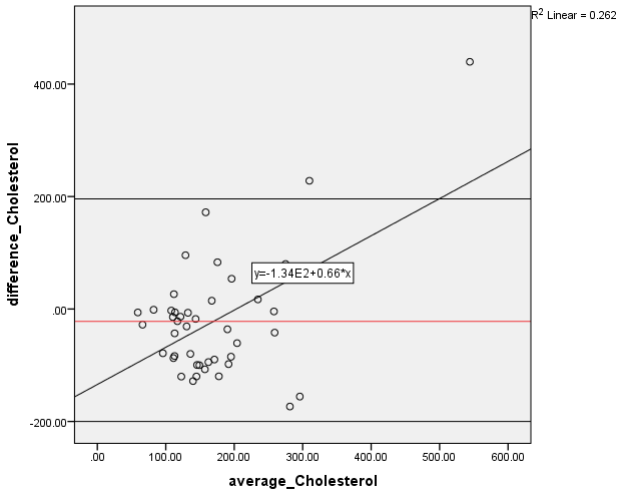

R² Linear = 0.347
y=-3.7+0.86*x
difference_FAT
average_FAT

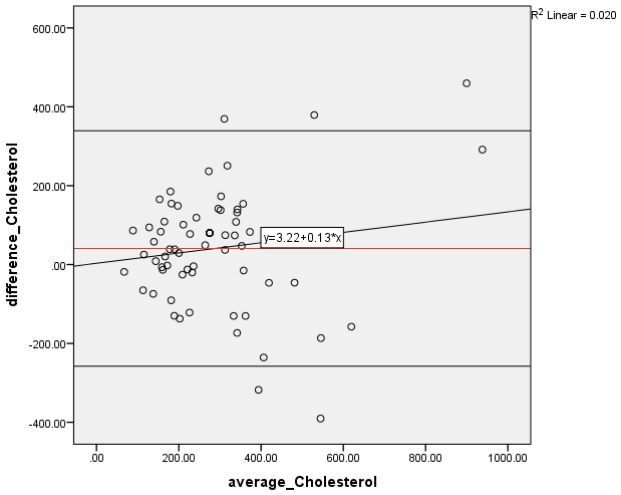

R² Linear = 0.424
y=-75.39+1.06*x
difference_GrFAT
average_GrFAT

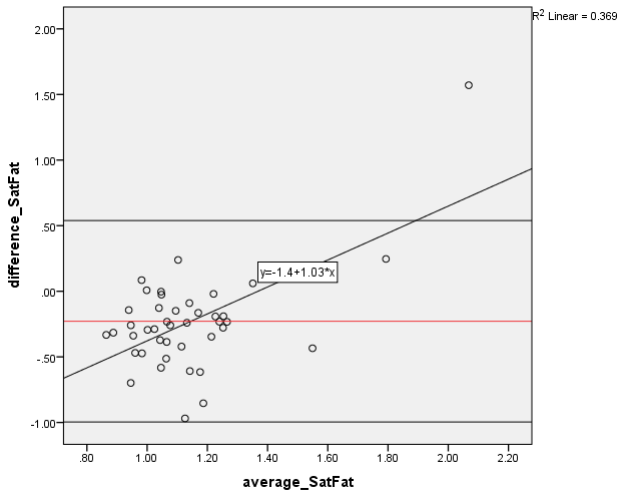

R² Linear = 0.354
y=-63.04+0.83*x
difference_GrFAT
average_GrFAT

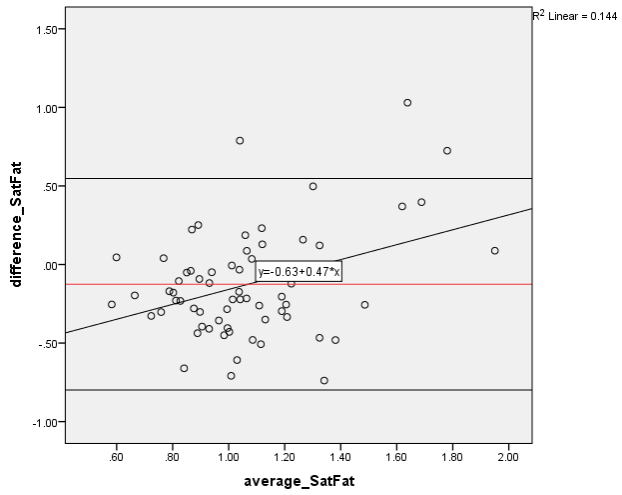

R2 Linear = 0.009
y=-0.84-0.12*x
difference_per_Cholesterol
average_per_Cholesterol

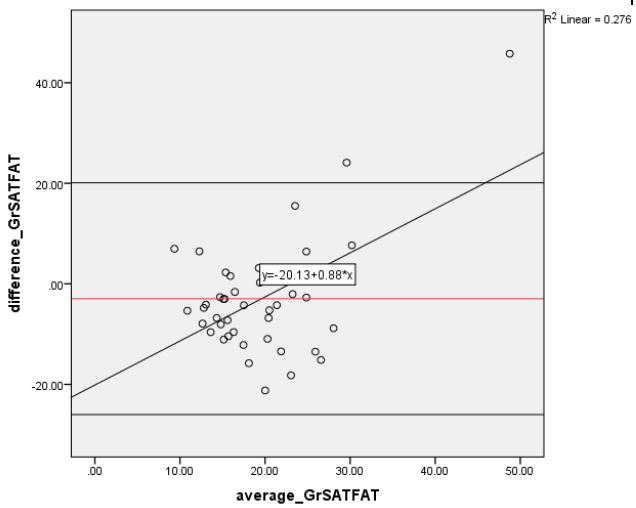

R2 Linear = 0.080
y=-3.05+0.23*x
difference_per_Cholesterol
average_per_Cholesterol

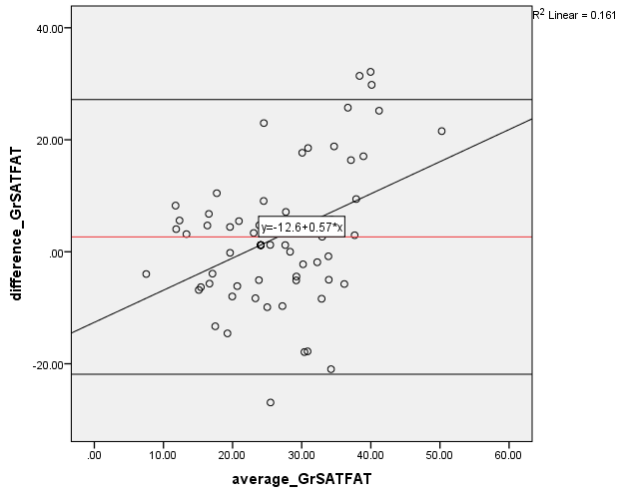

R2 Linear = 0.262
y=-1.34E2+0.66*x
difference_Cholesterol
average_Cholesterol

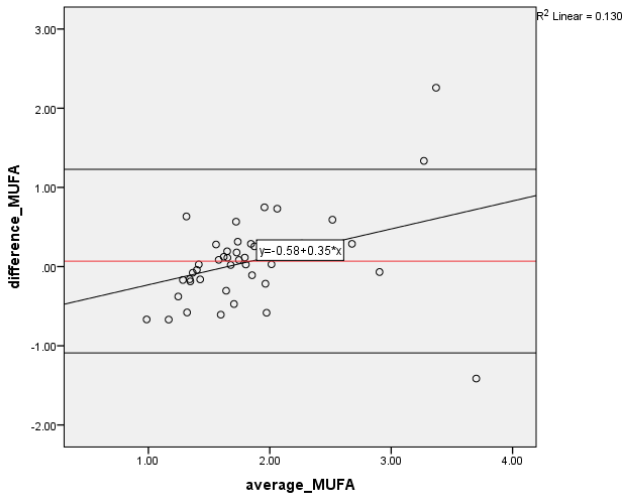

R2 Linear = 0.020
y=3.22+0.13*x
difference_Cholesterol
average_Cholesterol

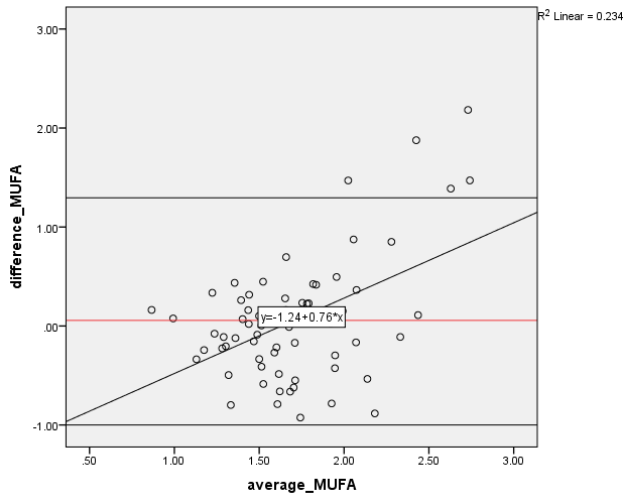

R2 Linear = 0.369
y=-1.4+1.03*x
difference_SatFat
average_SatFat

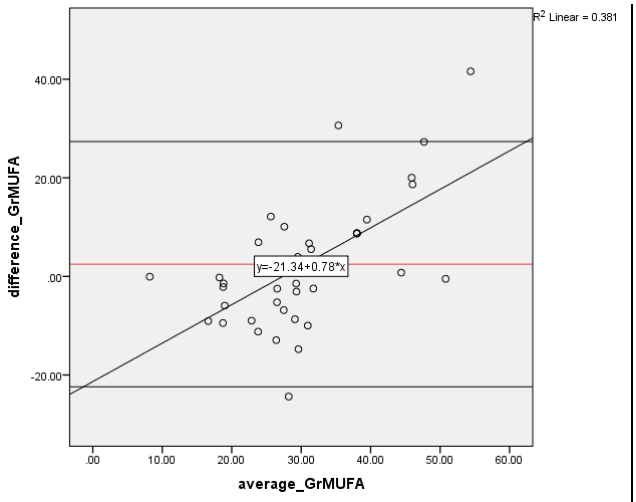

R2 Linear = 0.144
y=-0.63+0.47*x
difference_SatFat
average_SatFat

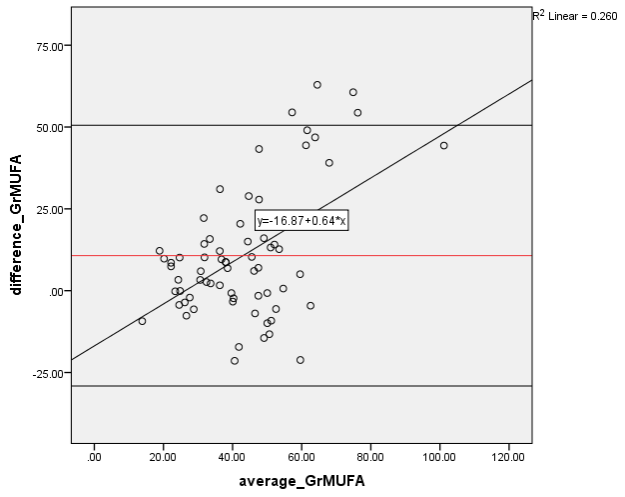

R2 Linear = 0.276
y=-20.13+0.88*x
difference_GrSATFAT
average_GrSATFAT

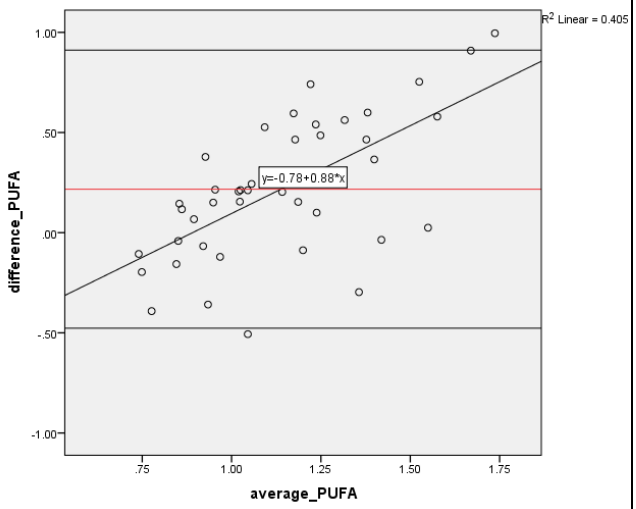

R2 Linear = 0.161
y=-12.6+0.57*x
difference_GrSATFAT
average_GrSATFAT

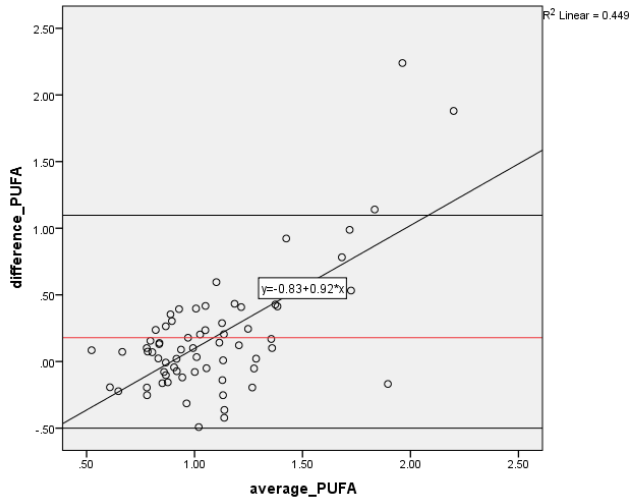

R2 Linear = 0.130
y=-0.58+0.35*x
difference_MUFA
average_MUFA

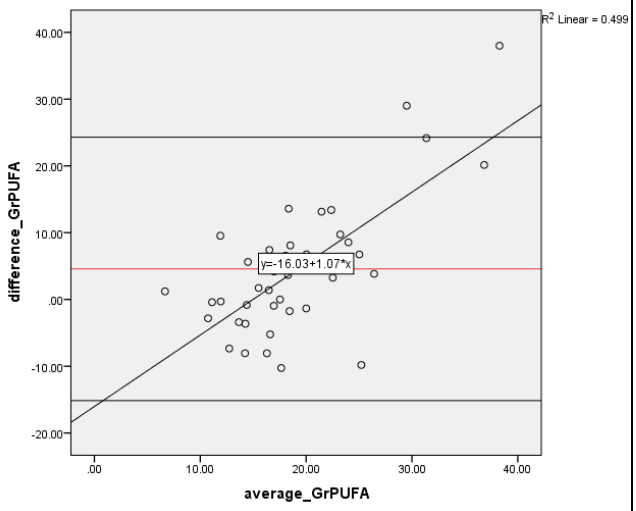

R2 Linear = 0.234
y=-1.24+0.76*x
difference_MUFA
average_MUFA

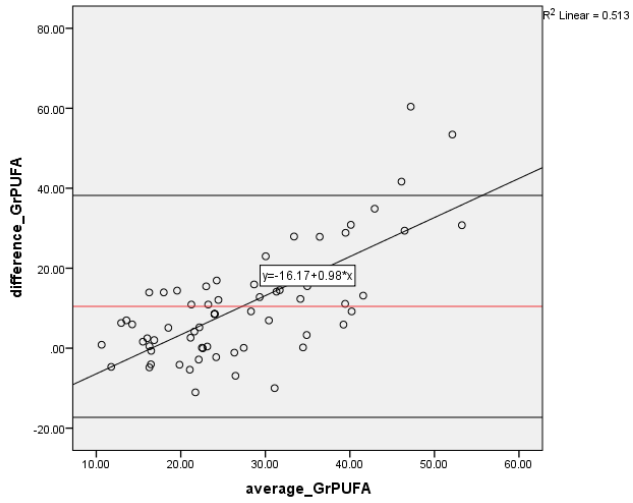

R2 Linear = 0.381
y=-21.34+0.78*x
difference_GrMUFA
average_GrMUFA

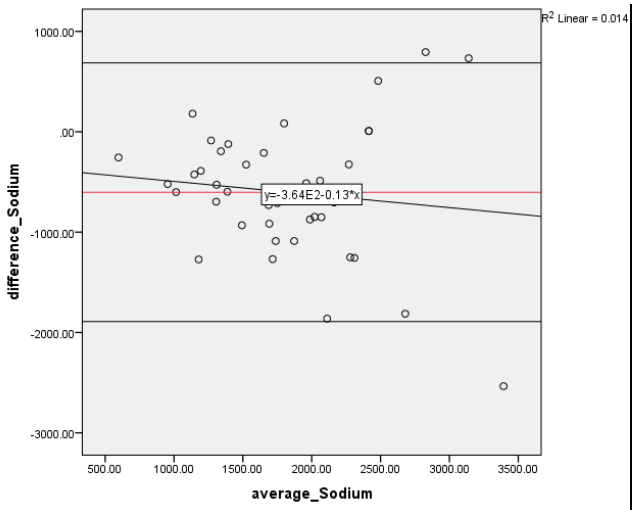

R2 Linear = 0.260
y=-16.87+0.64*x
difference_GrMUFA
average_GrMUFA

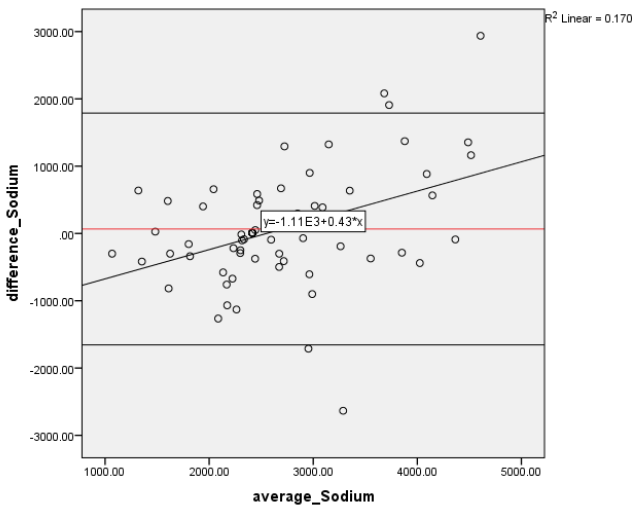

R2 Linear = 0.405
y=-0.78+0.88*x
difference_PUFA
average_PUFA

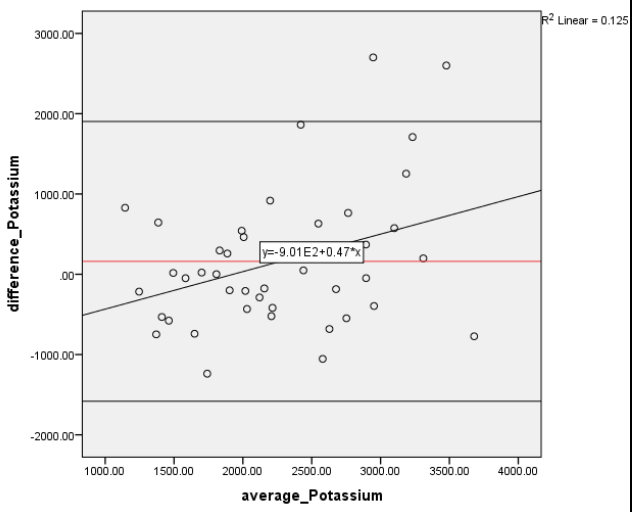

R2 Linear = 0.449
y=-0.83+0.92*x
difference_PUFA
average_PUFA

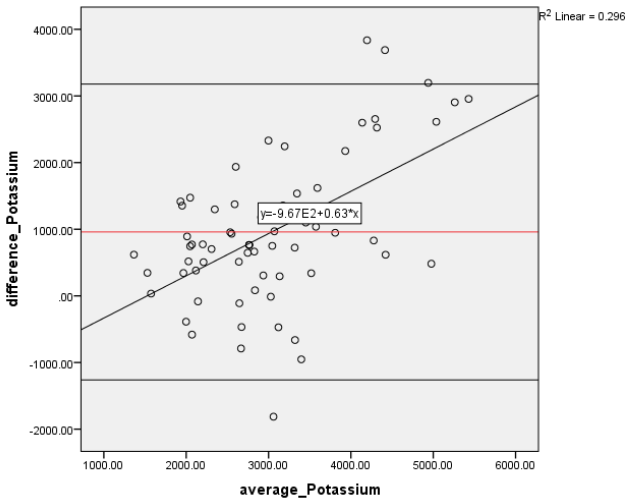

R2 Linear = 0.499
y=-16.03+1.07*x
difference_GrPUFA
average_GrPUFA

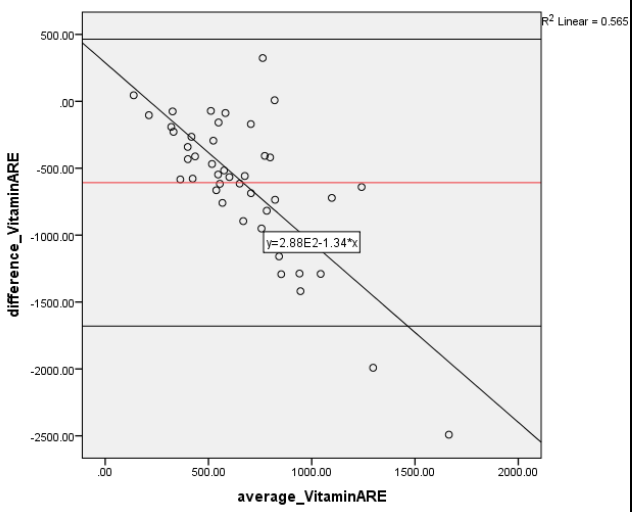

R2 Linear = 0.513
y=-16.17+0.98*x
difference_GrPUFA
average_GrPUFA

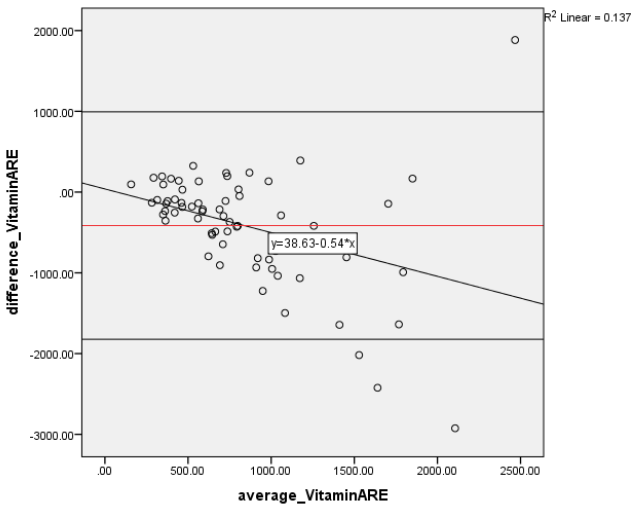

R2 Linear = 0.014
y=-3.64E2-0.13*x
difference_Sodium
average_Sodium

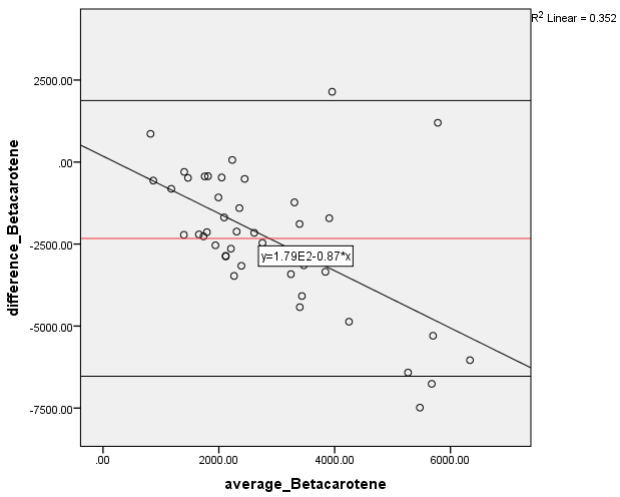

R2 Linear = 0.170
y=-1.11E3+0.43*x
difference_Sodium
average_Sodium

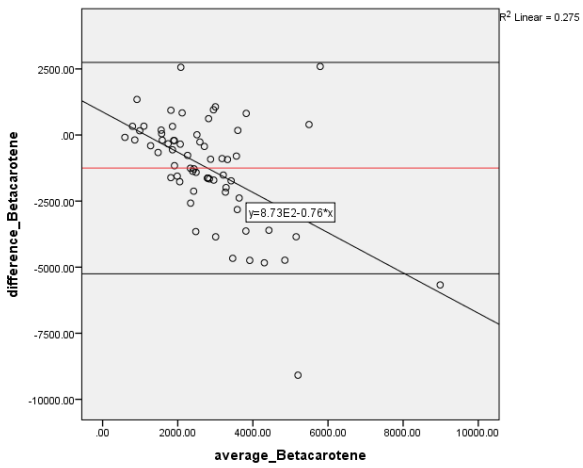

R2 Linear = 0.125
y=-9.01E2+0.47*x
difference_Potassium
average_Potassium

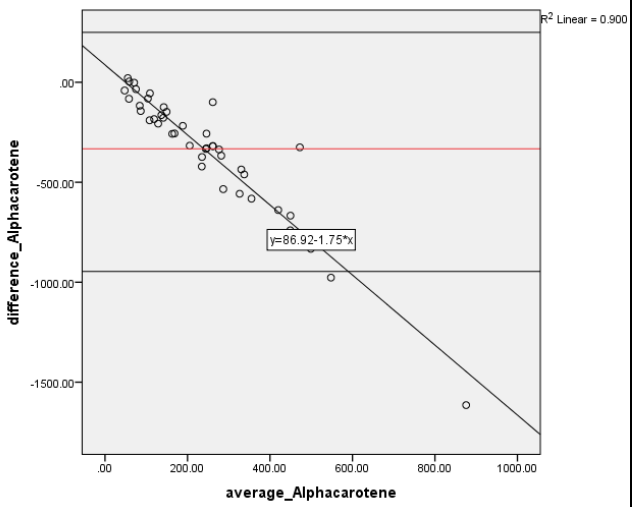

R2 Linear = 0.296
y=-9.67E2+0.63*x
difference_Potassium
average_Potassium

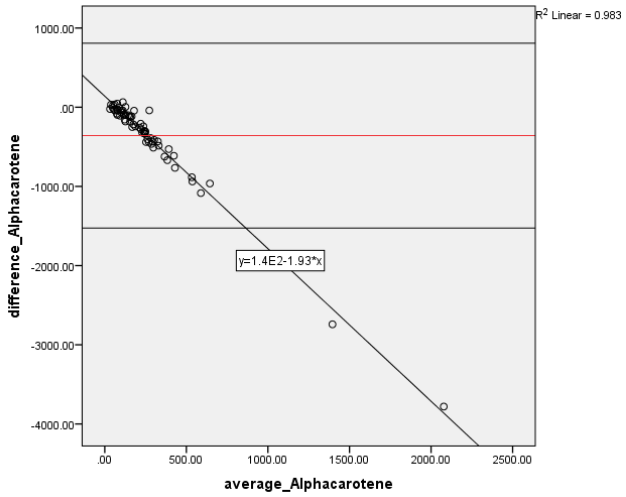

R2 Linear = 0.565
y=2.88E2-1.34*x
difference_VitaminARE
average_VitaminARE

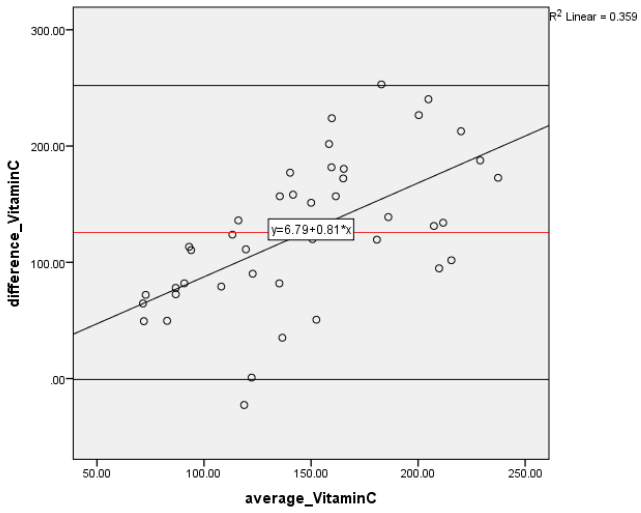

R2 Linear = 0.137
y=38.63-0.54*x
difference_VitaminARE
average_VitaminARE

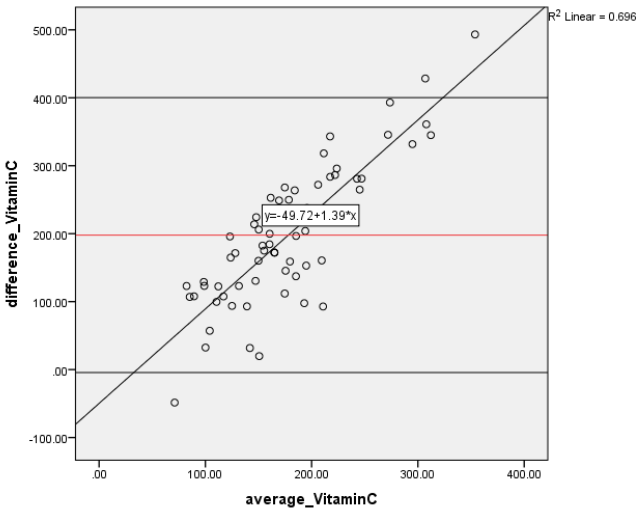

R2 Linear = 0.352
y=1.79E2-0.87*x
difference_Betacarotene
average_Betacarotene

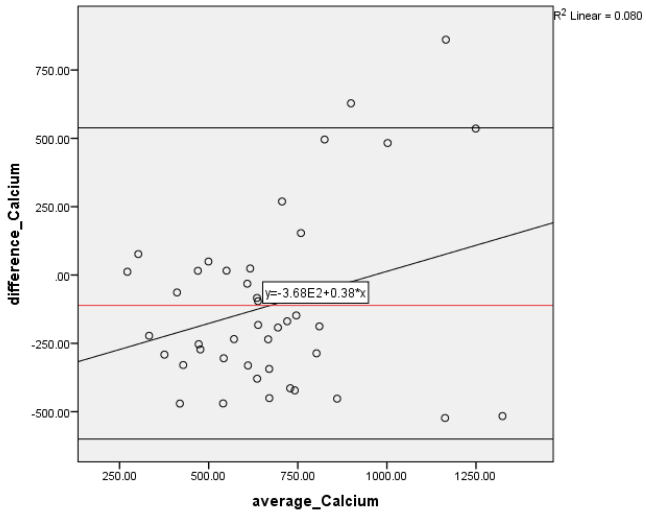

R2 Linear = 0.275
y=8.73E2-0.76*x
difference_Betacarotene
average_Betacarotene

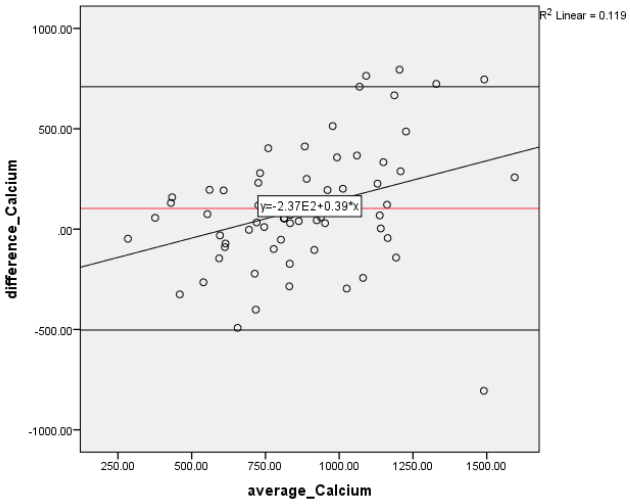

R2 Linear = 0.900
y=86.92-1.75*x
difference_Alphacarotene
average_Alphacarotene

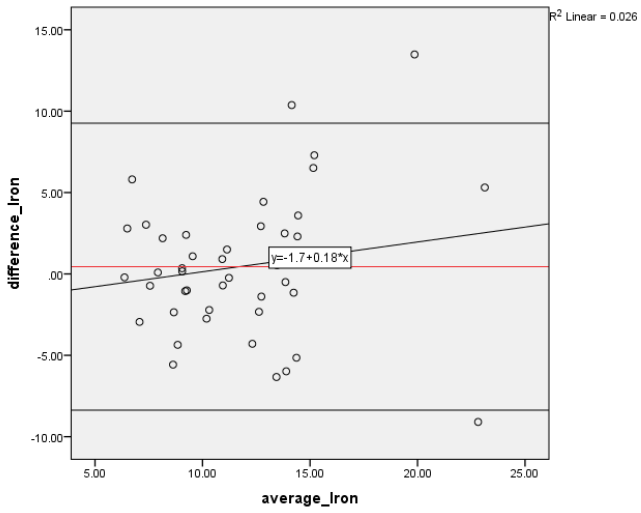

R2 Linear = 0.983
y=1.4E2-1.93*x
difference_Alphacarotene
average_Alphacarotene

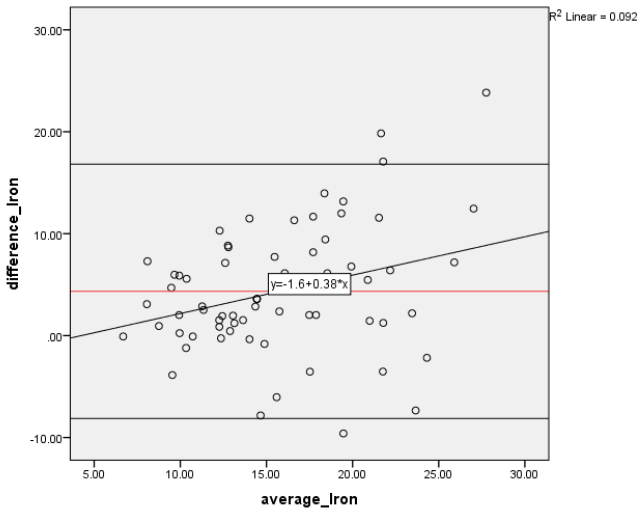

R² Linear = 0.359
y=6.79+0.81*x
difference_VitaminC
average_VitaminC
300.00
200.00
100.00
.00
50.00
100.00
150.00
200.00
250.00

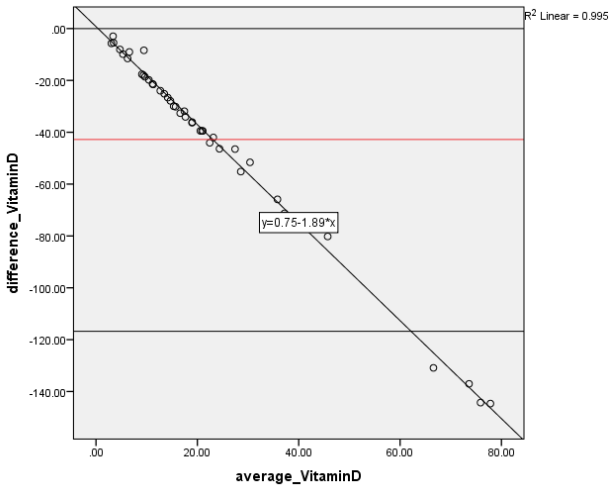

R² Linear = 0.696
y=-49.72+1.39*x
difference_VitaminC
average_VitaminC
500.00
400.00
300.00
200.00
100.00
.00
-100.00
.00
100.00
200.00
300.00
400.00

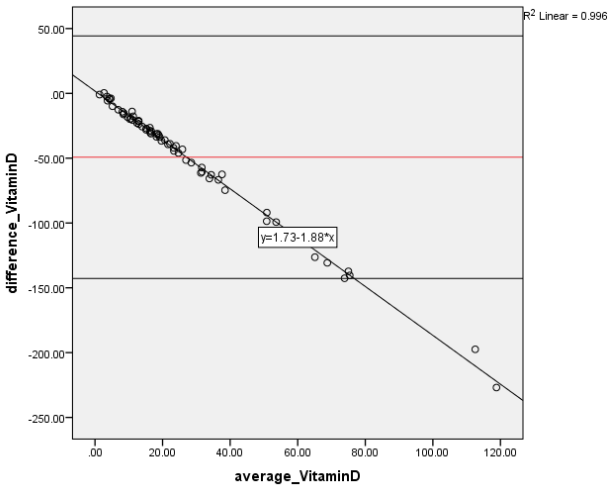

R² Linear = 0.080
y=-3.68E2+0.38*x
difference_Calcium
average_Calcium
750.00
500.00
250.00
.00
-250.00
-500.00
250.00
500.00
750.00
1000.00
1250.00

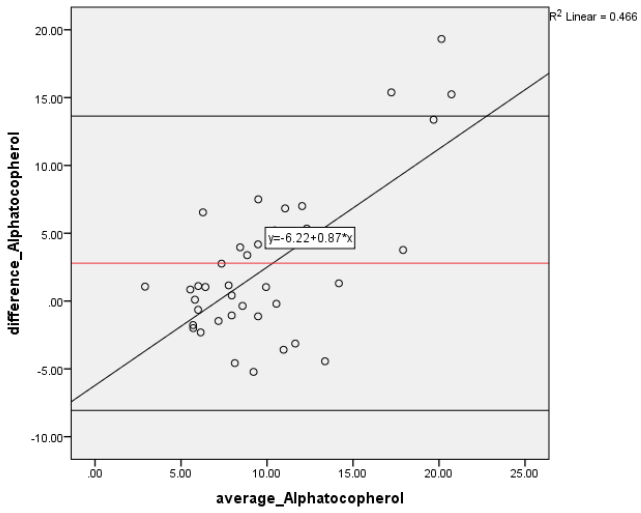

R² Linear = 0.119
y=-2.37E2+0.39*x
difference_Calcium
average_Calcium
1000.00
500.00
.00
-500.00
-1000.00
250.00
500.00
750.00
1000.00
1250.00
1500.00

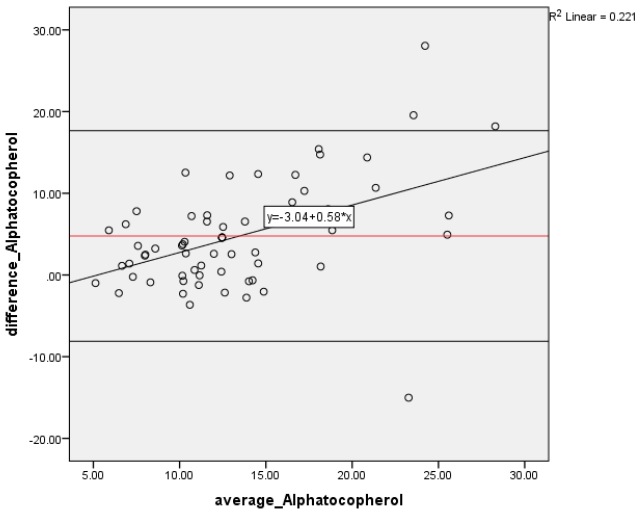

R2 Linear = 0.026
difference_Iron
average_Iron
y=-1.7+0.18*x

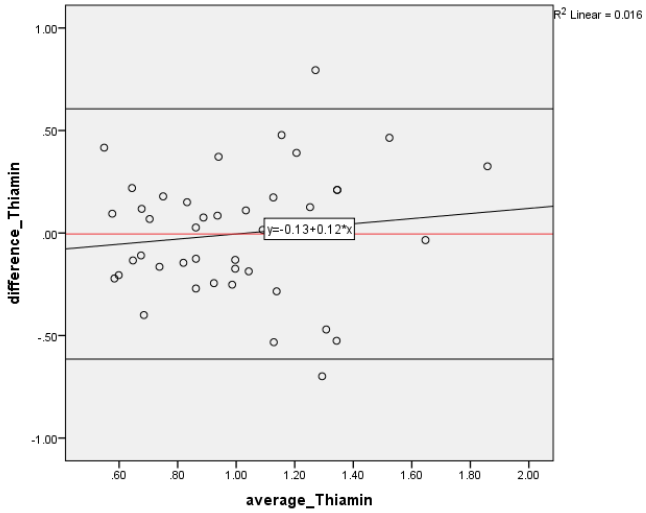

R2 Linear = 0.092
difference_Iron
average_Iron
y=-1.6+0.38*x

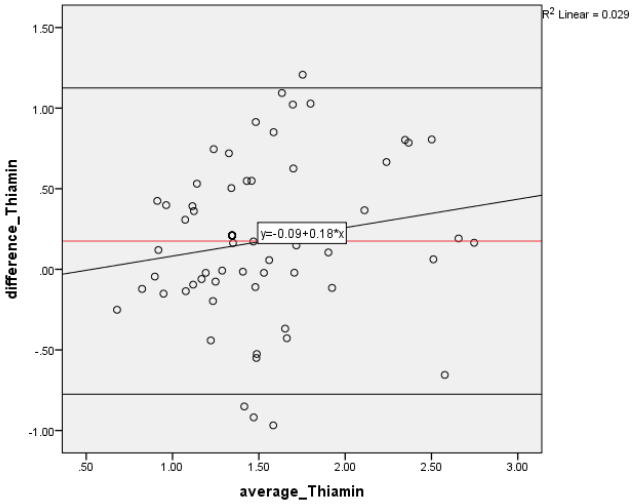

R2 Linear = 0.995
difference_VitaminD
average_VitaminD
y=0.75-1.89*x

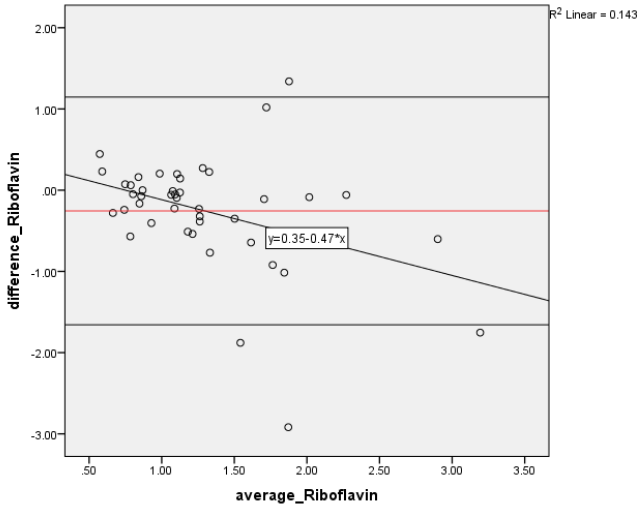

R2 Linear = 0.996
difference_VitaminD
average_VitaminD
y=1.73-1.88*x

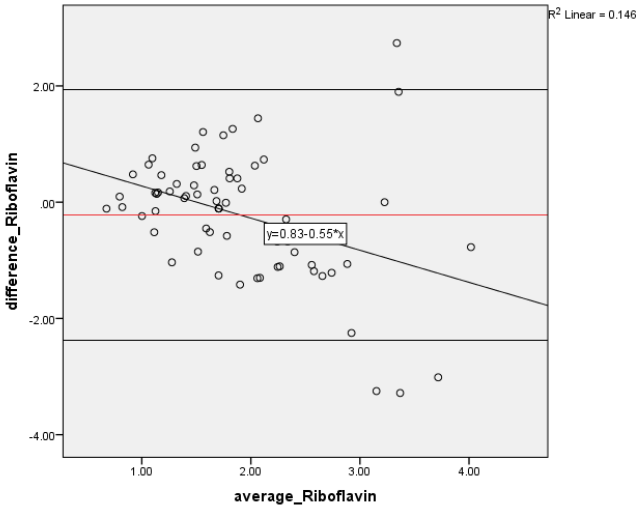

R2 Linear = 0.466
y=-6.22+0.87*x
difference_Alphatocopherol
average_Alphatocopherol

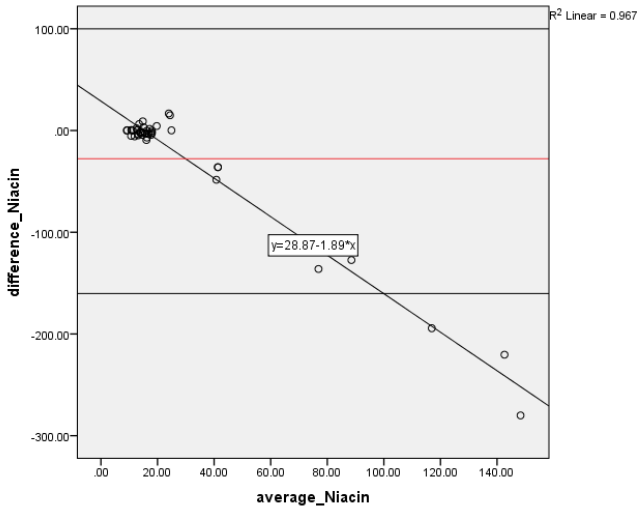

R2 Linear = 0.221
y=-3.04+0.58*x
difference_Alphatocopherol
average_Alphatocopherol

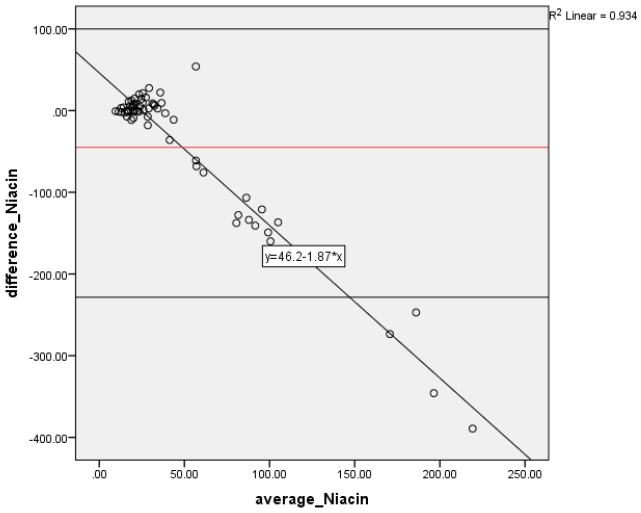

R2 Linear = 0.016
y=-0.13+0.12*x
difference_Thiamin
average_Thiamin

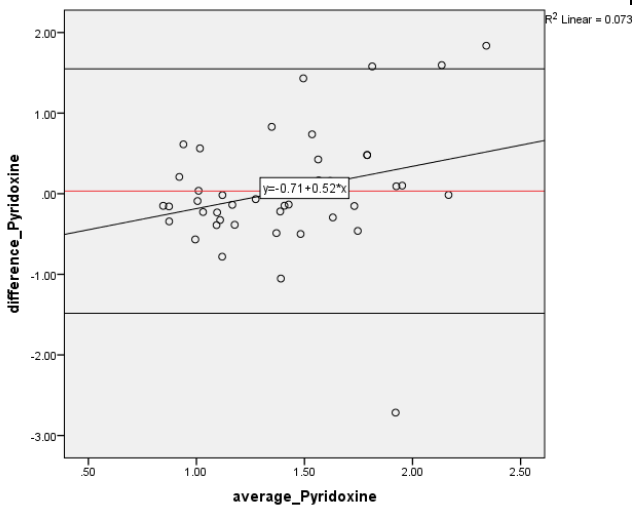

R2 Linear = 0.029
y=-0.09+0.18*x
difference_Thiamin
average_Thiamin

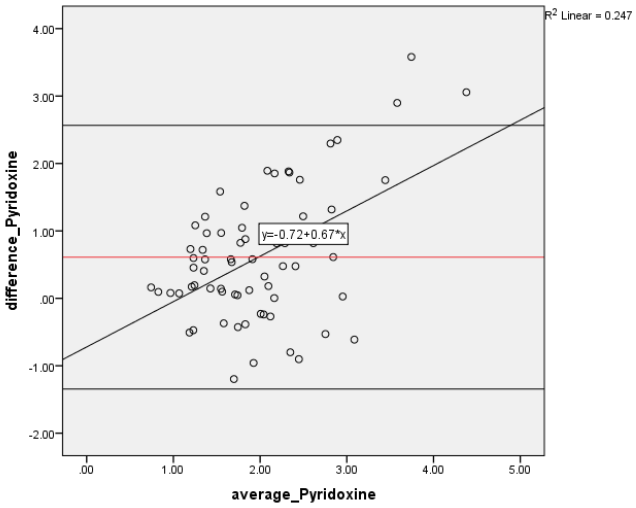

R2 Linear = 0.143
y=0.35-0.47*x
difference_Riboflavin
average_Riboflavin

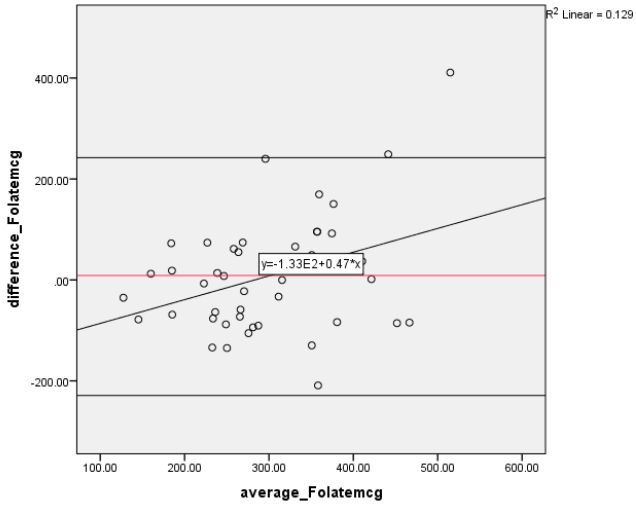

R2 Linear = 0.146
y=0.83-0.55*x
difference_Riboflavin
average_Riboflavin

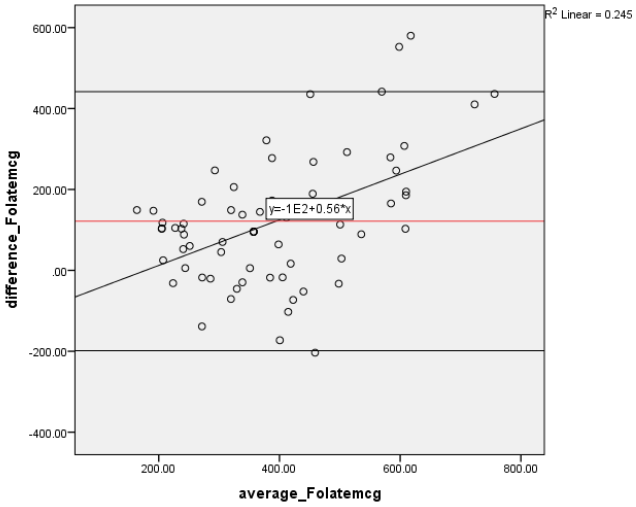

R2 Linear = 0.967
y=28.87-1.89*x
difference_Niacin
average_Niacin

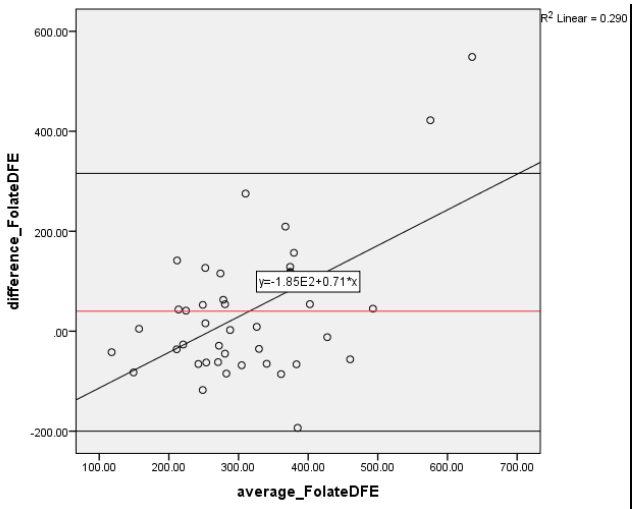

R2 Linear = 0.934
y=46.2-1.87*x
difference_Niacin
average_Niacin

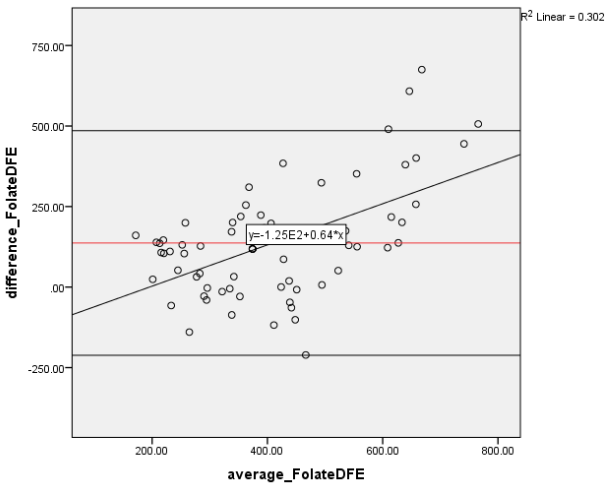

R2 Linear = 0.073
y=-0.71+0.52*x
difference_Pyridoxine
average_Pyridoxine

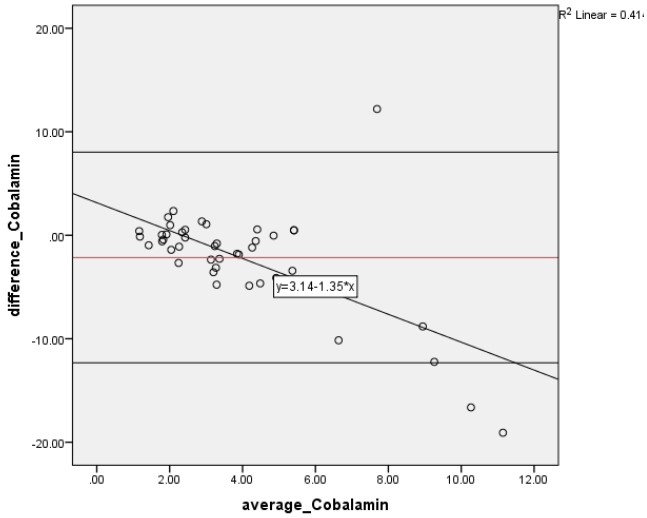

R2 Linear = 0.247
y=-0.72+0.67*x
difference_Pyridoxine
average_Pyridoxine

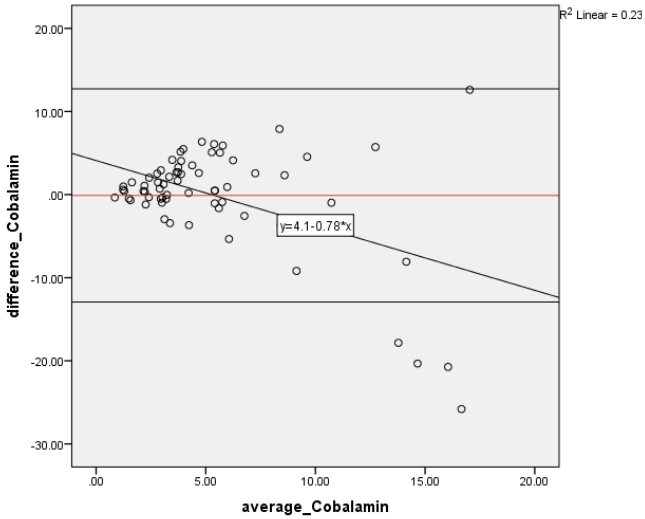

R2 Linear = 0.129
y=-1.33E2+0.47*x
difference_Folatemcg
average_Folatemcg

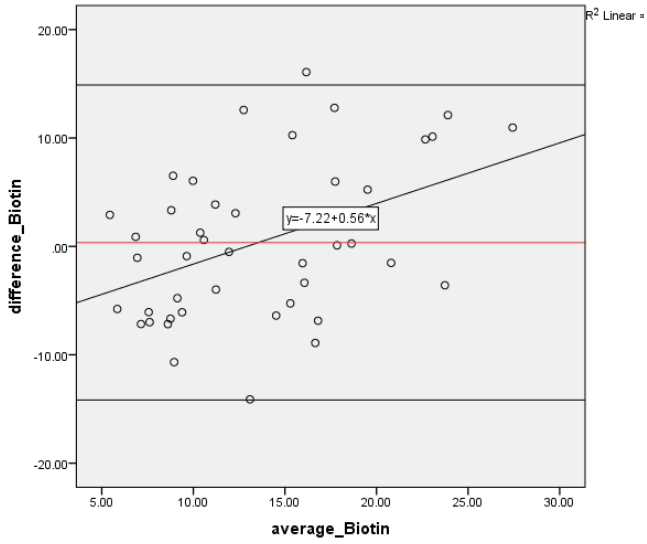

R2 Linear = 0.245
y=-1E2+0.56*x
difference_Folatemcg
average_Folatemcg

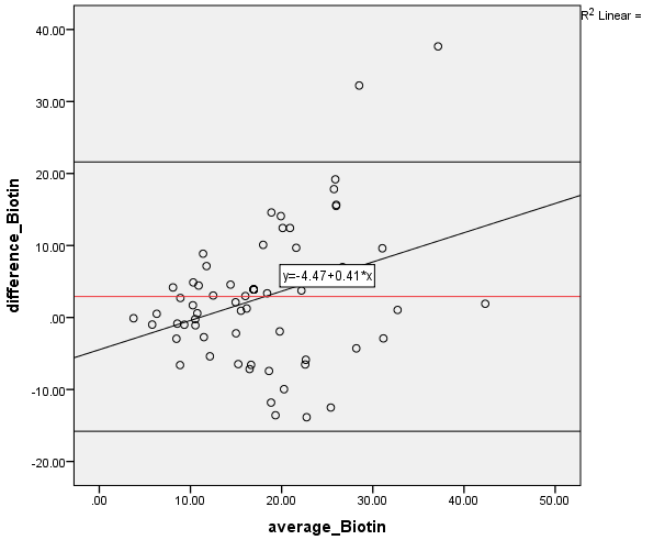

R2 Linear = 0.290
y=-1.85E2+0.71*x
difference_FolateDFE
average_FolateDFE

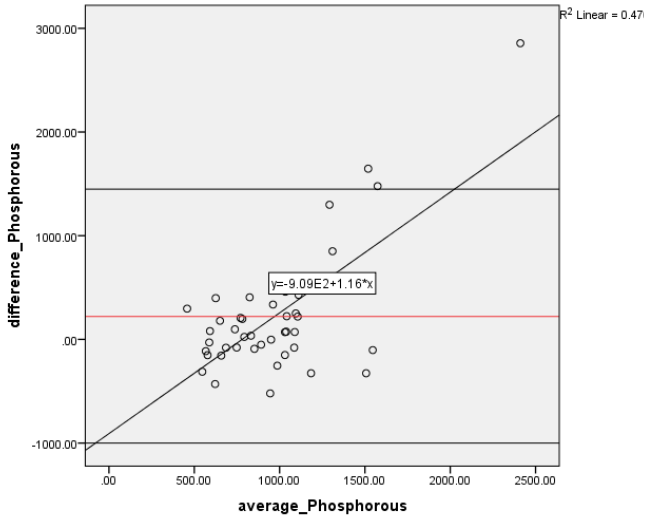

R2 Linear = 0.302
y=-1.25E2+0.64*x
difference_FolateDFE
average_FolateDFE

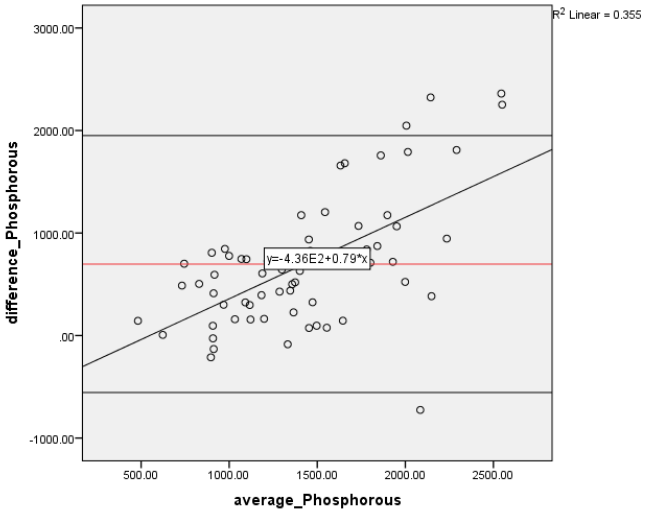

R2 Linear = 0.41
y=3.14-1.35*x
difference_Cobalamin
average_Cobalamin

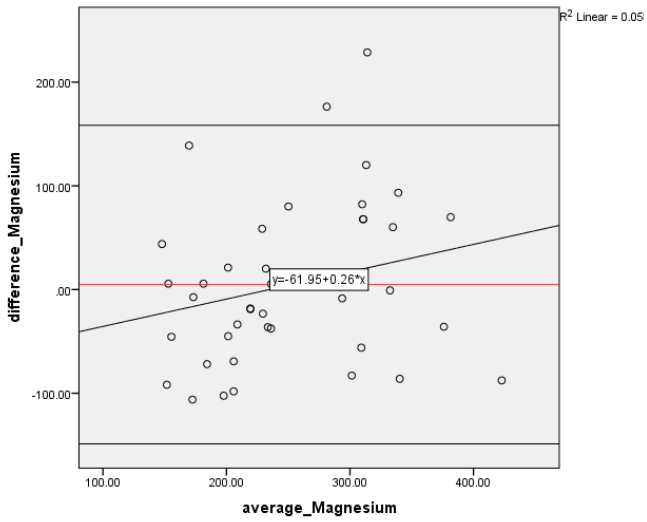

R2 Linear = 0.23
y=4.1-0.78*x
difference_Cobalamin
average_Cobalamin

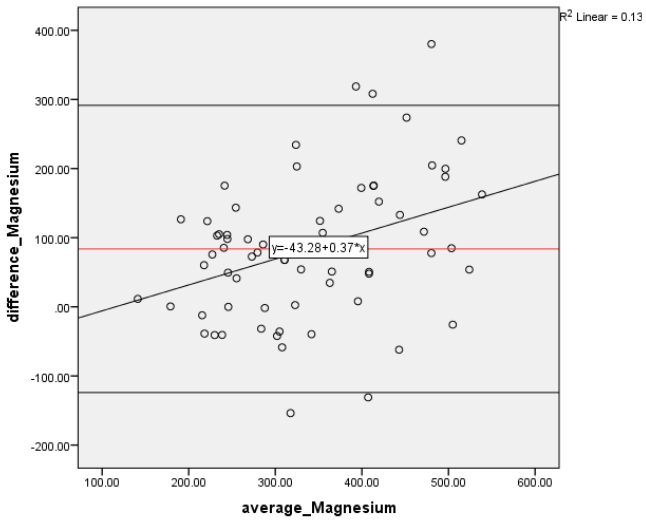

R2 Linear =
y=-7.22+0.56*x
difference_Biotin
average_Biotin
20.00
10.00
.00
-10.00
-20.00
5.00
10.00
15.00
20.00
25.00
30.00

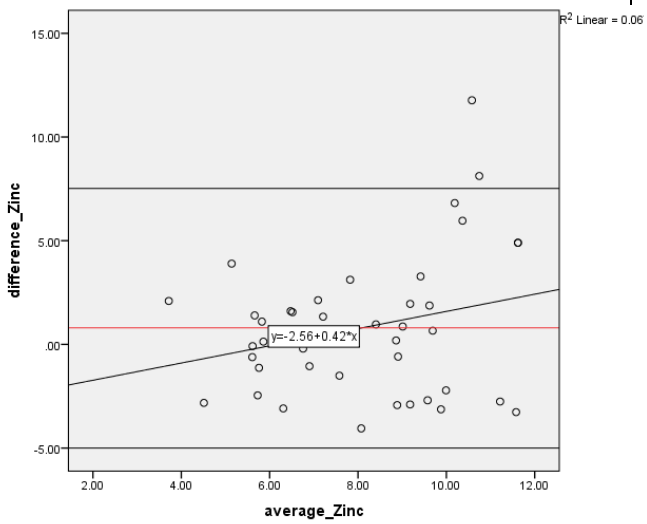

R2 Linear =
y=-4.47+0.41*x
difference_Biotin
average_Biotin
40.00
30.00
20.00
10.00
.00
-10.00
-20.00
.00
10.00
20.00
30.00
40.00
50.00

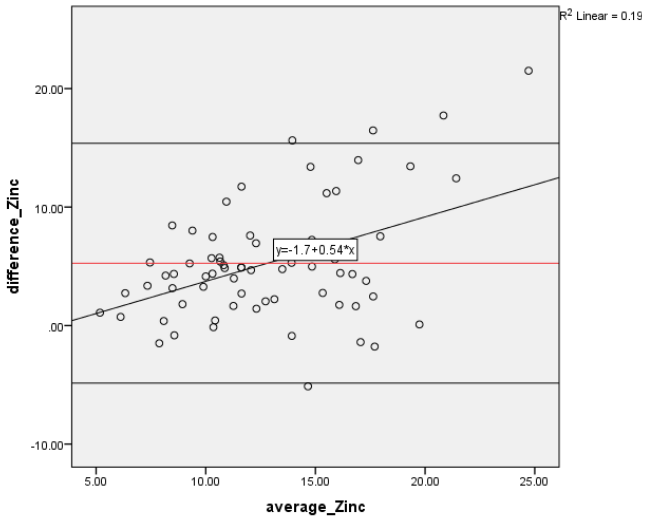

R2 Linear = 0.47
y=-9.09E2+1.16*x
difference_Phosphorous
average_Phosphorous
3000.00
2000.00
1000.00
.00
-1000.00
.00
500.00
1000.00
1500.00
2000.00
2500.00

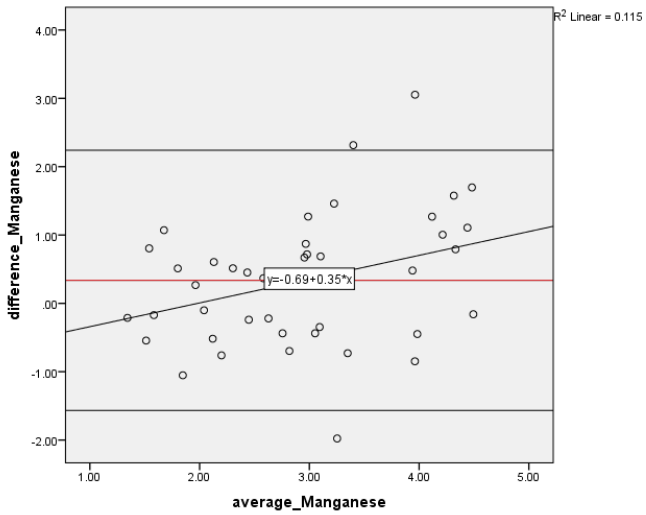

R2 Linear = 0.355
y=-4.36E2+0.79*x
difference_Phosphorous
average_Phosphorous
3000.00
2000.00
1000.00
.00
-1000.00
500.00
1000.00
1500.00
2000.00
2500.00

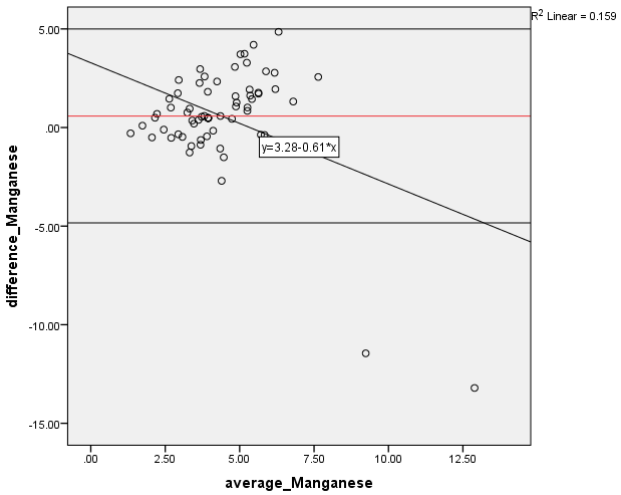

R2 Linear = 0.05
y=-61.95+0.26*x
difference_Magnesium
average_Magnesium
200.00
100.00
.00
-100.00
100.00
200.00
300.00
400.00

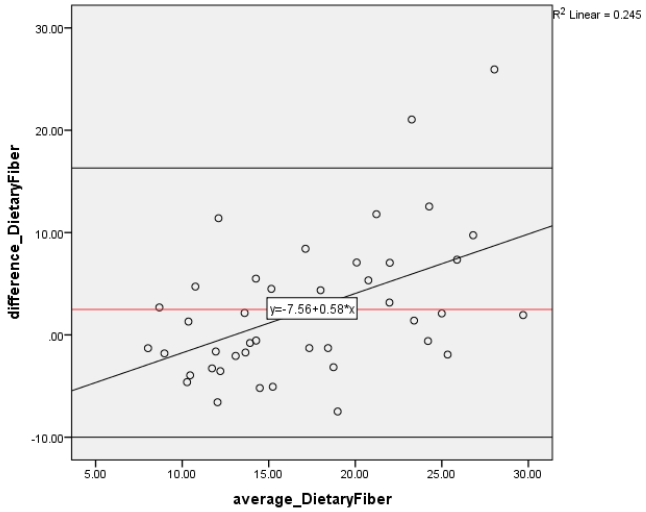

R2 Linear = 0.13
y=-43.28+0.37*x
difference_Magnesium
average_Magnesium
400.00
300.00
200.00
100.00
.00
-100.00
-200.00
100.00
200.00
300.00
400.00
500.00
600.00

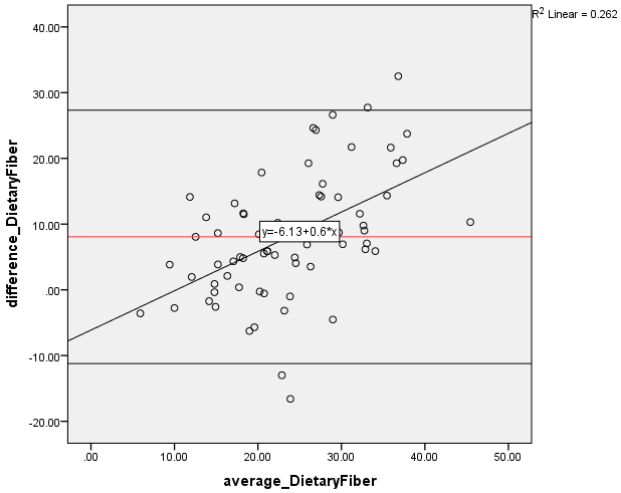

R2 Linear = 0.06
y=-2.56+0.42*x
difference_Zinc
average_Zinc
15.00
10.00
5.00
.00
-5.00
2.00
4.00
6.00
8.00
10.00
12.00

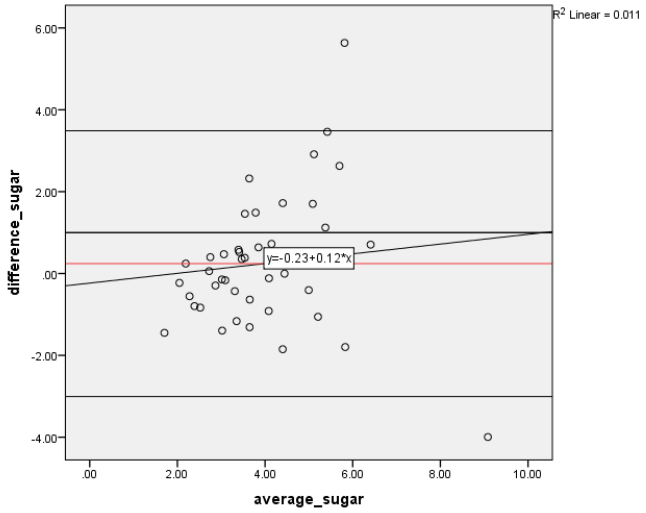

R2 Linear = 0.19
y=-1.7+0.54*x
difference_Zinc
average_Zinc
20.00
10.00
.00
-10.00
5.00
10.00
15.00
20.00
25.00

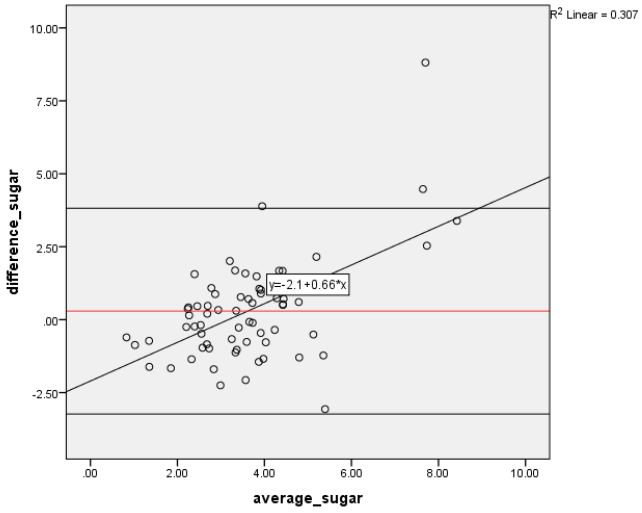

R2 Linear = 0.115
y=-0.69+0.35*x
difference_Manganese
average_Manganese

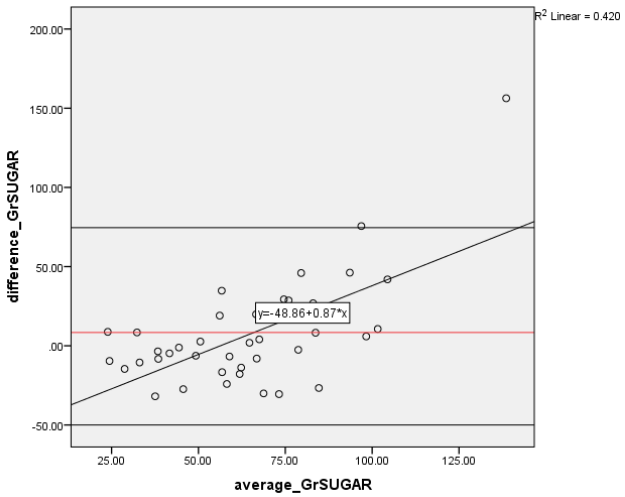

R2 Linear = 0.159
y=3.28-0.61*x
difference_Manganese
average_Manganese

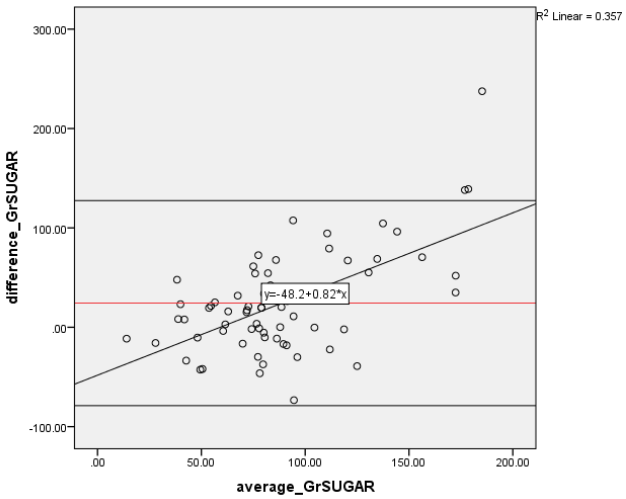

R2 Linear = 0.245
y=-7.56+0.58*x
difference_DietaryFiber
average_DietaryFiber


R2 Linear = 0.262
y=-6.13+0.6*x
difference_DietaryFiber
average_DietaryFiber


R2 Linear = 0.011
y=-0.23+0.12*x
difference_sugar
average_sugar


R2 Linear = 0.307
y=-2.1+0.66*x
difference_sugar
average_sugar


R2 Linear = 0.420
y=-48.86+0.87*x
difference_GrSUGAR
average_GrSUGAR
200.00
150.00
100.00
50.00
.00
-50.00
25.00
50.00
75.00
100.00
125.00


R2 Linear = 0.357
y=-48.2+0.82*x
difference_GrSUGAR
average_GrSUGAR
300.00
200.00
100.00
.00
-100.00
.00
50.00
100.00
150.00
200.00

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