An-Najah National University

Faculty of Graduate Studies

DEVELOPMENT AND VALIDATION OF FFQ SCREENER SOFTWARE FOR SODIUM INTAKE AMONG PALESTINIAN POPULATION

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Dedication

This thesis is dedicated to my mother, who taught me that higher degrees are the greatest treasures and acted as my initial motivation to continue learning. And also, to my husband, who constantly encouraged me to continue and provided me with support. And to my father, brother, sisters, and in-laws, who have stood at my side the entire time: thank you.

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I would also like to thank my family for their support, which provides me with passion and inspiration.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

DEVELOPMENT AND VALIDATION OF FFQ SCREENER SOFTWARE FOR SODIUM INTAKE AMONG PALESTINIAN POPULATION

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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ABSTRACT

Background: A high intake of sodium leads to cardiovascular, renal, and immune system effects. It also increases mortality from cardiovascular disease. Traditional sodium evaluation methods such as food frequency questionnaires (FFQ), 24-hour recall, and 24-hour records are inefficient and prone to error. Smartphone applications and software enhance the efficiency and accuracy of dietary assessment. The study aims to design and test a software-based FFQ screener to evaluate Palestinian sodium intake. Also, the relationship between dietary sodium intake, practices, and the FFQ screener, 3-day food recall, and 24-hour urine sodium levels was evaluated.

Methodology: The study consists of four phases. In Phase 1, Palestinian foods were classified and subclassified by method of consumption, sodium concentration, and food group. The Palestinian food culture determined serving size and frequency, whereas a database of food composition evaluated sodium levels. Three databases of food composition were used to validate the values. In Phase 2, four nutrition experts and three related researchers assessed the content validity of the FFQ screener. The screener was revised in response to their recommendations. In Phase 3, a pilot study assessed the reliability of test-retests. In Phase 4, the criteria validity of the screener was evaluated by comparing FFQ sodium intake data to 24-hour urine sodium test (Gold standard 1) and 3-day recall (Gold standard 2) results. SPSS was used to compare and evaluate the results.

Results: The FFQ sodium screener included 41 food items organized into nine categories, with photo-based estimations of portion size and frequency of consumption for each. The reliability test revealed a Pearson correlation coefficient of 0.70 (p0.01) between the test and retest results for 22 individuals. The correlation value between FFQ screener software dietary sodium consumption and 24-hour urine sodium test was 0.6 (p0.000) for criterion validity. The correlation between the FFQ screener software and 3-day recall sodium intake was 0.3 (p0.0001). A significant correlation exists between sodium intake, preferences for low-sodium foods, and previous salt reduction (p0.05). FFQ sodium was unrelated to salting after cooking, salted meal selection, or sodium on product labels ($p > 0.05$).

Conclusions: Software FFQ screeners are a valid and reliable method for measuring sodium intake. Validation assures a reliable and innovative approach to measuring sodium in the diet. Photo-based portion size estimation improves the accuracy of diet evaluation.

Keywords: FFQ; sodium; 24-h recall; 24-h urine and software.

Chapter One

Introduction and Theoretical Background

1.1 Background

Diet has a critical element in general health, start from the role in growth and development, to disease prevention and maintain wellness until its role in disease management. Due to differences in their constituents, different diets have different effects on the body. As an illustration, the Mediterranean diet, which abundant in nuts, olive oil, polyphenols, and antioxidants, has been associated with a reduced incidence of major cardiovascular risk events by 30%, a lowering of blood pressure by 5.8-7.3 mmHg in the systolic pressure and 3.3-3.4 mmHg in the diastolic pressure, a reduced cancer incidence and a lowering of non-chronic diseases(1).

Furthermore, there is DASH (Dietary Approach to Stop Hypertension) pattern which encourages eating of a variety of vegetables, fruits, fat-free or low-fat dairy products, whole grains, and various protein sources, along with reducing consumption of added sugars, saturated fats, and salt (less than 2300 mg per day). This diet's emphasis on sodium restriction has been demonstrated to reduce hypertension, and its concentrate on fat restriction has been shown to reduce the risk of cardiovascular disease and stroke (1). Comparing high adherence to low adherence to DASH showed a 20% reduction in cardiovascular disease(2). Furthermore, the Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet, which combined the two mentioned diets, demonstrated that utmost adherence to this diet reduced Alzheimer's disease by 53% and moderate adherence by 35%. Additionally, this approach increases cognitive functions. This diet emphasizes brain-healthy food choices such as green leafy vegetables, nuts, berries, beans, whole grains and salmon(3).

Sodium is a vital electrolyte in the blood, predominant in the extracellular fluids. It has a significant function in body health. One of its primary functions in the body is to regulate fluid balance and blood volume; Also, sodium is presumably required for muscles and neurons to function(4). Normal serum sodium levels range between 135 and 145 mmol\L (5). While the optimal sodium intake is less than 2300 mg per day(6). However, studies have demonstrated that sodium consumption exceeds the normal rate, with study demonstrating that sodium consumption for ages two and older exceeded 3400 mg per day (6). Increasing sodium intake causes critical problems including; renal system, cardiovascular system, vascular system, and immune system and the resulting problems and complications. According to the World Health Organization, consuming more than 5000 mg of sodium per day promotes severe hypertension and cardiovascular disease. The increasing sodium ratio causes water retention, increased oxidative stress, and endothelial dysfunction, all of which reduce NO(Nitric Oxide) generation(7). This causes systemic vascular resistance and arterial stiffness, which plays a major role in systolic and diastolic pressure(8). According to another study, excessive sodium intake (2300-5000 mg per day) and hypertension are the leading causes of chronic renal disease and cardiovascular mortality(9). Therefore, it was very important to focus on sodium intake in the management of cardiovascular diseases including hypertension. To assure proper control for sodium intake it is very crucial to use trusted and reliable method to evaluate dietary sodium intake. The availability of sodium intake data will enable the researcher to determine the sodium's short and long-term effect on developing diseases in healthy individuals or on treating chronic diseases in patients.

Dietary assessment methods such as the food frequency questionnaire (FFQ), the 24-hour recall, and the 24-hour record are among the most popular dietary assessment methods. In FFQ, participants are typically questioned about the frequency with which they consume particular food over a given time period. Using FFQ method in diet assessment has a number of benefits; affordability, usability and subjects can use it themselves. On the other hand, the poor estimation of food portions contributes to the inaccuracy of food intake quantification, and it may have an impact on the use of standard portion size. The 24 hours recall can be done face-to-face or telephone interview in which the respondent is asked what and how much he ate in the previous day (24 hours). This method has the advantages of being quick and having no effect on dietary choices. However, the subject may forget certain food items, and it is difficult to identify the exact consumed amount of food. In the diet record, the participant must write down every meal and its quantity consumed over the course of 24 hours. The primary benefit of this procedure is its precision, as it does not rely on memory or omission. However, the patient may alter his diet or refuse to participate in the record because it requires admittance to recording and is time-consuming (10).

The Most reliable method for sodium intake assessment is 24 hours urinary sodium. Therefore, it has been used in the literature as a gold standard to determine the validity of other tools used for dietary sodium intake assessment (11). The relationship between sodium intake using the FFQ or diet recall with 24-hour urine collection was shown to be significant (12). Ferreira et al. demonstrated that FFQ is a valid and accurate method for assessing nutritional consumption (13). As a result, 24-hour urine collection was selected as the standard for sodium FFQ and a 3-day recall period to verify that all consumed items were accounted for. Furthermore, a Saudi Arabian study confirmed the correlation between 24-hour urine collection and the dietary sodium intake using FFQ (14).

Technology is the discipline that facilitates all aspects of life. Using technology in nutritional assessment enhances efficiency by making it easier to recall the consumed food items and to estimate the amounts. Additionally, it may assist the users in recalling the consumed items by using photos or videos. The operation of making a system for dietary assessment is complex, beginning with the collecting of dietary data and continuing with the assignment of a code and quantity for each food item. The items are then examined by the food database. The application is finally tested and validated based on the outcomes of the data analysis (15).

The significance of the study depends on the fact that it is the first study in Palestine to assess sodium intake. Furthermore, because there are no studies in Palestine investigating the relationship between heart disease, kidney disease, and sodium consumption, this study might open the way for future research. Furthermore, the use of technology for assessing nutrients is rare in Palestine, and its implementation will represent a significant advance in clinical nutrition. It was determined through research that these applications and software are utilized in other nations, particularly in Europe. Due to various eating habits and food types, however, the same screeners or applications and software cannot be used; therefore, it was necessary to develop a unique software for Palestine based on its food culture.

1.2 General Objective

To develop and validate sodium intake screener by software for sodium intake assessment among healthy Palestinian adults utilizing Palestinian food culture. Also investigate the association between salt practices and FFQ sodium outcomes

Specific objectives

a. To determine the relationship between the dietary sodium intake and dietary sodium practices.
b. To determine the correlation between the dietary sodium intake using FFQ screener, 3 days diet recall and 24 hours urinary sodium.

1.3 Research Hypothesis

Using short sodium intake screener by software for sodium intake assessment is valid and reliable method to assess the sodium intake as compared to 24- hour urinary sodium and three days diet recall among Palestinian healthy adults .

1.4 Significance of the Study

Due to the severity of noncommunicable diseases, particularly CVD (Cardio Vascular Diseases) such as ischemic heart disease, which is regarded the leading cause of death in Palestine, the incidence of ischemic heart disease has increased by 31.2% from 2009 to 2019. The second leading cause of death in Palestine is stroke, which has grown by 22.4% in the ten years since 2009(16). While the prevalence of hypertension is 27.6%, it affects a greater proportion of men than women, and only a third of patients control their condition(17). Hypertension and CVD are connected, therefore reducing systolic pressure is associated with a 4% to 5% reduction in the relative risk of ischemic heart disease and cardiovascular death(18). Restriction of daily salt intake, which consists primarily of sodium, is associated with an average reduction in blood pressure, a lower incidence of hypertension, and a lower cardiovascular risk in the general population(18).

In addition to table salt, sodium is included in meat, rice, bread, and even vegetables. Additionally, primary Sodium sources vary from country to country. USA 75% of sodium is derived from processed foods. In China, 77.2% of sodium is derived from salt added during cooking, followed by soy sauce and vegetables, but in Japan, one-fifth of the sodium is derived from soy sauce and one-third from fish and soups(19). Therefore, it was required to develop a sodium screener to determine the average daily salt intake in Palestine based on the nature of the meals.

A valid FFQ screener application for sodium intake will mostly be utilized in research and hospitals to create successful diets and medications for cardiovascular and renal patients. This will be developed into an application allowing patients to maintain their health and continue with their regular life without hospitalization. In addition, the results of this study will be utilized by researchers, hospitals, and communities.

1.5 Literature review

1.5.1 Nutrition and health

A healthy diet is one that meets the nutritional needs of the human body, improves general health, and prevents chronic diseases. Dietary patterns, lifestyle, and food selections have an effect on health. Several studies have been published to demonstrate the significance of the relationship between nutrition and health. Diverse dietary patterns have different effects on health due to the fact that various nutrients perform essential roles in the body. Some diets are beneficial, such as the Mediterranean, DASH, and MIND diets(1). And some diet have negative effect such as the Western diet, which is high in proteins and fats and low in vegetables and fruits that destroys nephrons (20).

Another factor that has an effect on health is food choices, which have been the subject of a lot of studies. One of these studies demonstrates that reducing meat and dairy intake has a positive effect on health. Reducing meat and dairy led to a 40% reduction in saturated fat, hence lowering the risk of CVD. Furthermore, lowering red meat consumption will also lessen colorectal cancer risk(21). Another poor meal choice is sugar, which increases body fat and CVD risk. Moreover, foods high in free sugar increase calories by 1275 kJ (95% CI 889,1660), which increases the risk of obesity and type 2 diabetes, especially when sugar-sweetened beverages are consumed. Compared to other carbohydrates, consuming free sugars results in an increase of 0.85(95% CI 0.5,1.2) kg in body weight while 20% diabetes type 2 risk rise for every 330 ml of this sweetened beverage (22).

According to a study demonstrating the association between CVD and dietary components, a rise in sodium will increase blood pressure, which leads to lethal CVD, whereas an increase in potassium will decrease stroke(23). In a research, reducing Sodium intake by 1 g per day and increasing Potassium intake (>120 mmol/L) will decrease CVD by 20% and stroke by 24%(2). In addition, fish and omega-3 reduce the risk of coronary heart disease , but processed meat, trans fat, and sugar-sweetened beverages raise the risk(23). Two servings/day versus one serving/month of sugar-sweetened beverages increases the risk of cardiovascular disease by 31%, while two servings/week of processed red meat increases the risk by 7%. Similarly, replacing SFA (Saturated Fatty Acid) with TFA (Trans Fatty Acid) will boost the CVD by 5%. Likewise, fiber consumption improves cardiac health and reduces CHD (Chronic Heart Disease) by 6%(2).

1.5.2 Health effect of sodium

Sodium is the predominant cation in ECF (Extra Cellular Fluid) with atomic mass 23 mg. 50% of the body's sodium is distributed in ECF (2430-2610 mg), while 1100 mg is intracellular and 3500 mg is found in the skeleton. The majority of sodium absorption occurs in the distal small bowel, while the kidneys maintain its balance. Because of its role in hemostasis and physiological functions such as transporting nutrients across the cell membrane, maintaining ECF due to its osmotic nature, and stimulating muscles and nerves, sodium balance must be maintained throughout the body(24).

Health problems are caused by even a slight elevation in sodium levels. Globally, uncontrolled hypertension is fatal, and sodium consumption is closely associated with hypertension. This is because an increase in sodium ingestion causes water retention and arterial vessel flow, which raises blood pressure. When the blood pressure in the renal arteries elevates, sodium and water levels decrease. This hemodynamic stress can cause microvascular endothelial inflammation, morphological remodeling, and functional difficulties. In addition, high plasma sodium levels can impact both large elastic and tiny resistance arteries (8). This negatively affecting the renin-angiotensin system, a significant homeostatic system that regulates body fluid volume, electrolyte balance, and blood pressure, this system plays a crucial role in the vascular relaxation mechanisms that impaired by hypertension(25). In response to an increase in plasma and CSF Na+, the hypothalamus and adrenals also produce endogenous ouabain (EO), a steroid hormone secreted by the adrenal gland. Both plasma [Na+] and plasma EO correlate positively with blood pressure. EO functions in the brain (hypothalamus) to increase sympathetic drive and in the periphery to increase arterial Ca2+ signaling and vasoconstriction due to its distinct effects on myocytes and endothelium. Aldosterone-EO-angiotensin II (Aldo-EO-ANG II) pathway is dependent on hypothalamic EO. To modulate Na+ homeostasis, all three hormones interact directly with hypothalamic neurons, kidneys, adrenal glands, and arteries. Slow (modulatory) pathways in the brain and periphery that are mediated by EO may contribute to the long-term elevation of blood pressure (25).

Numerous studies have indicated that a 4.4 g reduction in salt lowers blood pressure by 4.2\2,1 mm Hg. And since hypertension impacts heart health, it is found that consuming more than 2000 milligrams of salt per day has been shown to increase the risk of cardiovascular disease by 17% and the risk of stroke by 23%(26). In a study that looked into the influence of sodium on CVD by comparing low (less than 120 mmol/24 h), moderate (120–150 mmol/24 h), and high (more than 150 mmol/24 h) sodium levels, there are various components that influence the state of the cardiovascular system. Left ventricular hypertrophy is an indicator of cardiovascular mortality and morbidity, and dietary sodium intake is the strongest predictor of left ventricular hypertrophy in patients with essential hypertension. It was revealed that the left ventricular mass was greatest in patients whose sodium intake was more than the median. Also, a rise in heart rate increases mortality and the diastolic period. It was discovered that reducing sodium (42-341mmol24hfor 4-90 days) increases heart rate, whereas high sodium (250mmol24 hours for 7 days) decreases mean 24 h heart rate in normo and hypertensive subjects (27).

There is a strong correlation between high sodium intake and the development of chronic renal disorders, as an increase in sodium intake affects the estimated glomerular filtration rate (eGFR), which is crucial for sodium excretion. An increase of 5 mmol/L in serum sodium at baseline was related with a decline in eGFR of 7.4 mL/min/1.73 m2 over 6 years in patients with established CKD (Chronic Kidney Disease) (28). Due to this decrease in GFR and increase in tubular reabsorption, sodium accretion decreases, worsening the condition of CKD patients(29). Considering the impact of hypertension on the cardiovascular system and kidney function, there have been investigations examining the correlation between sodium restriction and blood pressure. Reducing sodium intake to fewer than 2000 mg daily has been shown to lower blood pressure, with a 3.47 mm Hg drop in systolic pressure and a 1.81 mm Hg drop in diastolic pressure (30).

In addition, high sodium impairs calcium metabolism in the body. Because of this, more calcium is excreted, and when serum calcium levels drop, more calcium is reabsorbed from bones, resulting in osteoporosis. In addition to the association between high sodium levels and stomach cancer, asthma, and numerous other disorders(26). An ingestion of 500–1000 mg of sodium per kg of body weight is considered hazardous and potentially lethal(24).

Sodium is derived from the dietary supply, and the sodium content of different foods varies. The sodium content of oil, grains, fruits, and vegetables is around 20 mg/100 g less than that of whole milk, which contains 50 mg/100 g. Meat and fish contain between 40 and 120 mg per 100 g, while shellfish contain roughly 500 mg per 100 g. Depending on the amount of added salt, processed foods contain substantially more sodium. For instance, cheese may contain 2,500 mg per 100 g (24).

1.5.3 Diet assessment

The main objective of dietary assessment is to determine an individual's average dietary intake. Dietary assessment techniques include the 24-hour diet recall, the diet record, and the food frequency questionnaire (FFQ), each of which has distinctive characteristics.

Diet recall

It is a retrospective strategy that requires a qualified interviewer to conduct a direct face-to-face or telephone interview to record in detail the foods consumed(31). A coding system is utilized to assign food types and serving sizes with numbers that facilitate computer analysis (32). The interview starts by asking about the participants' previous day's main meals and snacks. The interviewer jogs the memory of the subject by reminding him about activities that may be related to his eating and drinking habits(32). When using 2- to 5-day recalls to determine the real average amount of food consumed in order to eliminate day-to-day variation. This approach has a great degree of precision and reliability. Also, seasonal fluctuations should be considered, and holidays should be used as one of the remembered days. The biggest drawback is that it relies on memory, which can misrepresent actual consumption (31).

Diet record

It is prospective, with the participant keeping track of everything they eat and drink for a specific period of time (usually 3-7 days), either digitally or manually, and they can estimate or weigh their food using common kitchen equipment (33). This method does not rely on memory but demands a significant chunk of cooperation. In addition, 30-50% of participants in this method alter their diet or lower their daily items in order to reduce recording time, leading in underreported results (32).

FFQ (Food Frequency Questionnaire)

It is a retrospective method, which is a low-cost method that relies on frequently consumed foods or nutrients over a period of one month to one year; consequently, it can be utilized for researches, specifically for nutrients assessment (33). There are three varieties of FFQs: Nonquantitative questions that inquire how often a person consumes a specific food item, such as rice, per year, month, week, or day (32). While semiquantitative provides respondents an indication of portion size, it asks how often a person eats a cup of salad, for example, annually, monthly, weekly, or daily. Quantitative inquire how many times each year, month, week, or day a person consumes a specific food item and ask about the portion size (32).

FFQ screeners

Via the FFQ screener, it is feasible to detect a single nutrient or ingredient, such as calcium, fiber, or fruits, but not the whole diet. This method is used to determine the association between a nutrient and a disease, such as the association between dietary fat and cardiovascular disease(32). This can be verified by a diet record and a 24-hour recall, in addition to nutritional biomarkers in the blood, urine, or tissue (31). However, a 24-hour recall is preferred(34), and a 24-hour urine sample for sodium nutrient levels is the gold standard(27). That because more than 90% of sodium consumed is eliminated in urine. However, the variation in salt intake from day to day (20%) cannot be ignored, hence it was preferable to take repeated samples. (27).

MEDFICTS Nutritional Assessment Questionnaire (Meats, Eggs, Dairy, Fried Foods, In-Baked Goods, Convenience Foods, Table Fats, Snacks) is a popular screening tool that measures a person's intake of total fat, saturated fat, and dietary cholesterol by focusing on high fat food groups. If the score is over 70, the individual should alter his diet to prevent heart disease. There is also a National Health and Nutrition Examination Survey (NHANES)examines the relationship between nutrients and cancer. National Cancer Institute first utilized 24-hour recalls, but because there is diet variance from day to day, multiple 24-h recalls were required, making it difficult for participants. In addition, there are epidemiological screeners, such as the Willett Questionnaire, that detect the associations between nutrient and food intake and the risk of chronic disease. This approach is distinctive in that it is self-administered, requires minimal time, and is inexpensive. It is convenient to utilize in research if the items are representative and do not exceed 150, but it is difficult to construct.(32).

Sodium intake assessment using FFQ screener

A number of studies demonstrated the optimal method for evaluating sodium screener. Estimates of food sodium consumption and urinary excretion were compared with 24-hour urine samples in a research involving 802 participants in Ireland in 2015(11). The study illustrates that 24-h urine is the gold standard for indicating of sodium intake, contrary to the findings of certain studies that used spot urine samples instead(11). This is supported by study conducted on the South Island of New Zealand by R. Peniamina et al. Despite the diverse age group (9-11 years), the results revealed that 24 h urine accurately measures sodium intake(35). Despite the mean group error, calculating dietary sodium is superior to recall and FFQ since it takes less than 20 minutes(11). Also, 24h recall underestimates sodium intake by less than 9% compared to the biomarkers, which may be related to a lack of knowledge of the actual amount of salt used in cooking(11).

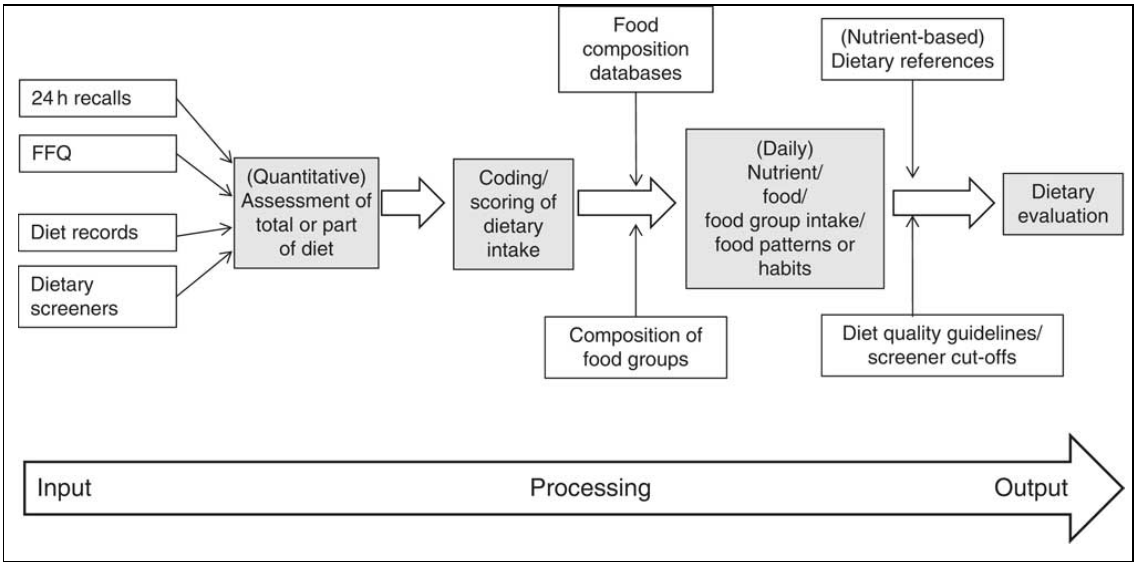
Alkhalaf, M. M., et al. conducted research in Saudi Arabia in 2015 on the salt intake of 601 individuals between the ages of 19 and 60 using multiple repeated 24-hour dietary recall in comparison to 24-hour urine collection and 133 questions FFQ. The association between FFQ and meal recall was poor, while the correlation between FFQ and urine excretion was high(14). Yuan, et al. research conducted in the United States in 2017 demonstrates that 7-day diet records had the highest associations with biomarkers of intake, and the short FFQ plays a crucial role in diet and health investigations, although requiring additional evaluation (36). There was a correlation between the three-day recall and the questionnaire, as well as the 24-hour urine, according to a study conducted on 324 individuals in South Africa in 2007 to create a short questionnaire to determine the amount of sodium intake(12). Another study found that using both the Recall and Record for three days and the questionnaire is preferable to using either method alone; Recall and Record estimate the amount of sodium consumed over a short period of time, whereas the questionnaire measures the rate of sodium consumption in general, but it is not optimal to be measured alone (13).

1.5.4 Using technology in diet assessment

Due to the significance of dietary assessment, which is not limited to calorie counting, for research and development, scientists are concentrating on developing a straightforward approach for obtaining direct findings. Technological advancements lower the time and cost of food evaluation studies. Now, an electronic diary and coding system employing images of food types and kitchen scales produce more precise and participant-acceptable data (37). Using technology in diet evaluation reduces bias and raises awareness of food intake, particularly for those with diseases who can then monitor their diet. There have been developed six types of technology-assisted instruments for nutritional assessment: interactive computer-based technologies, Personal Digital Assistants (PDAs), web-based technologies, mobile devices, specialized cameras and tape recorders, and scan and sensor technologies (38). These techniques enable health-care providers to comprehend their patients' food habits, hence enhancing the efficacy of health treatments(38). Utilizing technology to calculate nutrients is one of the development corners that aids the patient in adhering to a rigorous diet and facilitates the specialist's correct patient monitoring. However, the phases of diet assessment using technology begin with the input of diet recall, record, or FFQ data. Then, data coding and analysis are completed. The final evaluation will then be displayed(15). Figure1.1 shows the steps.

Figure 1.1

Dietary assessment as a system (15)



The FFQ data must be compared with photographs to clarify the type and quantity of meals (15). Additionally, it might have options that display the precise quantity, such as double or treble the quantity in the image, to eliminate any prejudice.

Smartphone application in diet assessment

Smartphones are now ubiquitous, with at least one smartphone in every home. In 2017, studies found that nearly everyone aged 18–29 owned a smartphone, while nearly half of those aged 65 and up did as well(39). They enable web browsing and the usage of online applications (40). That allow digital dietary assessment simpler, cheaper, faster, more acceptable, and more popular (41). One of the benefits of using a smartphone for diet assessment is that it enhances the participant's serving size estimation by placing the responsibility in their hands (41).

Researchers found no evidence of bias or statistically significant differences between smartphone diaries and 24-hour recall(39). In fact, it has been demonstrated that using the app is preferable to the traditional method, as the burden has decreased and the interest in the app has increased due to its designation as a component of the technology, along with important additions like the ability to take a picture of food and analyze it or the presence of different items and their images, which facilitated selection and labeling(39). Another study on pregnant women demonstrated the flexibility of dealing with applications, as well as the reliability and validity of its findings, which were found to be identical to those of the traditional methods (42).

My Fitness Pal is a mobile application that assists users in calculating their calorie consumption. This is going to include psych educational content and referral information regarding food disorders. This enables patients with chronic diseases to utilize the program. Even though the app does not provide specific information or screening for eating disorders, it does warn users against consuming below a certain calorie threshold(43).

Previous studies review

Numerous previous studies investigated the same field as ours and utilized a comparable methodology. In 2015, an Arab investigation on salt involving 601 participants, 55% of them were women, aged 19 to 60 was conducted in Saudi Arabia by Alkhalaf et al. All participants complete the FFQ and 24-hour recall, but only 71 provide urine samples; 49 participants supplied 24-hour urine collections that were accepted using the creatinine index. P- value 0.05 was used. Altman diagrams were used to illustrate the difference between FFQ with each urine sample and 24 h recall(14).

The study by Ferreria et al. was based on 132 randomly selected participants (the majority of whom were women) aged 18 to 85. It was conducted on the sodium intake of hypertensive participants. A 24 h recall (132 subjects), a 3 days diet record (121 subjects), and a biomarker (24 h urinary Na; 121 subjects) served as gold standards for validity. The overall validity of the FFQ was determined by calculating Spearman correlation coefficients between self-reported salt consumption and Na excretion from a 24-hour urine sample with P-value 0.05 while the Mann–Whitney test was used to detect variations in gender between self-reported salt consumption and 24 h urine Na, and the kappa coefficient was used to evaluate the reproducibility of the FFQ. (13).

The study by Charlton et al. examined the salt ingestion of South Africans in 2007. It was conducted on 324 randomly selected men and women. Utilizing repeated 24-hour urinary Na values and 24-hour dietary recalls as gold standards on three separate occasions. Spearman correlation coefficient was used to test validity. Additionally, the Cronbach alpha test (coefficient) was performed for Na content. (12) .

Yuan et al. conducted a study on 627 women in the United States in 2017 regarding the nutrients (energy, protein, sodium, potassium, specific fatty acids, specific carotenoids, retinol, tocopherols, and folate). Validation techniques of semi-quantitative FFQ were 24-Hour Dietary Recall, 7-day dietary records, urine and plasma biomarkers. Spearman correlation coefficients (rs) and 95% confidence intervals for correlations between nutrient intakes reported on single and averaged 24 h recalls, Semiquantitative FFQs, and 7 days diet recalls and the corresponding biomarker intakes. When correlations between 0.4 and 0.6 (moderate correlations) with a "gold standard" approximation are deemed to represent a reasonably valid measurement. Furthermore, this study employed intraclass correlation coefficients to assess reproducibility (36).

The study by Peniamina et al. compared the following methods for estimating the intake of sodium, potassium, and iodine among 84 children aged 9–11 years in New Zealand: 24-h diet record, 24-h urine, and duplicate diets. 37 participants collected duplicate diets , all participants weighed food records, and 82 participants gave 24 hour urine samples within the same 24-hour period. The strength of the relationship between the methods was determined by calculating both Spearman's and intraclass correlation coefficients with p-value 0.05. Bland–Altman diagrams displaying the mean difference and 95% limits of agreement were generated(35).

In a 2015 study on sodium conducted in Ireland by Kelly et al., 802 participants between the ages of 18 and 64 participated, with 50 completing a 24-hour urine collection. Other FFQ validation techniques included a 24-dietary recall and spot urine samples. Bland Altman plots verified the 24-hour urine sodium gold standard and provided methods. While Pearson's correlation coefficients measured approach agreement and ANOVA was used to compare means(11). These studies are summarized in table 1.1.

It is readily apparent that the sample sizes ranged from 84 to 802 participants, and that the study's target population varied, but it is also evident that the sodium assessment methodologies relied heavily on FFQ, diet recall or record, and 24h urine analysis. In addition, all studies utilized a p-value less than 0.05, and the Spearman correlation test served as the primary test in all cases. Spearman correlation test assesses relationships between two variables. It is applicable to both linear and nonlinear relationships. Similar to the Pearson Correlation, the Spearman Correlation quantifies the covariance between two variables, or shared variance. Unlike the Pearson Correlation, which was ysed in Kelly et al. study, the Spearman Correlation utilizes data rank order(44). While some tests were used in one or two of the previously mentioned studies, such as the Kappa Correlation Test, which measures inter-rater reliability(45), the Mann Whitney Test, which is a nonparametric hypothesis examination that compares two independent groups(46), the Cronbach Alpha Test, which measures internal consistency and reliability(47), and the Intraclass Correlation Test, which measures the reliability of ratings or measurements for clusters, were not (48).

Bland Altman plots were also utilized in the majority of studies because they quantify the degree of agreement between two quantitative measurements by examining the mean difference and creating limits of agreement(49).

Table 1.1

Previous study review

Study author	Study year	Study country	Sample size	Nutrients that were studied	Validation method to assess nutrients	P-value	Statical test
Alkhalaf et al. (14)	2015	Saudi Arabia	601 participants aged 19-60	Salt	FFQ 24-h dietary recall 24-h urine collection	0.05	Spearman correlation test Bland Altman
Ferreria et al.(13)	2008	Brazil	132 low income hypertensive adults aged 18 to 85	Sodium	FFQ 24 h recall 3-d diet record 24h urinary Na	0.05	Spearman correlation test kappa coefficient Mann–Whitney test
Charlton et al.(12)	2007	South Africa	324 participants	Sodium	24-hour dietary recalls on three occasions 24h urine collection	0.05	Spearman correlation test Cronbach's α test
Yuan et al. (36)	2017	United State	627 women	energy, protein, sodium, potassium, specific fatty acids, specific carotenoids, retinol, tocopherols, and folate	Semiquantitative FFQ 24-Hour Dietary Recall 7-day dietary records Urine and plasma biomarkers	0.05	Intraclass correlation coefficient Spearman correlation coefficient
Peniamina et al.(35)	2019	New Zealand	84 participants aged 9-11	Sodium Potassium Iodine	24-h diet record 24-h urine Duplicate diets	0.05	Spearman correlation test Interclass correlation test Bland Altman plots
Kelly et al.(11)	2015	Ireland	802 participants aged 18-64	Sodium	A FFQ A 24-dietary recall Spot urine samples A single 24-24-h urine collection	0.05	Pearson correlation coefficient Bland Atman plots ANOVA

Chapter Two

Methodology

2.1 Study design

The research was conducted in four phases. The study design was formulated after comprehensive literature review of previously conducted studies for assessing sodium dietary intake among different countries (11), (35), (14), (36), (12), (13). Based on these investigations, the study four phases are: (1) FFQ screener development; (2) content validity; (3) pilot study for reliability testing (4) criterion validity.

Phase1: FFQ screener development

This phase started with categorizing the Palestinian food items into groups and subgroups depending on food classification and consumption method; i.e., bread bases dishes were all collected and categorized to subgroups according to sodium content, similarly salty snack; nuts, seeds, chips and popcorn they were collected in one group even they are from different food groups depends on the mood of consumption among Palestinians. Depending on this categorization: thirteen food groups were considered. These groups are listed next: 1) salty snacks consisting of the most popular chips kinds on the Palestinian market and popcorn. 2) Nuts, such as almonds, cashews, walnuts, roasted legumes, and seeds, etc. 3) Pickles, such as olives, turnips, peppers, makdous, carrots, and cauliflower, spread throughout Palestine. 4) Pastries in their various types. 5) All varieties of bread, including Arabic, French, Lebanese, wheat, and others. 6) Salads such as Arabic salad, tabbouleh, fattoush, cabbage salads, chicory, molasses and mayonnaise salads. 7) Dairy products containing salt, such as all types of cheese and labaneh. 8) Meat consists of red, white, fresh, processed, and canned forms, as well as its diverse cooking methods, including grilling, frying, and boiling, in addition to different meat components, such as liver. 9) Foods with tomato stew, including potato, okra, peas, vegetables, beans, and cowpea stews, and also dishes of kofta, eggplant, pasta, and potatoes. 10) The meals prepared with white sauce, including béchamel, mushroom cream, tahini, and yogurt. 11) Famous Palestinian rice recipes include boiled rice, makloubah, and others. 12) Soups including lentil, noodle, and freekeh, among others. 13) Others, such as thyme, hummus, falafel, beans, musakhan, ketchup, and mayonnaise, that were not included in the preceding categories. Several items, including milk, beverages, fruits, and vegetables, were omitted from the list since their sodium content is less than 30 mg per 100g.

The next step was determining serving sizes based on household measurements using the Palestinian Atlas (ladle, plate, etc.)(50) Additionally, each item's image was taken from the Palestinian atlas to help the user in quantification of the serving size. Then, the sodium content for each food item was extracted from the PALNUT website(51). PALNUT is Palestinian food composition database owned by Al-Quds University, the access to the data was done after taking the permission from the food composition table owner (Dr. Radwan Qasrawi). Then the other popular and well-known data bases including USDA database(52), and the Jordanian reference(53), were also used to compare the sodium content in the food items and to make sure that the sodium content is acceptable and consistent with the other databases. The sodium content was assessed and reported per 100 grams and per serving size of each food item, and compare the results between the three sources. Other items, such as pomegranate molasses, beverages, and chips, whose sodium content was not among the three references were determined by reading their food labels from many brands for the item and then take the mean of them. In each group, all foods with similar sodium levels were combined into one item, as long as the difference between them was less than 100 mg. Moreover, several of the categories were merged, resulting in nine groups (41 items) organized as follows: 1) Snacks consisting of chips, flour-coated chips, nuts, seeds, and popcorn. 2) Pickles including pickles in water, pickles in oil, and olives. 3) Bread-based dishes which include bread, manakesh, pizza and sfeha, baked pastries, and mussakhan. 4) Seeds as boiled rice, mahashe, cooked rice with veggies, cooked freikah, and bulgur. 5) Vegetable salads with and without salad dressing, such as pickles, pomegranate sauce, and mayonnaise. 6) Dairy products including white cheese, labaneh, Cheese Foundue, and Cheese Spreadable. 7) Meat, including burger sandwiches, processed or canned meat, lamb or beef cooked meat, chicken cooked meat, cooked fish, shawarma sandwiches, and KFC chicken. 8) Soups and stews containing soups with chicken broth, tomato sauce, or yogurt and lentil soup. 9) Side dishes such as zaater, hummus, fool msabaha, avocado with lemon, flafel, egg chicken fried W-olive oil, kubba, tomato paste, and macaroni.

Phase 2: Content validity

Four nutritionists and three researchers were invited and agreed to review and evaluate the FFQ screener. The researcher was asked to examine and evaluate the food items grouping, serving and the household measurement, if they are relevant and users friendly. After receiving that the reviewer done with the requested tasks, the results were discussed in an interview person to person to have final agreement for the best presentation for the food groups, serving size and the frequency of consumption. There was no remark on how the groups operate or their content; rather, clarifications were requested, such as the type of chips. Or a request to identify a quantity, such as determining the number of pickled olives per serving, however these explanations were resolved by adding photos to illustrate each item. There were no comments that required significant revisions. The majority of comments were clarification requests, as they were to confirm the items. Table 2.1 presented below illustrates the basic comments.

Table 2.1

Main comments of content validity

Category	Comments for screener developments development
1. Food groupings	No remarks
2. Serving size	They requested images of the portion sizes. They requested to identify a quantity, such as determining the number of pickled olives per serving
3. Frequency of consumption	No remarks
4. household measurements	No remarks

Phase 3: Pilot study and reliability

This phase consists of a pilot study to assure the reliability of the screener. Test and retest reliability test was done for reliability determination. The participants for the reliability were selected by convenience sampling, the 22 participants were provided with the screener and they were asked to complete the screener (test), then after 10 – 14 days they were asked to re-fill the same screener (re test). The results of the test and retest were computed manually by multiplying the consumption of each item by its sodium content, which was calculated and approved in the screener, and dividing by the number of repetitions, noting that these operations were arranged in the Excel software. Afterward, the correlation between test and retest outcomes was examined for reliability.

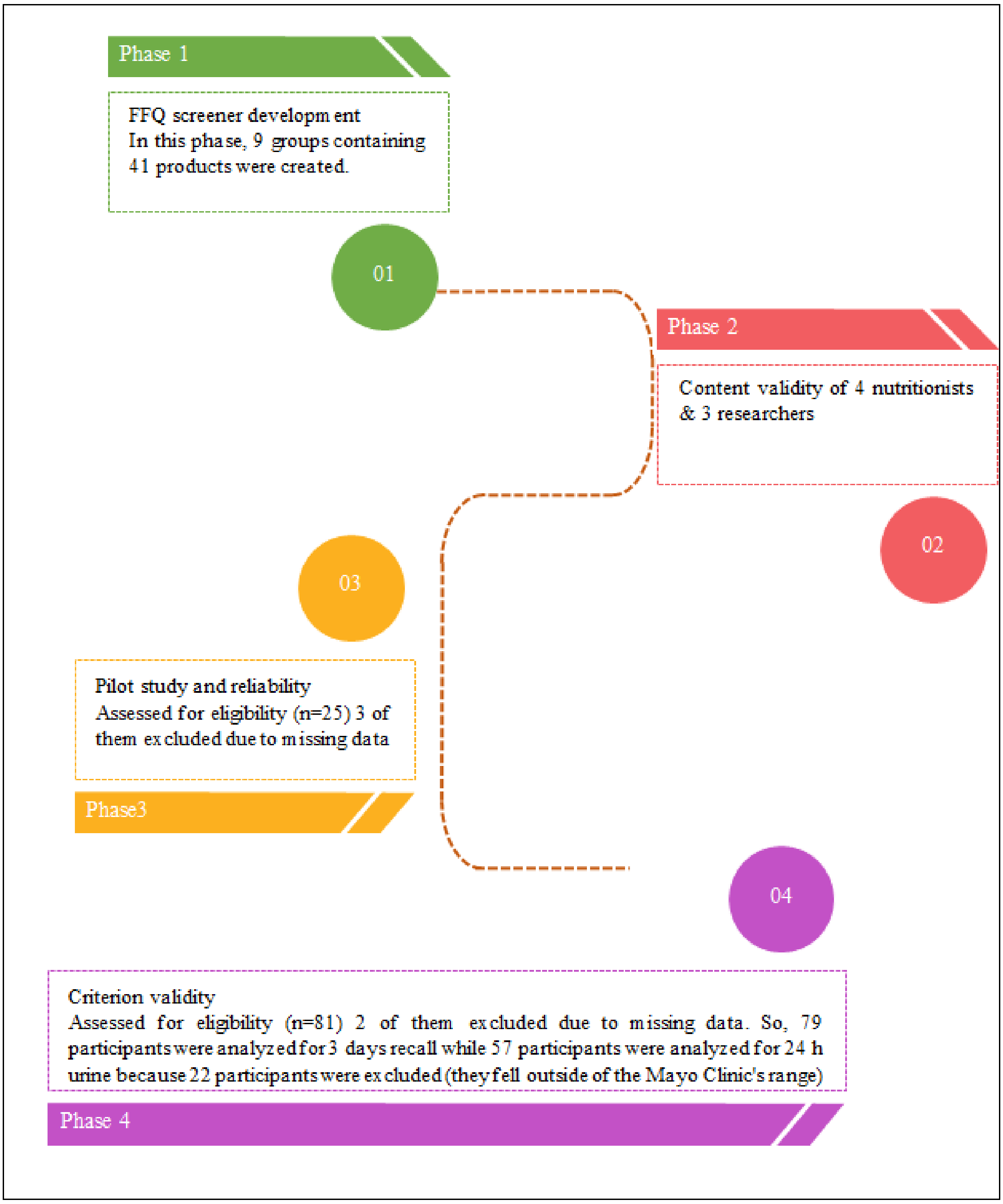
Phase 4: Criterion validity

The criterion validity was done for the screener by comparing the results of sodium intake from the screener with the sodium intake assessed by gold standard. The screener is shown in appendix A. There were two Gold Standards used for the screener's validity determination: the first gold standard is the 3-day diet recall(3DR), the second is 24-hour urinary sodium. Therefore, in addition to completing the screeners, the participants filled out a 3DR form and collected the urine for 24 hours. The 3DR form includes the timings of the day's initial and last meals. It also includes the number of items consumed, their time and place, whether they were consumed inside or outside the home. In addition to the type of meal, breakfast, lunch, or snack, the meal's name and quantity according to home measurements are recorded. Significant here is the meal consumption quantification that was determined based on the food atlas from Al-Quds University(54), which contains indexed pictures of food items and recipes that indicates the amount food consumed by grams. The form of the 3DR is shown in appendix B.
The diet analysis converting the food into nutrients was done by trained nutritionist specialist in the field, the calculated results of the three-day recall for each participant were reported then the average of the three days for each participant was considered as the sodium intake.

The second gold standard-24-h urine collection- each participant was given a urine container to collect urine after being instructed to discard the first morning's urine and then collect urine for 24 hours. After then, the volume is recorded(55). The samples were then stored in the university's refrigerator until a minimum of 15 samples were collected, after they were sent to the Al-Najah university hospital for sodium and creatinine analyses. The unit for calculated sodium intake (from the screener and diet recall) and measured sodium intake (using the 24 hours urinary sodium) were standardized from the three methods to be in milligram. These phases are summarized in figure 2.1.

Figure 2.1

Study phases flow chart



Sodium Screener Software

The development of a software for monitoring sodium intake is regarded as a significant advance in self-health management. This software contains 41 food items organized into 9 groups and aims to provide accurate information for self-monitoring of sodium consumption. This software contains common Palestinian food recipes, making it simple to control one's own dietary consumption and choose healthful food options.

The software's dietary database is rigorously curated using a range of common and culturally diverse recipes. That makes the software user-friendly and simple. The software provides users with an in-depth understanding of their sodium intake from different sources. This is organized to allow users to comprehend the distribution of high sodium sources by creating 9 groups containing 41 items. This classification simplifies the entry for users and provides recommendations for minimizing sodium consumption based on their consumption of particular food groups.

Utilizing significant factors such as serving size, frequency of eating, and sodium content of each item, the software creates a personalized health profile based on the inputted data after conducting an accurate analysis of the data, making the sodium screener an accurate and reliable tool. This enables users to make decisions regarding their dietary practices and make positive changes. In this regard, the screener mobile application, which is supported by a huge food database and complex analytical tools, enables individuals to alter their sodium consumption and improve their health.

2.2 Subjects characteristics

Study population

For the criterion validity phase: the study population consisted of 81 young, healthy Palestinian adults between the ages of 18 and 40 residing in the West Bank, the data was collected between June and December 2022.

Inclusion criteria

The individuals between the ages of 18 and 40 from the West Bank did not have any diseases that influenced their urinary sodium levels.

Exclusion criteria

Participants who were pregnant, diabetic, or who have high blood pressure or any disease affect urinary sodium level. Participants who didn't collect the total urine in the 24 hour were excluded: the exclusion for these participants was done depending on the creatinine in urine results, the creatinine values were compared to the reference ranges established by the Mayo Clinic (men: 13-29 mg/kg/day; women: 9-26 mg/kg/day)(56). If it was outside the acceptable range, means the participants didn't collect all of the excreted urine, so the participants were excluded.

2.3 Sampling method and sample size calculation

The sample size was calculated using MEDCALC software for a method comparison study, using the Bland-Altman plot. Type one error 0.05, type two 20%, expected mean difference (120mg), expected standard deviation difference 50 from (previous study AlKhalaf et al 2015) the allowed difference 250. So, the required sample size is 75 participants. The sampling method was done by convenient sampling technique(14).

2.4 Data collection for the survey phase

The data is collected by structured questionnaire that is consisted of five sections. First one which shows the demographic characteristics which are (1) age, (2) length and weight, (3) gender, (4) studying level, (5) place of residence, (6) nature of residence, (7) income, (8) marital status, (9) current work. While the section two identifies medical history and life style which focus on: (1) chronic disease presence, (2) medication taken, if any, (3) vitamins taken, if any, (4) previous surgery presence, (5) playing sports duration, (6) walking duration. Section three shows his practices for salt which is asked about: (1) adding salt, (2) salt preferring, (3) reading food labels to find sodium quantity, (4) salt reducing or choosing food with less salt. Section four of https://sodium.emfid.org/public/forms/survey/R8M7Vl4zbql3aprOZqEg?fbclid=IwAR0YL4e17Bh6lW9UM1NQneLwPjnIaRLero1V__vrTEQP_x_JBH3KSdiOHBc is an FFQ that asks respondents to determine the quantity based on the photos provided, such as whether it is double, triple, etc., as well as the frequency of occurrence (daily, weekly, monthly, or rarely), as shown in appendix A. Section five clarifies the three-day recall in terms of date, day, time, kind of food, and quantity according to the food atlas coding system(54), as shown in appendix B.

2.5 Study instruments

The participants collected urine for 24 hours using 24-hour containers of 2–4-liter capacity. If the initial specimen is done, urine from each container is poured into two cups, one for analysis and one for storage. Because 85 to 90 % of consumed sodium is eliminated via urine, a 24-hour urine test is the most reliable standard for sodium. Moreover, the over and under collections have been reported using the creatinine level(57).

3DR validates FFQ. In a study, one FFQ and four 24-hour administrations demonstrated a correlation of at least 90%. With this combination, the difference between predicted and actual sodium, potassium, and protein intakes was 0.39–0.61 compared to 0.35–0.55 for a single FFQ(58). To achieve the highest level of precision, it is essential to record the exact time, location, composition, and salt content of each meal consumed. The list of primary meals, breakfast, lunch, and dinner, is followed by a list of snacks, and then each participant is asked what he ate during each meal and in what quantities. The participant is asked about his daily activities to help him recall anything he may have forgotten, as well as if he had a drink or something to eat outside the home, or ate chips or candy.

2.6 The statistical analysis

All statistical analyses were performed with Statistical Package for the Social Sciences (SPSS) version 26.0 software. The alpha value for all statistical tests employed in the study was set at 0.05(59). Shapiro-Wilk Test was used to assess the continuous variables for normality. To evaluate the data, descriptive statistics including means and standard deviations were employed. Using percentages, the category data were described. The bivariate correlation test was used to correlate FFQ screener results with 3-day recall and 24-hour urine collection results. One-way ANOVA is utilized to assess the relationship between sodium practice questions and sodium FFQ results. The Bland–Altman plot is used to illustrate the variation in FFQ, recall and urine sodium results.

The Bland-Altman plot is an excellent starting point for comparing two measurements of the same variable. The Y-axis represents the difference between the two values, while the X-axis represents their mean. If one method consistently produces excessively high results, for instance, the chart will depict all points as being either above or below the zero line. It may also reveal that a specific method tends to overestimate large quantities and underestimate small ones. The presence of points above and below zero on the Bland-Altman plot indicates there is no apparent bias favoring one method over another(60).

2.7 Ethical consideration

Al-Najah University's Internal Review Board for Research Ethics authorized the study protocol number Bse July, 2022\28. This is viewed in appendix C.

Chapter Three

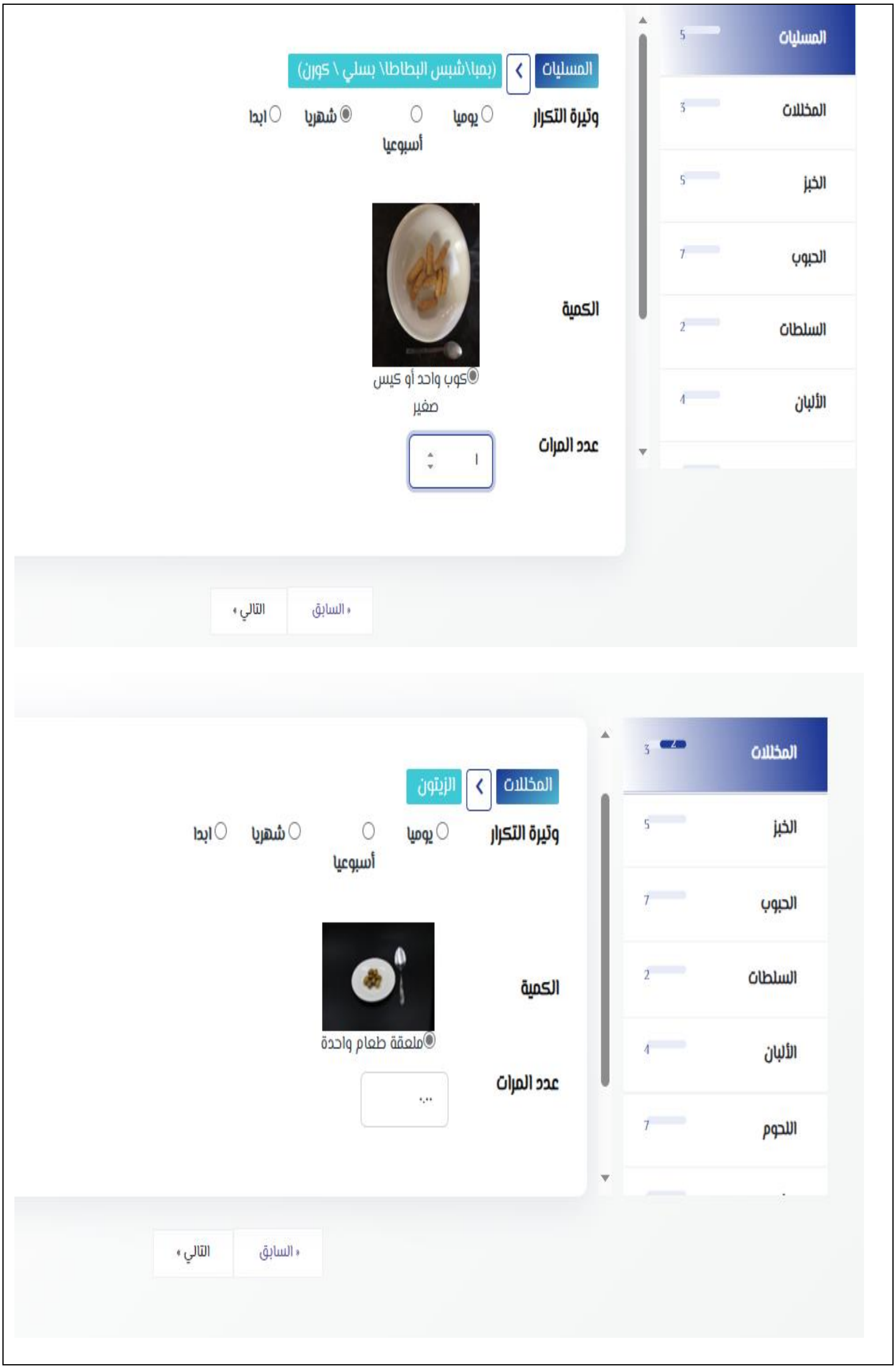
Results

FFQ development

The Na FFQ screener software's interface exhibits a high level of user-friendliness and graphic distinction. The webpage prompts the user to provide their name and code prior to presenting a multiple-choice query. The query applies to the addition of salt to one's food, specifically inquiring about the quantity of pinches added. The subsequent page is designed to prevent progression without the necessary information. The page that follows is divided into two sections, with the right side dedicated to food groups. The food items listed on the left side commence with the initial item inside the initial category. The questionnaire begins by asking about the item's frequency of consumption, namely whether it is consumed daily, weekly, monthly, or rarely. In addition, a visual representation of the item is provided, depicting its exact quantity as determined by a standard scale based on household measurements. The written representation of the amount is displayed beneath the image, along with the consumption frequency over the specified time. if the amount decreases by half, remains the same, doubles, or exceeds. The figure 3.1 depicts the arrangement of all components. The questionnaire ends with a presentation of the sodium content determined by the questionnaire's computational analysis.

Figure 3.1

FFQ screener component



3.1 Test and retest reliability results

A total of 25 participants were included in the test and retest reliability. Three of them failed to complete the survey. The test and retest results of 22 participants are presented in the table below table 3.1. The results revealed significant correlation between the first and the second results, the correlation coefficient was (0.7, $p < 0.001$). The minimum sodium level between them was 1258.6, but the maximum findings had a minor difference (test 5469.9 and retest 5068.1). Mean & standard deviation between the two are comparable, with test mean 3549.5 and std 1093. 7 as well as retest mean 3542.3 and std 1050. 5. These outcomes are shown in table 3.1.

Table 3.1

Results of sodium FFQ screener conducted as part of the pilot study

	Minimum	Maximum	Mean	Std. deviation	p- value	Correlation coefficient
Test	1258.6	5469.9	3549.5	1093.7	0.000	0.7
Retest	1258.6	5068.1	3542.3	1050.5		

3.2 Criterion validity results

3.2.1 Socio-demographic status

The total number of criterion validity participants was 81. Due to missing data, two of them were excluded. 22 participants were excluded from of the 24-hour urine samples because they fell outside of the Mayo Clinic's range(49). The results of criterion revealed the age mean is 29.37 and standard deviation is 9.16.

Table 3.2 presents the sociodemographic characteristics of the sample in frequencies and percentages. The majority of the participants were female (72.8%, n=59), while males constituted 27.2% of the sample (n=22). Most of the sample (n=53, or 67.1%) held a bachelor's degree. Additionally, 22.8% (n=18) had a tawjihi, 8.9% (n=7) were in ninth grade, and only one (1.2%) was a postgraduate.

The most common place of residency was the village (n=45, 57%), followed by the city (n=30, 38%), and then the camp (n=4, 5.1%). A total of 69.6% of participants resided in their own homes (n=55), while 6.3% (n=5) and 8.9% (n=7) lived in tents and hostels, respectively. There were no divorced or widowed participants. Single and married participants were equally represented (50%, n=39 each).

Income was less than 1500 shekels for 38% (n=30) of the participants, followed by 3400 to 5000 shekels for 27.8% (n=22). Furthermore, 19.0% (n=15) received a salary between 1500 and 3000 shekels, while 15.2% (n=12) received more than 5000 shekels. The majority of participants were unemployed (59.5%, n=47), and 26.6% (n=21) had full-time work. The remaining participants had part-time work (13.9%, n=11).

Table 3.2

Sociodemographic characteristics of criterion validity participants

Variable		N	%
Gender	Male	22	27.2
	Female	59	72.8
Educational level	School ninth grade	7	8.9
	School tawjihi	18	22.8
	Bachelor	53	67.1
	Post graduate	1	1.3
Place of residence	City	30	38
	Camp	4	5.1
	Village	45	57
Living nature	Own	55	69.6
	Tent	5	6.3
	Hostel	7	8.9
	With family	12	15.2
Personal status	Single	39	50.0
	Married	39	50.0
	Divorced	0	0.0
	Widow	0	0.0
Income	Less than1500	30	38.0
	1500 to 3000	15	19.0
	3400 to 5000	22	27.8
	More than 5000	12	15.2
Current work	Full time	21	26.6
	Part time	11	13.9
	Not work	47	59.5

3.2.2 Medical history

The medical history and lifestyle characteristics are presented in table 3.3. 93.7% (n=74) of the participants have no chronic diseases, whereas 6.3% (5 participants) have non-sodium-related chronic diseases that have no effect on blood pressure, kidneys, or cardiovascular health, such as osteoporosis and ulcers. 12.7% (n=10) of them use non-sodium-related medications such as Nexium and Atozet, whereas 87.3% (n=69) do not. Twenty participants (25.3%) utilize vitamins, primarily vitaminD3, meanwhile 59 participants (74.7%) do not use any vitamins. 30 of them (38.0%) had previous surgery which is cesarian or appendectomy, while 49 (62%) had not.

Table 3.3

Medical history and life style of criterion validity participants

Variable		N	%
Chronic disease presence	Present	5	6.3
	Not	74	93.7
Medications use	Yes	10	12.7
	No	69	87.3
Vitamin use	Yes	20	25.3
	No	59	74.7
Previous surgery	Yes	30	38.0
	No	49	62.0

3.2.3 Physical activity and BMI (Body Mass Index)

In relation to lifestyle and physical activity, it was found that 18.52% (n=15) of the participants engage in sports, while the majority, 81.48% (n=66), do not. Furthermore, out of the participants, 33 individuals (41.7%) reported walking as a form of physical activity, while the remaining 58.3% (n=64) did not incorporate walking into their exercise routine. The information is depicted in Figures 3.2 and 3.3.

Figure 3.2

Percentage of participants practicing sport

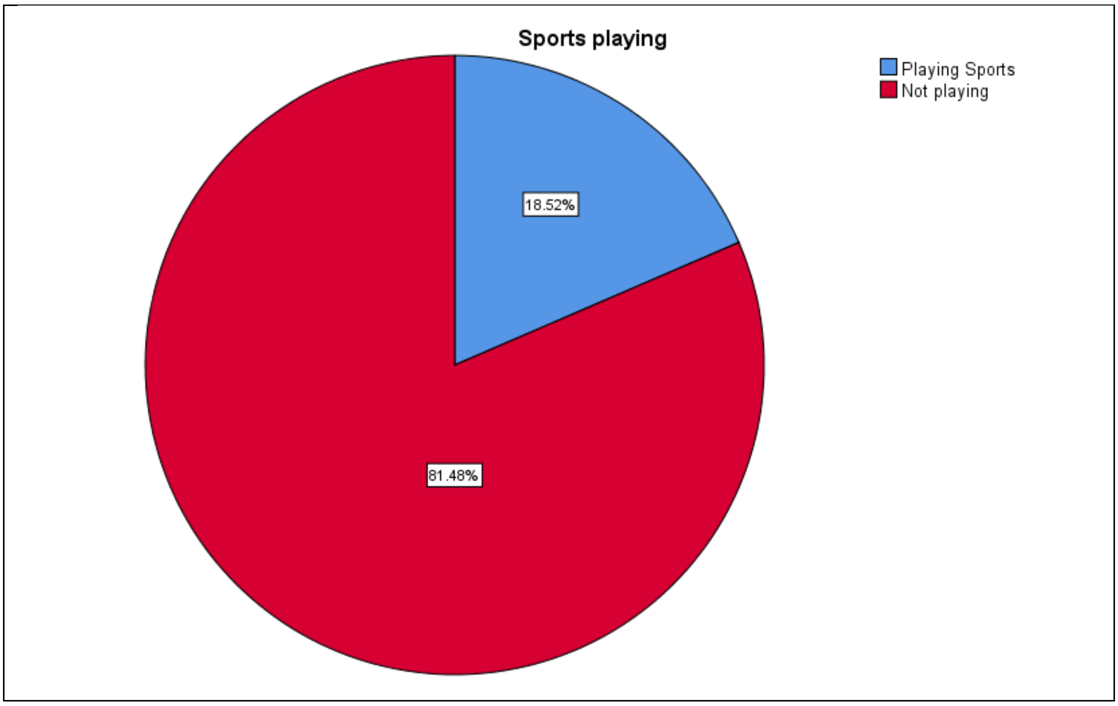
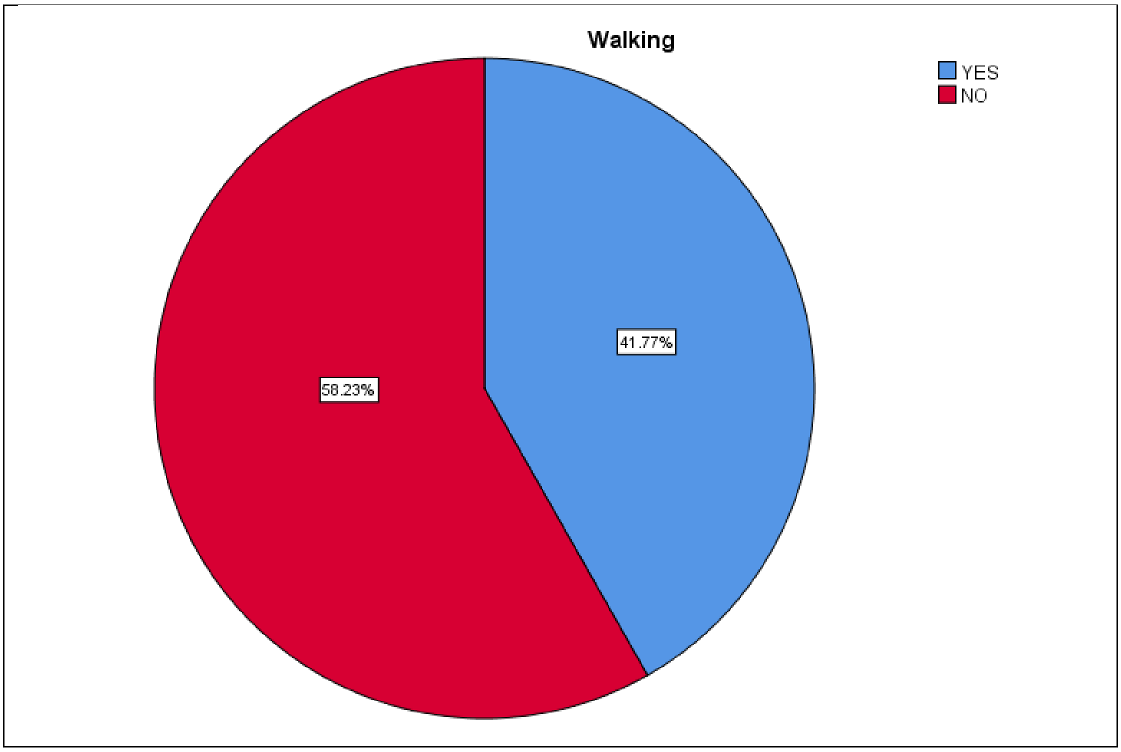


Figure 3.3

Percentage of participants practicing walking sport

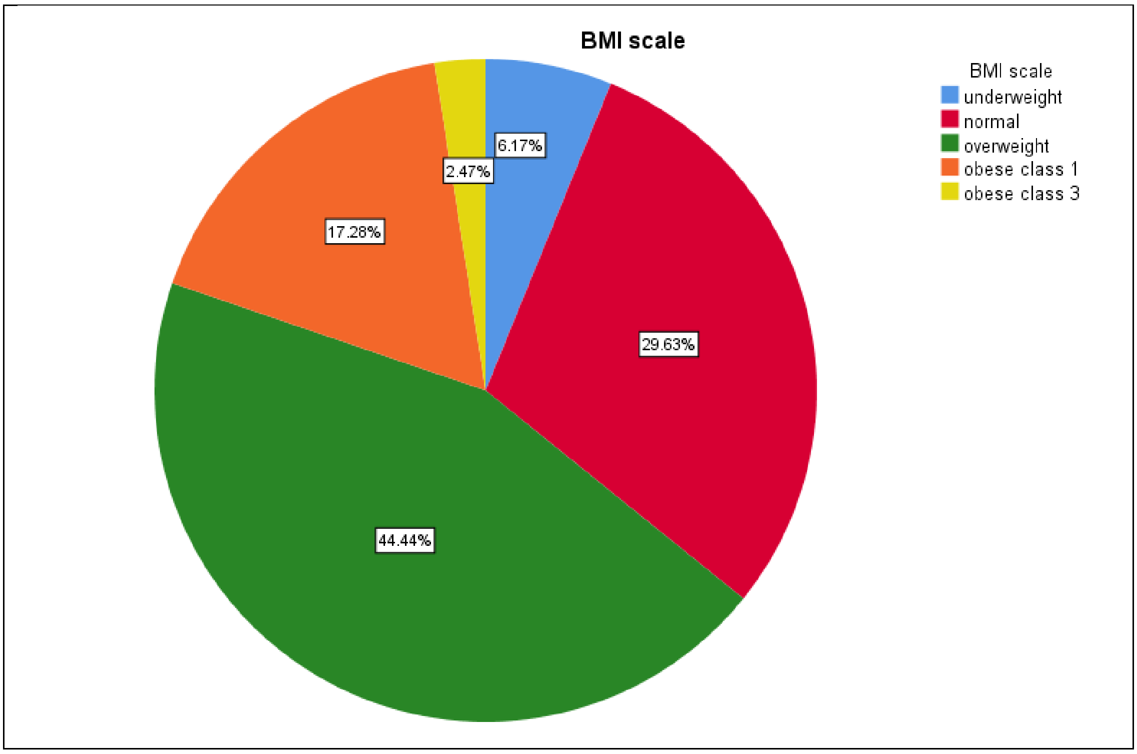


The Body Mass Index (BMI) was calculated using the widely acknowledged formula, which divides a person's weight in kilograms by their height in square meters. The resulting value was then classified based on international criteria. A BMI ratio between 15 and 19.9 indicated an underweight status, whereas a BMI ratio between 20 and 24.9 indicated a healthy weight. Ratios between 25 and 29.9 were classified as overweight, while those between 30 and 34.9 were classified as obese class 1. In the context of obesity classification, individuals with a ratio between 35 and 39.9 are considered to have class 2 obesity. If the ratio exceeds 40, however, a person is classified as having class 3 obesity(61).

Figure 3.4 depicts the distribution of Body Mass Index (BMI) among the individuals. 44.44% of the sample consisted of individuals who were classified as overweight, while 29.63% were within the normal weight range. The prevalence of those classified as obese class 1 was discovered to be 17.28%, while the prevalence of those classified as underweight was 6.1%. Class 3 obesity was the category with the lowest percentage of individuals(2.47%)..

Figure 3.4

BMI scale percentages



3.2.4 Sodium intake results

The minimum value of urine volume was 370 ml and the maximum value was 3300 ml, with a mean of 1144.7 ml and a standard deviation of 613.9 ml. Creatinine readings ranged from 308,4 to 2953.9 mg, with a mean of 994.1 mg and a standard deviation of 467.7mg.

The sodium results are described in table 3.4, where sodium levels in FFQ ranged from 1167.0 to 6908.9 mg, in urine from 461.7 to 5720.4 mg, and in recalls from 1171.0 to 7661.9 mg. Mean sodium levels were as follows: 2247.2 in urine, 2972.7 in FFQ, and 3236.1 in recall in milligrams. There is no substantial difference between their standard deviations. FFQ standard deviation was 1203.3 mg, urine sodium standard deviation was 1150.6 mg, and recalls standard deviation was 1338.1 mg.

Table 3.4

Sodium results of criterion validity participants

In milligram	Min	Max	Mean	Std
Na in urine	461.7	5720.4	2274.2	1150.6
Na intake (recall)	1171.0	7661.9	3236.1	1338.1
Na intake (app FFQ)	1167.0	6908.9	2972.7	1203.3

3.2.5 Correlation between the three methods

There were two gold standards used in this study: 24-hour urine collection and 3-day recall. Consequently, correlation tests were conducted for both. The two-tailed p-value for the correlation between FFQ and urine sodium was 0.000, with a Pearson correlation coefficient of 0.6. Figure 3.5 displays an Altman plot illustrating the difference between the FFQ app and urine sodium values.

The p-value for the association between FFQ and recall sodium values was 0.01, and the Pearson correlation coefficient for all 79 participants was 0.3. Figure 3.6 shows an Altman plot depicting the difference between the FFQ app and sodium recall values. Table 3.5 presents the results.

Table 3.6 describes the distinction between sodium values in the FFQ and 3DR for all 79 participants. The mean, standard deviation, and standard error for the FFQ were 2972.7, 1203.3, and 135.4 mg, respectively, while for recall, they were 3236.1, 1338.1, and 150.6 mg. The second set of data illustrates the differences in mean, standard deviation, and standard error between sodium from the FFQ and sodium in urine, after excluding samples with creatinine levels outside the acceptable range. The number of samples included was 57 for each, with the mean, standard deviation, and standard error for the FFQ being 3035.6± 1331.0, and ± 176.3, respectively. For urine, the corresponding values were 2437.1, 1135.2, and 150.4. The results show a clear convergence. Figure 3.7 summarizes the findings in Table 3.6**.**

Table 3.5

Correlations between 3 days diet recall, urinary sodium and FFQ sodium results

		3days diet Recall sodium	Urine sodium
FFQ sodium	Pearson correlation	0.300	0.600
	p-value	0.010	0.000

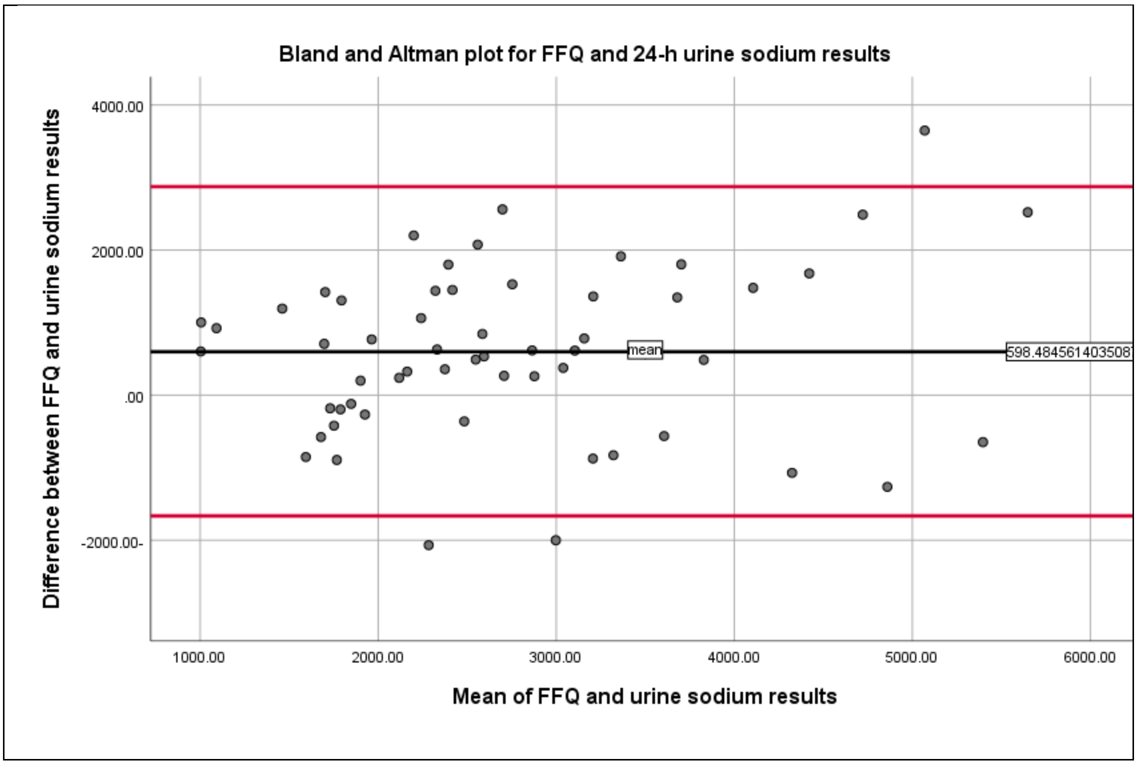
Table 3.6

Mean differences between sodium values in the FFQ, urine and recall

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	FFQ app results	2972.7	79	1203.3	135.4
	recall sodium	3236.1	79	1338.1	150.6
Pair 2	FFQ app results after excluding.	3035.6	57	1331.0	176.3
	urine sodium	2437.1	57	1135.2	150.4

Figure 3.5

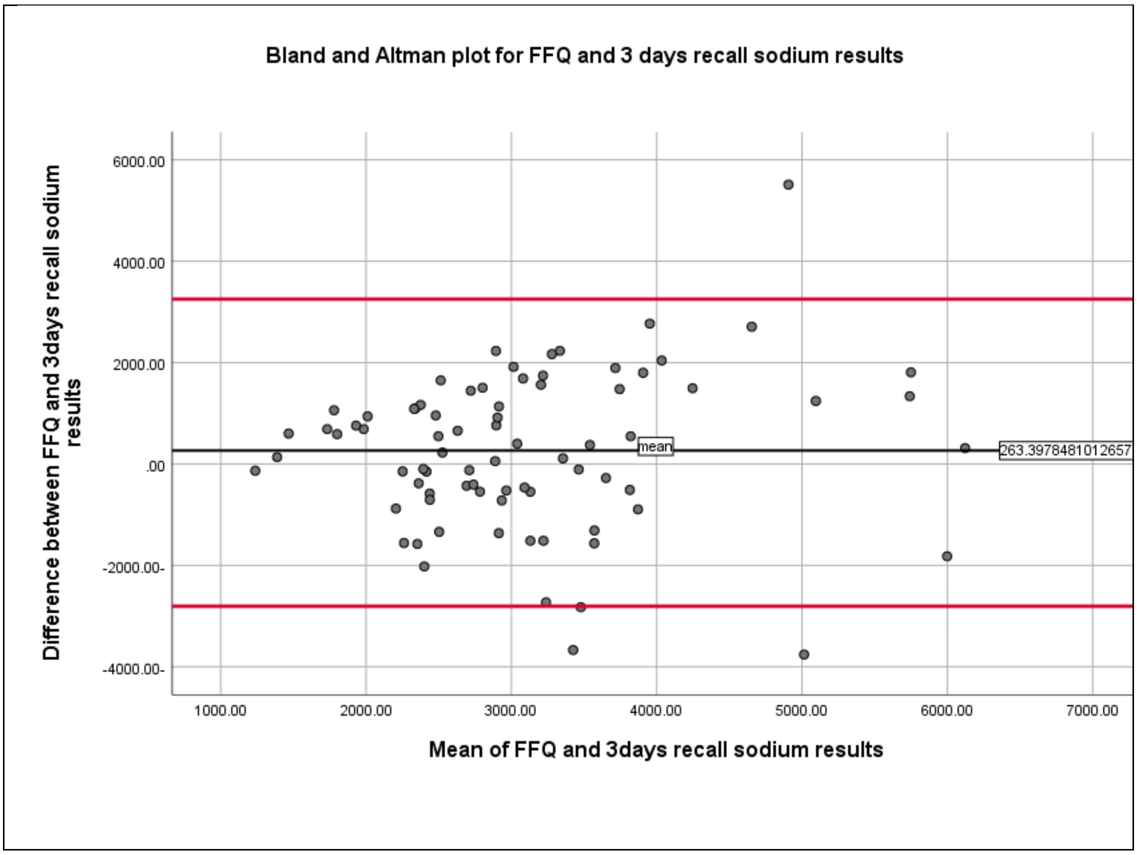
Bland and Altman plot for FFQ app and 24-h urine sodium results



This graph compares the difference between FFQ screener sodium results and 24-hour urine sodium findings which appear on y-axis to the mean of two measurements on x-axis. The 598.485-unit bias is represented by the distance between the x axis corresponding to zero differences and the x-axis parallel line at 598.5. Colored lines indicate the outliers (mean+- standard deviation*1.96) with a lower limit of -1676.6 and an upper limit of 2873.6. There are three outlier values, and the majority of the values align with the middle of the figure between the outliers.

Figure 3.6

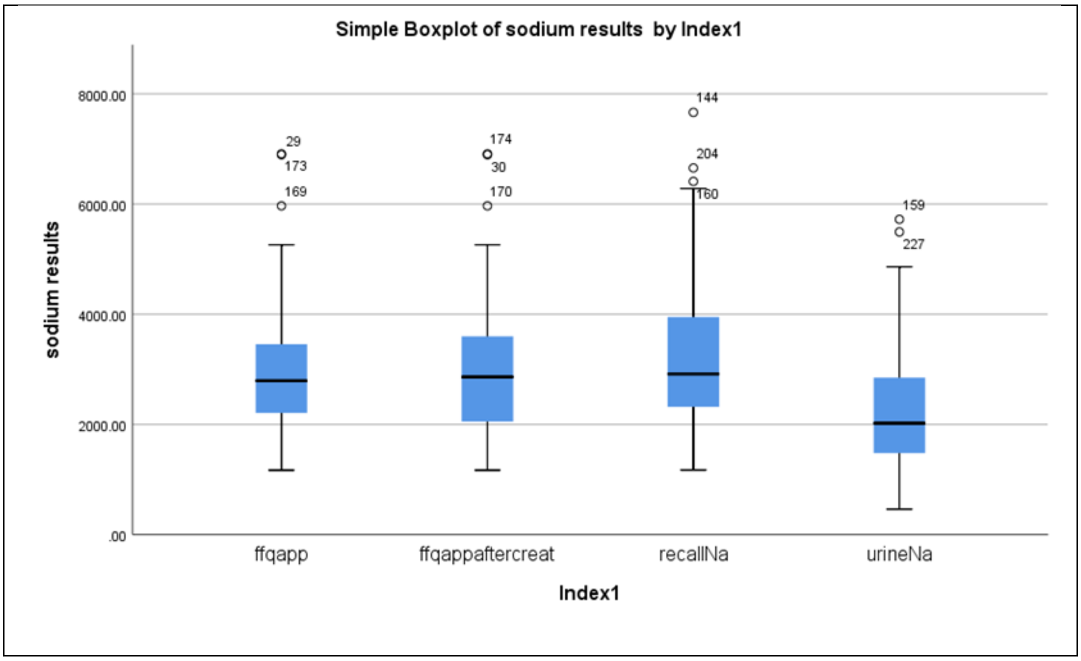
Bland and Altman plot for FFQ app and 3 days recall sodium results



This graph compares the difference in sodium results between the FFQ sodium results and the three-day recall method on y-axis to the mean of two measurements on x-axis. The 263.4-unit bias is represented by the distance between the x axis corresponding to zero differences and the parallel x-axis line at 263.4. Colored lines indicate the outliers (mean+- standard deviation*1.96) with a lower limit of -2,725.9 and an upper limit of 3,252.7. There are three outlier values, two of values on the lower outlier, and the majority of the values align with the middle of the figure between the outliers.

Figure 3.7

Boxplot for FFQ screener, recall and urine sodium results



This figure discusses the differences between sodium results from FFQ screener, recall and urine sodium results.

3.2.6 The relationship between salt practice and sodium intake

Salt practice questions are presented in table 3.7 and figure 3.8. 32.9% (n=26) add salt after cooking with a mean sodium consumption of 2985.1, 32.9% (n=26) add salt occasionally with a mean sodium intake of 3170.4, and 34.2% (n=27) do not add salt after cooking with a mean sodium intake of 2770.3. This question's FFQ sodium result has a p-value of 0.486. In response to the second question, 21.5% (n=17) of participants prefer very salty food (mean sodium consumption: 3,290.2 mg/day), 59.5% (n=47) prefer the food as is (mean sodium intake: 2,942.6 mg/day), and 19.0% (n=15) prefer less salty food (mean sodium intake: 2,707.2 mg/day). Using FFQ, the p-value for this question is 0.383. The majority of individuals (55.7%, n=44) do not check food labels to assess sodium content; their mean sodium consumption was 3,135.1 mg, whereas 12.7% (n=10) do so, consuming 3,319.5 mg of sodium on average. In contrast, 31.6% (n=25) of individuals occasionally read food labels with a mean of 2,547.1. The corresponding p-value is 0.092. 12,7% look for less salty foods (n=10) with a mean sodium of 2724.4, whereas 57% do not with a mean sodium of 3262.0. And, 30.4% (n=24) of respondents frequently seek with mean of 2533.5. The p-value for this FFQ question is 0.042. 60.8%

(n=48) never sought to reduce salt intake with a sodium mean of 3217.4, whereas 39.2% (n=31) did so with a sodium mean of 2593.8. The p-value for this question employing FFQ is 0.024.

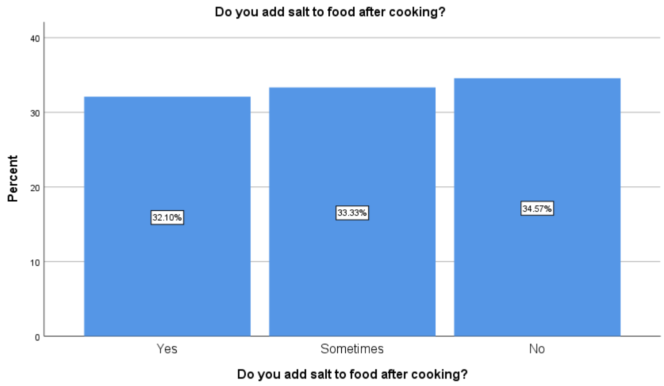
Table 3.7

The relationship between salt practice and sodium intake

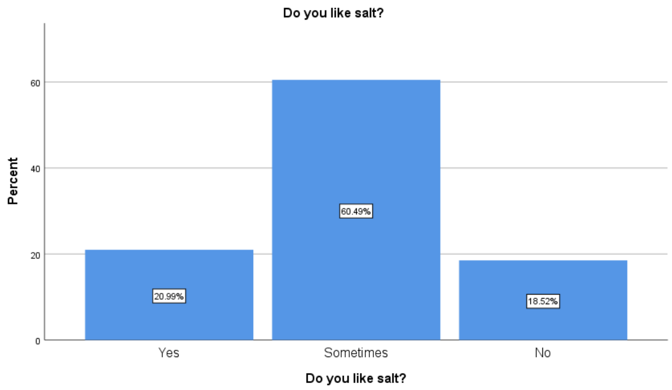
Question		N	%	Sodium intake mean (mg\day)	P value
Do you add salt to food after cooking?	Yes	26	32.9	2985.1	0.486
	Sometimes	26	32.9	3170.4	
	No	27	34.2	2770.3	
Do you like salt?	Saltier	17	21.5	3290.2	0.383
	No difference	47	59.5	2942.6	
	Less salty	15	19.0	2707.2	
Do you usually read food label?	Yes	10	12.7	3319.5	0.092
	Sometimes	25	31.6	2547.9	
	No	44	55.7	3135.1	
Do you generally prefer out less salty foods?	Yes	10	12.7	2724.4	0.042
	Sometimes	24	30.4	2533.5	
	No	45	57.0	3262.0	
Have you ever reduced salt intake?	Yes	31	39.2	2593.8	0.024
	No	48	60.8	3217.4	

Figure 3.8

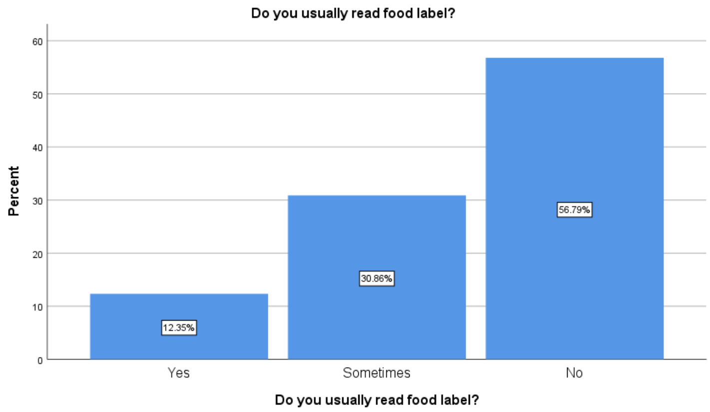
Salt practice and sodium intake



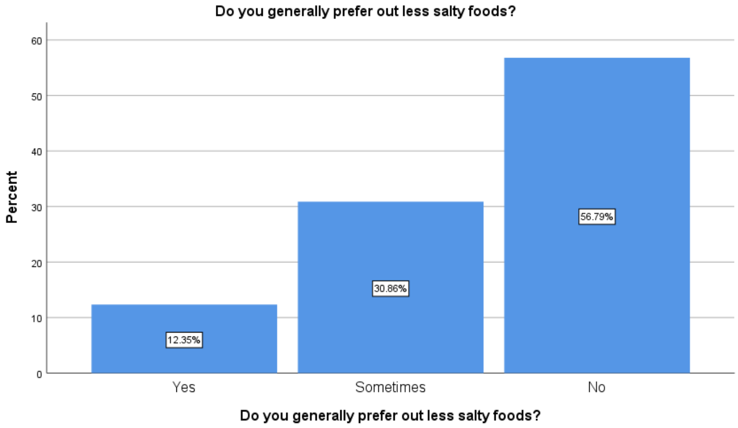
a. Do you add salt to food after cooking answer



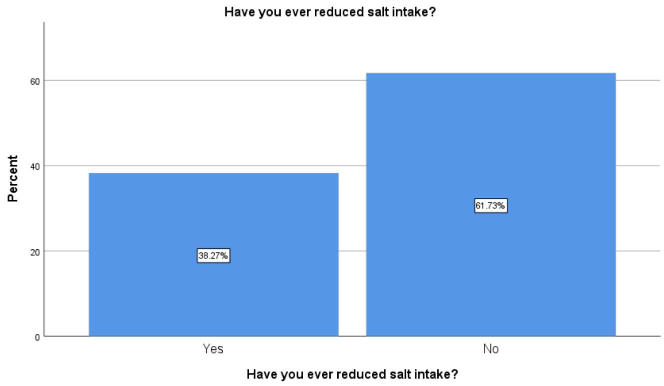
b. Do you like salt answer



C. Do you usually read food label answer



D. Do you generally prefer out less salty food



e. Have you ever reduced salt intake answer.

Chapter Four

Discussions and Conclusions

This study successfully validates the FFQ screener application for sodium intake among a representative sample of 18–40-year-old Palestinian adults from the West Bank. The appropriate sample size was obtained to answer the research questions and conduct the essential statistical analysis. According to our knowledge, this is the first study in Palestine to develop and validate an FFQ screener for sodium consumption among Palestinians. This study's key findings are presented in the following sections.

4.1 FFQ screener development

The nine groups were created using the serving size and sodium concentration of items in the primary groups, chosen from typical Palestinian food for their high sodium content. Some items, like tomato paste and flour chips, have relatively low salt content but are widely consumed. In contrast, others like mussakhan are consumed less frequently but have significant sodium content. The screener examines all aspects of food items, taking into account that salt pinches after cooking are also important.

The first step in this study is to determine which foods will be included on the sodium screener. A specific sodium content was set as the lowest threshold, assuming the chosen items are consumed frequently and regularly. Similar results were found in other studies(12), (13). The next stage is determining the average serving size for each item. The source for determining serving size varies between studies; this research used the Palestinian Atlas, while another study estimated the average serving size by analyzing and comparing repeated 24-hour recall data(12).

The third stage in this phase involves determining the sodium calculation method for each item. This study is unique in its precision for determining repetition times with two questions per item. The program calculates sodium intake based on various frequencies (daily, weekly, monthly, or annually). Other studies used different categories and frequency factors to determine daily intake(12), (13). The first phase involved deriving a conversion factor from food composition tables, while the second phase consisted of specialists examining the content's validity.

The next step is assessing reliability, which in this study involved a pilot study with participants who completed a second questionnaire after a specific time frame. Following this is the Criterion validity, which included healthy participants of various ages without any diseases that affect sodium levels. Other studies had different participant compositions, including hypertensive and normotensive individuals (12), (13).

4.2 Pilot study and reliability

Before initiating the application of the required sample and gathering urine samples for 24 hours and 3DR, it was necessary to confirm the questionnaire's reliability. According to van Teijlingen et al., a pilot study refers to shorter-scale versions or test runs conducted prior of a wider-scale study. This study provides a warning if the project's steps are correct, as well as a warning of any potential failure. Furthermore, it aids in data adjustment(62). For example, a study to validate technology-assisted FFQ for elementary and middle school children, a pilot study was conducted for 55 children to modify graphics, food groupings, portion sizes, and food items, if necessary, before its use with children(63). In our study, the Pilot was used to assess the usability of the questionnaire, the consistency of the results between the test and the retest, the difficulty of the questions for the participants, the clarity of the images, and the comprehension of the quantities. In the study by Pritchard et al., a pilot study was conducted to validate FFQ for assessing Calcium, Vitamin D, and Vitamin K. In conjunction with a 5-day dietary record, 15 women completed the FFQ as part of the study. Due to participants' awareness of the significance of the research, it was determined that this investigation overestimated nutrient intakes. In addition, the number of items was relatively high, 161 items, and this prompted the study to expand and subdivide the population and it should emphasize the use of a questionnaire that includes food items consistent with cultural, socioeconomic, and geographic dietary trends to maintain the participant's connection to the study's purpose (64).

4.3 Correlation between sodium intake using FFQ and 24-h urine sodium results

The study's p-value of 0.000 and Pearson correlation of 0.567 indicate a strong association between salt readings from the FFQ screener and 24-hour urine samples. This contradicts the findings of Fadhillah et al., who concluded that the correlation between 24-hour urine and FFQ is insignificant (p = 0.381)(65). Nevertheless, Fadhillah et al. study was limited to 29 participants, and they converted spot urine to 24-hour urine using the Tanka equation before calculating the association. In a study including 430 participants, Kamiliah et al. evaluated the association between spot urine and 24 hours of urine with the FFQ and observed a moderate relationship between them(66). This study confirms that the 24-hour urine sodium measurement is the gold standard because 95% of consumed sodium is eliminated in the urine. Fadhillah et al., Ferreira et al., and Alkhalaf et al. also used 24-hour urine as the gold standard for assessing sodium intake(13), (14), (65). In Gallani study, it was determined that FFQ-Na would be significantly and strongly connected to the 24 h sodium urine, with a correlation coefficient of 0.30, which is moderately significant; however, FFQ-Na often underestimates the total intake by 2.3 g (67). Comparing recall across numerous days to 24-h urine collection, it was determined that 24-h urine collection is the most precise and accurate method for measuring sodium intake, although it is a laborious technique(35). It is crucial to include the table salt and processed foods inside the FFQ. If it isn't in quantification, FFQ findings will be 30% lower than urine results(68). Processed foods and table salt were included in our investigation which permitted to contain all significant aspects.

4.4 Correlation between FFQ and 3-day recall (3DR) sodium results

3DR was used as the gold standard in this study to assess sodium consumption as in Ferreira et al. and Alkhalaf et al.'s studies(13), (14). The study's p-value of 0.010 and Correlation coefficient of 0.283 indicate a moderate to strong relationship between FFQ salt values and 3DR. In a trial where FFQ was established for cardiac patients and compared to 3DR, one of the days was a weekend, just as our study. There is a significant relationship between Sodium FFQ and the 3DR, the association between them for sodium was acceptable to moderate when table salt was included (0.628) and poor when table salt was omitted (0.400) (68). The correlation coefficients were 0.42 for the FFQ alone, 0.59 when two 24-hour recalls were included, 0.68 when four 24-hour recalls were included, and 0.74 when six 24-hour recalls were included. The results were enhanced by the addition of a 24-hour recall, and they improved when the recall period was longer than 24 hours(69). The 24-hour recall is regarded as unbiased, whereas the FFQ cannot be used alone in studies. Even though it is challenging to complete 4-6 recalls with the FFQ, it is the most accurate and reliable method for producing reliable results(69). In the study by Del Pino et al, who developed a screener for children ages 6 to 10 to check energy and nutrients, including sodium, it was determined that the P-Value between the FFQ and the mean of 24-hour recalls is less than 0.0001 and the correlation for sodium is 0.59, confirming the significance of using a 24-hour multi-recall for validation(70). Notable is the fact that some studies favored 3-day records over recalls. However, this technique is laborious for the participant and allows him to alter his diet throughout the duration of the participation as Gallani et al study (67).

4.5 Validation of software

The significance of technology comes from its ability to produce results quickly and cheaply. Using technology for diet assessment is also essential for improving the accuracy of data, reliability, and precision. Also, the presence of qualified interviewers is not necessary for a comprehensive interview, and computerized assessment can save a great deal of time in data coding because data are immediately saved, which facilitates research and helps to simplify the self-tracking process, thereby increasing compliance and the validity of self-reported food and energy intake(71). Software is one of the most significant types of technology used to monitor the diet. Before it is released in its final form, it undergoes several stages of verification and validation, beginning with the requirements definition phase, which tests the adequacy, correctness, completeness, and consistency of the requirements. Then enter the design and construction phases, which consist of the general design, structural codes, and testing. Finally, operation and maintenance must be correlated to the level of redevelopment(72).

The study by Phyllis J. Stumbo examined digital methods for increasing food record accuracy(34). He discussed the evolution of technology and the emergence of mobile phones with cameras and wireless devices, which make it simple to capture photographs or videos to clarify the type of food and portion size. Automated Self-Administered 24-h (ASA24) dietary recall is one of the precise methods that uses food images to help report the type and quantity of foods consumed. It is a web-based, 24-hour dietary recall system that is accessible from anywhere with an internet connection. ASA24 is an application that utilizes a three-panel food entry screen, with two panels to browse for foods in a database and one panel to access serving size and record amount consumed.

This confirmed that the precision of newer technologies has the potential to propel dietary assessment to the next level(34).

4.6 Sodium practice vs. FFQ results

In order to look into the relationship between sodium and its practices, it was necessary to pose five questions, as the answers to the first two questions demonstrated that there is no correlation between the addition of salt and sodium FFQ results (p-value 0.486). In a similar study conducted in China, it was discovered that the relationship between adding salt to food after cooking and FFQ sodium intake was weak (0.268)(73). also, there is no relationship between salty food preference and sodium FFQ results (p-value 0.383). Examining the sodium consumption rates according to the FFQ, when analyzing the answer to the question "Do you like salty food? ", reveals that the average sodium in the yes answer is higher than in other answers .In contrast, a Jatinanguri study that demonstrated a moderate correlation between salt taste threshold and urinary excretion of sodium with a p-value ratio of less than 0.01(74). In a similar study to Jatinanguri conducted in Korea, the correlation between diet sodium intake and sodium taste preference was found to be significant (p-value 0.001)(75).

As for the relationship between label reading and sodium, it was determined that there is a weak relationship with a p-value of 0.092, but the relationship cannot be adequately explained using the available data. Frequent users of nutrition labels consumed 92.79 mg less sodium per day, according to a U.S. study, but this varied significantly by age, gender, and socioeconomic status(76). The p-values for the questions "Do you generally prefer out less salty foods?" and "Have you ever reduced salt intake?" were 0.042 and 0.024, respectively, indicating that there was a statistically significant correlation between the two variables and FFQ sodium. This was seen in the FFQ sodium mean, which was lower among those who chose less salty food and among those who previously reduced salt.

4.7 Conclusions

This study effectively validated the FFQ screener software for sodium intake among a representative sample of West Bank adults aged 18 to 40. Using the serving size and levels of sodium of each of the 41 items in the nine primary categories, the FFQ screener comprised nine groups. Validation of software is essential for enhancing precision, accuracy, and reliability. Comprehensive interviews do not require the presence of qualified interviewers, and computerized assessment can save time in data coding.

The correlation between FFQ and 24-hour urine sodium results and 24-hour recall results was found to be significant. These two variables were chosen as the gold standard for determining the validity of the screener.

In addition, the study found a correlation between lower sodium FFQ results and consuming less sodium or preferring less salted foods. There is no correlation between adding salt to food after cooking and sodium FFQ results, nor between a preference for salted foods and sodium FFQ results with weak correlation between reading food labels and sodium FFQ results.

4. 8 Recommendations

The study's findings suggest that further research is warranted to evaluate dietary sodium practices across various age and regions groups. Additional studies are necessary to build upon these results. Comprehensive cross-sectional investigations are necessary to evaluate the consumption of variables that impact sodium intake. Additionally, further research is imperative to establish the correlation between sodium intake and health outcomes across various age cohorts, particularly among students who have an affinity for processed foods. Educational intervention studies aim to enhance understanding of the impact of sodium on health status.

4.9 Limitations

The study's sample size was limited due to a relatively low engagement rate, as a significant proportion of individuals declined to provide a 24-hour urine sample. Furthermore, the study was geographically restricted to specific regions.

List of Abbreviations

Abbreviation	Meaning
ASA24	Automated Self-Administered 24-h
BMI	Body Mass Index
CHD	Chronic Heart Disease
CKD	Chronic Kidney Disease
CVD	Cardio Vascular Diseases
DASH	Dietary Approach to Stop Hypertension
3DR	3-day recall
ECF	Extra Cellular Fluid
EO	Ouabain
FFQ	Food Frequency Questionnaire
GFR	Glomerular Filtration Rate
ml	Milliliter
mg	Milligram
MIND	Mediterranean-DASH Intervention for Neurodegenerative Delay
NO	Nitric Oxide
rs	Spearman correlation test
SFA	Saturated Fatty Acid
Std	Standard deviation
TFA	Trans Fatty Acid

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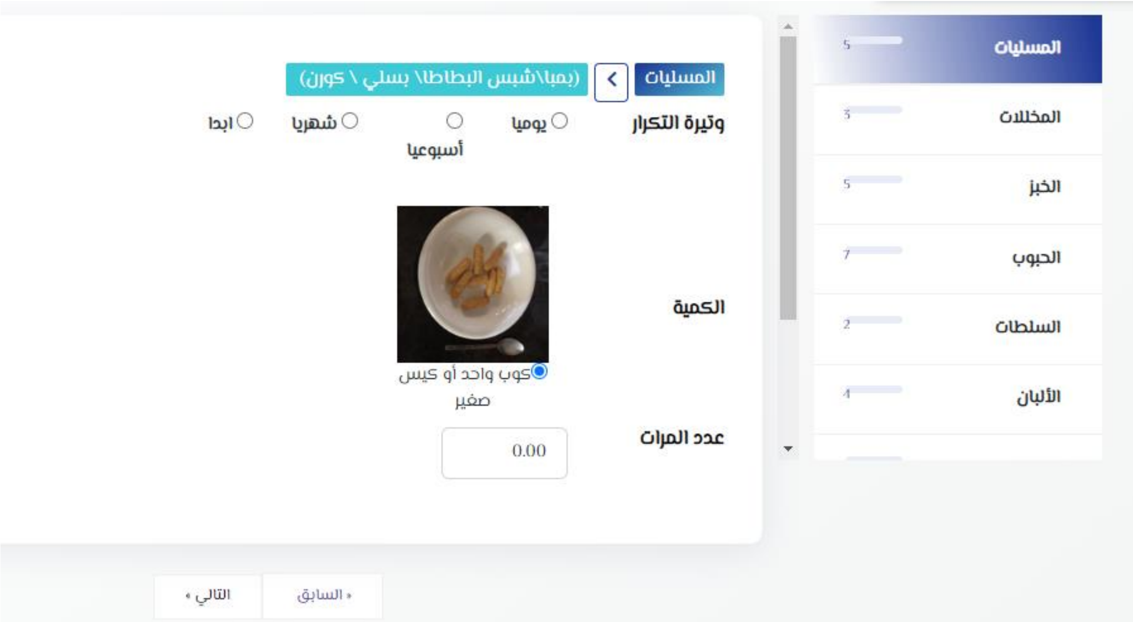
Appendices

Appendix A

FFQ screener software



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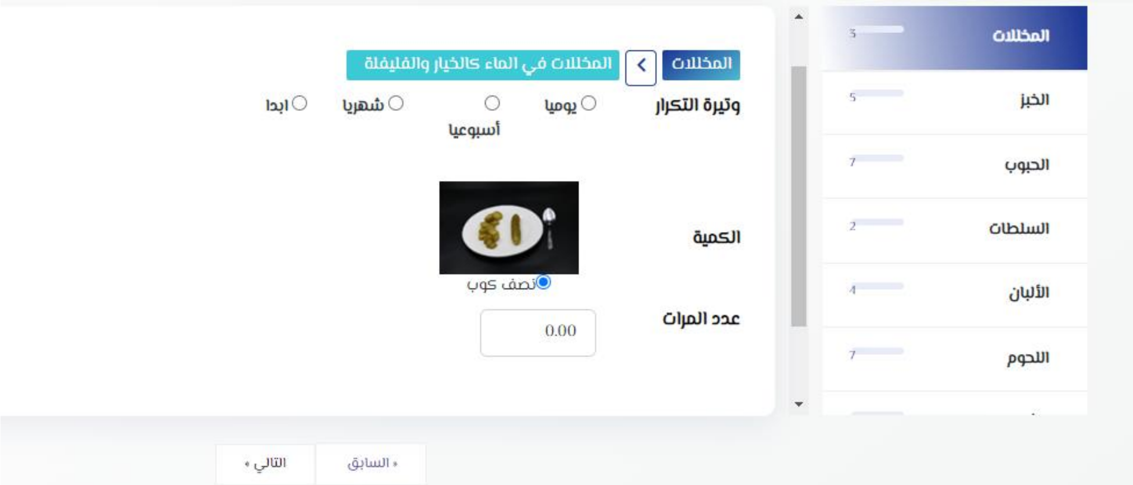

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Appendix B

3-days recall

الجزء الخامس : استذكار الوجبات (ثلاث ايام – يومين خلال الاسبوع ويوم في نهاية الأسبوع)

اليوم ١ :______________________________ التاريخ:______________________________

ساعة اول وجبه (اول شي تناولته)

ساعة اخر وجبة (أخر شي تناولته)

القائمة السريعة:

رقم المأكول المشروب	الساعة	مكان الاكل البيت\خارج البيت	اسم الوجبة	اسم الصنف ووصفه	الكود لتقدير الحجم	الكمية

الجزء الخامس : استذكار الوجبات (ثلاث ايام – يومين خلال الاسبوع ويوم في نهاية الأسبوع)

اليوم٢ :______________________________ التاريخ:______________________________

ساعة اول وجبه (اول شي تناولته)

ساعة اخر وجبة (أخر شي تناولته)

القائمة السريعة:

رقم المأكول المشروب	الساعة	مكان الاكل البيت\خارج البيت	اسم الوجبة	اسم الصنف ووصفه	الكود لتقدير الحجم	الكمية

الجزء الخامس : استذكار الوجبات (ثلاث ايام – يومين خلال الاسبوع ويوم في نهاية الأسبوع)

اليوم ٣ :___________________________ التاريخ:__________________________________

ساعة اول وجبه (اول شي تناولته)

ساعة اخر وجبة (أخر شي تناولته)

القائمة السريعة:

رقم المأكول المشروب	الساعة	مكان الاكل البيت\خارج البيت	اسم الوجبة	اسم الصنف ووصفه	الكود لتقدير الحجم	الكمية

Appendix C

IRB approval letter

An-Najah National University
Faculty of Medicine & Health Sciences
Institutional Review Board

النجاح الوطنية
لب وعلوم الصحة
لاقيات البحث العلمي

Ref: Bse July, 2022/28

IRB Approval Letter

Title of Research:

Development and Validation of FFQ Smartphone Application for Sodium Intake Amo Palestinian Population,2022.

Submitted by:
Razan Awwad, Nisreen Jadaa, Noor Alsheikh, Haneen Maatan , Shahd Eid

Supervisor:
Manal Badrasawi

Approved:
20th July 2022

Your Study Title **"Development and Validation of FFQ Smartphone Application for Sodi Intake Among Palestinian Population,2022."** reviewed by An-Najah National University IR committee and was approved on 20th July 2022.

جـامعـــة النجاح الوطنية

كليــة الدراســـات العليــا

تطوير وتقييم تطبيق جوال (FFQ screener) لحساب الصوديوم المتناول بين الشعب الفلسطيني

إعداد

رزان عرفات محمد عوّاد

إشراف

د. منال بدرساوي

د. رضوان قصراوي

قدمت هذه الرسالة استكمالا لمتطلبات الحصول على درجة الماجستير في التغذية وتكنولوجيا الغذاء، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2023

تطوير وتقييم تطبيق جوال (FFQ screener) لحساب الصوديوم المتناول بين الشعب الفلسطيني

إعداد

رزان عرفات محمد عوّاد

إشراف

د. منال بدرساوي

د. رضوان قصراوي

الملخص

الخلفية: تؤثر كميات الصوديوم المرتفعة بشكل سلبي على القلب والكلى والمناعة. حيث أن ارتفاع تناول الصوديوم مرتبط بزيادة نسبة الوفيات بين مرضى القلب. الطرق التقليدية في تقييم الطعام كالاستبيانات المتعلقة بتردد تناول الطعام، أو تذكر ٢٤ ساعة للأطعمة المتناولة، أو تسجيل الطعام المتناول لمدة ٢٤ ساعة معرضة للخطأ. ومن هنا ممكن استخدام التكنولوجيا في التقييم مما يزيد الفعالية. تهدف هذه الدراسة تهدف الى تطوير وتقييم برنامج (FFQ Screener Software) لحساب الصوديوم المتناول بين الشعب الفلسطيني. تهدف هذه الدراسة الى تطوير هذا البرنامج والتحقق من صحة FFQ باستخدام برنامج لتقييم الصوديوم المتناول بين الفلسطينيين. كما يهدف إلى تحديد العلاقة بين تناول الصوديوم الغذائي وممارسات الصوديوم الغذائية، وكذلك تحديد العلاقة بين تناول الصوديوم الغذائي، FFQ، تذكر الغذاء ل٣ أيام، والصوديوم في البول على مدار ٢٤ ساعة.

منهجية الدراسة: تمت هذه الدراسة على أربع مراحل. في المرحلة الاولى تم وضع الأطعمة الفلسطينية في مجموعات وتقسيمها الى أطعمة حسب كمية استهلاكها ومحتواها من الصوديوم. وبعد ذلك، تم تحديد حجم الحصة وعدد مرات استهلاكها حسب تقاليد الشعب الفلسطيني حيث تم حساب مستويات الصوديوم بناءا على ثلاث قواعد استهلاك. في المرحلة الثانية، تم تقييم دقة المحتوى من خلال ارسال الاستبيان لأربعة

خبراء في مجال التغذية وثلاثة باحثين في مجال التغذية، وبناءً على تعليقاتهم تم تعديل الاستبيان. في المرحلة الثالثة قامت مجموعة (study pilot) بالفحص وإعادة الفحص وذلك لتقييم دقة الاستبيان. في المرحلة الرابعة، تم مقارنة النتائج من الاستبيان بنتائج عينات البول المجموعة لمدة ٢٤ ساعة والذي يعتبر المقياس الذهبي الأول ومقارنتها مع نتائج الاستذكار الذي يعتبر المقياس الذهبي الثاني. النتائج حللت بواسطة SPSS software.

النتائج: تم تطوير استبيان للصوديوم يحتوي على ٤١ بند مفروزة الى تسع مجموعات مع الصور والحصة ومدى تكرار التناول لكل بند. نتائج فحص الدقة Pearson correlation بين الفحص والاعادة ٠,٧٠٣ (، p<0.01). نتائج Pearson correlation لفحص المعيار بين نتائج الاستبيان ونتائج فحص البول ل ٢٤ ساعة ٠,٥٦٧(p<0.000). نتائج Pearson correlation لفحص المعيار بين نتائج الاستبيان ونتائج الاستذكار لثلاثة أيام ٠,٢٨٣(p<0.000). ارتبط تناول الصوديوم بشكل كبير مع تفضيلات الأطعمة منخفضة الصوديوم وتقليل الملح المسبق (P <0.05) على الرغم من عدم وجود ارتباط بين استبيان الصوديوم والتمليح بعد الطهي، وتفضيل الطعام المملح وقراءة محتوى الصوديوم على ملصقات الطعام (p> 0.05).

الاستنتاجات والتوصيات: يعد استخدام السوفتوير لاستبيان تردد الطعام لتقييم استهلاك الصوديوم في النظام الغذائي طريقة صالحة وموثوقة. تضمن عملية التحقق من صحة البرنامج طريقة موثوقة ومبتكرة في تقييم الصوديوم الغذائي. يؤدي استخدام الطريقة القائمة على الصور لتقدير حجم البند والحصة إلى تحسين الدقة والدقة في تقييم النظام الغذائي.

الكلمات المفتاحية: استبيان تناول الطعام، فحص البول ٢٤ ساعة، استذكار الطعام ل ٢٤ ساعة، سوفتوير.