ABSTRACT

Title of Document: **Development and Validation of a Semi-quantitative Food Frequency Questionnaire to Measure Macro-Micro Nutrients Intake for Saudi Population in the Western Region of Saudi Arabia**

Norah Aljohani, PhD of Science, 2017

Directed By: Dr. David K.Y.Lei, Ph.D.
Professor
Department of Nutrition and Food Science

Background: Among numerous dietary assessment methods, the food frequency questionnaire (FFQ) is the most common dietary assessment in large-scale epidemiological studies. The aim of this research was to develop a semi-quantitative food frequency questionnaire (SFFQ), which is a form of food frequency questionnaire (FFQ) for the western part of Saudi Arabia, as well as to examine the validation of this SFFQ for the measurement of macro-micro nutrients intake. Additionally, this project was aimed at testing the efficacy of an electronic intervention in a randomized controlled trial among college populations. The specific aim was to determine whether the electronic interventions achieved increases in the consumption of fruits and vegetables and decreases in the consumption of saturated fats, and added sugars in the intervention group relative to the control group. *Methods:* A list of foods consumed by 150 healthy Saudi participants, between 18 to

75 years old was obtained from 24-hour recalls. This list was combined with foods listed in a nationally representative survey. The food list for the new SFFQ was selected by stepwise multiple regression. Twenty-one models were generated, first one for energy and 20 models for each nutrient. To assess the new SFFQ validity, energy and macro-micro nutrient intake estimated from the SFFQ were compared with those calculated from 24-hour recall. Spearman's rank correlation coefficient, cross-classification method and bland-Altman plots for 100 adults (aged 18 to 75 years) were used to analyze the validity. The electronic intervention study took place over ten weeks. The intervention delivered selected healthy diet goals using two methods (text messages and e-mail) to 200 college students weekly. Food intake was evaluated by three-day food records, at the beginning of the study (baseline), at the middle (week 5) and at the end (week 10). Also, weight, height and BMI were measured at these different points of time during the study. Outcomes were reported as nutrient intake in addition to average daily servings of food intake. *Results:* To propagate the SFFQ, 230 different food items were recorded. After performing stepwise multiple regressions, final SFFQ included 152 food items. The food list was transformed to a new SFFQ form. The correlation coefficient between the new SFFQ designed to be used in Saudi Araba and 24-hour recall ranged from 0.2 for vitamin D to 0.7 for energy. Moreover, correlation coefficients were statistically significant for energy, vitamin D, fat, polyunsaturated fat, and monounsaturated fat. Also, in the overweight group, the correlation coefficients were statistically significant for energy, vitamin D, fat, polyunsaturated fat, and monounsaturated fat, calcium and phosphorus. The SFFQ intake data were significantly higher than the recall data.

Cross-classification analysis revealed that the average proportions of participants classified into the same or adjacent quartiles, one quartile apart, and those misclassified were 72.2 %, 20.4%, and 7.4 %, respectively. There is no systematic bias between the administration of the two methods, the new SFFQ and 24-hour recall, according to Bland-Altman plots analysis. The intervention study found a significantly higher fruit and vegetable consumption in the intervention group (4.68 servings a day) compared to the control group (3.55 servings a day) at week 10, ($P \leq 0.05$). *Conclusion*: The new Arabic SFFQ has been developed and this study indicates the need for continued development and validation of this new Arabic SFFQ. Also, the intervention conducted in Saudi college students reported significantly improved fruit and vegetable consumption. However, further research is needed to evaluate the intervention efficacy on long-term health behavior changes in this population.

DEVELOPMENT AND VALIDATION OF A SEMI-QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE TO MEASURE MACRO-MICRO NUTRIENTS INTAKE FOR SAUDI POPULATION IN THE WESTERN REGION OF SAUDI ARABIA

By

Norah Eid Aljohani

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Advisory Committee:
Dr. David K. Y. Lei, Dissertation Chair
Dr. Frauke Kreuter
Dr. Hee-Jung Song
Dr. Qin Wang
Dr. Seong-Ho Lee
Dr. Amy Schweitzer

Dedication

I dedicate my academic achievement to the memory of my father, and to my mother and my husband Ibrahim, who made all of this possible through their constant love, patience, support, times, and words of encouragement during the challenges of graduate school and life.

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Chapter 1: Introduction

1. Rationale

The objectives of this project were 1) to develop a semi-quantitative food frequency questionnaire (SFFQ) to be used in the western part of Saudi Arabia, 2) to examine the validation of this SFFQ for the measurement of energy, and macro-micro nutrients intake, and 3) to test the efficacy of an electronic intervention in a randomized controlled trial among college students to determine whether the electronic interventions achieved increases in the consumption of fruits and vegetables and decreases in the consumption of saturated fats and added sugars in the intervention group.

The Kingdom of Saudi Arabia, which has an area of approximately 2,250,000 Km^2, is the largest Arab state in Western Asia by land area. According to the 2010 Saudi Arabia Central Department of Statistic and Information, the Kingdom of Saudi Arabia has an estimated population of 27 million, of which 9 million are registered foreign expatriates and an estimated 2 million are illegal immigrants (1). Most of the foreign expatriates and immigrants live in the western part of Saudi Arabia, especially in the Al Western region. This diverse community has existed in the area for approximately seventy years and many of them have been issued Saudi nationality status, indicating they are permanents residents as opposed to transitory groups. The food habits in this part of the Kingdom of Saudi Arabia are distinct from other areas due to the unique dietary patterns from Turkish, Indian, Pakistani, Egyptian, African, and Moroccan cultures. For this

reason, the development of a novel SFFQ is needed to examine the dietary habits in this culturally diverse part of the Kingdom of Saudi Arabia.

A second issue related to dietary patterns has been identified among Saudi female college freshmen. For young adults in general, transferring from high school to college life has been identified as a critical period for marked changes in students' food consumption. This is especially true for Saudi female freshmen students. Because there are no meals offered to the students in high school, and due to the conservative culture for Saudi females, their food consumption will reflect the eating habits at home prior to the first week at the university. When arriving on a college campus, these students often have their first chance to make independent meal choices. On campus, they are faced with many unfamiliar and unhealthy food choices, which in turn, can lead to development of unhealthy eating habits.

In general, the transition to college has been identified as a critical period for adoption of an unhealthy lifestyle, such as poor-quality diet, and physical inactivity. In fact, unhealthy lifestyle is considered risk factors for diabetes, heart disease, and cancer (2). In addition, this transition period results in increased numbers of individuals being overweight. Overweight college students are at risk to have obesity. So, prevention steps aiming college students are important to decreasing obesity in the future. Yet compared with older adults, college students may be more amenable to new advice and interventions (3). Nutrition interventions aimed at improving dairy intake for example, may be successful in this population, with the effects continuing into adulthood (4). Moreover, because dietary intake

decreases substantially during young adulthood (5) intervention at this point and in this specific population is ideal for preventing further declines in eating habits.

Nutrition and health lifestyle interventions can efficiently be delivered to college students via the Internet. College students generally have access to the Internet. They are familiar with Web-based instruction, and they find its format acceptable (6). The World Wide Web has been shown to be an adequate method for delivering behavior-change programs (7). The ability to reach large numbers of people (41% of Saudi Arabian adults had Internet access in 2010) at a low cost is advantages of using the Web for health promotion (8,9). Additionally, individuals are having access to the Internet by using cell phones. Many of them, the cell phone is the first choice of accessing the Internet. Moreover, the Pew Internet & American Life Project indicates that it will be the situation around world in 2020 (8). In addition to accessing the Internet, mobile phones have other advantages, which is a text messaging. Mobile phone text messaging considers as a strong tool for health behavior improvement for many reasons as mentioned above (10,11). To our knowledge, this will be the first study to demonstrate effectiveness of e-mail and mobile phone text messaging, in a randomized controlled trial to improve health behavior in the Saudi female college population.

2. Objectives

a) To develop a semi-quantitative food frequency questionnaire for the western part of Saudi Arabia.

b) To evaluate the validity of this semi-quantitative food frequency questionnaire to accurately assess subjects' dietary intake in the population of the western part of Saudi Arabia.

c) To examine whether there are differences in the validity of this semi-quantitative food-frequency questionnaire between the normal weight adults (BMI < 25 kg/m^2) and overweight group adults (BMI ≥ 25 kg/m^2).

d) To test the efficacy of electronic intervention on changes in dietary intake in a randomized controlled trial among female freshmen college students in Taibah University.

3. Hypotheses

The above objectives are designed to test the following hypothesis.

a) Compared to reference method (24-hour recall), the semi-quantitative food-frequency questionnaire is a valid tool to accurately assess dietary intake of the Saudi population in the western region.

b) Compared to normal weight group (BMI < 25 kg/m^2), the overweight group (BMI ≥ 25 kg/m^2) will underreport their macro-micro nutrient intake by up to 15 % in the semi-quantitative food-frequency questionnaire approach.

c) Compared to control group, the electronic intervention group will eat more fruits and vegetables.

d) Compared to control group, the electronic intervention group will reduce consumption of saturated fat and sugar.

4. Long-Term Goals

The use of culturally appropriate SFFQs would allow a better assessment of dietary intake among western Saudi Arabians. It could also be applied to the entire Saudi Arabian population. It would also help public health researchers and clinicians.

Chapter 2: Background and Literature Review

Background

1. Freshman 15

The years between the ages of 18 and 20 are often difficult because individuals are transitioning from childhood to adulthood. Additionally, those attending college may find themselves on their own making independent decisions for the first time. In nutritional terms, these are important years because during this time, young adults develop eating habits that are likely to be maintained for the rest of their lives (12). Evidence suggests that freshmen college students may not consume an adequate diet or exercise regularly (13). In fact, increase in unhealthy dietary habits for example; missing breakfast meal, and consumption of unhealthy food, by young people are problems (14). The dietary habits of college students have been criticized for nutritional inadequacies as well as for resulting in weight gain (15). In fact, the phenomenon of gaining weight during a student's first year of college is called, in United States of America, the “Freshman 15”. The “freshman 15” is well known by most college students, and refers to a 15-lb (Libra Pound) weight gain during the first year of college. Most studies (17) yet not all, (16) described students weight changes through their first year of college, though the weight gain was typically well under 15 pounds (17,18,19). Vohs et al., reported that freshmen gain an average of 3.81lbs (1.73 kg) (20), and Vella-Zarb et al. reported a similar average weight gain of 3.86 lbs (1.75 kg) (21). Weight gain was found to be between 2 lbs. and 7.26 lbs. (0.9 kg to 3.3 kg) in the beginning of the first year of college (22, 23). In a review of fourteen other studies, Brown found an

average weight gain of 4.6 lbs. over the entire freshman year (24). Thus, while not the oft-mentioned “Freshman 15”, research indicates first year college students are at an increased risk for weight gain, which could have an effect on their future obesity status.

Less is known about weight gain in students attending college in Saudi Arabia. A few studies performed in Saudi Arabia reported that students gained weight during four years of college in general (25, 26, 27).

Dietary Assessment Methods

Dietary assessment is the process of evaluating food consumption and nutrient intake of individuals and/or groups of people. Dietary assessment methods are available to conduct evaluations at individual, household, and national levels. At the individual level, dietary assessment methods can be classified in several ways. One way is to classify them into two different methods; the first one is the retrospective methods. The second one is the prospective methods. In retrospective methods, the qualitative or quantitative information is gathered by self-reported forms or by interviews achieved through FFQs as well as 24-hour food recall. On the other hand, in prospective methods, qualitative or quantitative information may be collected by use of food records (FRs) including weighed FRs, estimated FRs and menu records. Food habit questionnaires ask the individuals to report on the diet that they usually eat, which is not necessarily the diet that they are currently eating. In this tool, investigators use diet history questionnaires and FFQs. The data obtained by dietary assessment methods may be collected by observation methods or by reports from relatives and family members close to the subject of

the study (in the cases of children and elderly people). In general, methods of dietary assessment include FFQ, 24-hour recall, FR, diet histories, and food habit questionnaires (28, 29).

A). The Food Frequency Questionnaire (FFQ)

1. Definition

The food frequency questionnaire (FFQ) can be defined as a quantitative or qualitative research tool, design to be used in nutritional assessment. An FFQ is a list of selected foods and beverages with a frequency response part. Participants ask to choose how many times each food was days, weeks, months, or year. Food lists differ by the aims of the study and the population in the study. The FFQ has a specific food list. Subjects will be asked in this FFQ if they consume selected foods and if they consume any of these foods, how often they consume it and the quantity of consumed foods. Little information is collected on characteristics of the foods eaten, such as cooking methods as well as the mixtures of foods (31). While portion size is not always collected, several options exist for researchers who do collect these data. One option is to specify a portion size as part of the question on frequency, such as asking how often a glass of milk is consumed rather than asking how often milk is consumed. This has been termed a semi-quantitative food frequency questionnaire (SFFQ). In terms of foods that come in a natural unit such as one egg, this additional specification can add clarity to the question. This specification of portion size as a part of the question is the main difference between simple FFQ and SFFQ (30). For both FFQs and SFFQs, the list of foods may be short (under 20 items) or long (over 100 items). Completion of the

questionnaire (either administered by an interviewer or self-administered) may take from 10 minutes to more than one hour (32). Usually, in FFQs or SFFQs frequency categories are used. The categories include: first) four times choices, starting from once day, once month, once a year and rarely or never); second) 7 food intakes options, starting from no food intake, to six times or more per day); and third) nine choices (7, 6, 5, 4, 3, 2, or 1 day per week, monthly, rarely or never) (33). FFQs are often used in large cohort studies to be able to place people into categories. Thus, the FFQ should be culture-specific. For instance, many lists of foods have been established for evaluating the diverse food intakes of some groups for example Japanese, Indian, Filipinos, Sri Lankan and Hawaiians (34).

2. Types of Food Frequency Questionnaires (FFQs)

There are three main types of FFQs. First type is the quantitative food frequency questionnaire (QFFQ). It allows subjects to specify any quantity of food they usually eat. QFFQ contains more precise food portion size information, such as how many cups or spoons).

Semi-quantitative food frequency questionnaire (SFFQ) is the other type of FFQs. In the SFFQ, portion size information is collecting such as one quantity choice (for example, one egg) or as a choice of portion sizes (for example, small, medium and large). Food models or photos are used to assist individuals to identify their portion size. A large number of nutritional epidemiological studies are based on SFFQ. One notable example investigated the relationship between diet and cancer (35).

A third type is the Non-quantitative food frequency questionnaire (FFQ), in which portion size information is not collected.

There are forms of FFQs have been developed in the past, for example:

First, Health Habits and History Questionnaire (HHHQ):

It was established at the National Cancer Institute under the direction of Gladys Block (36).

Second, Harvard Food Frequency Questionnaire (HFFQ):

Walter Willett and his assistants established this questionnaire at Harvard University. Portion size is involved as a portion of the questions and it is not as an individual listing (35).

Last, National Cancer Institute Diet History Questionnaire: This form established under the guidance of Subar and Thompson. In this questionnaire, an embedded question approach was used. Also, it requests information about habitual foods intake during the past year (37).

3. Advantages and Disadvantages of the Food Frequency Questionnaire (FFQ)

The major goal of an FFQ is to assess usual long-term diets, either in the past or the present. Advantages of FFQs include: relatively low dropout rate because of low subject burden, no need for skilled personnel to administer FFQs, ability to avoid interviewer bias through the use of self-administered FFQs Additionally, FFQs do not affect eating behavior and are simple and inexpensive to analyze because they can be self-administered utilizing machine-readable scanned forms and computer-generated data. In general, FFQs are relatively cheap, can be filled out quickly and are not difficult to analyze (30).

On the other hand, the disadvantage of these questionnaires is that subject must estimate usual frequency of consumption of approximately 100 foods and their associated usual portion sizes (in the case of SFFQs). These types of questions can be exceedingly difficult for many subjects because they rely on subject recall and memory (38). Another major disadvantage of these questionnaires is related to the close-ended nature of the form. The limited food list and fixed portion size will not be appropriate for all individuals in a population (39). Moreover, an FFQ requires a literate population (40). The FFQ is dependent upon the food list chosen by an investigator. Additionally, the validity of nutrient intake estimates will vary. Finally, an FFQ can result in measurement error due to factors such as respondent bias (34).

In conclusion, as with other types of dietary measurement tools, FFQs have strengths as well as weaknesses.

4. Design Characteristics of the Food Frequency Questionnaire (FFQ)

There are several general FFQ characteristic designs and issues related to these designs. These include the food items listed, the number of items included, portion size listing, the method of administration, and the length of the reference period.

The items on the FFQ or the food list, and the number of items listed are critical in the food frequency method. Also, the full variability of an individual's diet, which includes many foods, different brands, and preparation practices, cannot be totally captured with a finite food list. Obtaining precise descriptions for foods eaten as single items as well as in mixtures is a problem (41). For example,

FFQs can ask the respondent to report either a combined frequency for a particular food eaten both as a single item and in mixtures or separate frequencies for each food use. For instance, the interviewer could ask about corn eaten alone and in mixtures, or the interviewer could ask separate questions about refried corn, corn soups and so on. The first style is cognitively difficult for the respondent, but the second style may lead to double counting. Frequently FFQs include similar foods in a same question, for example, meats (beef, or lamb) (32). However, many ways might be used to compile a food list. The simplest is to assess available food composition tables and find the foods that contain significant amounts of the nutrients. Reducing long foods list is another way to generate a food list. At the beginning, investigator start with a long list that are essential nutrient sources, and then decrease this long food list. The original list may be derived from food composition tables or a registered dietician. Reduction of the food list can be accomplished by pilot testing of the questionnaire (30). Nevertheless, regarding the number of items on the FFQ, the review of the literature by Cade et al., showed that food lists ranged from 5 to 350, with a mean of 88 items (33). Likewise, Molag et al., (41) have mentioned in their review that the number of items in the FFQ ranged from 44 to 350. On the other hand, numerous shorter questionnaires exist that are used to assess single nutrients such as calcium (Ca). In particular, the shortest questionnaire had five items relating to fruit and vegetable intake in the study by Kristal et al., (42). The longest published questionnaire had 350 items in addition to a booklet with 120 photographs to estimate portion sizes by Riboli and Kaaks (43). Willett recommended that there is a quickly reducing marginal

increase in data achieved with more details in FFQ form (30). Nonetheless, Molag et al., concluded that the number of items on the FFQ should not be reduced because the food list is too long. This in might affect the validity of the FFQ (41). Moreover, in terms of correlation coefficients Cade et al., found that the correlation coefficients were affected by the number of items on the FFQs (33). The FFQs with the highest number of items had higher correlation coefficients than those with the smallest number of items. Molag et al., concluded that FFQ food lists (~200 items) had 0.01 – 0.17 greater correlation coefficients than the lists of (~100 items) for many of nutrients. Along the same lines, correlation coefficients were statistically significant and higher for crude protein for long lists (0.56 for 200 items) versus short lists (0.46 for 100 items) (41).

Portion size is another important characteristic of a FFQ. Although the amounts consumed by people are considered an important element in assessing food intakes, whether questions about portion size for the FFQ form must be involved in FFQ is controversial (43).

A number of researchers prefer the FFQ without the additional respondent burden of reporting serving sizes (30). Others mentioned small improvements in the performance of the FFQ when the respondents report usual serving size for each food (39,40). Several options exist for collecting information about portion size. One option is to specify a portion size as a part of the question on frequency, namely, to ask how often a glass of juice is consumed rather than only asks how often juice is consumed (30). According to Cade et al., portion size has been specified by the researchers in 85 of the questionnaires. Subjects could specify

their own portion size in 73 studies and there was no recording of portion sizes in 44 studies (44). Correlation coefficients were highest when subjects were able to describe their own portion sizes compared with no portion size specified. Molag et al., partially supported this result in their review, as they found that the FFQs with subjects' description of portion-size had greater correlation coefficients for energy-adjusted alcohol consumptions than the FFQs with regular portions (0.76 versus 0.61), though they were not statistically significant (41). On the other hand, the FFQs, where participants defined portion-size they ate, had significantly less energy-adjusted protein correlation coefficients than the FFQ with predefined standard portions (41). However, Nothlings et al., studied two different approaches to specify the food portion size. They conducted a study with 393 subjects (196 females 197 males) in which daily food consumption, measured by grams, was calculated for each subject twice. The first one was derived from the frequency subjects defined in the FFQ. For example, 2 slices of white bread. The second one was derived from frequency subject defined in 24-hour recall for each single food item. For example, 1 slice of white bread. After that, investigators compared these two different ways in reporting the portion size. The first approach was based on previous knowledge (predefined food portion size). Fitted portion size was the second approach. This approach was based on 24-hour food recall that involved the same time period as the FFQ. The study outcome was in the fitted portion size approach, the mean food intake was one hundred and two percent more in the FFQ. On the other hand, in the predefined portion sizes approach, the FFQ had a mean food consumption of seventy-nine percent for males as measured by the 24-

hour recall and ninety nine percent for female. Therefore, underestimate one hundred ninety seven percent males. Also, regarding correlation coefficients, the use of fitted portion sizes did not clearly lead to improvements (45).

A third characteristic of FFQs is the method of administration. Decisions about how to manage missing data are required when there are no quality checks to assure that all questions are answered. In self-administered FFQ, there are various frequency questions that are not answered. This might be problematic in the FFQ (16).

Generally, there are two main methods of administration in the FFQ. The first method is interviewer administered, either face-to-face or by telephone, where an interviewer asks each question. Self-administration is the second method that has two kinds: paper-and-pencil questionnaire, and computerized questionnaire administration (46). A literature review by Cade et al., showed that interviewers conducted 33% of the questionnaires, while 67% of the questionnaires were self-administered. Correlation coefficients between the FFQ and reference measures were higher for interviewer-administered questionnaires than self-administered questionnaires for energy (0.55 versus 0.46), fat (0.55 versus 0.50), and vitamin (A) (0.47 versus 0.37). Correlation coefficients were similar for calcium (Ca) (0.56 versus 0.55) and slightly higher for self-administered questionnaires for vitamin (C) (0.45 versus 0.49). One explanation of these results was that using interviewers may be an advantage in some situations and allows for immediate checking of the interviewer-administered questions for improbable responses (44).

The last principle of the FFQ approach is the reference period. It requires to assess the average long-term food intakes accurately. For example, intake over weeks, months or years, is essential exposure rather than food intake on some specific days. Therefore, the advantageous approach is to sacrifice precise intake measurement for one or two days in exchange for more general information over an extended period of time. Moreover, the simple way is to describe subject's usual frequency of consuming a food instead of describing what foods were eaten at any exact meal in the previous time (16). FFQs that focused on recall over the previous month had slightly higher correlations with the reference method than those with a recall period of the previous year (44). The studies of Sobell et al., (40) and Fraser et al., (47) which have used FFQ to assess diet, suggest that caution is required. A FFQ may not be suitable for recalling diet in the distant past.

B). Food Records (FRs)

1. Definition

Food record (FR) is quantitative research tool. FR is used in the nutritional assessment evaluation. Subjects in the FRs record all foods as well as beverages they eat or drink for a specified period of time (typically 3, 5, or 7 days). For example, three day FRs ideally covers two consecutive weekdays and one weekend day. In the three-day FRs, subjects assess their food intake by using household measures (for example, cups and spoons) or by photos of food quantity. In fact, the validity of many days of FRs is better than the validity of less days of FRs for measuring long-term food intake.

by adding more days of recording, the validity of FRs for measuring long-term food intake could be improved. Thus, more days of recording may be needed Obviously, this number depends on both the degree of accuracy that is needed and the variability of the nutrients in questions (30).

In this method, the foods and amounts eaten are recorded immediately, therefore eliminating reliance on memory (31). Usually, no more than 3 or 4 consecutive days are included. In fact, recording periods of more than 7 consecutive days are generally undesirable because of respondent tiredness. In addition, the interviewer must provide instruction in order for the respondents to adequately describe the foods and amounts consumed. FRs commonly ask about the name of the food also the brand name, if it is available), how subjects prepare the foods as well as recipes for mixed food, and portion sizes. At the end of the recording period, an interviewer should review the FRs with the respondent to clarify entries and to probe for forgotten foods (32). Most studies ask respondents to record the information in hard copy form, though some also use tape-recording and bar coding to collect descriptive and quantity information. Additionally, there are many mobile phone applications and electronic methods to record food intake. There are also two types of measurements, the weighed FR and the estimated FR. In the first one FR (weighed), subjects measure their food and beverages they ate with a scale, which should be provided to them. In the estimated FR, the subjects evaluate food they ate by using available tools at home such as cups or by using portion size estimating photos (31).

2. Advantages and Disadvantages

FR has advantages as well as some disadvantages. One of the advantages of using the FR method is offering precise data on food consumed through the recording period, so often it considered as the "gold standard" against other methods (31). Moreover, it is the most accurate and feasible method to measure food intake in adults (31). Also, food records are prospective and no memory is involved, so it is considered to be more accurate (48). On the other hand, the main disadvantage of the FRs is bias in the selection of the sample and in the measurement of the diet. FR requires that respondents' motivation as well as literate respondents (if done on paper). These requirements can limit the method's ability to be used in some population such as low socioeconomic status, recent immigrants, children, and some elderly people (31). During the assessment, a bias could be the result of the respondent's awareness about the study. This awareness may influence eating and recording and may result in under/over eating or under/over recording. On the other hand, keeping a FR needs a high level of motivation from the subject, which can lead to insufficient response rates in case if respondents are not motivated to maintain accurate records (49). The food records can be costly to administer and analyze, which could limit the FR use (47). The requirements for collaboration in keeping records might limit the generalizability of the dietary records outcomes to the entire population from which the study sample was taken (31). Research indicates that there is a significant increase in incomplete records as more days of records are kept. The validity of the collected data also reduces in the later days of a 7-day recording phase in contrast to collected data in the earlier days (36).

C). The 24-Hour Recall

1. Definition

The 24-hour diet recall is a quantitative research tool. This tool designed to be used in nutritional assessment. In this tool individuals describe all the foods and beverages they consumed during the previous 24 hours. Typically, this list is rich in details regarding items consumed (when, how, how much, with what) (50,51). The 24-hour diet recall is helpful for research that intentions to collect nutritional information from people; therefore, it can be used to provide an estimate of nutrient intake as well as energy intake. Also, the 24-hour diet recall allows investigators to evaluate what kinds of foods individuals in a specific community are consuming (50). Twenty four-hour diet recall records the daily intake of people and is very accurate when collect it more than one time for each person (52). Some scholars argue that 24-hour diet recall is most precise when administered more than 3 times (53). Other scholars claim that administration two times is acceptable (51).

The 24-hour diet recall can be self-administered or administered by a trained professional, but the typical 24-hour diet recall is performed by a well-trained interviewer. The interview can be performed in person, by telephone or via the Internet. When administered by a trained professional, the interviewer may ask a participant to recall the first thing he or she ate or drank the previous morning. The interviewer then records the estimated amounts of all the foods and beverages the participant consumed during the rest of the day (50).

2. Advantages and Disadvantages

It is inexpensive, quick to administer (30 minutes or less), needs short-term memory and can provide detailed information on specific foods, especially if brand names can be recalled (51,53). It is well accepted by respondents because they are not asked to keep records, and their expenditure of time and effort is relatively low. Thus, probability sampling within populations and individuals is possible to conduct (50). When administered by a trained professional, the pattern of the recall allows subjects and interviewers to discuss and review their food at the same time in the interview. This might be helping the researcher to obtain a rich contextual data to escort the quantitative nutritional assessment (50). Dietitians in the United States, usually use props to obtain more information, such as cards to symbolize an amount of food. Interviewers can show props to their subjects to measure the amount of food they consumed. In fact, in some cultural, these props may not be applicable. Researchers should use objects that the people would it be convenient for them and reflect precise amounts. If culturally specific props do not have a right quantity, the researchers could weigh the food on a scale, to be confident that measurements obtained are precise (50).

On the other hand, the 24-hour diet recall method has several disadvantages. To begin with, respondents may withhold or alter information about what they ate because of poor memory or embarrassment or to please or impress the interviewers and researchers. Respondents tend to underreport both binge eating and consumption of food perceived as unhealthy. Respondents also tend to over-report consumption of name-brand foods, expensive cuts of meat, and foods

considered healthful (53). Missing foods refer to foods eaten but not reported, and phantom foods are foods not eaten but reported. Several researchers report that when actual food consumption is low, respondents have a tendency to overestimate the amount recalled, and when their actual consumption is high, they underestimate the amount recalled. Some researchers call these phenomena the "flat-slope syndrome." Also, energy intake often is underestimated if the respondents do not report the drinks, sauces, and dressings (54, 55).

The other disadvantage of 24-hour diet recalls is that data on a single day's diet are a very poor descriptor of an individual's usual nutrient intake because of day-to-day or intra-individual variability (53, 41). Even if several 24-hour diet recalls are collected from one person, it may be impossible to measure intake of infrequently eaten foods, such as liver (56). However, a sufficiently large number of the 24-hour diet recalls may provide a reasonable estimate of the mean nutrient intake of a group (53, 57). In addition, this tool has been criticized due to the variation such as participants' variation as well as interview variation. In fact, intra-individual variance can be reduced by replicating recalls. Also, in the interview variation, professional trainer can decrease it (56). Besides, the researchers might standardize the interview process to reduce interview variation. However, the variation can be decreased by comparing results from 24-hour diet recalls to other methods, such as FFQs (50, 56).

Evaluation of dietary assessment methods

A). Validity and Relative Validity of Dietary Assessment Methods

The validity of a dietary assessment tool can be described as the degree to which the tool can evaluate what it is designed to evaluate. The dietary assessment method is a valid method when the individual has eaten as usual and this individual report his or her food intake in the dietary assessment method (28). The validity of measurements of dietary intake in free-living individuals is challenging to assess, because all methods rely on information given by the subjects themselves, which may be correct or not. In an attempt to establish impartial measures of validating dietary assessments, some researchers have used biological specimens that closely reflect food intake, for instance, 24-hour urine nitrogen technique (29). A biological marker for food intake is a marker that gives a predictive response to a given dietary component. A specimen in this context can be blood, urine, feces, hair, and nails (58). Biological specimens are advantageous in that they do not rely on reports of food consumption by individuals. Inadequate reporting when performing a validation study may lead to false associations between diet and disease markers (29). Relative validity is usually evaluated by assessing the dietary method versus another reference dietary method. For instance, multiple food records can be used as a reference for validating a FFQ. FRs is selected as reference due to their capability to quantity similar factors during the same time. Absolute validity indicates that the reference method suggests the real dietary intake, while relative validity recognizes that the reference method itself is not right, the assess of the validity of dietary intake data by using

of biomarkers is a more accurate approach. However, these biomarkers are expensive and unpractical (28).

Statistical methods used to measure validity include paired t-tests for comparing means of intakes from test and reference methods. Correlation analysis is the most commonly used method to measure the strength of the relationship between the test and the reference methods, as well as between the intake from the test method and the biomarker from biological specimens. Pearson correlation coefficient uses as an indicator for the strength of the relationship between two dietary methods. Correlation analysis, however, does not measure the extent of the agreement between two dietary methods. Therefore, other analyses such as percentage agreement and Cohen's weighed kappa could be described together (28).

B). Reproducibility of dietary assessment methods

Reproducibility (also called reliability) evaluates the precision of measurement methods. Reproducibility refers to the extent to which a specific dietary method used repeatedly in the same situation gives similar results (44). In conducting a reproducibility study, it is impractical to administer multiple questionnaires within a very short period of time, for example a few days. In this case, the subjects simply remember their previous responses. Hence, the administration of subsequent questionnaires after long interval of time is important for two reasons. One of these reasons is the true change in dietary intake; the other one is variation in response. These two reasons contribute to the measure of true reproducibility (30). However, reproducibility of a dietary assessment method

depends on some elements. For example; time period, the selected nutrients, population, as well as the procedure used to assess the foods intakes. In fact, true reproducibility is difficult to measure since nutrient intake varies daily. Moreover, reproducibility is estimated using the test and retest design. The extent of agreement is assessed between the intakes obtained from two different measurements by the same method (44).

Electronic Intervention

Health behaviors account for approximately sixty percent of the risks linked to chronic diseases such as diabetes and cardiovascular diseases (59). Successful and effective strategies for improving health-related behaviors must be developed and disseminated on a population level. Based on the spread of the internet, its interactivity, and cost-effectiveness, researchers have developed many online interventions that inspire people to reduce their unhealthy lifestyles, increase their physical activity, and better manage their weight. Community leaders are acknowledging that it is less expensive to support healthy lifestyles compared to spend money to handle the consequences of unhealthy lifestyles (60). Indeed, rising healthcare costs are driving the search for inexpensive electronic health solutions (61).

The Internet has become an important resource to find health information for many individuals. This makes the Internet an attractive and gradually more used medium for the delivery of healthy behaviors programs that aim to change and contribute to the primary prevention of chronic diseases and interventions intended to promote health behavior change (62).

A). How Features of Internet-based Interventions Might be Conceptualized

1. Theoretical Basis.

To create the intervention, theoretical basis is important because theory is used to build the intervention. For example, to enhance physical activity, Spittaels et al. (63) guided contributors to a website that provided a tailored message built on the theory of planned behavior (64). Griffin and his colleagues (65) used the social cognitive theory to create a physical activity intervention that can be distributed via the Internet.

There is argument over the importance of theory (66,67) in spite of assertions that use of theory leads to more effective interventions (68,69). In addition, it is unclear that how use of theory influences intervention effectiveness, specifically in relative to Internet-based interventions (70).

2. Behavior Change Techniques

It indicates to particular approaches used in the intervention to inspire behavior change. For instance, some interventions designed to encourage healthy food consumption, prompt barrier identification and problem resolving (71); yet, other interventions prompt subjects to observer their behaviors (72). It is necessary that standardized descriptions of the techniques involved in behavior change interventions are used and connected to intervention effectiveness. This allows the scientist to identify which techniques contribute to success and to ensure that effective interventions can be repeated (72).

3. Mode of Delivery

Mode of delivery refers to the type of delivery used in the intervention approach to enhance health behaviors, such as emails, online classrooms, blackboard, and health websites. The mode of delivery is closely linked to an intervention's cost and viability. In order to develop evidence-based strategies for the intervention, a careful consideration of the comparative efficacy and intensity of different approaches is needed. Also, by examining studies that compare the same resources and mode of delivery offered through the Internet as opposite to other resources of delivery, the effect of Internet mode of delivery can be assessed (73, 74). However, Internet-based interventions have the potential to differ significantly from written interventions in their mode of delivery. As an example, content can be provided in an interactive approach (75, 76). Interventions may also use supplementary delivery modes (for example; email, mobile phone text messaging, or telephone) that may impact the effectiveness (76).

B). Advantages of Using the Internet for Improving Health Behaviors

The Internet has the advantage of reaching many people. Additionally, Internet-based interventions contribute to diffusion of health information that can be retrieved fast, at any time, and at any location. Furthermore, contrary to face-to-face interventions, the cost of delivering Internet interventions to a large number of individuals is unlimited (77). In addition, the ability to use an intervention program anonymously may appeal to people who may be unwilling or hesitant to seek in-person help, such as obese people. Internet technology allows for reaching stigmatized or isolated groups, decreasing cost and increasing convenience for

users, reducing health service costs, and timeliness. Kreuter and Skinner (78) defined 'tailoring' as: "Any combination of information or change strategies intended to reach one specific person, based on characteristics that are unique to that person, related to the outcome of interest, and have been derived from an individual assessment." Furthermore, computer-tailored interventions allow for the delivery of information unique to the population characteristics, circumstances, beliefs, motivation to change, and individual's behavior (79, 80). Personally, tailored methods and information through computer tailoring are more effective than general information, as indicated in some studies (77, 81). The Internet is an excellent media for delivering computer-tailored interventions that reach large numbers of people with health issues and concerns. Therefore, using this approach can be highly influential.

C). Mobile Phone Text Messaging

Mobile technology is one important way to promote health and prevent disease nowadays (82, 10, 83). Mobile health (mHealth) is an expression used for the practice of medicine and public health facilitated by mobile devices. In other words, cell phone is used to distribute health care guidance. MHealth involves video messaging, voice calling, Internet connectivity, and text messaging (84, 10, 85, 86).

A short messaging service, known as a text message, is one of the fastest mechanisms for communication worldwide. Mobile phone text messaging, an application built into most phones worldwide, allows users to send messages of up to 160 characters between mobile phones. Some evidence suggests that mobile

phone text messaging has a greater ability to influence people's behavior than radio or television (87).

Text messaging is a simple way of communication between mobile phones (88). Also, text messaging is a strong tool for health behavior improvement for various reasons. First, the availability, text messaging is available on every kind of mobile phone, second, low cost, widespread. Third, it does not involve high level of technological expertise, and it is widely applicable to many health behaviors (89, 90, 10, 11). Finally, text messaging is asynchronous because cell phone is accessible at any time during the day (11, 85). Also, in case if the phone is not working, text messages can be sent when the phone is turned back on (11). Additionally, text messaging can be used anywhere even when people may not have access to expensive technology (85, 91, 11). Thus, text messages have had a significant effect in developing countries (92, 84, 93). Also, text messaging allows for in the moment, low cost individually tailored health communication and reinforcement. Thus, text messaging is appropriate for behavior change interventions.

Literature Review

1). Freshmen studies

A). The Freshmen Health Study (FHS) was a study in the western United States conducted among 159 college freshmen students (102 women, 57 men). FHS studied the physical activity, dietary habits and other health-related behaviors changing, including students weight through the first semester. In this research, two FFQs were collected from each student. Also, weight was measured at the beginning of the student's first semester as a baseline and at the end of their first semester. In fact, the students' average weight increased during the 15-week was moderate (3.3 Ib). However, 23% of students' body weight increased ≥ 5% from the baseline. Also, ten pounds was the average weight gain among students who gained ≥ 5%. Moreover, students who gained ≥ 5% of weight stated less physical activity during college life compare to high school life. Also, students were more expected to eat breakfast, besides slept more than students who did not gain ≥ 5% of body weight (94).

B). Al Qauhiz (26) conducted a study in Princess Nora Bint Abdul Rahman University, Riyadh, Kingdom of Saudi Arabia, aimed at exploring the Body Mass Index (BMI) distribution among university female students as well as the food consumption pattern and health related behaviors. A total of 799 students were involved in the study. Data were collected using self-administered surveys that included socio-demographic, lifestyle, and dietary habits questions. Forty eight percent of the study participants were overweight or obese. Number of times students drinking sodas, marriage, and family members' obesity were connected to

increased risk of obesity. Also, analysis of food intakes as well as lifestyles showed that there were large numbers of unhealthy behaviors among students.

C). Al Rethaiaa et al., (27) conducted a study in Saudi Arabia, at Rass, Qassim University. This study aimed to discover the prevalence of obesity in male college students as well as to discover the association between the students' body weight status, body composition and students' eating and drinking habits, a total of 357 male students, their age between 18 to 24 years. Students were randomly chosen from the College of Health Sciences. The results from this study found that 21.8 percent of the students were overweight while 15.7 percent were obese. The total body fat percentage was excessive (set by the researcher as between 8 and 19.9%) in 55.2% of the participants (95).

2). Development of the FFQ Studies

A). In Sri Lanka, Jayawardena et al., aimed to develop a FFQ for adults. A sample size of 600 adults was used, and 24-hour dietary recall was obtained from the participants. Also, food portion sizes information was collected from subjects by using available household measures for example; bowls, cups, and spoons. Moreover, photographs and food atlas were used to help measuring food amount. Open-ended questions, asking for details about seasonal fruits and festival food intake were included to obtain a more comprehensive food list. Moreover, local nutrition experts were contacted to find unrecorded foods for the diverse ethnic groups. Three hundred and twelve different food items were recorded and were divided into eight groups: First, cereals or similar; second, vegetables; third, pulses; fourth, meat; fifth, fruits; sixth, drinks; seventh, miscellaneous; and eight,

alcohol. In Sri Lanka FFQ, investigators included only foods that provided a cumulative 90% of the variation in energy, macronutrients and dietary fiber. Also, foods were grouped into groups depended on the energy, macronutrients, dietary fiber, eating habits and nutrients. At the end, 90 foods were chosen for FFQ (96).

B). In South India, a pilot study was conducted in order to develop a new FFQ for Indian people and to develop nutrient databases not only for urban area populations but also for rural Indian populations with different dietary habits. This research was apart from the international project Prospective Urban Rural Epidemiology (PURE). The food list for the rural FFQ was obtained from 24-hour dietary recalls collected from eight four participants. The urban food list was obtained from sixty participants. Moreover, nutritionists familiar with local Indian food habits checked the food list for validity and indicated if any local Indian foods were missed from the 24-hour dietary recalls. The food lists were separately classified for the urban and the rural FFQs into nine food groups as follows: cereals; legumes, pulses, gravies; sweets and snacks; chutneys and salad; non-vegetarian foods; miscellaneous additions; beverages; fruits and vegetables. Also, one hundred twenty-nine foods were in the final food lists in the urban FFQ and one hundred and two foods in the rural FFQ list. Eighty-two items were common in both lists. In fact, fourteen urban foods as well as eight rural foods were included in the new FFQ. Moreover, everyday food intake for most of the nutrients and food groups were double to triple higher in the urban group compare to the rural group. However, the new FFQs can capture dietary habits in these Indian populations with numerous dietary habits sufficiently (97).

3). Validity of the Food Frequency Questionnaire Studies

A). Paalanen et al., aimed to examine the validity of the FFQs against the 3-day food record (FR) method. In addition, they assessed whether there were differences in the FFQs by age or Body Mass Index (BMI). The cutoff point for the BMI groups was the median among all the subjects (26.8 kg/m^2). Two hundred and ninety-four subjects were involved in this study, which included one hundred thirty-seven men and one hundred fifty-seven women. All the subjects completed both FFQs and three-day FRs. However, the researchers found that mean nutrient intakes were higher when measured with the FFQs than with the FRs ($P > 0.05$) for all nutrients except retinol. In particular, the most overestimated nutrients were polyunsaturated fatty acids, long-chain fatty acids (LCFA), carotenoids, vitamin E, and vitamin C, in both men and women. Also, in terms of gender, overestimation was greater in women than in men. The researchers suggested that due to their greater health awareness, women may report the same food consumption in the two methods. Furthermore, for both genders, most of the Pearson correlation coefficients were higher among subjects in the lower BMI group (BMI < 26.8 kg/m^2) than in the upper BMI group (BMI ≥ 26.8 kg/m^2). The difference between BMI groups was statistically significant ($P > 0.5$) in men for monounsaturated fatty acids, total fat, and alcohol, and in women, for saturated fatty acids, total fat, riboflavin, calcium, and fiber (98).

B). Sevak et al., conducted a study among one hundred healthy South Asian women living in United Kingdom, in order to examine the validation of a FFQ compared to monthly 24-hour recalls collected over one year. The results of this

study show that the 24-hour recalls produced lower mean estimates of absolute intake than the FFQs, particularly for vitamins C and A. However, the difference between the two methods was smaller after adjustment for energy intake. Moreover, the proportion of individuals who were classified by the FFQs and the multiple 24-hours recalls in the same or adjacent quartiles of energy and macronutrient intake ranged from 74% (total energy) to 96% (protein). Similar levels of agreement were observed for micronutrients, ranging from 89% (vitamin D and folate) to 65% (Vitamin A) (99).

C). A FFQ was developed and validated in a South Indian population. Urban subjects (n=1,351) and 1,169 rural subjects were recruited as a part of the Prospective Urban Rural Epidemiological Study (PURE) in order to refine the FFQ. For the FFQ validation, 100 participants who had completed the first part completed two FFQs and 24-hour recall forms over 4 months. The first FFQ (FFQ1) and 24-hour recall were administered in September 2005, and the second refined FFQ (FFQ2) and 24-hour recall were administered in November 2005. By comparing the FFQ1 and the 24-hour recalls, this study found that the correlation coefficients ranged from 0.11 for vitamin A to 0.44 for protein intake, while the correlations for the FFQ2 ranged from 0.09 for vitamin A and saturated fatty acids (SFA) to 0.35 for protein intake. The researchers concluded that the FFQ over estimated nutrient intake for energy, protein, carbohydrate, fiber, fat, SFA, vitamin A, vitamin C, Calcium (Ca), Zinc (Zn), and folate in comparison with 24-hours dietary recall data (100).

D). Dehghan et al., (101) aimed to develop a FFQ for use in urban and rural areas of Poland. One hundred men and women recorded their 24-hour dietary intake, resulting in the development of a 158-food item FFQ. Two FFQs and four 24-hour dietary recalls were administered to PURE participants from both the urban (n=73) and rural (n=73) areas over one year. At the end of the study, FFQs were underestimated energy and nutrient intake in urban area. On the other hand, FFQs were overestimated energy and nutrient intake in rural area. This difference between urban and rural areas results of the FFQ validation may be due to portion size and recall bias. For almost all nutrients, the unadjusted and de-attenuated correlations varied from 0.2–0.77, which indicated that the validated FFQ is suitable for ranking individuals in both urban and rural settings, though for some nutrients the study found slightly weaker correlations in rural settings. The study suggested that FFQ has good validity and reproducibility compared to the reference method, which was 24-hour dietary recalls. Thus, FFQ is able to rank people according to macro and micronutrient intake.

E). Dehghan et al., (102) compared SFFQs with 24-hour dietary recalls to assess dietary intake in 30 adult Kuwaitis. The SFFQs and the 24-hour dietary recalls were collected two times; at the baseline and after 4 months. The study found that the correlation coefficients between SFFQ 1 and SFFQ 2 for macronutrients varied from 0.74 for carbohydrates to 0.69 for fat. Vitamin C had the highest correlation coefficient and calcium was the lowest. The correlation between SFFQ2 and dietary recalls for total caloric intake, protein, total fat, and carbohydrate were

noted. Among micronutrients, vitamin A had the highest correlation, while the lowest correlation was noted for vitamin C.

4). the Effectiveness of Electronic Intervention to Increase Health Behaviors in the College Population Studies

A). ALIVE! (A Lifestyle Intervention Via Email) was randomized controlled trial guided by Block et al., (103). ALIVE was intervention to improve healthy lifestyles. Promoting physical activity, saturated and trans fats intakes, besides added sugars, also to increase fruit and vegetable consumption were the aims of the ALIVE. Additionally, it designed to assess the quality of life which is related to health, such as life satisfaction, and self-efficacy. The ALIVE! Participants were seven hundred and eighty-seven non-medical employees of Kaiser Permanente of Northern California. They were randomized to control group or intervention group. Three hundred fifty-one subjects were randomized to the intervention group. And 436 participants to the control group. After randomization of the sample, the intervention group subjects select one of three aims to begin the study: first aim was to increase physical activity level, second aim was to increase fruits and vegetables intakes, last aim was to decrease fats and added sugars. After the selection period, participants received messages every week offering small-step guidance for accomplishing those goals. Pre- and post-questionnaires that assessed the participants' dietary, physical activity, lifestyles were part of the ALIVE! program. The study found that the intervention resulted in increased physical activity (odds ratio 1.42) and fruits and vegetables consumption (odds ratio 1.76) in the intervention group compared to the control group. Moreover, intervention

group physical quality of life and mental health scores were higher than it is in the control group scores. In conclusion, ALIVE! is a low-cost intervention shown to affect improvements in health behaviors.

B). Gow et al., (104) conducted a study among college populations aimed to evaluate an Internet intervention in the first year of college. A total of one hundred and fifty-nine students were appointed to one of four treatments groups randomly: 1) no treatment (n = 40), 2) 6-week online intervention (n = 40), 3) 6-week weight and caloric feedback only (n = 39), and 4) 6-week, feedback as well as online intervention (n = 40). Baseline anthropometric measures and three-month follow-up questionnaires were obtained from the control group however, they did not receive any treatments. One the other hand, via the study's Blackboard, participants weighed themselves and report their weight to the investigator every week in the feedback intervention group. Also, participants were given diagram characterizing individualized change in their weight delivered direct to their email accounts as well as report of equivalent energy change. Additionally, six sessions of the study were distributed through the study's Blackboard to the Internet intervention group. Moreover, in the study's Blackboard discussion board contributory behaviors were included. Furthermore, homework assignments and tasks were given to participants in order to support the new skills achievement. Personal, environmental, and behavioral influences were involved in each session to support healthy lifestyle, suggested weight and exercising every day. At the end of the study period, the investigators discovered that the joined intervention group had lesser BMIs at post-testing compared to the other three groups. The study

concluded that an online intervention is a feasible and effective way to prevent weight gain among college students.

C). Project Web Health conducted by Greene et al., (105) was a Web-based health promotion intervention developed for college students. The project aimed to test the impact of a non-dieting online intervention tailored to college populations. using online psychosocial, fruit and vegetable consumption, and on-site physical and fitness assessments. One thousand six hundred eighty-nine college students were recruited from eight universities in the United State of America. The study included two groups: a control group (n = 859), and an intervention group (n = 830). The intervention group was given a plan which had ten lessons. This plan concentrated on healthful eating and physical activity. Also, these lessons provided in project website. Furthermore, weekly e-mails indicated that the lesson was ready to view. Each individual had a separated page. So, they could see his or her measurements. At the end of fifteen months, the intervention group had significantly higher fruit and vegetable intake and physical activity participation than the control group. Also, first-year college students gained more weight than participants in other school years. The Web Health study indicated that the intervention planned to promote healthy food intake and physical activity had a positive result in college populations.

Chapter 3: Experimental Design and Methods

Study Design

A cross-sectional study is an observational epidemiology study that can be conducted on representative samples of a population. Cross-sectional studies are one of the most common and well-known study designs (106).

A cross-sectional study was conducted in the Western Region of Saudi Arabia in order to develop a new semi-quantitative food frequency questionnaire (SFFQ) to measure macro-micro nutrients intake for the Saudi population in this region and to examine its validity in the general population in Al-Madinah City, which is located in the Western region of Saudi Arabia. An additional, study examined the effectiveness of electronic interventions for increasing health behaviors in the college population study.

Development of a Semi-Quantitative Food-Frequency Study Design

1). Study Setting

The development of a semi-quantitative food frequency questionnaire (SFFQ) was conducted in the Western region of the Kingdom of Saudi Arabia, which lies on the shores of the Red Sea. The principal cities of the western province are Al-Madinah, Jeddah, and Makah in addition to several small cities such as Taif and Yanbu. Al-Madinah City serves as the capital of the Al Madinah province. It had a population of about 1.1 million in 2010 and it has an area of 151,990 km², according to the Saudi Arabia Central Department of Statistic and Information (1). Many immigrants live in Al-Madinah city for religious reasons. Thus, the development of the SFFQ was conducted in Al-Madinah City.

2). Population

The target population for the development of a semi-quantitative food frequency questionnaire study was people living in the western province of the Kingdom of Saudi Arabia. The sample population was derived from Al-Madinah City. Data that had been collected in previous national studies, which evaluated the nutritional status of the people of Saudi Arabia to represent the Saudi population (107), was also used.

3). Sample

Prevalence study: Females or males between 18 and 74 years old were recruited from Al-Madinah City. The participants were chosen from visitors of primary healthcare center in Al-Madinah City in the Kingdom of Saudi Arabia.

1. Sample criteria:
    - Inclusion criteria:
        - Female or males.
        - Aged 18 - 74 years.
        - Not currently pregnant or lactating (Female).
    - Exclusion criteria.
        - Having an eating disorder.
        - Already had bariatric surgery.
        - Currently in treatment for weight loss.
        - Having any chronic health conditions.
2. Sample size: Using G*Power statistical software, a priori power analysis for multiple regression analysis with 21 responses variables indicated that a sample size of 160 was needed to reliably detect medium effect size of 0.15 with alpha of 0.05 and desired statistical power level of 0.80 (108,109,110).

Sampling technique: a systematic sampling procedure was used to recruit one hundred and sixty participants from the eligible subjects who were visited the healthcare center. The first participant who fulfilled the inclusion criteria was invited to enroll in the study. Then, every fourth attending participant who fulfilled the criteria was selected and so on until completion of the required sample was achieved. However, if a selected subject did not fulfill the inclusion criteria or refused to participate, then selection proceeded to the next sample subject.

Informed consent form should be signed by participants if they agreed to participant.

24-hours recall.

All participants were asked to fill out the 24-hour recall **(Appendix A)**. A brief introduction and the reasons for conducting the study were given to participants. In addition, the participants were given the self-administered 24-hour recall booklet in Arabic language. The participants were asked to record all their food and beverage consumption for the previous day in special booklets provided by the researcher. A pictorial serving guide sheet (e.g., 1 oz (ounce) = thumb) was included in the booklet, and an example of a one-day recall was provided. The booklet included a table for the food and beverage consumption.

Procedure for Development of the Semi-Quantitative Food-Frequency

Three components were needed: a complete food list, portion size, and frequency of intake in order to develop the SFFQ,

I. A complete food list

1). Briefly, data from the Evaluation of the Nutritional Status of the People of Saudi Arabia (107) was used to identify the foods consumed by the target population. A detailed table containing more than 300 food items consumed in the different regions of the country was obtained. Then, a test of this food list was performed on a convenience sample. Thus, 30 subjects aged between 18 and 74 years from Al Madinah City, who met the above inclusion and exclusion criteria were recruited. In sum, subjects were asked how many times they ate the food items which were obtained from national representative food list (300 foods) on a regular basis (once a month). Foods reported by more than 15 subjects were considered for the final food list.

In a second step, 160 healthy subjects, aged between 18 and 74 years, were recruited from Al-Madinah City in order to include regional foods in the new FFQ. The present study was particularly focused on the measurement of energy and 20 macro-micro nutrients including Carbohydrate, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium. These participants were asked to fill out the self-administered form of 24-hour diet recalls in Arabic language **(Appendix A)**. After collecting the 24-hour diet recall forms from the participants, a food list was constructed. The list from the 24-hour recalls and the list constructed from the previous National Nutrition Study of Saudi Arabia (107) were combined. Similar foods were reported only one time.

The selection of food items for the development of the SFFQs was performed according to the methodology proposed by Willett. Thus, Stepwise multiple regression analysis was carried out using the total intake of energy and each specific nutrient as the dependent variable, including Carbohydrate, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium, and the independent variables as the intake of all food such as milk, rice, potatoes, soup, and meat (30). To be able to generate the Stepwise multiple regression analysis, list of foods items was grouped in 30 different food groups according to the similarity of nutrient content and ingredients. The list of food per food groupings and number of food items in each group can be seen in Appendix B. The food grouping approach has been performed in other studies (111,112, 113).

Validation of a new semi-quantitative food-frequency study

1). Study Setting

This validation study was performed in order to test the new SFFQ in the same general population as in the development study. Thus, the validation of the new SFFQ was carried out in a group of visitors of outpatient clinics of the general hospital in Al-Madinah City.

2). Population

The target population for the validation study was in the western province of the Kingdom of Saudi Arabia, with the sampling population selected from Al-Madinah City.

Females or males between 18 and 74 years old were recruited from individuals visiting outpatient clinics of the general hospital in Al-Madinah City in the Kingdom of Saudi Arabia

1. Sample criteria:

- Inclusion criteria:
    - Female or males.
    - Aged 18 - 74 years.
    - Not currently pregnant or lactating (Female).
- Exclusion criteria.
    - Having an eating disorder.
    - Already had bariatric surgery.
    - Currently in treatment for weight loss.
    - Having any chronic health conditions.

2. Sample size: Power analysis was performed by using G*Power statistical software. The sample size given 80% power, at the 0.05 level of significance was 100 subjects (110). Thus, a total of 100 healthy subjects were recruited to participate. Participants were selected by systematic sampling from the eligible visitors attending the outpatient clinics of the general hospital. To select a systematic sample of n elements, the first element was selected with a random start r from 1 to sample intervals (k), where k=N/n. Every k th subject was included where $1 \leq r \leq k$. N = 70, n = 10, then k = 70/10. K = 7. Then the random start r was selected between 1 and 5 (r = 5). The fifth clinic visitor who fulfilled the inclusion

criteria was invited to enroll in the study. Then, every fifth visitor who fulfilled the criteria was selected until a sample size of n = 100 were achieved. All participants were asked to sign the consent form, filled out a 24-hour recall **(Appendix A)** and Semi-quantitative food frequency questionnaires (SFFQs) **(Appendix C)**

a). 24-hours recall.

A brief introduction and the reasons for conducting the study were given to participants. In addition, the participants were instructed on how to fill out the self-administered 24-hours recall form, which was written in Arabic language.

b). Semi-quantitative food frequency questionnaires (SFFQs)

The SFFQ was developed in the first study in the Arabic language. In the new self-administered SFFQ, participants were asked to indicate how often they consumed each food and beverage during the period of a month. The frequency of consumption for each food and beverage was classified into the following six categories: Never, once a month, one time every two weeks, less than 3 times in one week, 3 to 6 times in one week, finally, more than 6 times in one week. Portion size information was collected using conventional portion size and an average serving size for the food items, such as one glass of milk or juice, and one medium apple. New SFFQ was designed based on the Harvard FFQ design (35). The SFFQ was divided into seven food groups: 1) Milk, milk products (milk with different quantities of fat); 2) Vegetables; 3) Fruit; 4) Meat, and eggs; 5) Cereal; 6) Beverages; and 7) Baked goods (Bassbossa, etc.), nuts like cashew, and nutcracker.

Third study: **Study of the Effectiveness of Electronic Intervention to Increase Health Behaviors in the College Population**

1). Study Setting

This study was conducted in Al-Madinah City, which is situated on the eastern part of the Al Hijaz region in the west side of the Kingdom of Saudi Arabia. There are two big universities in Al-Madinah City: one is the Islamic University of Madinah and the other one is Taibah University. Taibah University is a public comprehensive University that currently enrolls over ~ 63,000 students through its twenty-eight colleges. Taibah University was chosen as the recruitment site for this study.

2). Population

In the University, each college is strictly segregation along gender lines with separate buildings for females and males. The target population was Taibah University female freshmen college students aged 18-20 years old. The sampling population was chosen randomly from female-only colleges to represent Taibah University female freshmen students.

3). Sample

Female freshmen college students from Taibah University were recruited in this study.

1. Sample criteria

I. Inclusion criteria:

- Female.
- Aged 18 - 20 years.
- Enrolled in Taibah University in fall semester of 2015.
- Not currently pregnant or lactating.

- Have access to email on a regular basis (at least once per week).
- Have text messages enabled cell phone.

II. Exclusion criteria:

- Having an eating disorder.
- Had bariatric surgery.
- Currently in treatment for weight loss.
- Having any chronic health conditions.

2. Study sample size: Target sample size was based on the number of groups (n = 2) in the randomized controlled trial, and 80% power to detect a difference in mean change in diet. Based on the literature review, average effect sizes are 0.16, 0.16, and 0.22 for fruits and vegetables, saturated fat, and sugar intakes, respectively (114). The G*Power statistical software indicated that a sample size of 168 was needed to reliably detect an effect size of 0.22 with an alpha of 0.05 and desired statistical power level of 0.80 (110). This target sample size was increased by 25% to account for non-response and non-compliance during the sample collection procedure. Hence, the number of subjects required for this study was determined to be approximately 200 subjects (30).

3. Study sample technique: A random sampling procedure was used. Five all-female colleges were chosen randomly from the 28 total all-female colleges at Taibah University. The female colleges and female freshmen students list were obtained from the Taibah University Deanship of Admission and Registration. The average number of the freshmen female students who are accepted in Taibah University is about 800 students each year. Thus, a sufficient number of students were available for study. Forty freshmen female students were chosen by using the same computer-generated random numbers through SPSS statistical software from

each college Table (1). The female freshmen students who satisfied the inclusion criteria were invited to participate in the study. Screening interviews were performed to make sure each subject fulfilled the inclusion and exclusion criteria **(Appendix E).**

Collage	Number of students
1. Medicine	40 students
2. Dentistry	0
3. Pharmacy	0
4. Applied Medical Science	0
5. Applied Medical Science–Yanbu	0
6. Applied Medical Science – Ola	0
7. Medical Rehabilitation	0
8. Nursing	0
9. Science	40 students
10. Community College – Khaibar	0
11. Science- Yanbu	0
12. Engineering	0
13. Engineering – Yanbu	0
14. Computer Science	0
15. Computer Science – Yanbu	0
16. Family Science	40 students
17. Education	40 students
18. Arts & Humanities	0
19. Arts & Humanities – Yanbu	0
20. Business Administration	0
21. Business Administration – Yanbu	0
22. Law	0
23. Sciences & Arts – Ola	0
24. Community College	40 students
25. Community College – Hnakyyah	0
26. Community College – Mahd	0
27. Community College – Ola	0
28. Community College – Badr	0

Table (1). Selected female colleges the Effectiveness of Electronic Interventions to Increase Health Behaviors in the College Population Study (n = 200)

4). Study of the Effectiveness of Electronic Intervention to Increase Health Behaviors in the College

Population Protocol

The Electronic Intervention study was a 10-week prospective randomized controlled trial in which e-mails and text messages were delivered to participants. The emails and texts aims were to increase fruits, vegetables intakes, as well as to lower saturated fats intake and decrease intake of added sugars.

The study protocol consisted of four face-to-face visits.

Visit (1): The first visit was performed one week prior to baseline. For all participants, consent forms were obtained in this visit, a brief introduction and instructions on how to fill out the three-day FR was given as well. Socio-demographic and health questionnaires **(Appendix F)** and three-day FRs **(Appendix G)** were given to the participants, anthropometric measurements were taken.

Visit (2) (baseline), Participants were asked to return three-day FRs. Randomization was performed in this visit. The randomization was done by computer-generated random numbers through SPSS (2011) to the control group, or electronic interventions group (*n*= 100 each). Same procedure was applied to control and experimental groups. Yet, no treatment for control group (106). A description of the electronic interventions procedure was given to the participants in this visit.

Electronic Intervention: from the baseline visit to week 10

After the baseline, the participants received one e-mail and one text message each week for 10 weeks, depending on which group they belong to. The sham control group received a weekly e-mail of at least one page (8 x 11 in) in length and a text message limited in number to 160 Arabic language characters for 10 weeks. Email and text messages contained available information about general health which was not related to diet. The intervention participants received a weekly e-mail and text message providing health advice based on goals selected by the study investigator and the dietitian for 10 weeks. The information was derived from scientific, peer-reviewed educational materials that are publicly available (from the U.S. Department of Agriculture, National Dairy Association, and U.S. Food and Drug Administration) adapted for Saudi Arabian culture as well as from Dietary Guidelines for Saudis (116). A dietitian and nutrition expert from Taibah University reviewed this information. The information was called 'My Goal for this Week,' and provided advice on dietary intake. Web-based resources for diet and nutrition information were included in the weekly e-mails. These e-mails and text messages were sent by blind copy to e-mail addresses and mobile phone numbers to maintain confidentiality once every seven days through the intervention period. The study aims were the same for all participants. Four emails and texts messages during 4 weeks aimed to increase fruits and vegetables intake. Three emails and texts messages during 3 weeks aimed to decrease saturated fats intake. Three emails and texts messages during 3 weeks aimed to decrease added

sugars intake. Example of e-mails and mobile telephone text messages can be seen in Appendix H.

Visit (3) the third visit occurred during the middle of the trial at week 5. At this visit, the anthropometric measurements were performed and three-day FRs was given to the participants. They were asked to return the three-day FRs the following week. All participants continued to receive the weekly e-mails and text messages.

Visit (4), the fourth visit occurred at the end of the randomized controlled trial at week 10. The anthropometric measurements and three-day FRs conducted at baseline were repeated.

5). Data Collection Tools

Data were collected using the following tools: 1) a socio-demographic and health questionnaire **(Appendix F)**, 2) anthropometric measurements, 3) three-day FRs **(Appendix G)**. Data Collection tools were developed in the Arabic language.

First: A socio-demographic and health questionnaire was developed after a review of existing questionnaires and relevant literature by the researcher. This self-administered questionnaire has the following parts:

I. Socio-demographic data

Socio-demographic variables such as age, marital status, and family income level were obtained from participants. Marital status cataloged as follows; married and not married (divorced, widowed, and separated). The total monthly household income levels were presented in Saudi Riyal (SR), which can be converted to 0.27 U.S. dollars. Income was divided into five categories: ≤ 4000 SR low income;

4001 SR to 6000 SR low medium income; 6001 SR to 8000 SR high medium income; ≥ 8001 SR high income; and prefer not to answer.

II. Medical, family history, and allergies

This part contained two sections: the first section collected the medical and family history, including the participant's history of chronic diseases such as asthma, cardiomyopathy, chronic renal disease, coronary artery disease, diabetes mellitus types 1 and 2, and hypertension. This section also recorded the participant's history of medications, as well as whether the participants had taken any supplements such as vitamins or minerals. Family history of chronic disease was also included. The second section asked about the participant's history of food allergies such as eggs and tree nuts.

Second: the Anthropometric Measurements

Anthropometric measurements were obtained three times from the female freshmen students during the trial period: at the beginning, in the middle, and at the end. All procedures were explained to the participants before conducting the measurements. Weight and height measurements were taken by using SECA 703 Digital Medical Column Scale with a stadiometer attached to the scale. The scale was zeroed out before and after measuring the participants. Participants were asked to remove all heavy clothing, their shoes, and any accessories from their hand, neck and hair. They were told to stand in the center of the scale with both feet together, hands at side, with head pointing straight forward and wait until a figure is displayed. Weight was recorded in kilograms (106). Height was measured to the

nearest 0.1 centimeter using the stadiometer attached to the scale at the same time for weight measurement. Then, Body Mass Index (BMI) was computed as follows; Weight should be divided by squared height (Kg/m^2) from the Taibah University female freshmen college students. BMI was categorized as follows: underweight ($BMI < 18.5$), normal ($18.5 \leq BMI < 25$), overweight ($25 \leq BMI < 30$), and obese ($BMI \geq 30$) as stated by World Health Organization (106). All measurements were conducted by the researcher in a private room provided for the study by the Department of Food Science in the College of Family Science in Taibah University

Third: Three - days food records.

Female freshmen college students at Taibah University were given three-day FRs three times **(Appendix G)**: at the beginning of the trial, which was also the beginning of their first semester, at week 5, and at week 10.

A brief introduction and the reasons for conducting the study were given to participants. In addition, the participants were given the self-administered three-day FRs in Arabic language. The participants were asked to record all their food and beverage consumption in special booklets provided by the researcher for three non-consecutive days (one weekend day and two weekdays). Pictorial serving guide sheet (e.g., 1 oz (ounce) = thumb) was included in this booklet along with an example of one-day record. The booklet also had food records forms.

Food Intakes Analysis

Dietary intake including 24-hour recalls, three-day FRs and SFFQs were analyzed for nutrient content using the Food Processor Plus computer program

software (117). The ESHA master database is composed of 50,000 food items. For foods that were not found in the software, Saudi Arabian (114), Middle East (128,119), and Arab Gulf countries composition tables (120*)* were used. This approach has been used in Saudi Arabia population in many studies (121,122,123).

Statistical Analysis

The Statistical Product and Service Solutions (SPSS) software version 20 was used (124) for data analysis for all three studies. Prior to analysis, data was screened for normality and outliers. Mean and standard errors were shown for all quantitative variables including age, height, weight, BMI, and nutrient intakes. Frequencies and percentage were used for qualitative variables including, resident status, marital status, and family income levels.

1). Development of the Semi-Quantitative Food-Frequency Questionnaire study

Stepwise multiple regression analysis was carried out in order to identify the food items to be included in the new SFFQ ($P \leq 0.05$). First, the food list was constructed. Second, grams of foods consumed and nutrient content per gram of food were obtained from the Food Processor Plus computer program software, food composition tables for use in Saudi Arabia (107), food composition tables for use in the Middle East (118,119), as well as from the Arab Gulf countries food composition tables (120).

Stepwise multiple regression analysis was carried out in order to identify the list of food items used for the development of the SFFQ. Stepwise multiple regressions are a way of choosing predictors of a dependent variable on the basis

of statistical criteria. Variables are added to the regression equation one at a time, to maximize the R-square (R^2) to include variables in the result. R-square (R^2) can be described as follows; it is the quantity of variance in the dependent variable and this quantity can be predicted from the independent variables. Essentially the statistical procedure decides which independent variables are the best predictor, the second-best predictor, and so on. (125). Stepwise multiple regression analysis was used with each of the following dependent variables: total food energy intake, Carbohydrate, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium. The independent variables were the food items for example breads, chicken and so on. In this process, the computer algorithm identifies the food that explains the most between person variance in nutrient intake as first independent variable, the food not accounted for by the first food as the second independent variable, and so on (30). The contribution a food makes is reflected in the change in cumulative square of the multiple correlation coefficients (R^2). This study test was two-tailed. The statistical significance was considered at $P \leq 0.05$. Consequently, the best predictor food items were selected by using stepwise multiple regression analysis.

2). Validation of a Semi-Quantitative Food-Frequency study

The two dietary assessment methods, new SFFQs and 24-hour recalls, were compared using paired t-tests based on the following response variables: Energy, Carbohydrate, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated

Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium. This study test was two-tailed. The statistical significance was considered at $P \leq 0.05$.

Moreover, ranking nutrient intakes into quartiles is commonly used in epidemiological studies for the analysis of the relation between diet and chronic diseases (126). Thus, the new SFFQ and 24-hour recalls were conducted and compared in terms of their ability to accurately assess individuals according to their nutritional intake by calculating the percentage of subjects classified in the same, or in opposite quartiles. Also, Cohen's kappa coefficient was calculated to assess agreement between quartile classifications, while taking chance agreement into account. Additionally, the performance of the new SFFQs was assessed by comparing the intake of each nutrient estimated from the SFFQs with that estimated from 24-hour recall using the Spearman's rank correlation coefficient to determine the strength of the relationship for nutrient intakes between the SFFQ and 24-hour recall. All the study tests were two-tailed. The statistical significance was considered at $P \leq 0.05$.

Furthermore, the validity of the new SFFQ was compared between the two groups of subjects, normal weight (BMI < 25 kg/m^2) and overweight (BMI ≥ 25 kg/m^2) groups. Spearman's rank correlation coefficient was used to compare the validity of the new SFFQ between the two groups of subjects. Statistical significance was considered at two-tailed p-value ≤ 0.05.

3). the Effectiveness of Electronic Interventions to Increase Health Behavior

in the College Population

The dietary outcomes of fruit, vegetable, saturated fat, and sugar consumption were measured via three-day FRs. The primary outcomes were performance of the following variables

- Dependent variables: fruit and vegetable intake, saturated fat intake, and sugar intake.
- Independent variable: group (a 2-level categorical variable (intervention or control)).
- Covariates: baseline BMI and age (both continuous variables).

As the dependent variables were measured multiple times over the study period (baseline, week 5, and week 10), repeated measures ANOVAs (127,128) were used to determine if there was a relationship between each of the dependent variables and group, after controlling for age and BMI. The time (baseline, week 5, and week 10) and group (control versus intervention) interaction effect was included in the models to determine if the group effects varied statistically significantly at different levels of time. The F-test was used to determine if an effect was statistically significant. All the study tests were two-tailed. The statistical significance was considered at $P \leq 0.05$.

Chapter 4: Results

PAPER I: Development of a Semi-Quantitative Food Frequency Questionnaire to Measure Macro-Micro Nutrients Intake for Saudi Population in the Western Region of Saudi Arabia.

Abstract

Background: The Food Frequency Questionnaire (FFQ) is a tool in the epidemiologic studies. Usually, researchers use it in order to evaluate dietary consumption. The present study aimed at describing the development of a cultural Semi-Quantitative Food Frequency Questionnaire (SFFQ) for the western region of Saudi Arabia. *Methods:* A Nationally representative food list was combined with 24-hour recall data collected in this study. Participants were 150 healthy residents of Al Madinah City in Saudi Arabia, and were between 18 to 75 years old. The food list for the new SFFQ was selected by Stepwise multiple regression. Separate models were created for energy plus 20 nutrients that included Carbohydrates, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium. *Results:* Two hundred thirty food items were recorded in the 24-hour diet recalls, and 152 foods were selected to create the final food list for the new SFFQ. *Conclusion:* A new SFFQ for the Saudi Arabian population in the western region was developed to measure diet and food habits. Once the validity and reliability of this new SFFQ is established, it will serve as a useful tool for researchers in

epidemiologic studies to investigate the role of diet on chronic disease in Saudi population.

Introduction

Valid assessment of nutrient intake is very important for researchers to investigate the diet-related conditions, for example, cardiovascular disease, and diabetes (1). Food records (FRs), 24-hour food recalls, and food frequency questionnaires (FFQ) are the most common methods used to evaluate people dietary intake. All methods have advantages and limitations. The choice of a specific method depends on the purpose for which the information is intended. The 24-hour recall is based on gathering retrospective information on food and beverage consumption within the past 24-hour period. Food records (FRs) or food diaries are prospective recordings of all foods and beverages consumed. FFQs require a more long-term estimate of dietary intake over past weeks, months or within the past year. A SFFQ is a type of food frequency questionnaire that ask subjects to report portion size information as identical portions or as a choice of portion sizes.

When portion sizes are collected from participants, it is called semi quantitative food frequency questionnaires (SFFQ). The portion size information can be collected as one predefined portion size or a choice of portion sizes. The FFQ is the most commonly used method in large epidemiological studies because it collects dietary information at a low cost to researchers (2).

Dietary habits and foods vary significantly among world cultures (3). Not only are foods different, but components, methods of preparation, and cooking

techniques, differ among cultures and regions. Even within regions, family and individual food preferences create new patterns of food choices (4). Thus, development of specific FFQs is necessary to correctly present cultural differences for any group of people. In particular, in the Kingdom of Saudi Arabia, diet is strictly governed by Islamic food intake laws. There are numerous special characteristics of Islamic food intake. One is prohibited consume any kinds of alcohol as well as eating pork. Islamic food intake laws are not influenced by industrialization and urbanization. Nonetheless, aspects of diet, which are not related to religion, continue to change rapidly in the Kingdom of Saudi Arabia.

The Kingdom of Saudi Arabia is the biggest Arab country in Western Asia. The estimated Saudi Arabia population is 27 million. Nine million of them are registered foreign expatriates. Also, 2 million of them are illegal immigrants (5). Most of the foreign expatriates and immigrants live in the Western region of Saudi Arabia. Their presence causes the food habits in this part of Saudi Arabia to reflect different cultures such as Turkish, Indian, Pakistani, Egyptian, and African. Consequently, the objective of this study was to develop a SFFQ that reflects the diverse cultures and foods of this region in order to examine the dietary habits of this population.

Methods

A cross-sectional study was conducted in Al-Madinah City, located in the Western region in the Kingdom of Saudi Arabia, in order to develop a new semi-quantitative food frequency questionnaire for the Saudi population in this region.

Sample

A priori power analysis for multiple regression analysis was performed with 21 response variables. The results indicated that a sample size of 160 was needed to reliably detect a medium effect size of 0.15 with an alpha of 0.05 and a desired statistical power level of 0.80 (6, 7).

Sample criteria:

- Inclusion criteria:
    - Female or males.
    - Aged 18-74 years.
    - Not currently pregnant or lactating (Female).
- Exclusion criteria.
    - Having an eating disorder.
    - Already had bariatric surgery.
    - Currently in treatment for weight loss.
    - Having any chronic health conditions.

A systematic sampling procedure was used to recruit 160 participants from the eligible subjects who visited the healthcare center. The first participant who fulfilled the inclusion criteria was invited to enroll in the study. Then, every fifth attending participant who fulfilled the criteria was selected and so on until completion of the required sample was achieved. However, if a selected subject did not fulfill the inclusion criteria or refused to participate, then selection proceeded to the next sample subject. Participants were excluded if they met the exclusion criteria listed above.

Informed consent form should be signed by participants if they agreed to participant.

Procedure for Development of the Semi-Quantitative Food-Frequency

In order to develop the SFFQ, three components were needed: a complete food list, portion size, and frequency of intake.

I. A complete food list

1) As Willett suggested, there are two methods for building an SFFQ food list: 1) to identify the foods consumed by the target population, and 2) using stepwise multiple regression techniques to identify foods that are the best predictors of dietary factors of interest (2). In the current study, data from the Evaluation of the Nutritional Status of the People of Saudi Arabia, (8) were used to identify the foods consumed by the target population. The total number of individuals who participated in the national survey was 19,598. The national data were collected via the 24-hour dietary recall. A detailed table containing more than 300 food items consumed in the different regions of the country was obtained. Regions included Riyadh, Al Madinah, Makkah, Asir, Tabouk, Jeddah, Hail, and other cities (8).

A test of this food list was performed on a convenience sample. Thus, 30 subjects aged between 18 and 75 years from Al Madinah City, who met the above inclusion and exclusion criteria, were recruited. In sum, subjects were asked how many times they ate the food items that were obtained from the national representative food list (300 foods) on a regular basis (once a month). Food reported by more than 15 subjects was considered for the final food list. In a second step, 160 healthy subjects aged between 18 and 75 years were recruited from Al-Madinah City in order to include regional foods in the new FFQ. The present study was particularly focused on the measurement of energy and 20

macro-micro nutrients including Carbohydrates, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium.

These participants were asked to fill out the self-administered 24-hour diet recall form, which was written in Arabic **(Appendix A)**. After collecting the 24-hour diet recall forms from the participants, the food list was constructed. Dietary intake was analyzed for nutrient content using the Food Processor Plus computer program software (9). For foods that were not in the software, food composition tables for Saudi populations (8) were used. This approach has been successfully used in the Saudi Arabia population in many studies (10, 11, 12). The list from the 24-hour recalls and the list constructed from the previous National Nutrition Study of Saudi Arabia (8) were combined. Similar foods were reported only one time.

The selection of food items for the development of the SFFQs was performed according to the methodology proposed by Willett. Stepwise multiple regression analysis was carried out using the total intake of energy and each specific nutrient as the dependent variable, including Carbohydrate, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium, and the independent variables as the intake of all food such as milk, rice, potatoes, soup, and meat (2). To be able to generate the Stepwise multiple regression analysis, food items were grouped in 30 different categories according to the similarity of

nutrient content and ingredients. The list of food in each category can be seen in Appendix B. The food grouping approach has been performed in other studies (13, 14, 15).

Statistical Analysis

The Statistical Product and Service Solutions (SPSS) software version 22 was used (16) to analyze the data. Prior to analysis, data were tested for normality and outliers. Independent variables of food intake had significant effects on the dependent variable of nutrients if the p-values of the t-test of the regression results were ≤ 0.05.

Results

The test of the previously obtained national food list (8) was performed on a convenience sample of 30 subjects (Males = 9; Females = 21) recruited from Al Madinah City; mean (standard deviation) age was 33.8 (9.4) years. One hundred and sixty-six foods were reported as being used on a regular basis.

Furthermore, from the total sample of 160 participants, 150 participants provided consent forms as well as completed 24-hour diet recall (Males = 80; Females = 70). The mean weight, height, BMI and age of the 150 participants as well as average daily energy, carbohydrates, protein, and fat intake are shown in Table 1.

Table 1. Characteristics of Al Madinah City participants *n*=150

	Mean ± Standard Deviation
Weight in kilogram	74.4± 17.9
Height in centimeter	175± 13
Age in year	30.4± 8.3
Energy in Calorie	2867± 421.1
Carbohydrates in gram	273.8±55.7

Protein in gram	58.8±7.3
Fat in gram	74.7±14.9
	N (%)
Male	80 (53.3)
Female	90 (46.7)

Regression Results of Effects of Intake of Different Food Items on Total Food Energy Intake

Table 2 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the energy consumption. The regression equation for total food energy intake = 2331.89 + [319.10 × Traditional dishes (gram)] + [545.41 × Pizza (gram)] + [210.24 × Traditional desserts (gram)] + [210.24 × Rusk with nuts (gram)] + [1.38 × Chicken (gram)] + [5.73 × Bread (gram)].

Table 2. Regression Results of Effects of Intake of Different Food Items on Total Food Energy Intake

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2331.89	81.91		28.47	< 0.01
Traditional dishes	319.10	78.19	0.30	4.08	< 0.01
Pizza	545.41	138.24	0.28	3.95	< 0.01
Traditional desserts	517.02	152.69	0.24	3.39	< 0.01
Rusk with nuts	210.24	67.16	0.23	3.13	< 0.01
Chicken	1.38	0.62	0.16	2.24	0.03
Bread	5.73	2.89	0.14	1.98	0.05

n =150

a. Dependent Variable: Total food energy intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Carbohydrate Intake

Table 3 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Carbohydrate consumption. The regression equation for Carbohydrate is = 105.29 + [29.33 × pizza (gram)] + [16.02 × Traditional dishes (gram)] + [1.35 × bread (gram)] + [0.62 × fried food (gram)] + [25.36 × fatayer (gram)] + [6.91× sugar (gram)] + [0.45 × pulses (gram)] + [0.16 × milk (fluid ounce)].

Table 3. Regression Results of Effects of Intake of Different Food Items on Carbohydrate Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	105.29	4.25		24.81	< 0.01
Pizza	29.33	7.37	0.29	3.98	< 0.01
Traditional dishes	16.02	4.20	0.28	3.81	< 0.01
Bread	1.35	0.27	0.62	5.01	< 0.01
Fried food	0.62	0.27	0.27	2.34	0.02
Fatayer	25.36	9.45	0.20	2.69	0.01
Sugar	6.91	3.53	0.14	1.96	0.05
Pulses	0.45	0.19	0.26	2.35	0.02
Milk	0.16	0.07	0.16	2.21	0.03

n =150

a. Dependent Variable: Carbohydrate

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Protein Intake

Table 4 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the protein

consumption. The regression equation for Protein = 320.36 + [27.34 × Rusk with nuts (gram)] + [76.35 × Pizza (gram)] + [33.40 × Traditional dishes (gram)] + [58.60 × Chicken (gram)]

Table 4. Regression Results of Effects of Intake of Different Food Items on Protein

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	320.36	11.72		27.32	< 0.01
Rusk with nuts	27.34	9.75	0.21	2.81	0.01
Pizza	76.35	20.15	0.28	3.79	< 0.01
Traditional dishes	33.40	11.39	0.22	2.93	< 0.01
Chicken	58.60	22.36	0.19	2.62	0.01

n =150

a. Dependent Variable: Protein

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Fat

Table 5 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on total fat consumption. The regression equation for total Fat = 79.06 + [10.84 × Rusk with nuts (gram)] + [22.82 × Pizza (gram)] + [13.82 × Traditional dishes (gram)] + [26.72 × Traditional desserts (gram)]

Table 5. Regression Results of Effects of Intake of Different Food Items on Fat Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	79.06	4.59		17.22	< 0.01
Rusk with nuts	10.84	4.03	0.21	2.69	0.01
Traditional desserts	26.72	9.19	0.22	2.91	< 0.01

Traditional dishes	13.82	4.71	0.23	2.93	< 0.01
Pizza	22.82	8.33	0.21	2.74	0.01

n =150

a. Dependent Variable: Fat Intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Saturated Fat Intake

Table 6 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the saturated fats consumption. The regression equation for Saturated Fat = 28.33 + [4.66 × Rusk with nuts (gram)] + [13.60 × Traditional desserts (gram)]

Table 6. Regression Results of Effects of Intake of Different Food Items on Saturated Fat Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	28.33	1.61		17.65	< 0.01
Traditional desserts	13.60	3.73	0.28	3.65	< 0.01
Rusk with nuts	4.66	1.60	0.22	2.91	< 0.01

n =150

a. Dependent Variable: Saturated Fat Intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Polyunsaturated Fat

Table 7 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Polyunsaturated Fat consumption. The regression equation for polyunsaturated fat

= 3.97 + [2.76 × Traditional dishes (gram)] + [5.78 × Traditional desserts (gram)] + [0.45 × nuts (gram)] + [2.30 × Rusk with nuts (gram)] + [4.54 × Fatayer (gram)].

Table 7. Regression Results of Effects of Intake of Different Food Items on Polyunsaturated Fat Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	3.97	0.65		6.13	< 0.01
Traditional dishes	2.76	0.69	0.28	3.98	< 0.01
Traditional desserts	5.78	1.32	0.29	4.37	< 0.01
Nuts	0.45	0.10	0.33	4.40	< 0.01
Rusk with nuts	2.30	0.59	0.27	3.92	< 0.01
Fatayer	4.54	1.57	0.21	2.90	< 0.01

n =150

a. Dependent Variable: Polyunsaturated Fat Intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Monounsaturated Fat

Table 8 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Monounsaturated Fat consumption. The regression equation for Monounsaturated Fat = 5.74 + [1.93 × Traditional dishes (gram)] + [2.60 × Rusk with nuts (gram)] + [6.62 × Fatayer (gram)] + [4.81 × Traditional desserts (gram)].

Table 8. Regression Results of Effects of Intake of Different Food Items on Monounsaturated Fat Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	5.74	0.74		7.73	< 0.01
Traditional dishes	1.93	0.79	0.19	2.46	0.02
Rusk with nuts	2.60	0.66	0.29	3.95	< 0.01

Fatayer	6.62	1.79	0.28	3.70	< 0.01
Traditional desserts	4.81	1.51	0.23	3.19	< 0.01

n =150

a. Dependent Variable: Monounsaturated Fat Intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Cholesterol Intake

Table 9 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Cholesterol consumption. The regression equation for Cholesterol = 363.30 + [1.94 × Meat (gram)] + [4.85 × Egg (gram)].

Table 9. Regression Results of Effects of Intake of Different Food Items on Cholesterol Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	365.30	17.82		20.51	< 0.01
Meat	1.94	0.63	0.26	3.06	< 0.01
Egg	4.85	2.17	0.18	2.24	0.03

n =150

a. Dependent Variable: Cholesterol Intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Dietary Fiber Intake

Table 10 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Dietary Fiber consumption. The regression equation for Dietary Fiber = 26.30 + [1.95 × Date (gram)] + [3.31 × Rusk with nuts (gram)]

Table 10. Regression Results of Effects of Intake of Different Food Items on Dietary Fiber

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	26.30	1.28		20.55	< 0.01
Dates	1.95	0.35	0.41	5.54	< 0.01
Rusk with nuts	3.31	1.28	0.18	2.58	0.01

n =150

a. Dependent Variable: Dietary Fiber

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Vitamin A Intake

Table 11 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the protein consumption. The regression equation for Vitamin A = 3234.83 + [30.78 × Milk (fluid ounce)] + [2520.80 × Soup (gram)] + [237.14 × Date (gram)].

Table 11. Regression Results of Effects of Intake of Different Food Items on Vitamin A Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	3234.83	354.73		9.12	< 0.01
Milk	30.78	8.26	0.28	3.73	< 0.01
Soup	2520.80	938.26	0.19	2.69	0.01
Dates	237.14	98.17	0.17	2.42	0.02

n =150

a. Dependent Variable: Vitamin A

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta =

Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Vitamin D Intake

Table 12 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Vitamin D consumption. The regression equation for Vitamin D = 24.87 + [29.98 × Traditional desserts (gram)].

Table 12. Regression Results of Effects of Intake of Different Food Items on Vitamin D Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	24.87	5.57		4.46	< 0.01
Traditional desserts	29.98	12.94	0.18	2.32	0.02

n =150

a. Dependent Variable: Vitamin D

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Vitamin E

Table 13 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Vitamin E consumption. The regression equation for Vitamin E = 2.28 + [4.79 × Fatayer (gram)] + [1.70 × Traditional dishes (gram)] + [1.16 × Rusk with nuts (gram)]

Table 13. Regression Results of Effects of Intake of Different Food Items on Vitamin E Intake

Model	Unstandardized Coefficients	Standardized Coefficients	T	Sig.

	B	Std. Error	Beta		
(Constant)	2.28	0.51		4.51	< 0.01
Fatayer	4.79	1.25	0.29	3.84	< 0.01
Traditional dishes	1.70	0.57	0.23	3.01	< 0.01
Rusk with nuts	1.16	0.47	0.18	2.47	0.02

n =150

a. Dependent Variable: Vitamin E

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Vitamin B1

Table 14 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the protein consumption. The regression equation for Vitamin B1 = 0.84 + [0.96 × Fatayer (gram)] + [0.39 × Traditional desserts (gram)] + [0.15 × Rusk with nuts (gram)] – [0.16 × Traditional dishes (gram)].

Table 14. Regression Results of Effects of Intake of Different Food Items on Vitamin B1 Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0.84	0.06		14.27	< 0.01
Fatayer	0.96	0.14	0.52	6.70	< 0.01
Traditional desserts	0.39	0.12	0.23	3.20	< 0.01
Rusk with nuts	0.15	0.05	0.21	2.86	0.01
Traditional dishes	-0.16	0.06	-0.20	-2.58	0.01

n =150

a. Dependent Variable: Vitamin B1

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Vitamin B2 Intake

Table 15 summarizes the Stepwise multiple regression analysis conducted to

determine the effects of consuming 30 different types of food on the Vitamin B2 consumption. The regression equation for Vitamin B2 = 0.06 + [0.66 × Fatayer (gram)] + [0.47 × Traditional desserts (gram)] + [0.20 × Rusk with nuts (gram)] + + [0.40 × Cereal (gram)] + [0.004 × Cheese (gram)] + [0.002 × Milk (fluid ounce)].

Table 15. Regression Results of Effects of Intake of Different Food Items on Vitamin B2 Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	0.66	0.06		10.35	< 0.01
Fatayer	0.66	0.14	0.34	4.65	< 0.01
Traditional desserts	0.47	0.13	0.26	3.69	< 0.01
Rusk with nuts	0.20	0.06	0.27	3.71	< 0.01
Cereal	0.40	0.13	0.22	3.05	< 0.01
Cheese	0.004	0.00	0.18	2.61	0.01
Milk	0.002	0.00	0.15	1.99	0.05

n =150

a. Dependent Variable: Vitamin B2

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Folate Intake

Table 16 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the folate consumption. The regression equation for Folate = 160.92 + [87.45 × Cereal (gram)] + [87.60 × Fatayer (gram)] + [67.61 × Traditional desserts(gram)]

Table 16. Regression Results of Effects of Intake of Different Food Items on Folate Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	160.92	10.60		15.18	< 0.01
Cereal	87.45	24.29	0.27	3.60	< 0.01
Fatayer	87.60	25.99	0.26	3.37	< 0.01
Traditional desserts	67.61	23.19	0.22	2.92	< 0.01

n =150

a. Dependent Variable: Folate Intake

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Vitamin C Intake

Table 17 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the Vitamin C consumption. The regression equation for Vitamin C = 66.19 + [0.21 ×Beverages (fluid ounce)].

Table 17. Regression Results of Effects of Intake of Different Food Items on Vitamin C Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	66.19	4.70		14.08	< 0.01
Beverages	0.21	0.07	0.26	3.28	< 0.01

n =150

a. Dependent Variable: Vitamin C

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Calcium Intake

Table 18 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the calcium consumption. The regression equation for Calcium = 1024.53 + [419.64 × Pizza (gram)] + [167.42 × milk (fluid ounce)].

Table 18. Regression Results of Effects of Intake of Different Food Items on Calcium Intake

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
	(Constant)	1024.53	72.63		14.11	< 0.01
	Pizza	419.64	150.06	0.21	2.80	0.01
	Milk	167.42	72.30	0.18	2.32	0.02

n =150

a. Dependent Variable: Calcium

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Magnesium Intake

Table 19 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the magnesium consumption. The regression equation for Magnesium = 94.55 + [1.07 × nuts (gram)] + [44.21 × Soup (fluid ounce)].

Table 19. Regression Results of Effects of Intake of Different Food Items on Magnesium Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	94.55	7.61		12.42	< 0.01
Nuts	1.07	0.48	0.18	2.25	0.03
Soup	44.21	21.45	0.17	2.06	0.04

n =150

a. Dependent Variable: Magnesium

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Potassium

Table 20 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the protein consumption. The regression equation for Potassium = 1046.53 + [133.76 × Date (gram)].

Table 20. Regression Results of Effects of Intake of Different Food Items on Potassium Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	1046.53	59.39		17.62	< 0.01
Date	133.76	16.82	0.52	7.95	< 0.01

n =150

a. Dependent Variable: Potassium

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Sodium

Table 21 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the sodium

consumption. The regression equation for Sodium = 5682.95 + [1463.92 × Traditional dishes (gram)] + [153.11 × Falafel (gram)] + [15.80 × Pasta (gram)].

Table 21. Regression Results of Effects of Intake of Different Food Items on Sodium Intake

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	5682.95	249.29		22.80	< 0.01
Traditional dishes	1463.92	287.02	0.38	5.10	< 0.01
Falafel	153.11	51.33	0.22	2.98	< 0.01
Pasta	15.80	6.39	0.18	2.47	0.02

n =150

a. Dependent Variable: Sodium

Std. Error = Standard error, B = Unstandardized regression coefficient, Beta = Standardized regression coefficients, t = t-statistic

Regression Results of Effects of Intake of Different Food Items on Phosphorus Intake

Table 22 summarizes the Stepwise multiple regression analysis conducted to determine the effects of consuming 30 different types of food on the phosphorus consumption. The regression equation for Phosphorus = 388.91 + [6.43 × Cheese (gram)] + [80.21 × Rusk with nuts (gram)] + [188.47 × Fatayer (gram)].

Table 22. Regression Results of Effects of Intake of Different Food Items on Phosphorus Intake

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	388.91	33.21		11.71	< 0.01
Cheese	6.43	1.07	0.46	6.00	< 0.01
Rusk with nuts	80.21	33.05	0.17	2.43	0.02
Fatayer	188.47	86.26	0.16	2.19	0.03

n =150

a. Dependent Variable: Phosphorus

Summary of Results

The following are the summarized results of the regression analyses:

- Intake of Traditional dishes, pizza, Traditional desserts, rusk with nuts, chicken, and bread have significant effects on the consumption of total food energy intake.
- Intake of pizza, Traditional dishes, bread, fried food, fatayer, sugar, pulses, and milk have significant effects on the consumption of carbohydrates.
- Intakes of rusk with nuts, pizza, Traditional dishes, and chicken have significant effects on the consumption of protein.
- Intakes of rusk with nuts, Traditional desserts, Traditional dishes, and pizza have significant effects on the consumption of fats.
- Intakes of Traditional desserts and rusk with nuts have significant effects on the consumption of saturated fats.
- Intakes of Traditional dishes, Traditional desserts, nuts, rusk with

nuts, and fatayer, have significant effects on the consumption of polyunsaturated fats.

- Intakes of Traditional dishes, rusk with nuts, fatayer, and Traditional desserts, have significant effects on the consumption of monounsaturated fats.
- Intakes of meat and egg have significant effects on the consumption of cholesterol.
- Intakes of date and rusk with nuts have significant effects on the consumption of dietary fibers.
- Intakes of milk, soup, and date have significant effects on the consumption of Vitamin A.
- Intakes of Traditional desserts have significant effects on the consumption of Vitamin D.
- Intakes of fatayer, Traditional dishes, and rusk with nuts have significant effects on the consumption of Vitamin E.
- Intakes of fatayer, Traditional desserts, rusk with nuts, and Traditional dishes have significant effects on the consumption of Vitamin B1.
- Intakes of fatayer, Traditional desserts, rusk with nuts, cereal, cheese, and milk have significant effects on the consumption of Vitamin B2.
- Intakes of cereal, fatayer, and Traditional desserts, have significant effects on the consumption of folate.
- Intake of beverages have significant effects on the consumption of

Vitamin C

- Intakes of pizza and milk have significant effects on the consumption of calcium.
- Intakes of nuts and soup have significant effects on the consumption of magnesium.
- Intakes of dates have significant effects on the consumption of potassium.
- Intakes of Traditional dishes, falafel, and pasta have significant effects on the consumption of sodium.
- Intakes of cheese, rusk with nuts, and fatayer have significant effects on the consumption of phosphorus.

The SFFQ formatted

The new SFFQ was constructed in the same format of the Harvard FFQ (17) and organized according to well recognized food groups into seven food categories: 1. Milk (whole, low-fat, and fat-free), 2. Vegetables, 3. Fruits, 4. Meat and eggs, 5. Breads, cereal and grain products, 6. Beverages (including juices and drinks), 7. Sweet, baked goods and nuts.

There were 6 options to report the intake frequencies in the new SFFQ: First; None (no intake); second, one time only in a month; third, one time only every two weeks; fourth, less than three times in one week; fifth, three to six times in one week; finally, more than six times per week. The reference period for the SFFQ was one month **(Appendix C)**.

Portion size and food intake frequency

In fact, in Saudi Arabia there is no specific guideline in terms of food portion size information. Thus, participants were asked to recall their food in the 24-hour recall forms using household measurements. The 24-hour recall forms have information about how to measure food portion sizes. A pictorial serving guide (e.g., 1 oz (ounce) = thumb) was included as well to quantify the food eaten. Therefore, in the new SFFQ, reference portion sizes were defined based on the most frequently reported portions in the 24-hour dietary calls. Otherwise, standardized portion sizes were estimated using Food Portion Sizes (18).

The use of standardized portions in the FFQ approach, however, is somewhat controversial. A review by Cade et al. showed that portion sizes in FFQs in general are inadequately estimated and do not contribute significantly to the between-person variations in dietary intakes. Yet, portion size measurements in FFQs will support the ranking of individuals in terms of their dietary intakes. In this review, 36% of the FFQs studied asked respondents to describe portion sizes, 42% provided standardized portions, and the remaining 22% did not have information about portion sizes (19). Portion sizes in FFQs should be adequate to the study population in order to avoid underestimating or overestimating intake (2). In this study, we included the most frequently reported portions in the 24-hour dietary calls in the SFFQ.

To estimate nutrient intake from the new SFFQ, Food Processor Plus computer program software database (9) and food composition tables for Saudi populations (8), were used to assign nutrient values to the foods. To calculate the

nutrient intake, the food portion was multiplied by the nutrient value for that portion found in the database. This approach matches similar approaches that have been performed in other studies (14, 15).

Pre-testing

Nutritionists in Saudi Arabia reviewed the new SFFQ to check the face validity (20). In terms of the new SFFQ, the nutritionists reviewed the new SFFQ and included any foods missing that were high sources of energy or macro-micro nutrients or ethnic-specific local Saudi foods, as well as to check the appropriateness of portion sizes. Thus, fruits and vegetables were added because they are important sources of many vitamins and minerals. Also, seafood as well as oil, butters and sweets were added. After these adjustments, the nutritionists concluded that the new SFFQ was complete.

The new SFFQ was pre-tested in the field to ensure that it was acceptable and understandable. A cognitive interviewing technique in the form of verbal probes viewing was used to pinpoint problems in design and comprehension of the questionnaire (21). Despite more than two decades of practicing cognitive interviewing, experts have little empirical or theoretical guidance to determine a sample size for cognitive interviewing. (22), after discussion with an expert in survey methodology, 6 participants (3 males and 3 females) were chosen to participate in the cognitive interviews. Participants were asked to answer a single question and then immediately asked about recall process or confidence judgment; for example: Last month, how many times did he/she drink one cup of low fat milk?. Recall probe: How do you remember that you drink a cup of milk twice a

week? Confidence judgment: How sure are you that the milk you drink was low-fat milk? Most participants were able to answer the questionnaire within the specified time frame of the past month.

Food items included in SFFQ

Whole milk	Potato	Fried Chicken	Fatayer with Zatar
Low fat milk	Broccoli	Chicken Shawarma	Fatayer with vegetables
Whole buttermilk	Carrot	Chicken soup	Kubbah
Low fat buttermilk	Pepper	Chicken salad	Whight soup
Yogurt	Cucumber	Mutabak	Zalibah
Whole-fat Yogurt	Eggplant	Fish	Water
Low-fat Yogurt	Thyme	Tuna	Black tea
MuhalibahArabic pudding	Lettuce	Shrimp	Green tea
Ice cream or milkshake	Mushrooms	Crawfish	Arabic coffee
Dairy cream	Bean	Corn flakes	American Coffee
White cheese	Onion	Bread Naan	Orange Juice
Cream cheese	Squash	Pita, whole wheat	Apple Juice
Slice cheese	Cabbage	Pita, white	Lemon juice
Cheddar cheese	Molokiah	Roti	Mango Juice
Samosa cheese	Corn	Whole wheat slice	Guava Juice
Yogurt Salad	Chickpeas	White slice	Mixed juice
Cheese sandwich	Spinach	Croissant	Soda, Coca-Cola
Cheese sandwich & egg	Fresh salad	Pancake	Soda, Sprite
Apple	Fruit salad	Waffle	Soda Miranda
Banana	Mixed vegetables	Muffin	Chocolates (snickers)
Fig	Fava	Rusk toast	Cookies
Grapes	Okra	Rice	Honey& Jam
Oranges	Stuffed grape leaves	Chicken Kabsa	Doughnuts
Mandarin	Muhashi (stuffed vegetables)	Meat Kabsa	Popcorn
Mango	Tosat with vegetable	Rice with vegetables	Cheesecake
Lemon	Vegetables soup	Rice Bukuri	Pie, apple
Guava	Mixed vegetables	Rice kably	Bas Bosa
Pineapple	Egg	Salige	Kunafa
Resin	Meat (beef, lamb, hotdog)	Kushari	Masoop
Apricots	Ground beef, meat balls	Jurish	Shirah with milk
Olives black	Beef liver	Pasta white sauce	Chips
Fresh dates	Cheeseburger	Meat pasta	Nuts
Dry dates	Meat Shawarma	Chicken pasta	Cake
Fruit juice	Kababo	Pizza	Canola oil
Guava Juice	Chicken grilled	Fatayer with cheese	Butter
Fruit salad	Chicken rotisserie	Fatayer with chicken	Olives oil
Tomato or tomato juice	Chicken boiled	Fatayer with meat	Ghee
Arugula	Chicken masala	Fatayer with labanh	

Discussion

Large numbers of FFQs have been adapted to different populations from existing questionnaires originally devised for use in the United States of America (19). For instance, Tayyem et al., (23) modified a version of the Diet History Questionnaire (24) to be used in Jordanian population. The Diet History Questionnaire was developed by the National Cancer Institute of the United States of America to estimate food intake of the American population. However, United States questionnaires cannot be used in Arab Gulf countries, including Saudi Arabia, because dietary patterns differ significantly and Arab people living in Gulf countries consume a unique diet (25). This diet consists of both Traditional Arab foods and commercial foods, which import from different countries around the world, (26). For this reason, Dehghan et al. developed a culture-specific FFQ for the Arab population in the United Arab Emirates (UAE) and Kuwait by using 24-hour dietary recall collated from 126 participants (27). Saudi Arabian dietary patterns are different from other countries and between regions within Saudi Arabia. In fact, Saudi Arabia has experienced significant socioeconomic development during the last two decades that has led to changes in lifestyle including dietary patterns. In the past, the diet consisted of dates, milk, whole wheat bread, vegetables, and fruit. However, during the past two decades, Saudis adapted the Western diet, with an excess intake of high-energy foods rich in fat. Thus, dietary patterns in Saudi Arabia are a mix of Traditional and Western diets (28). Hence, the new SFFQ was developed using existing data from a nationally representative sample (8) as well as data collected from 24-hours dietary recalls.

The results of this study suggested that including Traditional dishes, pizza, Traditional desserts, rusk with nuts, chicken, and bread items in the SFFQ will adequately predict energy intake. In fact, Traditional Saudi foods are unique and can be sweet or salty depending on the ingredients. Traditional dishes, such as Kabsa, Juraish, Margoog, Salig, Chicken Shawarma, Meat Shawarma, Grape Leaves, Mutabak, Tosat with Vegetable, and Muhashi are classified as salty foods in this study by registered dietitian. These traditional dishes are made mainly from rice or flour, white or red meat and, vegetables such as tomato, pepper, onion, garlic, as well as parsley, eggs. For example, Kabsa is made of rice, vegetables, and meat. Moreover, Fatayer is a pie made from flour, butter or oil, egg and milk. It can be stuffed with meat, chicken, vegetable, or cheese.

Traditional desserts, classified as sweet foods, include Basbousa, Kunafa, Baklawo, Masoop, Pudding, rice, Arikah, and Assedah. Traditional desserts consist of bread, dough, phyllo pastry or semolina, sugar, butter, milk, cream, eggs and nuts. So, these foods have many components from variety food groups. Hence they are mixed dishs. Furthermore, such items contribute several nutrients as well as energy to the dietary intake of Western Saudi Arabia.

Also, in terms of rusk with nuts, Musaigar (29) found that numerous kinds of nuts are consumed in the Arabian Gulf countries including Saudi Arabia, such as walnuts, almonds, and hazelnuts. Also, nuts can be combined with other foods such as rusk. Moreover, nuts, contribute significantly to energy intake because of their high content of fat. Also, Craig (30) indicates that nuts are a good resource of energy, magnesium, potassium, vitamins, and unsaturated fatty acids.

Moreover, the results of this study suggested that intake of rusk with nuts, and Traditional desserts items will adequately predict consumption of saturated fats.

The results of this study suggested that including dates and rusk with nuts in the SFFQ will adequately predict consumption of dietary fiber. In fact, in Saudi Arabia, date consumption per capita is highest in the world (31). Furthermore, dates have 15 grams of fiber in only 100 grams (9). So, dates are a significant source of dietary fibers in the Saudi Arabian dietary intake. Vegetables and fruit are consumed in amounts too low to contribute significantly to dietary fiber intake.

As mentioned above, Traditional desserts are made mainly from, dough, phyllo pastry or semolina, sugar, butter, milk, cream, and nuts. In fact, milk and its products are fortified with vitamin D in Saudi Arabia. This might be the reason why Traditional desserts contribute to vitamin D consumption. However, milk consumption in the 24-hours recalls collected in this study were low compared to Traditional desserts consumptions. Thus, this might be a reason why milk is not predictor of vitamin D consumption. In other words, milk intake by itself was consumed in such low amounts that there was insufficient power to detect milk by itself as a predictor of Vitamin D.

Beverages were likely predictors of Vitamin C because fruits juices were included in the beverage category. In fact, one study conducted in 2006 in Saudi Arabia, found that fruit drinks as well as carbonated beverages represented 26% of the adult Saudi diet, and 25% of the daily fluid consumed by adolescents. On the other hand, fruit and vegetable consumption was low in the collected 24-hour

recall, and thus they were not significant predictors of Vitamin C intake. In fact, consumption of fruits and vegetables by people in Arab Gulf countries is lower than the recommended allowances. More than 85% of adults in Arab Gulf countries including Saudi Arabia consumed fewer than five servings of fruit and vegetables per day according to WHO report (29).

Pizza and milk as items in the SFFQ will adequately predict consumption of calcium. All kind of pizzas contain cheese. Musaiger reported that people in the Arab Gulf countries including Saudi Arabia have increased fast foods and convenience foods consumption well as eating ready-made meals such as pizzas outside of their homes (32).

Including soup and nuts in the SFFQ will adequately predict magnesium consumption. Saudi soup, made of whole grains, tomato, dark leafy greens, yogurt, and whole grains is high in magnesium. Thus, this might be the reason why soup contributes to magnesium consumption.

Moreover, intake of cereal, fatayer (which have vegetables), and Traditional desserts, will adequately predict consumption of folate. Low vegetable intake likely resulted in insufficient power to contribute to folate consumption.

Dates in the SFFQ will adequately predict consumption of potassium. Also, low intakes of fruits, vegetables, and milk in the Saudi diet might be a reason why these items do contribute significantly to potassium consumption.

Low intake of seafood especially in a non-coastal city such as Madinah might be a reason why seafood did not adequately predict phosphorus consumption. However, experts recommended including seafood in the new SFFQ,

because, in general, seafood is good source of protein, vitamins and minerals.

The Arabic SFFQ created in this project has 152 items, which is consistent with other FFQs that ranged from 5-350 items, mean of 88 (19). Most FFQs have between 100 and 150 food items. In the Gulf countries, there are two FFQs. One was developed for the United Arab Emirates population, which has 153 food items, and the other one was developed for use in Al Kuwait. Kuwait's FFQ has 152 food items. In fact, these FFQs have been developed based on the most commonly reported foods and portion sizes in 24-hour recalls, without any further analysis as shown in the population study (27). In the Dehghan study, a long food list was constructed and converted to SFFQ format. The SFFQ was then field-tested to reduce the long food list. However, in this new Saudi SFFQ, stepwise regression analysis was used to construct the food list.

In general, it has been suggested by Willett that increasing the length of the food list decreases the accuracy (2). Furthermore, it has been indicated in many studies that increasing the number of foods in the FFQ can increase food intakes reporting (33). Not only is the newly created SFFQ appropriate in length, but it also has been designed to be culturally appropriate for the western region of Saudi Arabia by including Traditional food items commonly consumed in this region.

This study has some limitations. The choices of frequency were not mutually exclusive which would have resulted in errors. However, errors in the choices of frequency will be avoided in the future study. So, for the next version of the SFFQ, frequency categories will be as follows: Never or rarely, 1-3 times a month, 1-2 times per week, 3 to 6 times per week, every day.

Also, the pattern of eating food in Saudi Arabia can be described in two ways: Traditional and modern. These two patterns vary between families. Some Traditional families eat from a variety of foods that are served on common platters that are shared. Modern families eat from separate plates for each individual. On the other hand, some families have a mixed pattern: they eat from a variety of foods that may be served on common plates such as rice or on separate plates. Thus, in this study, reported portion sizes may have over or underestimated the portion size in 24-hour food recall. Another limitation is that the 24-hour recall was self-administered rather than administered by an interviewer. Since the sample was collected from a general population, the participants were asked if they were able to read and write in the Arabic language, without further questions about their education level. Even though the participants received instruction about how to fill out the 24-hour recalls, more reporting errors were found due to the unknown educational levels. However, compared to face-to-face interviews, a self-administered instrument would be briefer and cost effective. Moreover, respondents answered the forms at their convenience. Face-to-face interviews can be biased because of the presence of the interviewer (34,35). In this study, the choice of administration was dependent on cost, convenience, and time frame.

A nutrition expert in Saudi Arabia reviewed and checked the SFFQ to ensure it was understandable, complete and to ensure all frequency categories were included in the SFFQ. However, the new SFFQ needs to be validated in the general population as well as to test its reproducibility.

Conclusion

This study highlights the development of an SFFQ for the Saudi Arabian population in the western region. The 152 food items in the new SFFQ provide an up-to-date tool for assessing dietary intake, which will be an asset for researchers in future epidemiological studies in this region. However, the validity and reproducibility of this SFFQ needs to be determined. So, more research is needed to further validate this SFFQ. Moreover, future research is needed to develop the FFQ for the use in other population groups such as children, adolescents, pregnant women, and elderly people.

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Chapter 5: Results

PAPER II: Validation of a New Semi-Quantitative Food Frequency Questionnaire to Measure Macro-Micro Nutrients Intake for Saudi Population in the Western Region of Saudi Arabia.

Abstract

Background: Valid tools are necessary to measure dietary intake in a sample. Unreliable tools lead to biased outcomes. The validation of a new Semi-Quantitative Food Frequency Questionnaire (SFFQ) is essential because incorrect information may lead to biased associations in epidemiological studies. The objective of this study was to examine the relative validity of the new SFFQ developed for use in the Western Region of Saudi Arabia. *Methods:* A cross-sectional study was conducted in the Western Region of Saudi Arabia. Data from the new Arabic SFFQ and 24-hour recalls were collected from a sample of 100 healthy participants (aged 18 to 75 years). Validity was examined via Spearman's rank correlation coefficient, cross-classification method and bland-Altman plots. *Results:* Spearman's rank correlation coefficient between the new SFFQ and 24-hour recall ranged from 0.2 for Vitamin D to 0.7 for energy. Correlation coefficients were statistically significant for energy, fat, polyunsaturated fat, monounsaturated fat and Vitamin D ($p \leq 0.05$) for all 100 participants. However, in normal weight group the correlation coefficients were statistically significant only for energy ($p \leq 0.01$). On the other hand, in the overweight group, the correlation coefficients were statistically significant for energy, vitamin D, fat,

polyunsaturated fat, and monounsaturated fat, ($p \leq 0.01$), as well as for calcium and phosphorus ($p \leq 0.05$).

Cross-classification analysis revealed that the average proportions of participants classified into the same or adjacent quartiles, one quartile part, and those misclassified were 72.2 %, 20.4%, and 7.4 %, respectively. *Conclusions:* This study indicates the need for continued development and validation of this new Arabic SFFQ.

Introduction

Dietary patterns are critical determinants of lifestyle. They play a central role in the prevention and treatment of number of clinical conditions, particularly metabolic diseases such as diabetes (1). A variety of methods are available to assess dietary intake including Food Frequency Questionnaires (FFQs). The Semi-quantitative FFQ (SFFQ) is an FFQ that collects portion size information (2).

The FFQ is an important tool for use in epidemiological studies to examine associations between diet and chronic non-communicable diseases. An FFQ is useful because of its uncomplicated administration and relative effectiveness in measuring usual consumption of nutrients in large populations. Also, food consumption can be evaluated prospectively over a long period of time, such as one year, with low costs. In addition, a FFQ can be self-administered (2). However, food intake is difficult to assess, due to measurement errors and the difficulty of estimating portion size. It is crucial to identify the association between food intake reported by FFQ and other more accurate food intake measurement methods (3). Thus, FFQs must be validated. To validate FFQ, the FFQ results

should be compared to the results of another dietary assessment tools such as 24-hour recalls results. Additionally, FFQs should be validated for specific populations because dietary habits vary greatly according to ethnic, social, and cultural features within and between populations.

Most FFQ validation studies involve diet records or 24-hour recalls (75%), although biomarkers such as serum folates (19%) and doubly labeled water (6%) are also used as the gold standard (4).

In this study, the aim was to address whether the new Arabic Saudi Semi-quantitative FFQ (Aljohani and Lei., 2016) was valid in the general adult population in comparison to a 24-hour dietary recall. The 24-hour recall is the one of the most widely used validation methods in the literature. The number of 24-hour recalls used to validate FFQs varies from 1 to 28 days with a mode of one day (4). Multiple-day 24-hour recalls require highly motivated participants, especially in Saudi Arabia population. They are also expensive to administer and are time consuming. For these reasons, one 24-hour recall was used in this study.

Methods

A total of 100 healthy subjects, between 18 and 74 years of age, were included in this study. None of the participants had any significant medical problems nor were they taking any medication. The participants were selected from general hospital outpatient clinics in Al Madinah City by using a systematic sampling. In brief, every fifth attending visitor who fulfilled the inclusion criteria was then invited to participate until the required 100-sample size was achieved. If a selected subject did not meet the study criteria or refused to participate, the

selection then continued. Screening interviews were performed to determine whether each potential subject fulfilled inclusion or exclusion criteria. All participants were asked to fill out the consent form, the 24-hour recall **(Appendix A)** and the new SFFQ **(Appendix C)** in Arabic.

Nutritional Analysis

Dietary intake obtained from the 24-hour recalls were analyzed for nutrient content using the Food Processor Plus computer program software (5). For foods that were not in the software, food composition tables for Saudi populations (6) were used. This approach has been used in the Saudi Arabia population in many studies (7, 8, 9), as well as in Arabian countries such as Jordan (10). An Excel spreadsheet was created to measure nutrient intake from the new SFFQ, using the foods found in the new SFFQ, nutrients from the Saudi composition table, and nutrients from the United States Department of Agriculture nutrient database (11).

Statistical analysis

The newly created Saudi SFFQ and the 24-hour recall results were compared using the Wilcoxon Signed-Rank test for the following 21 response variables: Energy, Carbohydrates, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Magnesium, Phosphorus, Potassium, and Sodium. The two methods (SFFQ and 24-hour recall) were compared in terms of their ability to assess individual nutrient intake correctly by calculating how many participants classified in the same, adjacent, or in opposite quartiles. This method has been used in many studies (12, 13, 14, 15). For each nutrient, the distributions of SFFQ and 24-hour recall results

were divided into quartiles. Participants' results were then cross-classified in the SFFQ and 24-hour recall categories. Cohen's kappa coefficient was calculated to assess agreement between quartile classifications. Spearman's correlation coefficient was used to determine the strength of the relationship between the new Saudi SFFQ and the 24-hour recall for each nutrient assessed. To examine the bias between the administrations of new SFFQ and the 24-hour recall, Bland–Altman plots were used. Spearman's correlation coefficient was used to compare the validity of the new SFFQ between normal weight (BMI < 25 kg/m^2) and overweight (BMI ≥ 25 kg/m^2) groups. All the study tests were two-tailed. The statistical significance was considered at $P \leq 0.05$.

Results

The total number of participants in the validation study was 100. Prior to analysis, data was screened for normality and outliers. Histograms of nutrients assessed using SFFQs and 24-hour recalls (42 variables in total) were examined in order to determine if there were outliers. Normality of the 42 variables was examined using Shapiro-Wilk tests. The results suggest that 21 variables were not normally distributed ($P \leq 0.05$) **(Table 1)**. Thus, nonparametric tests were used in this study. No outliers were observed.

Table 1. Results (p-values) of the Shapiro-Wilk normality tests

Variable	SFFQ	24-hour recall
Energy (kcal)	0.68	0.40
Protein (g)	0.65	0.07
Carbohydrate (g)	0.33	0.60
Fat (g)	0.01*	0.28
Saturated Fat (g)	0.05	0.29
Polyunsaturated Fat (g)	0.02*	0.00*
Monounsaturated Fat (g)	0.19	0.00*

Cholesterol (mg)	0.09	0.00*
Dietary Fiber (g)	0.12	0.00*
Vitamin A (IU)	0.00*	0.00*
Vitamin D (IU)	0.00*	0.00*
Vitamin B1 (mg)	0.15	0.00*
Vitamin B2 (mg)	0.07	0.00*
Vitamin C (mg)	0.00*	0.00*
Calcium (mg)	0.00*	0.00*
Magnesium (mg)	0.07	0.00*
Potassium (mg)	0.05	0.00*
Sodium (mg)	0.74	0.07
Phosphorus (mg)	0.20	0.00*
Vitamin E (IU)	0.00*	0.00*

* Indicates significance at $P \leq 0.05$.

Half of the participants were female, about 60% of the participants were moderately active, slightly over half of the participants had normal weight and 47% of the participants were overweight **(Table 2)**. Also, the descriptive statistics of height, weight, age, and BMI for the participants are presented in Table 2

Table 2. Descriptive statistics of 100 Saudi Adults

		Percentage
Gender	Female	51%
	Male	49%
Physical activity	Lightly active	7%
	Moderately active	63%
	Very active	30%
BMI	Normal (BMI < 25)	53%
	Overweight (BMI ≥ 25)	47%
	Mean	**SD**
Height (centimeter)	160	13
Weight (kilogram)	68.3 (15.7)	15.7
Age (year)	32.0 (10.8)	5.8
BMI	25.2 (4.9)	3.9

SD = Standard Deviation

As most of the data were not normally distributed, Wilcoxon signed-rank tests were used to determine if there was a statistically significant difference in each nutrient between the new SFFQs and 24-hour recall. The results of Wilcoxon signed-rank tests suggested that there was a statistically significant difference

between the two dietary assessment methods in every one of the response variables, including, Energy, Carbohydrates, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium **(Table 3)**.

Table 3. Descriptive statistics of nutrients by Method*

Nutrient	SFFQ		24-hour recall	
	Mean (SD)	Median	Mean (SD)	Median
Energy (Cal)	3666.6 (850.3)	3673.4	2204.9 (514.6)	2278.5
Protein (g)	148.2 (39.6)	145.1	86.5 (24.1)	84.5
Carbohydrate (g)	510.5 (130.9)	497.2	316.7 (78.1)	322.9
Fat (g)	125.7 (35.1)	127.0	71.9 (27.4)	69.9
Saturated Fat (g)	44.6 (12.8)	44.2	23.8 (10.4)	23.8
Polyunsaturated Fat (g)	14.4 (6.2)	14.1	7.4 (8.4)	3.8
Monounsaturated Fat (g)	17.5 (5.6)	16.8	7.0 (6.6)	5.4
Cholesterol (mg)	450.7 (146.6)	451.4	264.1 (190.1)	218.3
Dietary Fiber (g)	48.8 (16.4)	47.1	26.7 (11.7)	23.1
Vitamin A (IU)	17446.4(8926.3)	16007.1	2943.8 (4083.1)	1894.5
Vitamin D (IU)	72.7 (51.1)	54.7	29.1 (43.2)	9.2
Vitamin B1 (mg)	1.5 (0.6)	1.5	0.8 (0.7)	0.6
Vitamin B2 (mg)	1.7 (0.7)	1.7	0.8 (0.6)	0.6
Folate (mcg)	354.0 (122.43)	356.4	183.2 (106.49)	158.6
Vitamin C (mg)	194.9 (87.41)	179.7	61.6 (51.79)	39.8
Calcium (mg)	1604.8 (487.67)	1512.3	777.3 (372.63)	693.6
Magnesium (mg)	191.3 (62.94)	186.0	79.8 (49.71)	70.1
Potassium (mg)	2459.0 (904.93)	2314.9	1112.6 (593.52)	1019.9
Sodium (mg)	6761.7 (2106.04)	6745.0	5339.8 (2047.19)	5194.7
Phosphorus (mg)	849.2 (266.34)	830.1	373.6 (235.03)	313.2
Vitamin E (IU)	8.1 (4.14)	7.0	2.9 (3.86)	1.3

* Wilcoxon signed-rank test indicated all values are significantly different between the two methods $p<0.01$

Table 4 shows the percentage for cross-classification of participants into quartiles estimated from SFFQs and 24-hour recalls, as well as the results of the kappa statistics. Classification of subjects into the same quartiles ranged from 23% (Folate and Calcium) to 54% (Energy), adjacent quartiles ranged from 30%

(Vitamin A) to 47% (Sodium), one quartile apart ranged from 10% (Energy) to 28% (Folate), while misclassified individuals varied from 3% (Energy, Fat) to 12% (Vitamin A). For weighted Kappa, energy, Protein, carbohydrate, fat, polyunsaturated, fat, monounsaturated fat, vitamin C and Phosphorus had a fair agreement (κ = 0.4 - 0.2), and other nutrients had kappa coefficients < 0.20, corresponding to slight agreement according to (16).

Table 4. The percentage of participants classified into quartiles estimated from SFFQs and 24-hour recalls

Nutrient	Same quartile (%)	Adjacent quartile (%)	One quartile apart (%)	Grossly misclassified (%)	Kappa statistic
Energy (Cal)	54	33	10	3	0.4 (0.00)*
Protein (g)	35	40	19	6	0.2 (0.02)*
Carbohydrate (g)	47	37	11	5	0.2 (0.00)*
Fat (g)	47	37	13	3	0.3 (0.00)*
Saturated Fat (g)	32	41	22	5	0.1 (NS)
Polyunsaturated Fat (g)	41	31	22	6	0.3 (0.00)*
Monounsaturated Fat (g)	42	36	16	6	0.3 (0.00)*
Cholesterol (mg)	28	39	22	11	0.1 (NS)
Dietary Fiber (g)	30	35	26	9	0.1 (NS)
Vitamin A (IU)	38	30	20	12	0.2 (0.00)*
Vitamin D (IU)	29	41	21	9	0.1 (NS)
Vitamin B1 (mg)	29	37	23	11	0.1 (NS)
Vitamin B2 (mg)	27	37	26	10	0.1 (NS)
Folate (mcg)	23	43	28	6	0.1 (NS)
Vitamin C (mg)	40	34	16	10	0.2 (0.00)*
Calcium (mg)	23	46	21	10	0.1 (NS)
Magnesium (mg)	32	38	22	8	0.1 (NS)
Potassium (mg)	27	39	27	7	0.1 (NS)
Sodium (mg)	27	47	19	7	0.1 (NS)
Phosphorus (mg)	34	37	22	7	0.2 (0.03)*
Vitamin E (IU)	29	42	23	6	0.01(NS)

Numbers in parentheses are p-values. * Indicates significance at $P \leq 0.05$.
NS = Non-Significant

The criterion validity of the new SFFQ was assessed by comparing the intake of each nutrient estimated from the SFFQs with that estimated from the 24-

hour recall using the Spearman's rank correlation coefficient. The validity of the new SFFQ was also compared between the two groups of subjects, normal weight (BMI < 25 kg/ m^2) and overweight (BMI ≥ 25 kg/ m^2) groups. Table 5 shows the Spearman's rank correlation coefficient of nutrients between SFFQs and 24-hour recalls, overall and by weight. For all subjects combined, energy and 4 nutrients out of 20 had statistically significant correlations, ranging from 0.2 (Vitamin D) to 0.7 (Energy), for the overweight group, energy and 6 nutrients out of 20 had statistically significant correlations, ranging from 0.3 (Calcium) to 0.7 (Energy).

Table 5. Spearman's rank correlation coefficient of nutrients between SFFQs and 24-hour recalls, overall and by weight

Nutrient	Overall (N = 100)	Normal weight (N = 53)	Overweight (N = 47)
Energy (cal)	0.7**	0.6**	0.7**
Protein (g)	-0.1	-0.1	-0.1
Carbohydrate (g)	0.3	0.2	0.2
Fat (g)	0.3*	0.1	0.4**
Saturated Fat (g)	0.2	-0.1	0.1
Polyunsaturated Fat (g)	0.3*	0.1	0.4**
Monounsaturated Fat (g)	0.4**	0.3	0.6**
Cholesterol (mg)	-0.1	-0.2	-0.1
Dietary Fiber (g)	0.1	0.1	0.1
Vitamin A (IU)	0.1	0.1	0.2
Vitamin D (IU)	0.2*	0.3	0.2
Vitamin B1 (mg)	0.1	0.1	0.1
Vitamin B2 (mg)	0.1	-0.1	0.3
Folate (mcg)	0.1	0.3	-0.1
Vitamin C (mg)	0.2	0.2	0.3
Calcium (mg)	0.2	0.1	0.3*
Magnesium (mg)	0.1	0.3	-0.1
Potassium (mg)	0.1	0.1	0.1
Sodium (mg)	0.1	0.1	0.2
Phosphorus (mg)	0.2	0.1	0.4*
Vitamin E (IU)	0.1	0.2	-0.1

*Indicates significance at P ≤ 0.05. ** Indicates significance at P ≤ 0.01.

Also, Bland-Altman plots were used to assess validity. The results showed that no systematic bias amongst the administrations of the two methods. Figure 1 shows that for the Bland-Altman plots for energy intake, only three percent of the participants located out of the of agreement lines. Additionally, for fat intake; only 4% of the participants fell outside the limits of agreement (Figure 2). The Bland-Altman plots for the other 19 nutrient intakes can be seen in **(Appendix D)**.

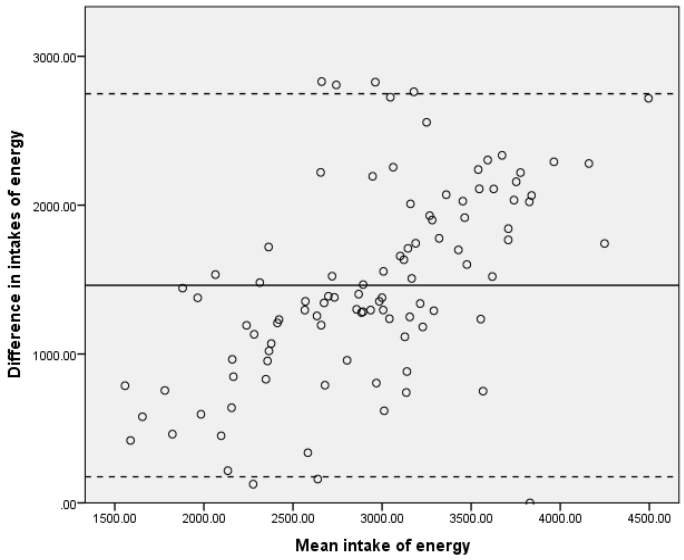

Figure 1: Bland-Altman method, used to evaluate the relationship between SFFQ and 24-hour recall for energy difference between means, lower limit, and upper limit

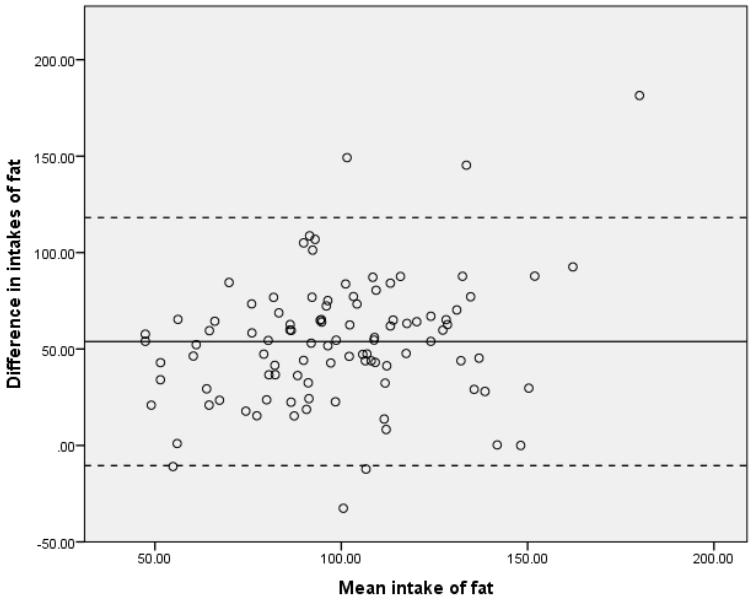

Figure 2: Bland-Altman method, used to evaluate the relationship between SFFQ and 24-hour recall for fat (g), difference between means, lower limit, and upper limit

Discussion

Due to measurement errors and limitations within every dietary assessment method, only relative validity of an FFQ can be determined (2). Thus, this study aimed to examine the relative validity of the new Arabic SFFQ, designed to be used in the Western region of Saudi Arabia, as compared to 24-hour recalls for this same region.

The results of cross-classification into quartiles show that the average correct classification of participants for each of the 21 nutrients at the same or adjacent quartiles, and one quartile a part rate were about 72.2%, 20.4%, respectively. Only 7.4 % of the participants were misclassified. These percentages of agreement between the two methods were comparable to those of other studies (17, 18, 19).

In general, food frequency questionnaire methods have been reported to overestimate nutrient intake when compared to other methods such as 24-hour

recall (20, 21, 22). The new SFFQ provided higher estimates of intake for all 21 nutrients examined compared to 24-hour recall. It is well known that food recalls commonly underestimate intake (2). Also, it might be that some of the foods may not have been eaten during the chosen the 24-hour recall. So, perhaps those contribute to the difference. Thus, more 24-hour recalls are needed. Also, collecting the multiple 24-hour recalls, such as one every week for 4 weeks, produces more accurate and reliable results. On the other hand, food records can be a good reference method because they do not rely on people's memory. Furthermore, due to day-to-day variations and seasonal variations in food records, multiple food records collected over the period of one year is considered a good standard reference method to evaluate other dietary assessment methods. Although biomarkers are excellent measures of accurate nutrient intake, they are costly, and hence they were not a part of this study.

Another explanation for the higher estimates of intakes in the new SFFQ is the estimation of portion sizes. The new SFFQ suggested predefined standard portion sizes, rather than asking the participants to describe their portion sizes in the 24-hour recall. The food amounts consumed by participants were quantified in an open-ended approach with the help of photos suggesting different portion sizes.

Furthermore, the new SFFQ is a self-administration method, so it relies on the participants' capability to quantify the consumption of a given food item from six categories of frequency, considering that many food items can be consumed individually or as part of a mixed dish. For example, an egg can be consumed as a single egg, or in a prepared dessert. It can be hard to estimate the number of eggs

consumed when eating a portion of a dessert that contains eggs. However, in 24-hour recalls, foods consumed from mixed dishes can be estimated independently. The new SFFQ had 152 food items. Participants often overestimate the actual food intakes when they ask to report how many times they eat the foods for a long list (23, 24).

The observed Spearman correlation coefficients were similar in this study to those observed in different Arabian populations (22), and South Asian populations in the United Kingdom (25), However, these results are likely to be underestimates of the real correlations between the new SFFQ and actual intake. It is possible that the 24-hour recall was not as representative of participants' long-term eating habits. The relatively low correlations of some of the nutrients could partially be due to limitations of one day of 24-hour recall. Correlations tend to be greater when multiple 24-hour recalls such as eight to fourteen 24-hour recalls are used. So, including more 24-hour recalls would have improved the correlations results (26). Also, in the overweight group the correlation coefficients were statistically significant for energy, vitamin D, fat, polyunsaturated fat, and monounsaturated fat, calcium and phosphorus. On the other hand, in normal weight group the correlation coefficients were statistically significant for energy ($p \leq 0.05$). Thus, there are differences in the validity of FFQ between the normal weight group and overweight group. In fact, overweight participants trying to obtain social acceptance by reporting their food intake correctly which might be results of the differences in the validity of FFQ between the normal weight group

and overweight group, however, further research is needed to comber the validity of FFQ between the normal weight group and overweight group

This finding was not consistent with other findings by Goris et al., (27). The present study is the first attempt to validate a new SFFQ for the Saudi Arabia population. More validation efforts with additional 24-hour recalls and biomarkers such as doubly labeled water, urinary nitrogen, and urinary sodium are needed to help validate the SFFQ. In fact, 86 participants were dropped from this study due to inadequate 24-hour recall data. However, it is common for self-reported 24-hour recalls to be recalled improperly. In the future validation study, it would be ideal to conduct interviews using the 24-hour recall method.

This validation study has limitations. One is the administration of only one 24-hour recall. Therefore, evaluation of the food intake recall over one month was not achievable. Also, the short-term food recall is not a perfect standard when compared with a long-term SFFQ (24). To better understand the relation between diet and disease, data regarding longer-term dietary habits should be obtained. This new SFFQ is limited to the measurement of dietary intake during the previous month. Also, because the frequency categories were not mutually exclusive, this might have affected the validity. So, for the next version of the SFFQ, frequency categories will be as following: Never or rarely, 1-3 times a month, 1-2 times per week, 3 to 6 times per week, every day.

Furthermore, the reproducibility of this new SFFQ should be assessed in additional research. Reproducibility is usually assessed by administering the SFFQ at two (or more) points in time to the same group of people. Finally, the mean age

of this study sample was 32 years; thus, the study cannot be generalized to the entire Western part of the Saudi Arabia population due to this imitation.

Conclusion

The aim of this study was to evaluate the performance of a 152-item Arabic SFFQ to be used in the Western region of Saudi Arabia. This new culturally sensitive SFFQ requires more validity testing with more 24-hour recalls and consideration of portion size estimates. For example, using trained nutritionists with food models and standard measures would improve SFFQ reporting of portions. It is important to continue to validate this SFFQ for it to be increasingly helpful in dietary interventions in Saudi populations to better understand and improve diet related health trends.

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Chapter 6: Results

PAPER III: Study of the Effectiveness of Electronic Intervention to Increase Health Behavior in the College Population

Abstract

Background: The transition to college can pose a significant challenge to a student's eating habits. Interventions targeted at improving health behavior might help prevent or mitigate chronic diseases. In this fast-moving world, interventions aimed at improving health behavior delivery through short message service (SMS) with the combination of e-mail may be more cost effective than other methods among college students. *Methods:* A 10-week diet intervention was delivered using text messages and e-mail to 200 randomly chosen college students. Students assigned to one of the two groups, the intervention or control group. The intervention involved weekly selected healthy diet goals. The control group received general health advice. Dietary intakes were assessed by three-day food records at baseline, week 5 and week 10. Outcomes reported were nutrient intake as well as average daily servings of food. At baseline, middle of the study (week 5) and at the end (week 10), weight, height and BMI were measured. *Results:* Two hundred participants were enrolled in the study, 176 completed all study period. Participants were female students18 to 20 years old. In the control group 63.2% were normal weight, 26% were overweight and 1.1% were obese. In the intervention group 73% were normal weight, 23% were overweight. Also, 39.4 % of the intervention group and 18.6% of the control group consume the recommended daily consumption of fruits and vegetables. In addition, 13.5% of

the intervention group and 4.6% of the control group consumed < 10% of energy intake from saturated fat. Moreover, 7.9 % of the intervention group and 90.8% of control group consumed <10% of energy intake from sugar. Furthermore, fruit and vegetable consumption was significantly higher in the intervention group (4.68 servings a day) compared to the control group (3.29 servings a day) at week 10 (P= 0.001). Repeated measures ANOVA identified a statistically significant interaction of time and group, indicating that the difference in fruit and vegetable consumption between control and intervention groups was significantly different. *Conclusion*: This intervention study reported significantly improved fruit and vegetable consumption after 10-weeks of emails and SMS messages. Further research is needed to evaluate the intervention efficacy in this population on long-term health behavior change.

Introduction

The transition from the developmental phase of adolescence to adulthood has been shown to be a critical stage for weight gain, body fat gain and for developing healthy or unhealthy lifestyles (1). During college, and especially during the first year, students often do not follow the dietary recommendations for healthy eating, which may result in inappropriate weight gain and the development of an unhealthy lifestyle (2, 1). Also, college students are faced with stressors related to new academic challenges as well as food selection and preparation (3). Stress has been found to be positively associated with the intake of calorically dense and high-fat food (4). Unhealthy lifestyle in earlier stages of life have been linked to diet-related chronic diseases later in life such as diabetes, obesity,

osteoporosis, and hyperlipidemia (5). A consequence of unhealthy lifestyles may be increased healthcare costs (6).

On the other hand, college students may be more responsive to new interventions targeting improvements in the college student health lifestyle such as maintaining normal weight and following the dietary guideline recommendations for healthy eating patterns (7). Some evidence indicates that intervention approaches have been successful in changing the students' health behaviors in the higher educational setting such as colleges and universities (8, 9). Specifically, interventions designed to inspire students to achieve their academic goals and remain healthy at the same time through creating learning within the community were effective (10).

Effective health interventions that combine text messages with technology such as e-mails to target positive health behaviors have increased knowledge and positive health behaviors in various populations including the technologically wired college generation and may help to prevent or relieve noncommunicable diseases (5). In general, texting and social media such as e-mails are acceptable methods of contact by the majority of the population (11, 12). Thus, these methods can also be acceptable and effective novel approaches to health promotion. However, the use of electronic health interventions is a relatively new practice for the promotion of health in the college population at Taibah University in Saudi Arabia.

The purpose of this study was to examine the effectiveness of text and email based intervention to improve diet among first-year female college students at Taibah University.

Methods

This current study was considered as a prospective randomized controlled trial. It was a 10-week program, which delivered e-mails and text messages designed to increase the consumption of fruits and vegetables, as well as to decrease the consumption of saturated fats and sugars. This intervention principle derived from social cognitive and social learning theories (13). Ethics approval for this study was obtained from the University of Maryland Institutional Review Board (IRB) as well as from Taibah University in Saudi Arabia.

Based on the literature review, averages of effect sizes are equal to 0.16, 0.16, and 0.22 for fruits and vegetables, saturated fat, and sugar intakes, respectively (14). Using G*Power statistical software, it was determined that a sample size of 168 was needed to reliably detect the effect size of 0.22 (larger effect sizes) with an alpha of 0.05 and desired statistical power level of 0.80 (15). Moreover, the sample size was increased by 25% to account for non-response and non-compliance during the sample collection procedure. Hence, the number of subjects required for this study was 200 subjects (16).

Recruitment

Participants were recruited from female-only colleges of Taibah University in Al-Madinah City. Participants were eligible if they were 18 to 20 years old, and had access to email, and had a cell phone capable of receiving text messages.

Participants were excluded if they were pregnant or lactating, had an eating disorder or bariatric surgery, or were following any special diet for weight loss **(Appendix E).**

Intervention

The study procedure consisted of four face-to-face visits. **Visit (1)**: The first visit was performed one week prior to baseline. Consent forms were obtained from all participants. Socio-demographic and health questionnaire **(Appendix F)**, the anthropometric measurements, and a 3-day food record (three-day FR) in a paper form **(Appendix G)**, were administered. Brief introduction and instructions on how to fill out the three-day FR were given, as well.

Anthropometric measurements

Anthropometric measurements were obtained from the female freshmen students, including weight and height. The procedure was explained to the participants before conducting the measurements. Weight and height measurements were obtained by using a SECA 703 Digital Medical Column Scale. The scale has a stadiometer attached. The scale was calibrated to zero before and after measuring each participant. All participants were asked to remove any heavy clothing and their shoes. The participants were asked to remove any accessories from their hand, neck and hair, and stand in the center of the scale with both feet together, hands at side, with head pointing straight forward. The weight shown on the scale was recorded in kilograms (17). Height was measured in centimetres on the same scale at the same time and under the same conditions as the previous weight measurement. The height gauge was measured to the next 0.1 centimetres.

Also, Body Mass Index (BMI) was computed as following; dividing the weight by squared height (Kg/m^2). Furthermore, BMI was categorized as follows: underweight (BMI < 18.5), normal ($18.5 \leq$ BMI < 25), overweight ($25 \leq$ BMI < 30), and obese (BMI $\geq$ 30) according to World Health Organization (1995) because there is no reference standard for body mass index (BMI) established specifically for usage in Saudi Arabia.

Visit (2) (baseline), participants were asked to return the three-day FR. Randomization was performed in this visit. The randomization process was conducted by computer-generated random numbers through SPSS (18) to one of two groups, the sham control group, and electronic interventions group (n = 100 each). Same procedure was applied to control and intervention groups. Yet, no treatment for control group (19). Also, the description of the electronic intervention procedure was given to the participants in this visit.

Electronic Intervention: from the baseline visit to week 10

After the baseline, the participants received e-mails and text messages each week for 10 weeks, depending on which group they belonged to **(Appendix H)**.

The intervention group's participants received a weekly e-mail and text messages with a limitation of 160 Arabic language characters for each text message about health and diet advice. The information was derived from scientific, peer-reviewed educational materials that are available at Saudi Arabia Ministry of Health Portal, the Dietary Guidelines for Saudis (20), from the U.S. Department of Agriculture, National Dairy Association, and U.S. Food and Drug Administration adapted for Saudi Arabian culture in Arabic language. This information was reviewed by a

dietician. The information was called 'My Goal for this Week.' Moreover, web-based resources for diet and nutrition information were included in the weekly e-mails. These e-mails and text messages were sent by blind copy to maintain confidentiality. A total of 10 text messages and 10 emails were distributed once every seven days through the intervention period, which was 10 weeks. At weeks 1, 2, and 3, participants received advice about reducing saturated fat consumption. At weeks 4, 5 and 6, participants received advice about reducing sugar consumption. At weeks 7, 8, 9 and 10, participants received advice about increasing fruits and vegetable consumption.

The control group received a weekly e-mail of at least one page (8 x 11 in) in length and text messages limited in number to 160 Arabic language characters for each text message for 10 weeks, enclosing information about health and food in general, which was not related to diet and generally available to the public.

Visit (3) occurred at the middle of the randomized controlled trial at week 5. At this visit, the anthropometric measurements, and the three-day FR were obtained from the participants. Participants were asked to return the three-day food record (three-day FR) the following week. All participants continued to receive the weekly e-mails and text messages.

Visit (4) was performed at the end of the randomized controlled trial at week 10. The anthropometric measurements and the three-day FR conducted at baseline were repeated. This visit was the endpoint of the randomized controlled trial, as outlined in Figure (1). The dietary outcomes of fruit, vegetable, saturated fat, and sugar consumptions were measured via the three-day FR.

The selected goals for the electronic interventions study for all the participants were:

1. Increase fruits and vegetables intakes.

3. Decrease saturated fats intakes.

4. Decrease added sugars.

Nutritional Analysis

Dietary intake obtained from the three-day FR were analyzed for nutrient content using the Food Processor Plus computer program software (21). For foods were not in the software, food composition tables for Saudi populations (22) were used. This approach has been used in the Saudi Arabia population in many studies (23, 24, 25).

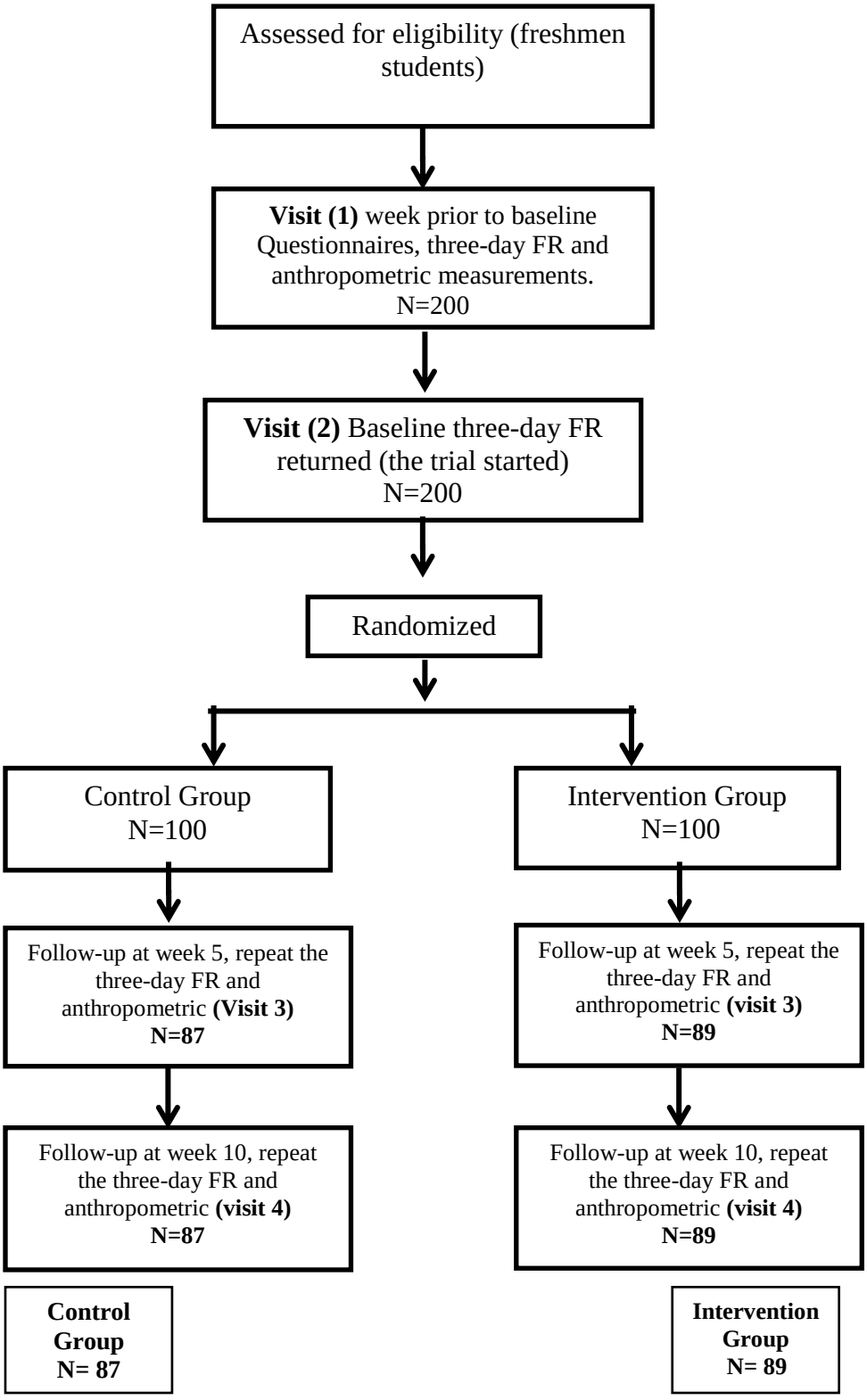

Figure 1: Flow diagram of the randomized controlled trial

Statistical analysis

Two hundred participants were enrolled in the study. Fruits and vegetables, saturated fat, and sugar consumption were measured at baseline, week 5, and week 10 during the study period. Demographic information collected included BMI, age, marital status, income level, vitamins consumptions, health issues, and food allergies. Demographic and baseline characteristics of participants in the intervention group were compared to those in the control group using a t-test for continuous variables or chi-square test of independence for categorical variable with p-value computed by the exact method (calculated significance level based on the exact distribution of the test statistic) (26).

In this study, it was also of interest to determine if there was a relationship between energy, fruit and vegetable, saturated fat, and sugar consumption, and group (intervention or control) over the study period of time, after controlling for age and BMI. The following variables were considered:

- Dependent variables: energy intake, fruits and vegetables intake, saturated fat intake, and sugar intake.
- Independent variable: group (a two-level categorical variable (intervention or control)).
- Covariates: baseline BMI and age (both continuous variables).

As the dependent variables were measured multiple times over the study period (baseline, week 5, and week 10), repeated measures ANOVAs (27, 28) were used to determine if there was a relationship between time (baseline, week 5, and week

10) and group (control versus intervention) interaction effect was included in the models to determine if the group effects varied significantly at different levels of time. The F-test was used to determine if an effect was statistically significant. If the test was significant, pairwise comparisons using the Bonferroni method was performed to see which two levels were statistically significantly different. Estimated marginal means were computed for the categorical variables (i.e., time and group). Note that estimated marginal means (mean response for each factor, adjusted for any other variables in the model) are not the same as the arithmetic means (mean response for each factor, not adjusted for any other variables in the model). A $p \leq 0.05$ indicated significance.

As discussed in Field (27) and Keselman et al., (28) the three assumptions of repeated measures ANOVAs needed to be met:

- Normality: the dependent variable is normally distributed, for every level of the within-subject factor.
- Sphericity (homogeneity of covariance matrices): the variances of the differences between any two levels of a within-subject factor (in this study, time was the only within-subject factor) are equal.
- Independence: observations from different subjects are independent.

The Chi-square QQ (quantile-quantile) plot was used to assess multivariate normality (29,30). The chi-square QQ plot was constructed based on the Mahalanobis distances for the sample. The ordered of Mahalanobis distances were plotted against estimated quartiles quantiles (percentiles) for a sample of size n from a chi-squared distribution with p degrees of freedom (p = number of

measures per subject, p = 3 in this study) for multivariate data. When the points lie along a straight line, the normality assumption remains tenable. Also, repeated measures ANOVA is robust with negligible violation of the normality assumption. However, violation of the sphericity might inflate the F statistic and increase the probability of type I error. Sphericity was checked via Mauchly's sphericity test (p-value > 0.05 indicates the sphericity assumption is satisfied) (18). All analyses were conducted using SPSS version 23 (IBM SPSS Statistics for Windows, 2015)

Results

Two hundred subjects were enrolled in the study, and 24 subjects were excluded from data analysis due to missing records for fruit and vegetable, saturated fat, and sugar consumption over the study period. Thus, the final sample size for the study was 176 subjects. Among the 176 subjects, 87 were in the control group and 89 were in the intervention group. Table 1 shows the demographics of the 176 subjects by group (control versus intervention). The results of the t-test and the chi-square tests of independence indicated that the demographics of the subjects were not statistically significantly different between the control and intervention groups at the baseline. Also, this study found that 92% of the intervention group and 97% of control were consuming >10% of energy intake from saturated fat. Also, this study found that 46% of the intervention group and 45% of control consumed <10% of energy intake from sugar.

Demographics at the baseline, by group (control and intervention) can be seen in Table 1. Table 2 shows the descriptive statistics (mean, and standard deviation) of energy, fruit and vegetable, saturated fat, and sugar consumption, by

group and time. Energy intake was lower for the control group at the end of the study (2197.88 Cal/kg/day) compared to baseline (2140.93 Cal/kg/day). Conversely, the intervention group energy intake was lower at the baseline (2025.41 Cal/kg/day) compared to the end of the study (2120.45 Cal/kg/day), however, the differences were not significant.

Fruit and vegetable consumption was higher in the control group at the baseline (3.55 serving a day) compared to week 10 (3.29 serving a day) ($P \leq 0.05$). In contrast, the intervention group's fruit and vegetable consumption was higher at week 10 (4.68 serving a day) compared to the baseline (4.07 serving a day) ($P \leq 0.05$).

Percentage and number of participants meeting health recommendations at baseline are presented in **(Table 3)**. No significant differences between control and intervention groups were detected for students meeting health guidelines at baseline.

Table 1. Demographics, (control and intervention groups) at baseline

		Control n (%) N=87	Intervention n (%) N= 89	Test statistic	P
Age (years): mean (SD)		18.90 (0.76)	18.82 (0.72)	t(174) = 0.68	Ns
BMI: mean (SD)		22.77 (3.02)	23.42 (2.58)	t(174) = -1.53	Ns
Marital status	Not married	84 (96.6)	82 (92.1)	1.602	Ns
	Married	3 (3.4)	7 (7.9)		
Income (Saudi Riyal)	<5000	4 (4.6)	2 (2.2)	7.40	Ns
	5001-7000	9 (10.3)	7 (7.9)		
	7001-9000	3 (3.4)	4 (4.5)		
	>9000	8 (9.2)	21 (23.6)		
	No answer	63 (72.4)	55 (61.8)		
Taking vitamin	No	66 (75.9)	71 (79.8)	0.39	Ns
	Yes	21 (24.1)	18 (20.2)		
Food allergy	No	76 (87.4)	84 (94.4)	2.62	Ns
	Yes	11 (12.6)	5 (5.6)		
Health issue	No	69 (79.3)	78 (87.6)	2.21	Ns
	Yes	18 (20.7)	11 (12.4)		
BMI category	Underweight	8 (9.2)	3 (3.4)	4.17	Ns
	Normal weight	55 (63.2)	65 (73.0)		

Overweight	23 (26.4)	21 (23.6)
Obesity class I	1 (1.1)	0

SD = Standard Deviation. BMI categorized: underweight (BMI < 18.5), normal (18.5 ≤ BMI < 25), overweight (25 ≤ BMI < 30), and obese (BMI ≥ 30). P ≤ 0.05

Table 2. Descriptive statistics of energy, fruit and vegetable, saturated fat, and sugar consumptions, by group and time

		Control (N = 87)		Intervention (N = 89)		
	Time	Mean	SD	Mean	SD	P value [a]
Fruit and vegetable (Serving)	Baseline	3.55	0.99	4.07	1.12	0.001
	Week 5	3.72	1.15	4.58	1.23	0.001
	Week 10	3.29	0.86	4.68	1.32	0.001
Saturated fat (Gram)	Baseline	26.88	12.77	31.25	24.17	Ns
	Week 5	28.47	14.44	28.51	18.78	Ns
	Week 10	27.32	15.04	30.13	19.30	Ns
Sugar (Gam)	Baseline	92.03	32.78	87.13	29.79	Ns
	Week 5	91.59	31.27	86.05	36.27	Ns
	Week 10	103.64	38.49	93.47	34.39	Ns

SD = Standard Deviation. Significantly different p ≤ 0.05

Table 3. Participants meeting health recommendations at baseline

Recommendation	Control n (%) N=87	Intervention n (%) N=89	P value [a]
Fruit and Vegetable (> 5 Serving /day)	16 (18.6)	35 (39.4)	Ns
Saturated fat intake (<10% daily calories)	4 (4.6)	12 (13.5)	Ns
Sugar intake (<10% daily calories)	79 (90.8)	82 (7.9)	Ns

[a] Chi-square analysis of differences between groups. P ≤ 0.05

Fruit and vegetable intake

The analysis results of the repeated-measure ANOVA with dependent variable; fruit and vegetable intake, independent variable; group (intervention or control), and covariates; age and BMI indicate that there was a statistically significant interaction effect of time and group [F (2, 348) = 38.311, p = 0.000], indicating that the difference in fruit and vegetable intake between control and

intervention groups was statistically significantly different. Moreover, the results of pairwise comparisons indicated that the mean fruit and vegetable intake for the intervention group was statistically significantly higher than the control group at baseline ($p = 0.003$), at week 5 ($p = 0.000$), and at week 10 ($p = 0.000$). Also, Figure 4 shows the profile plot of estimated mean fruit and vegetable intake, by group and time.

Additionally, from the profile plot **(Figure 2)**, the difference in fruit and vegetable intake between the control and intervention groups seemed to get larger over the study period of time (Difference was: -0.52 at baseline, -0.85 at week 5, and -1.38 at week 10, $p = 0.000$). There were no statistically significant age and BMI effects. The multivariate normality assumption of the model was checked via Chi-square QQ plot **(Figure 3)**. As most of the points lie closely to the 45-degree line, so the normality assumption was attained. The Mauchly's test of sphericity indicated that the sphericity assumption was satisfied ($p = 0.995$). Thus, the fitted model was adequate.

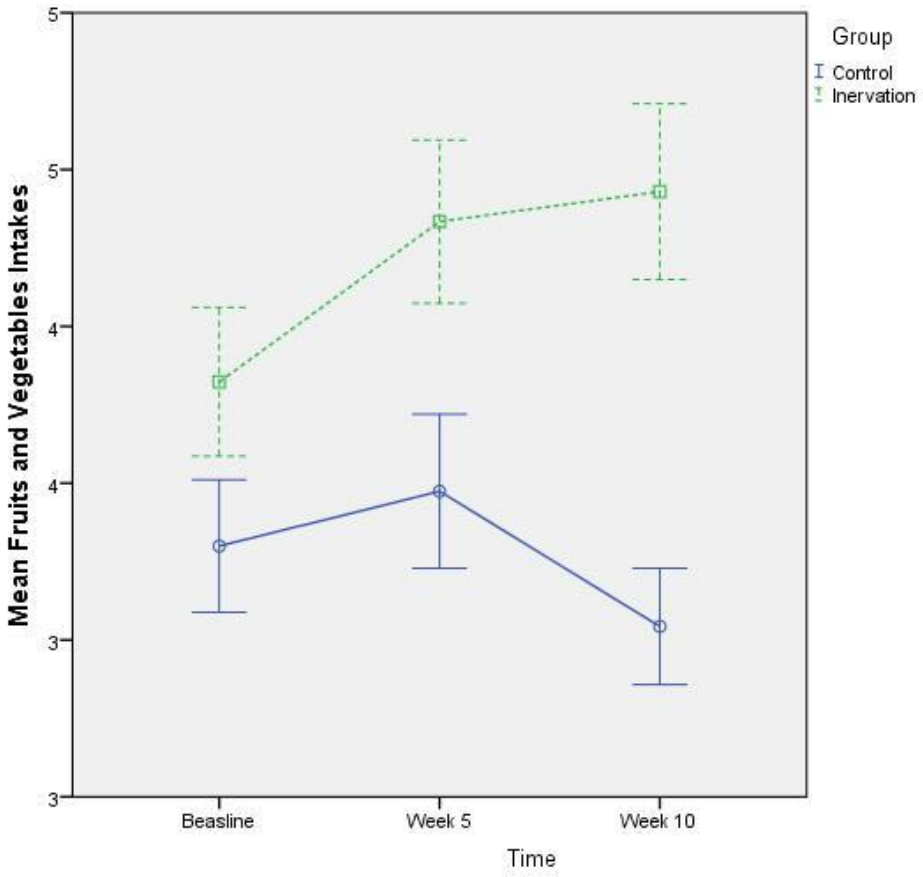

Figure 2: Profile plot of estimated mean fruit and vegetable intake and standard error. Shows the statistically significant change in fruit and vegetable intake in the intervention and control groups who completed all study visits (p = 0.000).

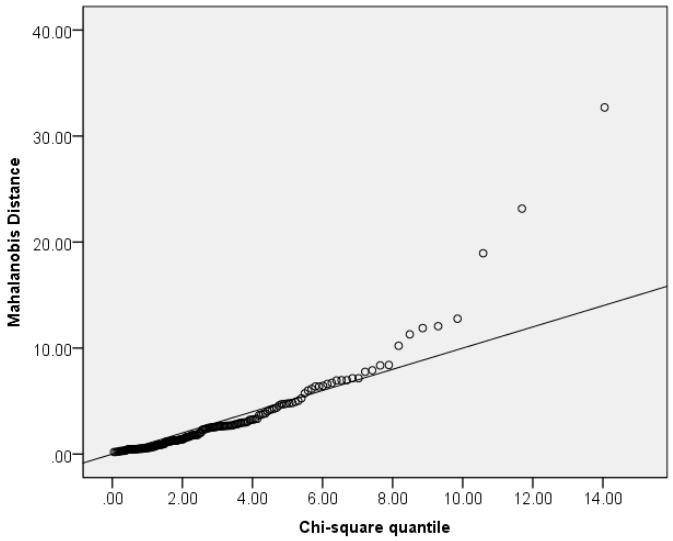

Figure 3: Chi-square QQ plot (Fruit and vegetable intake)

Saturated fat intake

The analysis results of the repeated-measure ANOVA with dependent variable; saturated fat intake, independent variable; group (intervention or control), and covariates age and BMI indicate that there was not a statistically significant interaction effect of time and group ($F(2, 348) = 2.002$, $p = 0.136$), indicating that the difference in saturated fat intake between control and intervention groups was not statistically significantly different across time. There were no statistically significant group, age, and BMI effects. Also, Figure 4 shows the profile plot of estimated mean saturated fat intake, by group and time. The multivariate normality assumption of the model was checked via Chi-square QQ plot **(Figure 5)**. As most of the points lie closely to the 45-degree line, so, the normality assumption was attained. The Mauchly's test of sphericity indicated that the sphericity assumption was satisfied ($p = 0.202$). Thus, the fitted model was adequate.

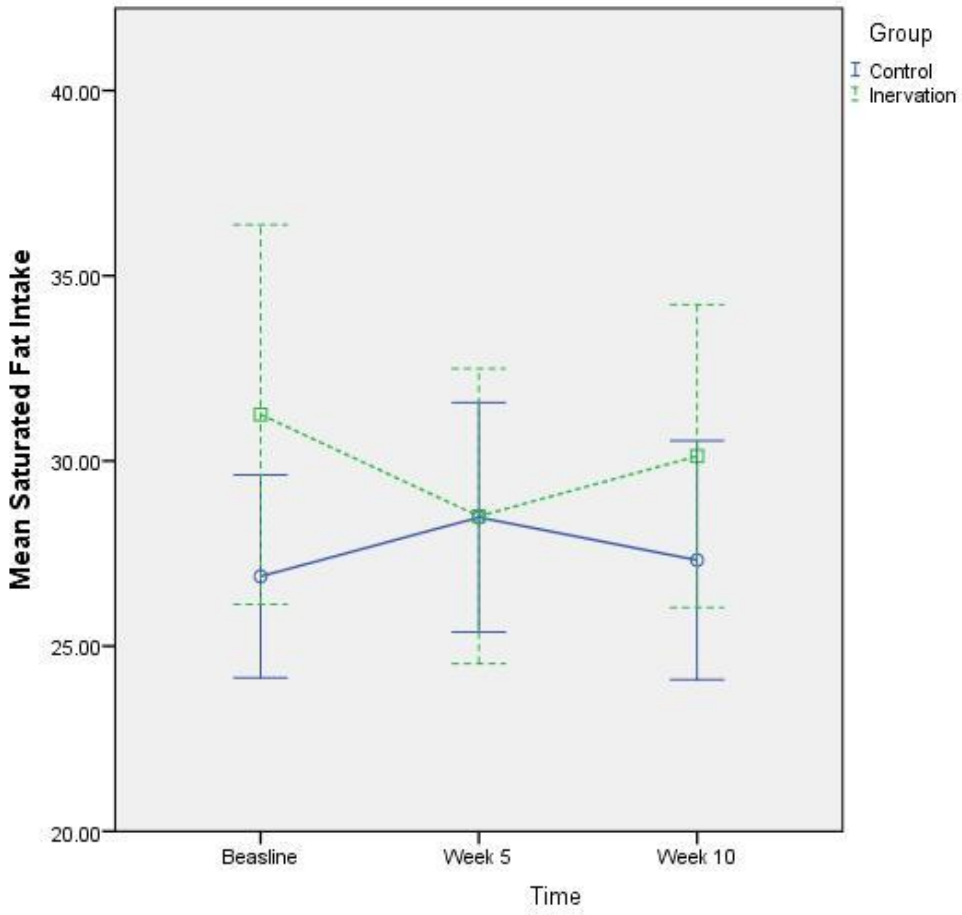

Figure 4: Profile plot of estimated mean saturated fat intake and standard error. Shows that there was no statistically significant change in saturated fat intake in the intervention and control groups who completed all study visits

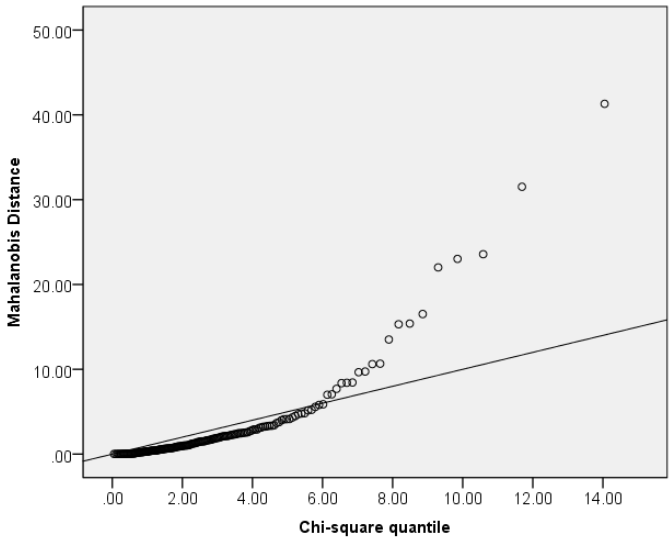

Figure 5: Chi-square QQ plot **(**Saturated fat intake)

Sugar intake

The analysis results of the repeated-measure ANOVA with dependent variable; sugar intake, independent variable; group (intervention or control), and covariates; age and BMI indicate that there was not a statistically significant interaction effect of time and group [F (2, 348) = 0.483, p = 0.617], indicating that the difference in sugar intake between control and intervention groups was not significantly different across the three time points (baseline, week 5, and week 10). There were no statistically significant group, age, and BMI effects. Also, Figure 6 shows the profile plot of estimated mean sugar intake, by group and time. The multivariate normality assumption of the model was checked via Chi-square QQ plot **(Figure 7)**. In fact, the normality assumption was satisfied because most of the points lie closely to the 45-degree line. The Mauchly's test of sphericity indicated that the sphericity assumption was satisfied (p = 0.262). Thus, the fitted model was adequate.

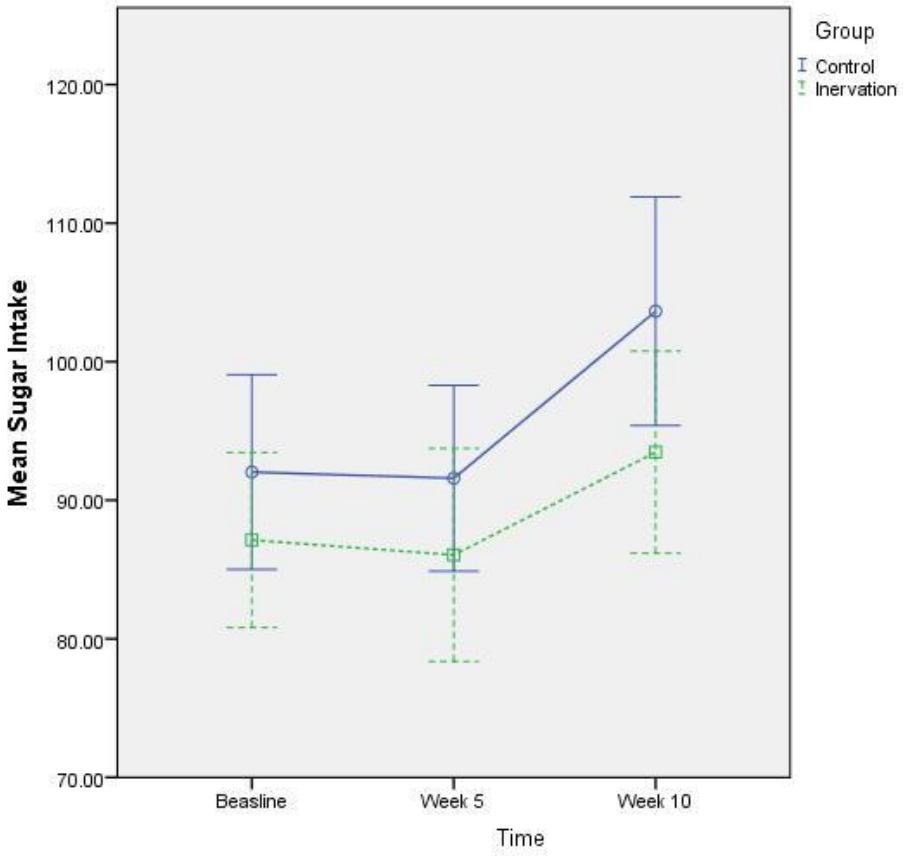

Figure 6: Profile plot of estimated mean sugar intake and standard error. Shows that there was no statistically significant change in sugar intake in the intervention and control groups who completed all study visits

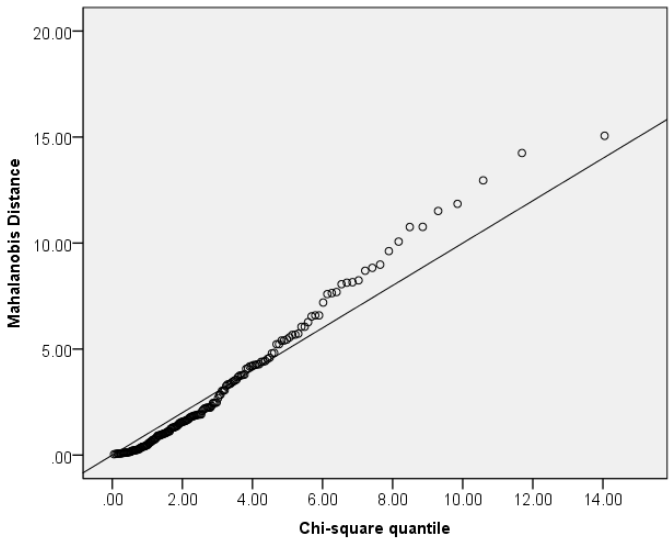

Figure 7: Chi-square QQ plot (Sugar intake)

Discussion

To our knowledge, this intervention study is the first study aimed at demonstrating the feasibility of a 10-week electronic health intervention to enhance consumption of fruits and vegetables and decrease saturated fat and sugar consumption in female college students in Taibah University, Saudi Arabia.

Poor dietary behaviors are related to obesity especially in college populations. Transition to college has been identified as a critical period for increases in unhealthy lifestyles, poor-quality diets, poor physical inactivity, and an increase in overweight status and obesity (31). Also, obesity is associated with metabolic syndrome and cardiovascular disease risk in adolescents (32,33).

Obesity is measured by BMI (33). Our data indicated that in the control group 63.2% were normal weight,26% were overweight and 1.1% were obese. In the intervention group 73% were normal weight, 23% were overweight with a BMI of $\geq$ 25 mg/kg^2. This finding is similar to findings from other studies in Saudi Arabia universities. For instance, at the University of Dammam in Dammam City, 64% of the students were normal weight and 18% were overweight or obese (34). In Al Qassim University in Rass City, 62% of the sample were normal weight and 23% were overweight or obese (35). However, Princess Nora Bint Abdul Rahman University's participating students have a higher rate of obesity, which was 47.9%, than Taibah University. Although our study sample is not large, prevalence of overweight and obesity is within the range as the same age group population reported by most other studies (36,37).

What is more important is the fact that this study found the participating

students did not consume the recommended intake of two fruits and three vegetables each day according to dietary guidelines for Saudis (The Healthy Food Palm) (20). The literature review by Ahmed et al. concluded that the majority of the Saudi population did not meet the minimum daily recommendation for fruit and vegetable consumption, especially among university students (38). AL-Qauhiz reported that eighty three percent of the seven hundred ninety-nine female university students studied did not consume fruits and vegetables every day. Moreover, this finding is similar to studies conducted in Saudi female universities. One of these studies was at Al-Hasa University, which found that only twenty two percent of the female university students consumed the recommended daily intake of fruits and vegetables (39). Epuru et al. conducted another study in 2014. In this study, researchers examined fruit and vegetable consumption among female students at Hail University in Saudi Arabia. The study results showed that less than 30% of the students consumed the recommended daily amount of fruits and vegetables (40). Aboul Azm and Elebiary (41) found that seventy percent of the female nursing students in Saudi Arabia did not eat fruits and vegetables every day. Furthermore, the Musaiger et al., (42) study showed that only 25% of Bahraini students met the WHO recommendations. On the other hand, 11% of Kuwaiti adults were reported by Dehghan et al. to have the recommended intake of fruit and vegetable intake per day (43). In fact, the results of this study support that most students consume more sugar than is recommended. Further, the results of this study support that students do not meet fruit and vegetable consumption recommendations.

This intervention study indicated that only the difference in fruit and vegetable consumption between control and intervention groups was a statistically significant difference across the three time points. Even though the recommended intake for fruit and vegetable consumption was not achieved, the improvement of fruit and vegetable consumption might be related to the availability of fresh fruit and vegetable juices and salads inside college campuses, which is not available in high school cafeterias in Saudi Arabia. In addition, the advice received by them about the health benefit of consuming fruits and vegetables might have played a role for increasing their consumption of the fruits and vegetables. Also, since there has not been a long-term follow-up for this study, there is no way to determine if the results had a lasting effect or if the behavior changes on the fruit and vegetable consumption only occurred during the intervention period. No significant treatment by time difference was detected in saturated fat and sugar intakes. This intervention study showed reported significant behavior changes in fruit and vegetable consumption. Similar results were reported by Brown et al., in their sample of college students (44) in the U.S. college population. The aim was to evaluate the acceptance and effectiveness of repetitive nutrition-related text messages on 150 college students' fruit and vegetable consumption. After sending text messages for seven weeks, the intervention group fruit and vegetables consumption was increased when compared to the control group. At South Dakota University, staged interventions have been successful in motivating college students to improve dietary behaviors. Researchers used stage-based newsletters and e-mails to increase the dietary quality of college students. The randomized,

four-months' intervention produced a significant increase in fruit and vegetable intake as compared with the control group (45). A similar outcome was stated by Greene et al., (46) among 1,689 college students from eight universities, namely, Michigan State University, South Dakota State University, Syracuse University, Pennsylvania State University, Tuskegee University, University of Rhode Island, University of Maine, and University of Wisconsin.

The national guidelines recommended that total fat should be less than 25% of calories with no more than 10% as saturated fat, and with minimal trans fat (20). In this study, both control and innervation groups reported an excessive contribution of saturated fat to total energy intake, 92% of the intervention group and 97% of control consumed >10% of calories from saturated fat at baseline. Previous studies of college students have reported a similar finding. For instance, Abdel-Megeid et al. found that the majority of the students (86%) in King Saud University, Riyadh, Saudi Arabia, reported a high intake of saturated fats, which exceeded the saturated fat intake recommendation (47). The present results showed that 56% of the intervention group and 55% of control consumed > 10% of calories from sugar, which exceeded the recommended intake according to dietary guidelines for Saudis (20). This result is apparently similar to those presented by Majeed (48), which indicated that the consumption of sugar and sugar products at the University of Dammamis located in Saudi Arabia is as high as 67% in the study participants, and the students reported that the sugar and sugar products were consumed a "few times" up to "three times" per week. Also, the students preferred sugar products over vegetables and fruits. Also, Al-Imam Mohammad IBN Saud

Islamic University College of Medicine students, there was a high consumption of sugar. Students report consumption of high amounts of chocolates and soft drinks, both which are excessive for the recommended sugar intake (49). On the other hand, Nicole et al. (50) found that 102 healthy college students, consumed a diet >25% energy from total sugar. In fact, the results of this study support that most students consume more sugar than is recommended.

In this intervention study, emails and text messages were used. In recent years, interventions delivered via the Internet have become increasingly popular for the promotion of a variety of health-related behaviors (51). One of the main purposes for adding the text message intervention for education along with emails is the simplicity and convenience of the text messages. They can be sent and/or read at the students' convenience and do not require them to have access to the Internet (51).

The major strength of this intervention study is that it tested a new approach for targeting the improvement of health behaviors in college students in Taibah University, Saudi Arabia. In addition, the intervention was a combination of the two methods of delivering health advice, which were text messages and e-mails. Some of the limitations of this study are that the three days of food records were self-reported, which may lead to a potential for reporting bias. Also, the fruit and vegetable consumption for the intervention group was statistically significantly higher than the control group at baseline, which indicates a bias prior to the start of the study, indicating that the randomization process was not successful.

Furthermore, the researcher did not have the ability to document if and

when the text messages were actually read by the receiver. Although this is a limitation to the study, it affects other methods of education, as we cannot confirm that the students were taking time to read the advice. Moreover, the study sample was not representative of Taibah University students in Saudi Arabia due to inclusion criteria, for example, email access. However, future use of interactive text messages to promote specific eating behaviors is recommended.

Conclusions

The focus of this study was to determine whether electronic health intervention could improve health habits in college students. The data show that there was an increase in fruit and vegetable consumption in the intervention group compared to the control. However, further research is needed to determine the effectiveness of texting and e-mails on long-term health behavior change such as from saturated fat and sugar intake.

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Chapter 5: Summary and Implications

In the present study, a SFFQ for the Saudi Arabian adult population in the Western Region of Saudi Arabia was developed to assess foods and beverages contributing to intakes of Energy, Carbohydrate, Protein, Fat, Saturated Fat, Polyunsaturated Fat, Monounsaturated Fat, Cholesterol, Dietary Fiber, Vitamin A, Vitamin D, Vitamin B1, Vitamin B2, Folate, Vitamin C, Vitamin E, Calcium, Magnesium, Phosphorus, Potassium, and Sodium. The FFQ was further validated for energy intake in a sample of Western Saudi adults. This study indicates the need for continued development and validation of this new Arabic SFFQ in order for it to be a useful tool in investigating the role of diet in chronic disease in Saudi population. Specifically, the new FFQ requires further validation for nutrients. The present study demonstrated also the effectiveness of electronic interventions delivered by e-mails and mobile phone text messages for improving fruit and vegetable consumption. However, even after the intervention, the Saudi students did not meet the daily recommendation for fruit and vegetable intake. Further research is needed to evaluate the long-term efficacy of the intervention in a female Saudi population. Electronic interventions could provide general dietary screening, recommendations, and effective, low-cost behavior change to large numbers of the Saudi population. Additionally, the intervention studied here could provide additional information to the administration of Taibah University for improving the nutrition status of its students.

Appendices

Chapter 4, Paper (1)

Appendix A

24-Hour Dietary Recall

Participant Name _____ Health Center_____

Date _____/_____/_____ Phone _____ E-mail _____

Date of Birth: _____ Age:_____ Gender □ male □ female

Address: _____

Please read the instructions on the following pages very carefully.

- Please write down everything you eat and drink for one day. Start from midnight-to-midnight
- Record this in the column marked TYPE of FOOD and BEVERAGES including water.
- Record only amounts EATEN, not amount served.
- Under 'AMOUNT'**,** record in 'teaspoons', 'cups', or fractions of these. You may use 'slices' or 'pieces' when necessary. If something eaten has a specific measurement on the label, record that amount. For example: Coke - 12 ounce can, Hershey bar - 1.45 ounces.
- It is important to remember the following while recording different types of food:
  - Milk: State if whole, skim, fortified, powdered, liquid, evaporated, or chocolate
  - Liquids: Record amount of milk and all beverages in 'cups' or 'liters'.
  - Bread: Specify white, whole wheat, raisin, etc.
  - Meats: Give the length, width and thickness of the portion, or its weight in 'ounces' after cooking.
  - Cereals, rice, and pasta: Record amount of cereals, rice, and pasta in 'cups' or fractions of a cup.
  - Do not record in 'BOWLS'. List anything added, e.g., fruit, sugar.
  - Fruits and Vegetables: Specify, fresh, frozen, canned, dried, or freeze-dried.
  - Condiments: Record any jelly, butter, ketchup, mayonnaise or seasonings added.
  - Canned foods: Record what food is packed in – oil, water, syrup, etc.
  - See ways to size up your servings provided in the last page.
- If you have any questions, please call this number: 0505324293.

24-Hour Dietary Recall- Filled-out Sample

TIME	TYPE OF FOOD and BEVERAGES	AMOUNT	WHERE	METHOD OF PREPARATION/ BRAND NAME
7:30 am	Corn Flakes	¾ cup	Kitchen	
	Milk – 2%	½ cup	" "	
	Banana	½ fruit		
			Home	
12:00 (noon)	Tuna	2 oz.	" " "	Baked
	Bread, Whole Wheat	2 slices		
	Mayonnaise	1 tsp.	Home	
	Tomato	2 slices		
	Green Apple	1 large		
	Pepsi, can	12 oz.		
3:00 pm	Medium Blizzard	Medium	Supermarket	
6:00 pm	Chicken (Breast)	3 oz.	Home	Grilled, no skin
	Green Beans	½ cup		Steamed, fresh
	Rice	1 cup		Boiled
	Apple juice	1½ cups		fresh

Please answer the following questions**:**

1-What kind of fat is usually added to your food?

□ Real butter □ Margarine □ Vegetable oil □ Olive oil □ None

2-What kind of fat is usually used for cooking at home (exclude any type of spray)?

□ Real butter □ Margarine □ Vegetable oil □ Olive oil □ Canola oil □ None

3-What kind of milk do you usually drink?

□ Whole milk □ 2- 3% low fat milk □ Free fat milk □ Soy milk □ Skim milk □ Dry milk □ None

4- Do you eat seafood (fish, Shrimp, Shellfish)?

□ Always □ Often □ Sometimes □ Never

Please specify what kinds of seafood you eat?_____

5-Are you taking any supplements such as vitamins or minerals currently on a regular basis (at least once per week)?

□ No □ Yes: If yes:

Name _____ How often do you take it? _____

Dose _____ How long have you been taking it?_____

Purpose of taking it_____

Day of the week: Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday.

Does this day represent your typical eating habits? ☐Yes ☐No

Date_____

TIME	TYPE OF FOOD AND BEVERAGES	AMOUNT	WHERE	METHOD OF PREPARATION

Ways to Size Up Your Servings

Remember

3 ounces of meat = thickness of a deck of playing cards		=	
A medium apple = tennis ball.		=	
1 ounce of cheese = 4 stacked dice.		=	
½ cup of ice cream = tennis ball.		=	
1 cup of mashed potatoes or broccoli = your fist.		=	
1 teaspoon of butter = tip of your thumb.		=	
1 ounce of nuts or small candies = handful.		=	

1 cup of Rice vegetables

½ cup of pasta

½ cup of cooked

250ml (1 cup) milk

One slice of bread or one six- inch pita is about the size of a DVD.

½ cup of pasta

½ cup of cereal

1 cup of pasta

1cup of cereal

2 cup of pasta

2 cup of cereal

3 cup of pasta

3 cup of cereal

Appendix B
Groupings of Food Intakes

Food	Grouping
1. Arbic Coffe	Beverages
2. Cappuccino	Beverages
3. Americano	Beverages
4. Coffee, Tasters Choice	Beverages
5. Drink, black cherry	Beverages
6. Drink, guava	Beverages
7. Drink, watermelon	Beverages
8. Juice, blueberry	Beverages
9. Juice, mango nectar	Beverages
10. Juice, orange	Beverages
11. Juice, pineapple	Beverages
12. Juice apple	Beverages
13. Juice pomegranate	Beverages
14. Drink, banana nectar	Beverages
15. Drink, orange	Beverages
16. Lemonade	Beverages
17. Soda, Coca-Cola	Beverages
18. Soda, Sprite	Beverages
19. Saudi tea	Beverages
20. Green, tea	Beverages
21. Rusk with nuts	Rusk with nuts
22. Biscuit with nuts with sesame	Rusk with nuts
23. Rusk with nuts salted chees	Rusk with nuts
24. Biscuit with nuts, buttermilk	Rusk with nuts
25. Rusk with nuts, cream	Rusk with nuts
26. Rusk toast	Rusk with nuts
27. Snack, puffs, cheese	Rusk with nuts
28. Cracker	Rusk with nuts
29. Qermeash	Rusk with nuts
30. Bread naan	Bread
31. Bread, French	Bread
32. Bread, pita, whole wheat	Bread
33. Bread, pita, white	Bread
34. Bread, roti	Bread
35. Bread, wheat slice	Bread

36. Bread, white slice	Bread
37. Fatter,	Bread
38. French toast	Bread
39. Croissant	Bread
40. Cake, carrot	Cake
41. Cake, chocolate chip	Cake
42. Cake, golden	Cake
43. English Muffin	Cake
44. Cereal	Cereal
45. Corn Flakes	Cereal
46. Oatmeal	Cereal
47. Popcorn	Cereal
48. Cheese, American, slices	Cheese
49. Cheese, white, crumbled	Cheese
50. Cheese parmesan	Cheese
51. Cheese, cheddar	Cheese
52. Cheese Spread	Cheese
53. Cream Cheese	Cheese
54. Mozzarella cheese	Cheese
55. Feta cheese	Cheese
56. Old cheese	Cheese
57. Akkawi Cheese	Cheese
58. Chicken,	Chicken
59. Chicken, rotisserie	Chicken
60. Chicken, grilled	Chicken
61. Chicken with tomato	Chicken
62. Chicken masala	Chicken
63. Chicken, fried	Chicken
64. Date dried	Date
65. Date fresh	Date
66. Egg	Egg
67. Shakshuka	Egg
68. Falafel	Falafel
69. Fatayer with chees	Fatayer
70. Fatayer with chicken	Fatayer
71. Fatayer with meat	Fatayer
72. Fatayer with labanh	Fatayer
73. Fatayer with Zatar	Fatayer
74. Beans, butter	Fats and oil
75. Butter	Fats and oil
76. Cream, whipping	Fats and oil
77. Canola oil	Fats and oil
78. Palm oil	Fats and oil

79.	Coconut oil	Fats and oil
80.	Sesame oil	Fats and oil
81.	Ghee	Fats and oil
82.	Chips, potato	fried food
83.	Doughnut	fried food
84.	French Fries	fried food
85.	Samosa meat	fried food
86.	Samosa chess	fried food
87.	Zlabiah	fried food
88.	Apple	Fruit
89.	Banana	Fruit
90.	Fig	Fruit
91.	Fruit Snacks	Fruit
92.	Grapes	Fruit
93.	Mandarin	Fruit
94.	Mango	Fruit
95.	Mixed Fruit	Fruit
96.	Olives black	Fruit
97.	Oranges, all types	Fruit
98.	Lemon	Fruit
99.	Peaches	Fruit
100.	Cherry	Fruit
101.	Plums	Fruit
102.	Guava	Fruit
103.	Pineapple	Fruit
104.	Resin	Fruit
105.	Apricots	Fruit
106.	Pomegranate	Fruit
107.	Salad, fruit	Fruit
108.	Strawberry	Fruit
109.	Watermelon	Fruit
110.	Beef ground	Meat
111.	Beef	Meat
112.	Beef, liver	Meat
113.	Cheeseburger	Meat
114.	Hot dog, beef	Meat
115.	Meat, lamb	Meat
116.	Meat balls	Meat
117.	Kabba	Meat
118.	Camel meat	Meat
119.	Buttermilk, low fat	Milk
120.	Buttermilk, whole	Milk
121.	Milk	Milk

122.	Milk, low fat	Milk
123.	Milk, non fat	Milk
124.	Skim milk	Milk
125.	Milk with cocoa	Milk
126.	Milk powder	Milk
127.	Evaporated milk	Milk
128.	Condensed milk (sweetened)	Milk
129.	Yogurt, plain low fat	Milk
130.	Yogurt, plain non fat	Milk
131.	Yogurt, Greek	Milk
132.	Yogurt, fruit	Milk
133.	Yogurt Salad	Milk
134.	Grapeleaves	Traditional dishes
135.	Mutabak	Traditional dishes
136.	Kabsa	Traditional dishes
137.	Juraish	Traditional dishes
138.	Margoog	Traditional dishes
139.	Salig	Traditional dishes
140.	Chicken Shawarma	Traditional dishes
141.	Meat Shawarma	Traditional dishes
142.	Tosat with Vegetable	Traditional dishes
143.	Muhashi	Traditional dishes
144.	Noodles	Noodles
145.	Bar, granola, honey	Nuts
146.	Nuts	Nuts
147.	Almonds	Nuts
148.	Seeds, pumpkin	Nuts
149.	Cashew	Nuts
150.	Watermelon seed	Nuts
151.	Pasta	Pasta
152.	Pasta with chicken	Pasta
153.	Pasta tomato	Pasta
154.	Pasta fettuccine	Pasta
155.	Pasta with white sauce	Pasta
156.	Spaghetti	Pasta
157.	Pizza with cheese	Pizza
158.	Pizza with veggies	Pizza
159.	Pizza with chicken	Pizza
160.	Pizza with meat	Pizza
161.	Baked Beans	Pulses
162.	Beans, fava	Pulses
163.	Rice with vegetables,	Rice
164.	Kabsa	Rice

165.	Meat Kabsa	Rice
166.	Rice	Rice
167.	Rice Bukuri	Rice
168.	Rice Kably	Rice
169.	Salige	Rice
170.	Salt	Salt
171.	Fish fillet	Seafood
172.	Fish, cooked	Seafood
173.	Fish, fried	Seafood
174.	Fish, tuna	Seafood
175.	Salad, tuna	Seafood
176.	Shrimp, fried	Seafood
177.	Soup, chicken	Soup
178.	Soup, vegetable	Soup
179.	Whole wheat soup	Soup
180.	Sugar	Sugar
181.	Candy Bar, KitKat	Sweet
182.	Candy Bar, Snickers	Sweet
183.	Candy Bar, Twix,	Sweet
184.	Cheesecake	Sweet
185.	Chips	Sweet
186.	Chocolate, Bar, dark	Sweet
187.	Chocolate Bar, milk	Sweet
188.	Cookie, chocolate	Sweet
189.	Honey, dark	Sweet
190.	Ice Cream Bar, chocolate	Sweet
191.	Ice Cream Cone vanilla	Sweet
192.	Jam strawberry	Sweet
193.	Jam, cherry	Sweet
194.	Pie, apple	Sweet
195.	Bas Bosa	Traditional desserts
196.	Kunafa	Traditional desserts
197.	Masoop	Traditional desserts
198.	Pudding, rice	Traditional desserts
199.	Arikah	Traditional desserts
200.	Assedah	Traditional desserts
201.	Arugula	Vegetable
202.	Potato	Vegetable
203.	Broccoli	Vegetable
204.	Carrot	Vegetable
205.	Chile Pepper	Vegetable
206.	Cucumber	Vegetable
207.	Eggplant	Vegetable

208.	Herb	Vegetable
209.	Ketchup	Vegetable
210.	Lettuce	Vegetable
211.	Mushrooms	Vegetable
212.	Okra	Vegetable
213.	Onion	Vegetable
214.	Garlic	Vegetable
215.	Ginger	Vegetable
216.	Molokiah	Vegetable
217.	Pumpkin	Vegetable
218.	Parsley	Vegetable
219.	Peppers, sweet	Vegetable
220.	Cabbage	Vegetable
221.	Cauliflower	Vegetable
222.	Salad, Caesar	Vegetable
223.	Salad, garden fresh	Vegetable
224.	Salad, Veggie	Vegetable
225.	Squash	Vegetable
226.	Tomatoes	Vegetable
227.	Tomato Sauce	Vegetable
228.	Vegetables soup	Vegetable
229.	Vegetables, mixed	Vegetable
230.	Vegetarian chicken	Vegetable

Number of food items in each group

Group	Items	Group	Items
Beverages	20	Milk	15
Rusk with nuts	9	Traditional dishes	10
Bread	10	Noodles and macaroni	4
Cake	4	Nuts	6
Cereal	4	Pasta	6
Cheese	10	Pizza	4
Chicken	12	Pulses	2
Date	4	Rice	7
Egg	2	Salt	1
Falafel	1	Seafood	6
Fatayer	5	Soup	3
Fats and oil	7	Sugar	1
Fried food	6	Sweet	14
Fruit	22	Traditional desserts	6
Meat	9	Vegetable	20

Appendix C

Semi-Quantitative Food Frequency Questionnaires

Name…… Date of Birth…….. Gender (male- female)
Height…….weight…….email…….……today date …….

INSTRUCTIONS

- We would like to know how often you ate certain foods over the past month, and their amounts.
- Answer each question as best you can. Estimate if you are not sure.
- Portion sizes; Amounts are described in various ways, including the number of: cups, teaspoons (tsp), ounces (oz), inches ("), pieces (e.g., 1 apple) grams (gm), tablespoons (tbsp), millilitres (ml), centimetres (cm).

			HOW OFTEN? (Complete one column only)					
	Food	Portion size	Never	< 3 times per week	3 to 6 times per week	> 6 times per week	Once per two weeks	Once a month
Dairy Foods								
1	Whole milk	1 cup						
2	Low fat milk	1 cup						
3	Whole buttermilk	1 cup						
4	Low fat buttermilk	1 cup						
5	Yogurt with fruit	1 cup						
6	Whole yogurt	1 cup						
7	Low fat yogurt	1 cup						
8	Yogurt Salad	1 cup						
9	Ice cream or milkshake	1 cup						
10	Dairy cream	2 tbsp						
11	White cheese	½ cup						
12	Cream cheese	2 tbsp						
13	Sliced cheese	1 slice						
14	Cheddar cheese	1/3 cup						
15	Samosa cheese	2 pieces						
16	Muhalibah (Arabic Puding)	1 cup						
17	Cheese sandwich	1 sandwich						
18	Cheese sandwich & egg	1 sandwich						
Fruits								
19	Apple	I fruit						
20	Banana	I fruit						
21	Fig	¼ cup						
22	Grapes	1 cup						
23	Oranges	I fruit						
24	Mandarin	I fruit						
25	Mango	I fruit						
26	Lemon	I fruit						
27	Guava	I fruit						
28	Pineapple	1 cup						
29	Resin	½ cup						
30	Apricots	I fruit						
31	Olives black	½ cup						
32	Fresh dates	1/4 cup						
33	Dry dates	½ cup						
34	Fruit juice	1 cup						
35	Fruit salad	1 cup						

			HOW OFTEN? (Complete one column only)					
	Food	Portion size	Never	< 3 times per week	3 to 6 times per week	> 6 times per week	Once per two weeks	Once a month
	Vegetables							
36	Tomato or tomato sauces	1 cup						
37	Arugula	1 cup						
38	Potato	1 cup						
39	Broccoli	1 cup						
40	Carrot	1 cup						
41	Pepper	1 cup						
42	Cucumber	1 cup						
43	Eggplant	1 cup						
44	Thyme	1/2 cup						
45	Lettuce	1 cup						
46	Mushrooms	1 cup						
47	Bean	1 cup						
48	Onion	1 cup						
49	Squash	1 cup						
50	Cabbage	1 cup						
51	Molokiah	1 cup						
52	Corn	1 cup						
53	Chickpeas	1 cup						
54	Spinach	1 cup						
55	Fresh salad	1 cup						
56	Mixed vegetables	1 cup						
57	Fava	1 cup						
58	Okra	1 cup						
59	Stuffed grape leaves	1 cup						
60	Muhashi(stuffed vegetables)	1 Piece						
61	Tosat with vegetable	I fruit						
62	Vegetables soup	I fruit						
Meat, egg &fish								
63	Egg	One						
64	Meat (beef, lamb, hotdog)	30 grams						
65	Ground beef, meat balls	½ cup						
66	Beef liver	½ cup						
67	Cheeseburger	One						
68	Meat Shawarma	One						
69	Kababo	1 cup						
70	Chicken grilled	1 piece						
71	Chicken rotisserie	1 piece						
72	Chicken boiled	1 piece						
73	Chicken masala	1 cup						
74	Fried Chicken	One piece						

		HOW OFTEN? (Complete one column only)						
	Food	Portion size	Never	< 3 times per week	3 to 6 times per week	> 6 times per week	Once per two weeks	Once a month
75	Chicken Shawarma	One						
76	Chicken soup	1 cup						
77	Chicken salad	1 cup						
78	Mutabak	3 pieces						
79	Fish	30 grams						
80	Tuna	30 grams						
81	Shrimp	30 grams						
82	Crawfish	30 grams						
Cereals, Bread & starches								
83	Corn flakes	1 cup						
84	Bread naan	¼ naan						
85	Pita, whole wheat	½ pita						
86	Pita, white	½ pita						
87	Roti	One						
88	Whole wheat slice	One						
89	White slice	One						
90	Croissant	One						
91	Pancake	One						
92	Waffle	One						
93	Muffin	One						
94	Rusk toast	3 pieces						
95	Rice	1 cup						
96	Chicken Kabsa	1 cup						
97	Meat Kabsa	1 cup						
98	Rice with vegetables	1 cup						
99	Rice Bukuri	1 cup						
100	Rice kably	1 cup						
101	Salige	1 cup						
102	Kushari	1 cup						
103	Jurish	1 cup						
104	Margoog	1 cup						
105	Potato	1 cup						
106	Noodles	1 cup						
107	Pasta white sauce	1 cup						
108	Meat pasta	1 cup						
109	Chicken pasta	1 cup						
110	Pizza	1 slice						

		HOW OFTEN? (Complete one column only)						
	Food	Portion size	Never	< 3 times per week	3 to 6 times per week	> 6 times per week	Once per two weeks	Once a month
111	Fatayer with chees	3 pieces						
112	Fatayer with chicken	3 pieces						
113	Fatayer with meat	3 pieces						
114	Fatayer with labanh	3 pieces						
115	Fatayer with Zatar	3 pieces						
116	Fatayer with vegetables	3 pieces						
117	Kubbah	One						
118	Whight soup	1 cup						
119	Zalibah	5 pieces						
Beverages								
120	Water	1 cup						
121	Black tea	1 cup						
122	Green tea	1 cup						
123	Arabic coffee	3Vinga						
124	American Coffee	1 cup						
125	Orange Juice	1 cup						
126	Apple Juice	1 cup						
127	Lemon juice	1 cup						
128	Mango Juice	1 cup						
129	Guava Juice	1 cup						
130	Mixed juice	1 cup						
131	Soda, Coca-Cola	1 cup						
132	Soda, Sprite	1 cup						
134	Soda Miranda	1 cup						
Sweets, baked goods& miscellaneous								
135	Chocolates (snickers, Twix	1 Piece						
136	Cookies	1 Piece						
137	Honey& Jam	1 tbsp						
138	Doughnuts	One						
139	Popcorn	1 cup						
140	Cheesecake	1 Piece						
141	Pie, apple	1 Piece						
142	Bas Bosa	1 Piece						
143	Kunafa	1 Piece						
144	Masoop	½ cup						
145	Shirah with milk	1 cup						

			HOW OFTEN? (Complete one column only)					
	Food	Portion size	Never	< 3 times per week	3 to 6 times per week	> 6 times per week	Once per two weeks	Once a month
146	Chips	15chips						
147	Nuts	½ cup						
148	Cake	I Piece						
Fats& oil								
149	Canola oil	1 tbs						
150	Butter	1 tbs						
151	Olives oil	1 tbs						
152	Ghee	1 tbs						

Chapter 5, Paper (2)

(**Appendix D)**

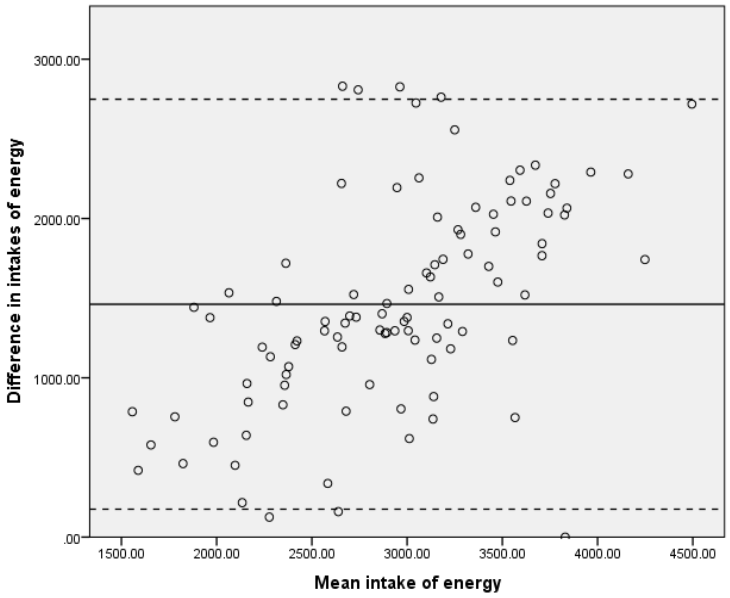


Figure 1: Bland-ltman method, used to evaluate the relationship between SFFQ and 24 –hour recall for Energy, difference between means, lower limit, and upper limit

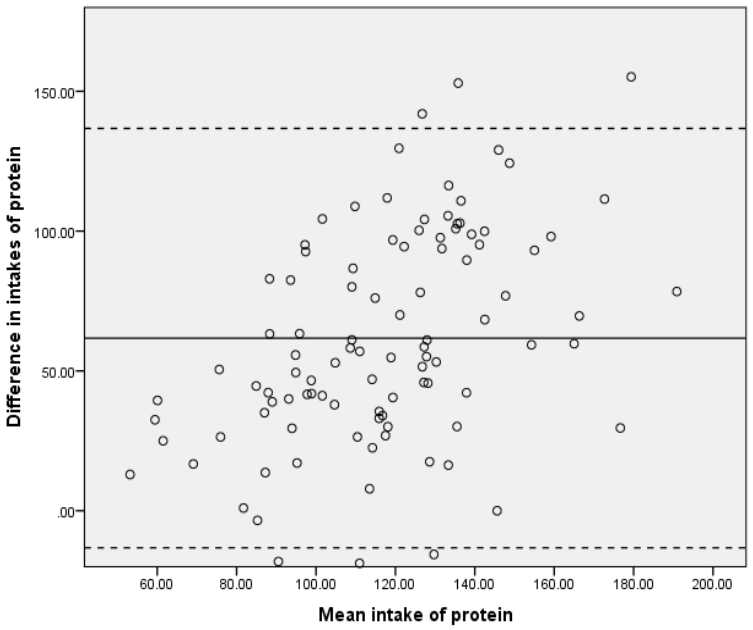


Figure 2:Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for protein, difference between means, lower limit, and upper limit

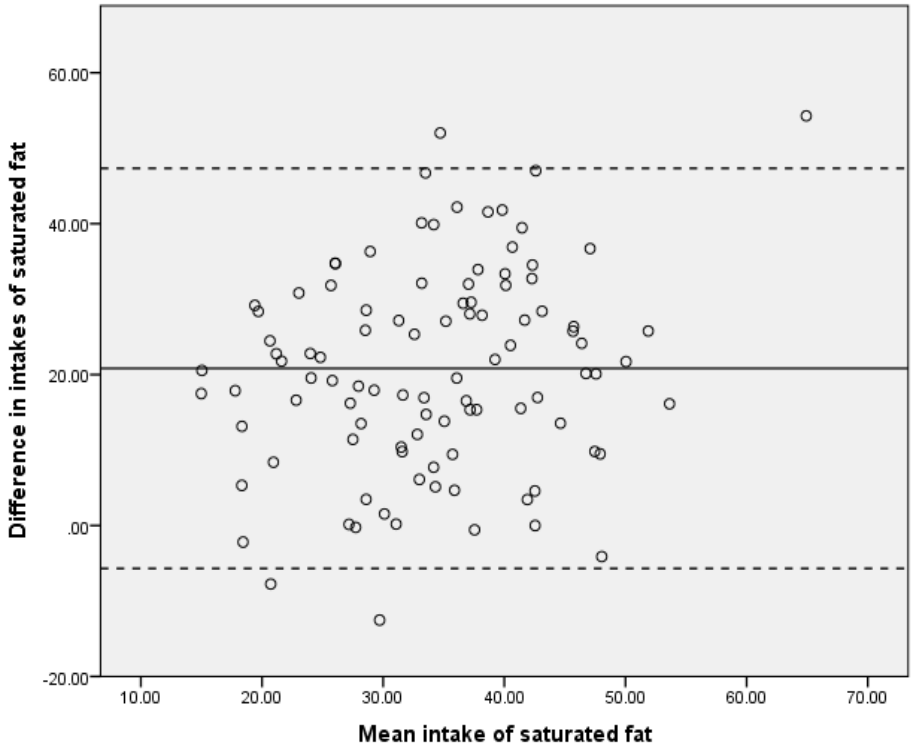


Figure 3: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for saturated fat, difference between means, lower limit, and upper limit

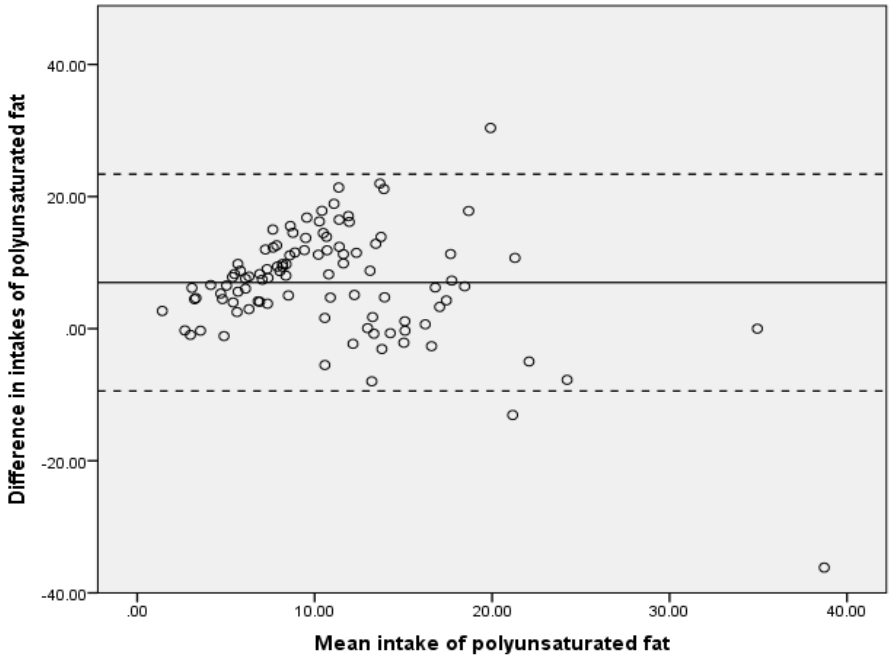


Figure 4: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for polyunsaturated fat, difference between means, lower limit, and upper limit

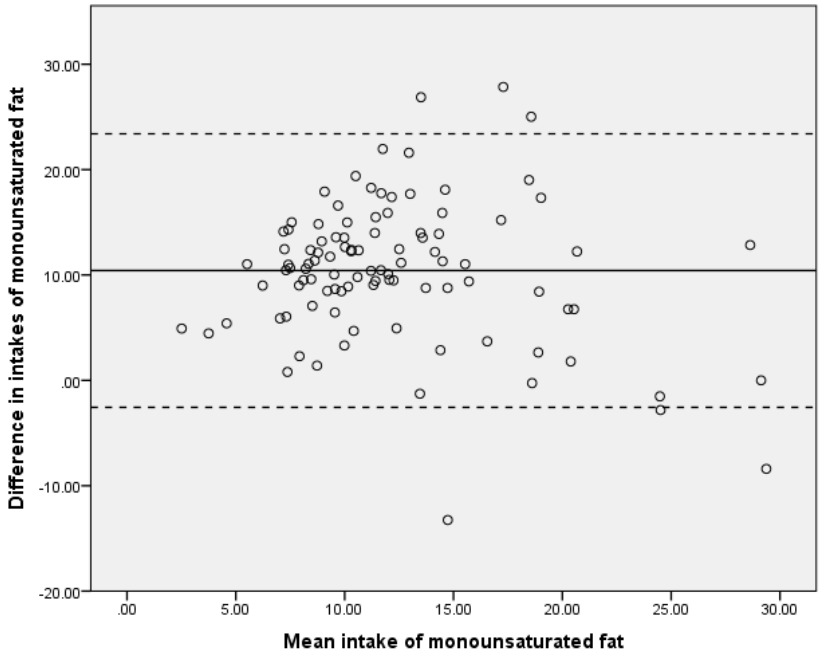


Figure 5: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for monounsaturated fat, difference between means, lower limit, and upper limit

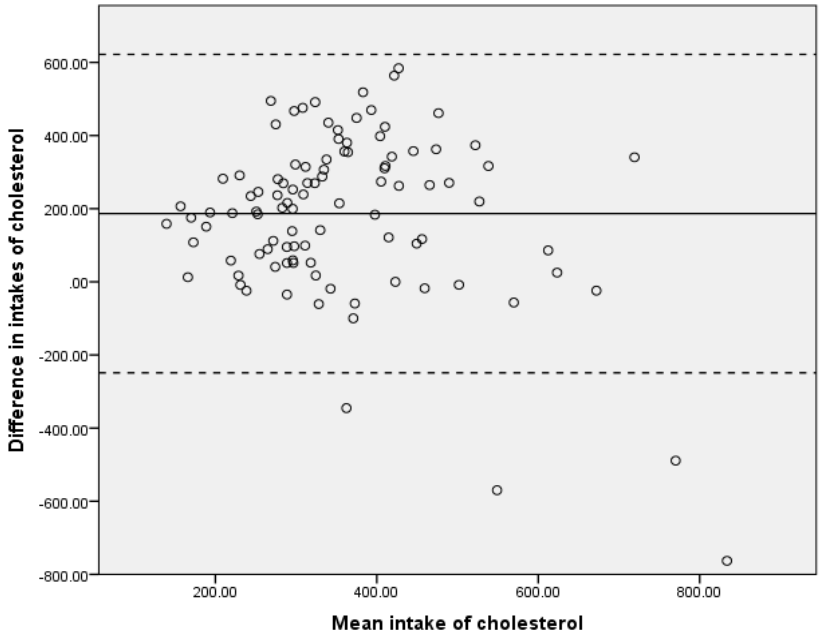


Figure 6: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for cholesterol, difference between means, lower limit, and upper limit

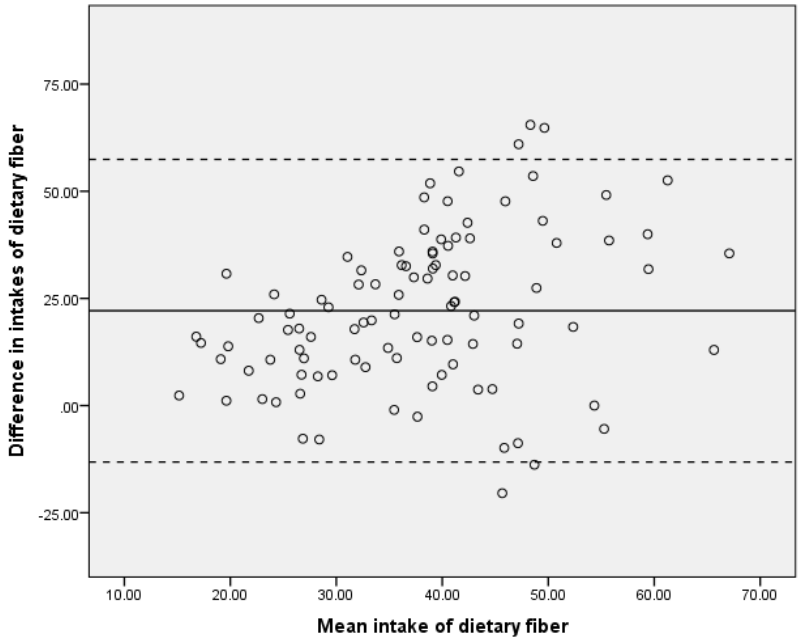


Figure 7: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for dietary fiber, difference between means, lower limit, and upper limit

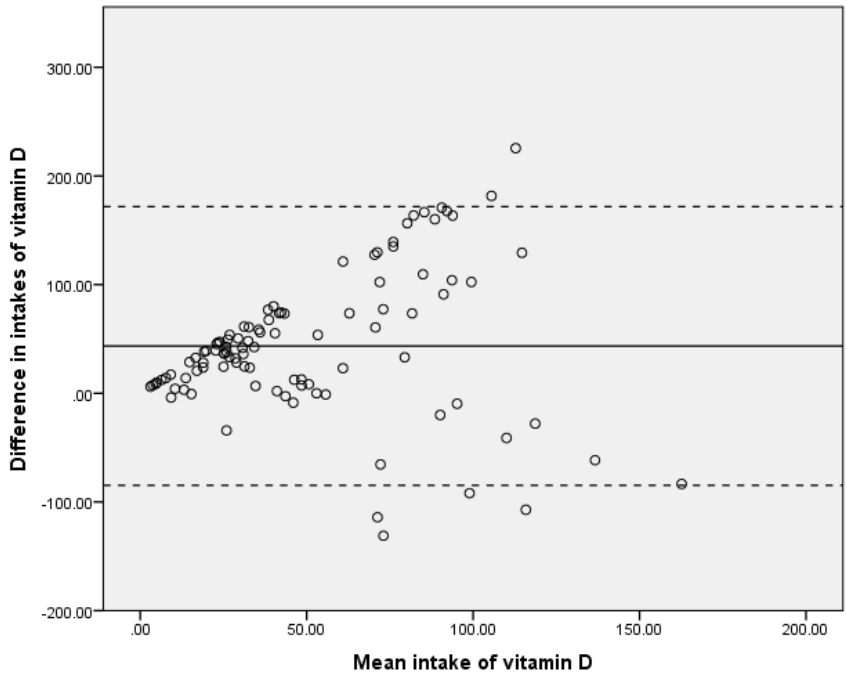


Figure 8: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for Vitamin D, difference between means, lower limit, and upper limit

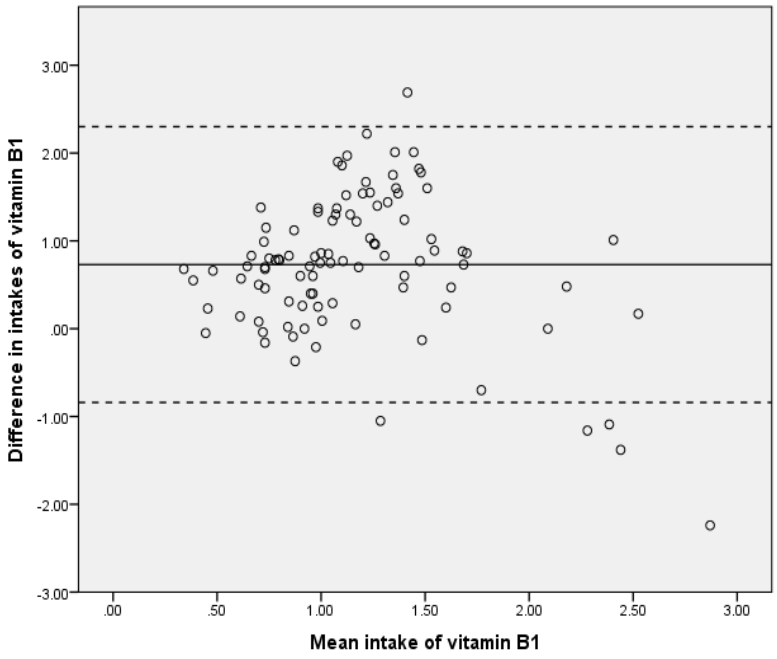


Figure 9: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for vitamin B1, difference between means, lower limit, and upper limit

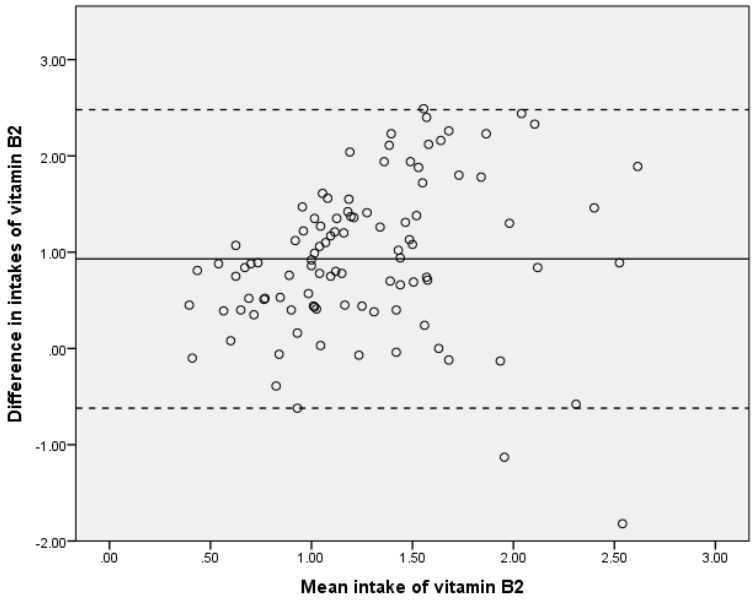


Figure 10: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for vitamin B2, difference between means, lower limit, and upper limit

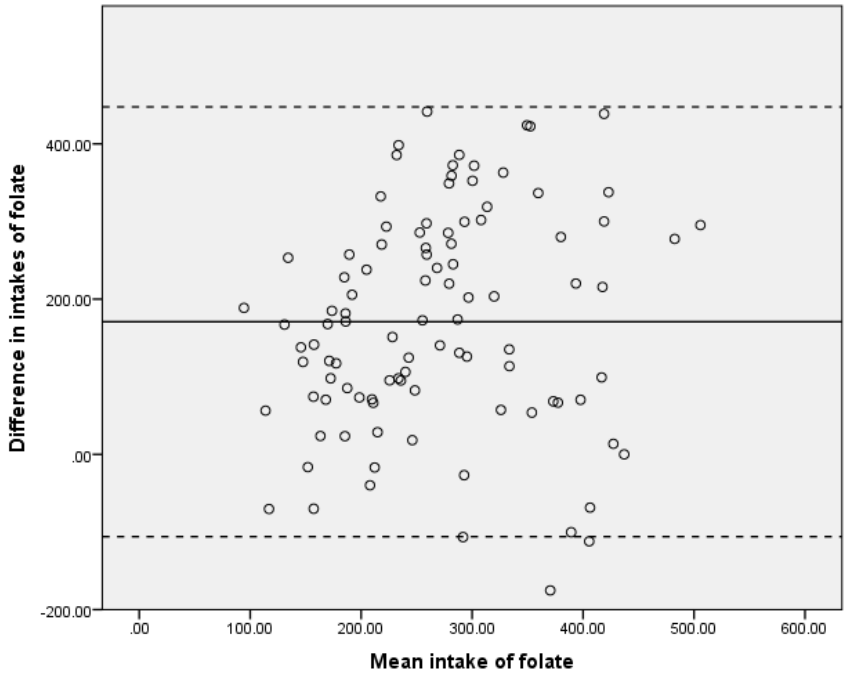


Figure 11: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for folate, difference between means, lower limit, and upper limit

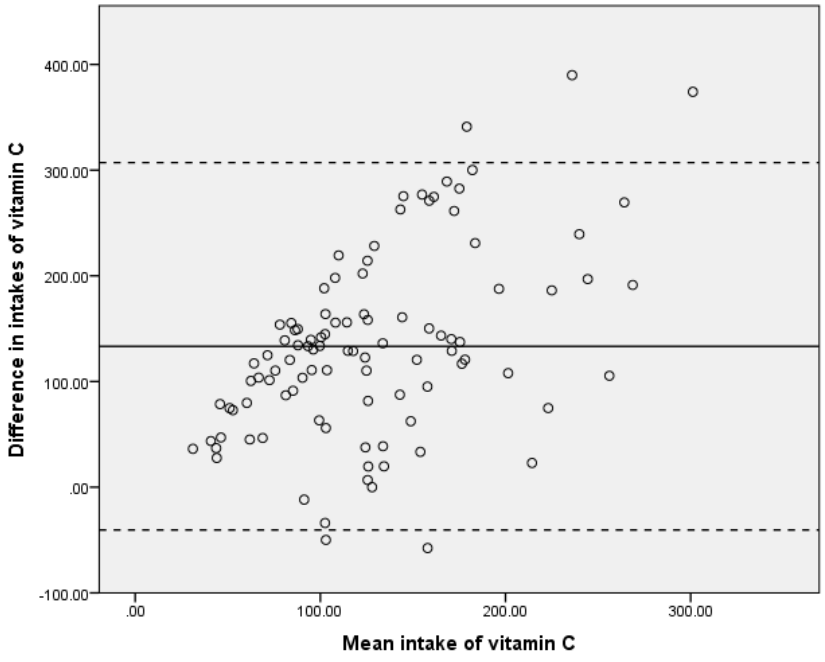


Figure 12: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for vitamin C, difference between means, lower limit, and upper limit

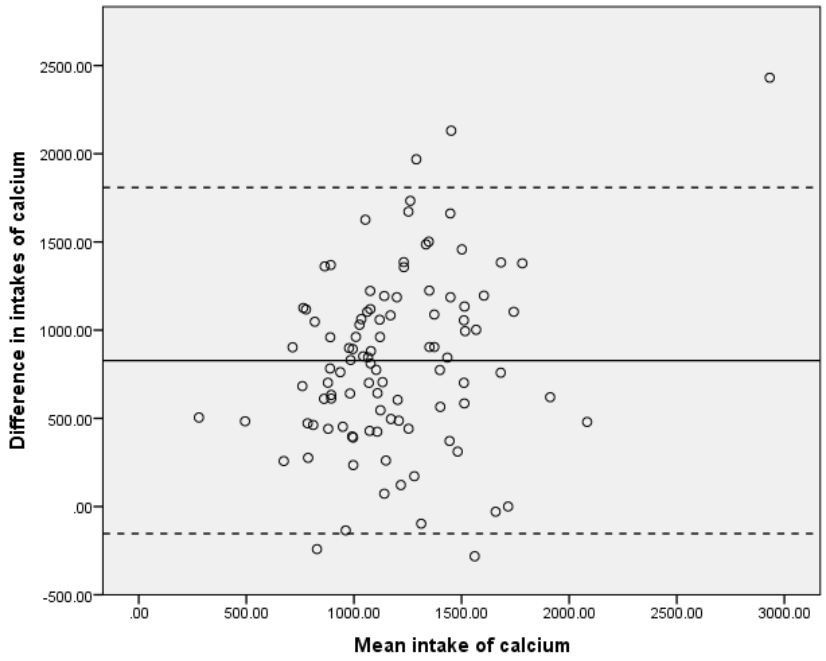


Figure 13: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for calcium, difference between means, lower limit, and upper limit

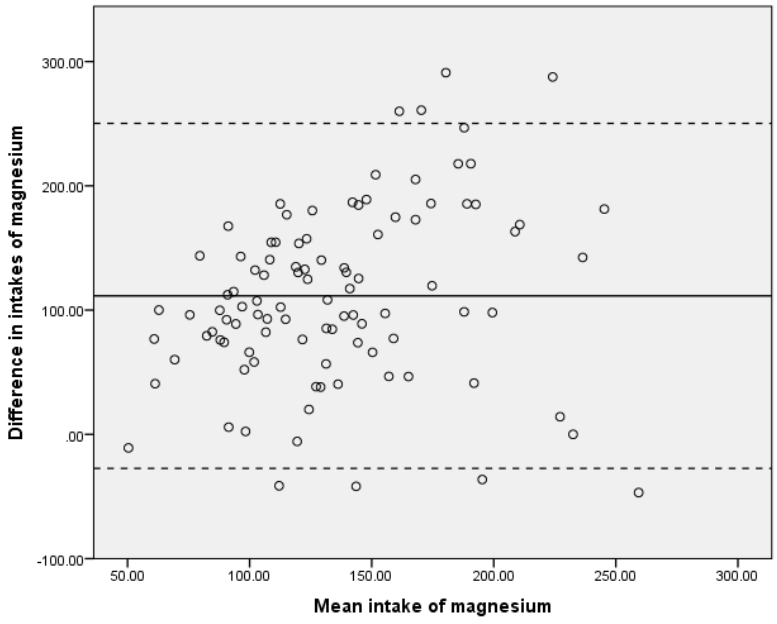


Figure 14: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for magnesium, difference between means, lower limit, and upper limit

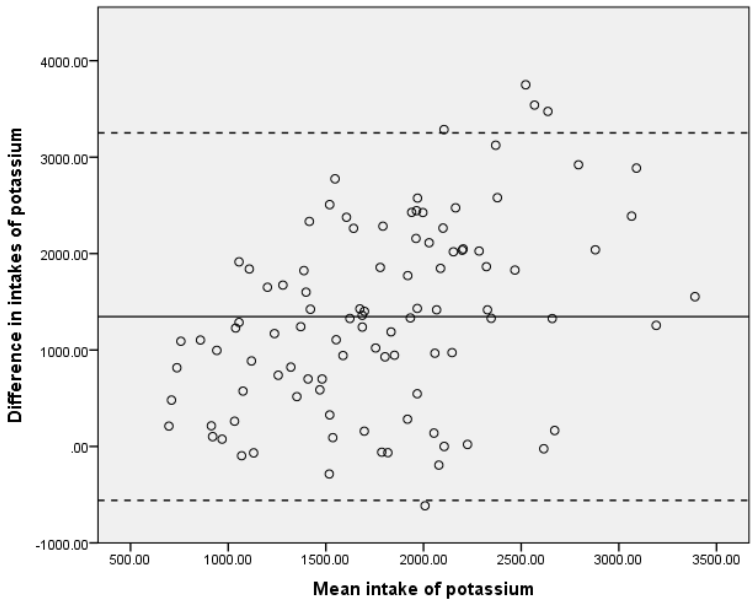


Figure 15: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for potassium, difference between means, lower limit, and upper limit

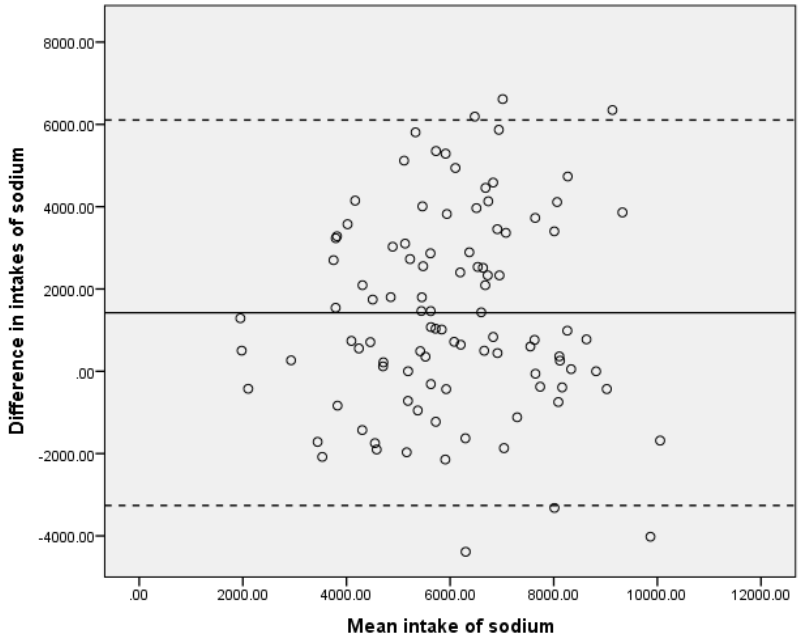


Figure 16: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for sodium, difference between means, lower limit, and upper limit

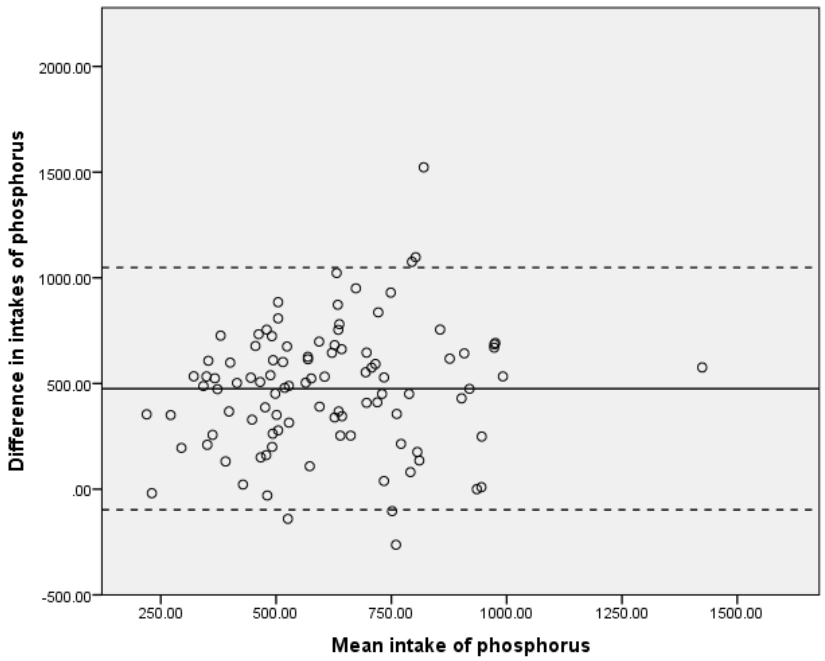


Figure 17: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for phosphorus, difference between means, lower limit, and upper limit

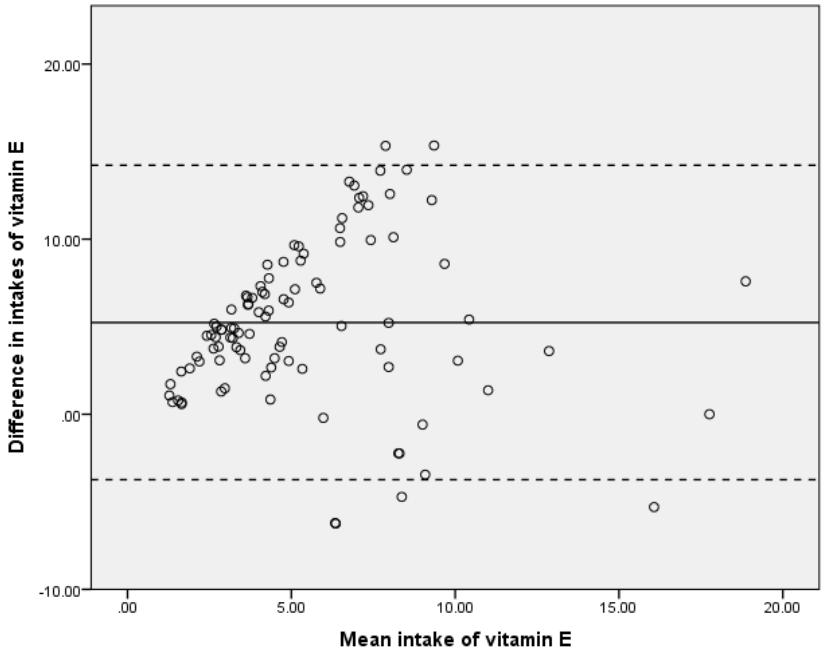


Figure 18: Bland-Altman method, used to evaluate the relationship between SFFQ and 24 –hour recall for vitamin E, difference between means, lower limit, and upper limit

Chapter 6, Paper (3)

Appendix E

Interview

Hi: My name is Norah Aljohani. I am a graduate student in University of Maryland, College park.

The University of Maryland College Park Department of Nutrition and Food Science is recruiting volunteers between 18-20 years old to participate in a research study that uses three days food record. Also, this research study uses a weekly e-mails and text messages developed to improve healthy eating and physical activity. Participants will receive personal study results on their food choices, physical activity levels, and body composition. If you agree that you will record your food for three days in form of three-food record. You will be asked to complete questionnaires (health history, demographic). Also, we will take your high, and weight. You will do that three times, one in the beginning of the semester, in the middle and at the end of the semester. The procedures involve that four face-to-face visits.

No blood will be drawn

Thank you,

Screening Interview

Participant Name _____ ID_____

Date _____/_____/_____ Phone _____ E-mail _____

Date of Birth: _____ Address: _____

1. Are you enrolled at Taibah University this semester?
   - ○ Yes. If yes, "What College do you attend?"----------
   - ○ No
2. Is this is the first semester for you at Taibah University?
   - ○ Yes
   - ○ No
3. Are you between 18 and 20 years of age?
   - ○ Yes
   - ○ No

4-Do you have access to email on a regular basis (at least once per week)?
   - ○ Yes
   - ○ No

5- Do you have cell phone enabled text messaging?
   - ○ Yes
   - ○ No

6. Are you currently in treatment for weight loss or bariatric surgery?
   - ○ Yes
   - ○ No

7. Do you have any chronic health conditions?

- ○ Yes
- ○ No

8. Have you ever been diagnosed with an eating disorder?
   - ○ Yes
   - ○ No
9. Are you pregnant or do you think you may be pregnant?
   - ○ Yes
   - ○ No
10. Are you nursing or lactating?
    - ○ Yes
    - ○ No

If the percipient answers yes for these questions (from 1 to 5) and answers No for these questions (from 6 to 8), the percipient will be eligible; otherwise, the percipient is ineligible.

- O Ineligible. Thanks
- O Eligible. Thanks. Let's schedule our first visit, when will be the best time for you?

_____

Appendix F

Name:_____Date of Birth:_____Age:_____Date:____

Phone number: _____Email_____College_____ID_____

Socio-demographic Questionnaire

1-What is your marital status? ☐Single ☐Married

If Single:

☐Never married ☐divorced ☐widowed ☐separated

If married, do you have children? _____ How many? _____

2- Where do you live?

- On-campus housing
- Off-campus housing

3-What is your family income level for this year 2014 in Saudi Riyal (per 30 days)?

- ≤ 4000 SR,
- 4001 SR to 6000 SR
- 6001 SR to 8000 SR
- ≥ 8001 SR
- Prefer not to answer

Health History Questionnaire

1. Have you ever been diagnosed with any of the following? □ No □ Yes, If yes please check √.

❑ Diabetes	❑ High Blood Pressure	❑ Other medical conditions (such as Thyroid disease, genetic disorders, etc.)
❑ Asthma	❑ High Cholesterol	
❑ Cancer	❑ Anemia	
❑ Kidney Disease	❑ Bleeding disorder	
❑ Liver Disease	❑ Heart Disease	

2-Do you have a food allergy? □ No □ Yes, If yes please check √.

❑ Peanut allergy	❑ Tree nut allergy	❑ Milk allergy	❑ Soy allergy
❑ Egg allergy	❑ Fish allergy	❑ Wheat allergy	❑ Seed allergy

Others: _____

3. Are you taking any medications? □ No □ Yes: If yes

Name the medicine: _____How often you take it _____

Dose _____ How long you have been taking it_____

4. Are you taking any supplements such as vitamins or minerals currently on a regular basis (at least once per week)? □ No □ Yes: If yes:

Name _____ How often you take it _____
Dose _____How long you have been taking it_____
Purpose of taking it_____

5. Any family history of the following? □ No □ Yes, If yes please check √.

❑ Diabetes	❑ High Cholesterol	❑ Stroke	❑ Obesity
❑ Heart Disease	❑ High Blood Pressure/ Hypertension		❑ Others_____

Current Physical Activity Patterns

Does your regular day involve sitting for large parts of the day? □ No □ Yes

2. Do you engage in regular physical activity patterns?
□ No □ Yes: If yes:
a) Frequency: the activity sessions per week?
☐ Always ☐Often ☐ Sometimes ☐ Never

b) Intensity: the activity sessions per week?
☐ sedentary ☐Moderate ☐Vigorous
c) Duration: minutes per session (on the average)?
☐ 0 minute per week ☐ < 100 minutes per week ☐ ≥100 minutes per week
d) How long have you been following this routine (circle one)?
☐Less than 3 months ☐3-6 months ☐6-12 months ☐More than a year

3. What types of exercises do you regularly do? Please check all that apply.
____ Walking ____ Running ____ Stair-stepping
____ Brisk Walking ____ Elliptical machine ____ Swimming
Other: _____

4. Do you have to do any household chores such as picking up everything that lies around
and bringing it to where it belongs? □ No □ Yes
If yes:
a) Frequency: the activity sessions per week?
☐ Always ☐Often ☐ Sometimes ☐ Never

b) Intensity: the activity sessions per week?
☐ Sedentary ☐Moderate ☐Vigorous
c) Duration: minutes per session (on the average)?
☐ 0 minute per week ☐ < 100 minutes per week ☐ ≥100 minutes per week

5. What is your usual pace of walking?
a. Casual (less than 3 km/h)
b. Normal (3 to 4 km/h)
c. Fairly brisk (4 to 5 km/h)
d. Brisk or striding (5 km/h or faster)

Thank you so much

Appendix G

Three-Day Record Form

Name: _____ Date of Birth:_____Age:____

Today date:____Phone_____Email:_____

Please read the instructions on the following pages very carefully.

- Please write down everything you eat and drink for three non-consecutive days
  (one weekend day and two weekdays). Start recording from midnight-to-midnight
- Record this in the column marked TYPE of FOOD and BEVERAGES including water.
- Record only amounts EATEN, not amount served.
- Please indicate in this column the name of the restaurant if you ate out.
- Under 'AMOUNT', record in 'teaspoons', 'cups', or fractions of these. You may use 'slices' or 'pieces' when necessary. If something eaten has a specific measurement on the label, record that amount. For example: Coke - 12 ounce can, Hershey bar 1.45 ounces.
- It is important to remember the following while recording different types of food:
  - Milk: State if whole, skim, fortified, powdered, liquid, evaporated, or chocolate.
  - Liquids: Record amount of milk and all beverages in 'cups' or 'liters'.
  - Bread: Specify white, whole wheat, raisin, etc.
  - Meats: Give the length, width and thickness of the portion, or its weight in 'ounces' after cooking.
  - Cereals, rice, and pasta: Record amount of cereals, rice, and pasta in 'cups' or fractions of cup.
  - Do not record in 'BOWLS'. List anything added e.g. fruit, sugar.
  - Fruits and Vegetables: Specify, fresh, frozen, canned, dried, or freeze dried.
  - Condiments: Record any jelly, butter, ketchup, mayonnaise or seasonings added.
  - Canned foods: Record what food is packed in – oil, water, syrup, etc.
  - See ways to size up your servings provided in the last pages.
  - If you have any questions please call this number 0505324293

Please answer the following questions**:**

1-What kind of fat is usually added to your food?

□ Real butter □ Margarine □ Vegetable oil □ Olive oil □ None

2-What kind of fat is usually used for cooking at home (exclude any type of spray)?

□ Real butter □ Margarine □ Vegetable oil □ Olive oil □ Canola oil □ None

3-What kind of milk do you usually drink?

□ Whole milk □ 2- 3% low fat milk □ Free fat milk □ Soy milk □ Skim milk □ Dry milk □ None

4- Do you eat seafood (fish, Shrimp, Shellfish)?

□ Always □ Often □ Sometimes □ Never

Please specify what kinds of seafood you eat?_____

5-Are you taking any supplements such as vitamins or minerals currently on a regular basis (at least once per week)?

□ No □ Yes: If yes:

Name _____ How often do you take it? _____

Dose _____ How long have you been taking it?_____ Purpose of taking it_____

Example

TIME	TYPE OF FOOD and BEVERAGES	AMOUNT	WHERE	METHOD OF PREPAR
7:30 am	Corn Flakes Milk	¾ cup	Kitchen	
	– 2% Banana	½ cup	" "	
		½ fruit		
	Tuna		Home	
12:00 (noon)	Bread, Whole	2 oz.	" " "	Baked
	Wheat Mayonnaise	2 slices		
	Tomato			
	Green Apple	1 tsp.	Home	
	Pepsi, can	2 slices		
		1 large		
	Medium Blizzard	12 oz.		
3:00 pm				
	Chicken (Breast)	Medium	Home	
	Green Beans			
6:00 pm	Rice	3 oz.	Home	Grilled, no skin
	Apple juice	½ cup		Steamed, fresh
		1 cup		Boiled
		1½ cups		fresh

Day 2 TIME	TYPE OF FOOD AND BEVERAGES	AMOUNT	WHERE	METHOD OF PREPARATION

Day 2 TIME	TYPE OF FOOD AND BEVERAGES	AMOUNT	WHERE	METHOD OF PREPARATION

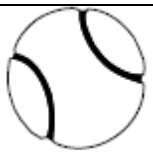
Day of the week:_____Is this a typical day? Yes No. If no, please explain._____

DAY 3 TIME	TYPE OF FOOD AND BEVERAGES	AMOUNT	WHERE	METHOD OF PREPARATION

Day of the week?_____Is this a typical day? Yes No. If no, please explain. _____

Ways to Size Up Your Servings

Remember

3 ounces of meat = thickness of a deck of playing cards		=	
A medium apple = tennis ball.		=	
1 ounce of cheese = 4 stacked dice.		=	
½ cup of ice cream = tennis ball.		=	
1 cup of mashed potatoes or broccoli = your fist.		=	
1 teaspoon of butter = tip of your thumb.		=	
1 ounce of nuts or small candies = handful.		=	

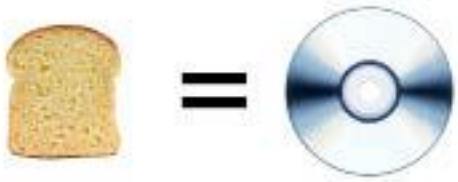
1 cup of Rice

½ cup of pasta

½ cup of cooked vegetables

250ml (1 cup) milk

One slice of bread or one six-inch Pita is about the size of a DVD.



½ cup of pasta

½ cup of cereal

1 cup of pasta

1cup of cereal

2 cup of pasta

2 cup of cereal

3 cup of pasta

3 cup of cerea

Appendix H

Example of e-mails and mobile telephone text messages

E-mail:

My Goal for this Week is Eating More Fruit

Why is it Important to Eat Fruit?. fruits have many health benefits.

Fruits give Individuals body nutrients to maintain healthy body.

Fruits are good sources of Vitamin C.

Your steps to accomplish this goal:

- Get started by making your favourite fruits list.
- Keep fruits handy. Store them washed, ready to eat and at eye level.
- Orange, apples, and bananas make a colourful bowl arrangement on the table.
- Include a piece of fruits in your lunch.

Mobile telephone text messages*:*

- Eat plenty of fruits every day and reduce the risk of heart disease.
- Choose and prepare foods with less salt and sauces.

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