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DIET QUALITY ASSOCIATED WITH RISK OF NON-COMMUNICABLE DISEASES AND NUTRIENT INADEQUACY AMONG FEMALE UNIVERSITY STUDENTS USING THE GLOBAL DIET QUALITY SCORE

by
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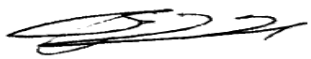	Signature
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ABSTRACT
OF THE THESIS OF

Rana Mahdi Ibrahim for Master of Science
Major: Human Nutrition

Title: Diet Quality Associated with Risk of Non-communicable Diseases and Nutrient Inadequacy among Female University Students using the Global Diet Quality Score

Background: Lebanon has been facing an increasing burden of non-communicable diseases (NCDs). Poor diet quality is a major driver of NCDs. The Global Diet Quality Score (GDQS) is a global measure of diet quality that is designed to be sensitive to diet-related outcomes associated with NCDs and nutrient inadequacy.

Objectives: This study aims to assess the diet quality of Lebanese female students at the American University of Beirut using the GDQS, determine the food groups that are driving a low GDQS score, explore drivers of consumption of these food groups, and assess changes in diet quality (GDQS) and food groups consumption that occurred over time.

Methods: This study was implemented in 2 phases. Phase 1 was a cross-sectional survey conducted among female students at the American University of Beirut (AUB). Three hundred Eighty-Four female students at AUB aged between 18-24 years were recruited. The sample size was determined using the World Health Organization (WHO) sample size calculator. Diet quality was assessed using the GDQS App, which is an electronic data collection tool developed by Intake to provide a standard, easy-to-use, low-cost, and time-relevant method for collecting data. A multi-component questionnaire which includes sociodemographic, lifestyle factors and drivers of consumption as well as self- reported anthropometric measurements was also collected from participants using face-to-face interviews.
Phase 2 was a secondary analysis of dietary intake data stemming from the national nutrition survey carried out in Lebanon between 2008 and 2009. Data pertinent to Lebanese female adults aged 18-24 years were analyzed to determine the diet quality (GDQS) and investigate the changes in diet quality and food groups consumption overtime.
The Statistical Package for the Social Sciences (SPSS; version 25) was used for all computations.

Results: In 2022, the mean total GDQS, GDQS+ and GDQS- scores of Lebanese AUB female students were 16.1±4.8, 7.0±3.7, and 9.1±2.9, respectively. Only 8.3% of the participants had a high GDQS score suggesting low risk of disease outcomes, whereas 48.4% had a moderate GDQS score suggesting moderate risk and 43.2% had a low GDQS score suggesting high risk for NCDs. Living at parental home, living in rural areas and high-intensity physical activity were associated with higher GDQS scores compared to

living at student residence, living in urban areas and low and moderate-intensity physical activity. Low consumption of other fruits (fruits other than deep orange and citrus fruits), dark green leafy vegetables, legumes, deep orange tubers, nuts and seeds, whole grains, fish, and low-fat dairy and high consumption of processed meat, refined grains, sweets, sugar sweetened beverages, juice, white root tubers and purchased deep fried foods were shown as determinants of low GDQS score. Of the factors influencing consumption of the food groups taste was mostly reported as a predominant factor followed by past eating habits, availability, and cost. Compared to 2008/2009, the consumption of citrus fruits, dark green leafy vegetables and sugar sweetened beverages were lower in 2022 whereas the consumption of dairy, liquid oils, juice, cruciferous vegetables, poultry, white roots tubers and deep-fried foods were higher in 2022.

Conclusion: The study showed that in 2022, the majority of young Lebanese female AUB students have a low and moderate GDQS score suggesting high risk of NCDs. Low consumption of fruits, vegetables, legumes, deep orange tubers, nuts and seeds, whole grains, fish, low fat dairy and eggs and high consumption of processed meat, refined grains, sweets, sugar sweetened beverages, juice, white root tubers and purchased deep fried foods were major contributors to low GDQS score. This study also identified taste as most significant driver of consumption followed by past eating habits, availability and cost and showed that the diet quality among young Lebanese female adults has worsened over time. Interventions strategies to address such targeted poor dietary habits are needed to promote adherence of university students to healthy diets for mitigating the increase in NCDs in the country.

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ABBREVIATIONS

NCDs:	Non-communicable diseases
WHO:	World Health Organization
GDQS:	Global Diet Quality Score
LMICs:	Low- and middle-income countries
DQIs:	Diet quality indices
MDD-W:	Minimum Dietary Diversity for Women
HEI:	Healthy Eating Index
AHEI:	Alternative Healthy Eating Index
DQI-I:	Diet Quality Index- International
USDA:	US Department of Agriculture
DGA:	Dietary Guidelines for Americans
24-HR:	24-hour dietary recall
FFQ:	Food Frequency Questionnaire
MUAC:	Mid-upper arm circumference
AUB:	American University of Beirut
CITI:	Collaborative Institutional Training Initiative
BMI:	Body Mass Index
IPAQ:	International Physical Activity Questionnaire
SD:	Standard Deviation
ANOVA:	Analysis of variance
OR:	Odds Ratio
CI:	Confident Interval
SPSS:	Statistical Package for the Social Sciences
CMD:	Cardio-metabolic diseases

CHAPTER I

INTRODUCTION

In Lebanon, triple burden of malnutrition (characterized by the simultaneous occurrence of obesity, undernutrition and micronutrient deficiencies) have been reported to exist in the country (Nasreddine et al., 2018). NCDs contribute to 91% of total deaths in the country (World Health Organization., 2018), and the prevalence of obesity among female adults has been on the rise, escalating from 30.1% in 2000 to 37% in 2016 (World Health Organization., 2017). Unhealthy diets are among the recognized modifiable risk factors for obesity and several NCDs (World Health Organization., 2018; World Health Organization., 2017), especially if adopted during early adulthood (Nasreddine et al., 2012; Rinaldi et al., 2012). At the same time, several micronutrient deficiencies have been recognized in the country, resulting from either low nutrient-dense and high energy-dense diets or undernourishment. In Lebanon, females across all age groups were shown to have lower micronutrient intakes and a higher risk of micronutrient deficiencies, including calcium, iron, zinc, and vitamin B12, compared to males (Nasreddine et al., 2020). The prevalence of anemia among women of reproductive age has been found to be 42% which is classified as severe based on the global WHO (World Health Organization) threshold (United Nations Children's Fund., 2022; World Health Organization., 2011). Vitamin D deficiency was also reported to be high among Lebanese women over 18 years of age, estimated at 51.5% (Arabi et al., 2021). Increasing focus on evidence-based interventions to improve the nutritional status and eating behaviors of women of reproductive age is needed to curb NCDs and improve the health and well-being of current and of future generations.

In addition to the nutritional transition previously reported in the country, a multitude of socioeconomic and political factors might have led to increased consumption of unhealthy diets. The traditional Mediterranean diets was reported to being progressively replaced by more Westernized diet and lifestyle (Nassreddine et al., 2019). Studies conducted in Lebanon have suggested that young adults may be at a higher risk of adopting dietary habits reflective of the nutrition transition, with current evidence indicating a higher adherence to the Westernized dietary pattern in this age group as compared to older adults (Naja et al., 2011).

University students may experience significant environmental changes that may exert a negative influence on the quality of their diet and lifestyle. University student populations are widely reported to engage to unhealthy eating behaviors and poor nutritional intake (Deliens et al., 2014; Nnanyelugo et al., 1987). Studies conducted in Lebanon among university students aged 18-25 years old that assessed diet quality using the Mediterranean diet score showed poor to moderate adherence to the Mediterranean diet (Hajj & Julien., 2021; Karam et al., 2021). Therefore, a focus on strengthening protective factors and earlier investment in prevention of NCDs among young adults and particularly university students is essential.

Numerous diet quality indices have been developed to assess diet quality, but each has focused on particular nutritional needs (such as nutrient inadequacy or NCDs risk) or have been designed for particular geographical area or populations (usually high-income) or have high data needs (such as the use of food composition data for analysis) that are not feasible in limited- resource settings. Conversely, existing metrics that are conducive to applications in limited-resource settings usually compromise simplistic ways of scoring amounts of foods consumed, which limits metric

performance (Miller et al., 2020). Therefore, the Global Diet Quality Score (GDQS) has been recently developed to overcome the limitations of other diet quality scores. The GDQS, a global measure of diet quality, is a novel, low-cost, food-based metric for assessing diet that is easy to interpret and has been validated in a number of low- and middle-income countries (LMICs) settings (Bromage et al., 2021). Different from other available diet quality-related metrics, the GDQS is intended to be sensitive to diet-related disease outcomes correlated with NCDs and nutrient inadequacy. The metric is entirely food-based and thus does not require the use of a food composition table for nutrient analysis. Moreover, the GDQS comprises an expanded set of food groups and a measure of the amount of intake in the metric scoring to permit for a sensitive assessment of diet qualities (Intake Center for Dietary Assessment., 2021). The GDQS was developed for use among nonpregnant, nonlactating women of reproductive age (Intake Center for Dietary Assessment., 2021), considering the importance of this group as the main focus of nutrition interventions globally. The GDQS performed comparably with the Minimum Dietary Diversity - Women indicator in capturing nutrient adequacy and anthropometric and biochemical indicators of undernutrition and comparably or better than the Alternative Healthy Eating Index - 2010 in capturing outcomes related to NCDs (Bromage et al., 2021). Using the GDQS in young Lebanese females provides valuable information on determinants and barriers to adequate nutrient and foods consumption which will allow for evidence-based strategies to curb the escalating burden of NCDs and address nutrient adequacy.

Scarce studies assessed diet quality among young women in Lebanon and no study was found to assess diet quality using the GDQS in Lebanon. Therefore, dietary data are needed to understand the dietary behaviors among young women and the

magnitude of risk associated with poor dietary habits to develop evidenced based strategies to curb the increasing risk of NCDs and improve the health not only among young women but also the health of their offspring.

CHAPTER II

LITERATURE REVIEW

A. Definition and Overview of Diet Quality Indices

Diet quality indices (DQIs) are tools used to evaluate the overall diet quality against dietary guidelines or known healthy dietary patterns (Tan et al., 2022). Numerous DQIs have been developed, over the years, to assess diet quality, including, among others, the Minimum Dietary Diversity for women (MDD-W), the Healthy Eating Index (HEI), the Alternative Healthy Eating Index (AHEI), and the Diet Quality Index- International (DQI-I) with each targeting a specific objective.

1. Minimum Dietary Diversity for Women (MDD-W)

MDD-W is a dichotomous indicator developed and validated as a proxy measure for assessing micronutrient intake adequacy in women of reproductive age (between 15 and 49 years old) at the population-level. MDD-W has the potential to be used for assessment at national and subnational levels. It consists of 10 food groups: starchy staples, pulses, nuts and seeds, dairy, meat, poultry and fish, eggs, dark green leafy vegetables, other vitamin A–rich fruits and vegetables, other vegetables, and other fruits. MDD-W is associated with a higher probability of nutrient adequacy for 11 micronutrients: vitamin A, thiamine, riboflavin, niacin, vitamin B-6, folate, vitamin B-12, vitamin C, calcium, iron, and zinc. MDD-W can be measured using two qualitative dietary assessment methods: open recall or list-based. MDD-W is based on the number of food groups consumed by a woman in the past 24 hours from the total of the ten food

groups required. MDD-W equaled 1 if the women consumed (at least 15g) from at least 5 different food groups during the past 24 h and 0 otherwise. Women who achieve minimum diet diversity (consuming foods from 5 or more food groups) are likely to have higher micronutrient adequacy compared with women who consume foods from fewer food groups (FAO & FHI., 2016; FAO., 2021).

However, for research purposes, some studies use MDD-W as a continuous variable ranging from 0 to 10, with 1 point assigned for each of the 10 food groups consumed over the last 24 hours and 0 points allocated otherwise, rather than a binary indicator.

2. Healthy Eating Index (HEI)

The HEI was originally developed in 1995 by the US Department of Agriculture (USDA) Center for Nutrition Policy and Promotion to understand how closely American diets align with national dietary recommendations. The structure of the HEI was modified in 2005 and has been updated twice since 2005. HEI-2015 is the most recent version of the index. The HEI-2015 is a measure of diet quality, independent of quantity, which assesses adherence to the 2015-2020 Dietary Guidelines for Americans (DGA) for individuals aged 2 years and older. (USDA., 2020).

The HEI-2015 uses a scoring system to assess a set of foods with scores ranging between 0 and 100. The HEI-2015 consists of 13 dietary components: nine adequacy components (those that are encouraged for a healthful diet) and four moderation components (those that should be consumed in moderate quantities to maintain a healthful diet) (Table 1). For adequacy components, higher scores indicate higher

intakes, since higher intakes are more desirable whereas, for moderation components, higher scores indicate lower intakes, since lower intakes are more desirable. A higher total HEI score reflects a diet that aligns better with the dietary recommendations (USDA., 2018).

Table 1: *Healthy Eating Index-2015 components and scoring standards (USDA., 2018).*

HEI-2015[1] Components and Scoring Standards

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Adequacy:			
Total Fruits[2]	5	≥0.8 cup equivalent per 1,000 kcal	No Fruit
Whole Fruits[3]	5	≥0.4 cup equivalent per 1,000 kcal	No Whole Fruit
Total Vegetables[4]	5	≥1.1 cup equivalent per 1,000 kcal	No Vegetables
Greens and Beans[4]	5	≥0.2 cup equivalent per 1,000 kcal	No Dark-Green Vegetables or Legumes
Whole Grains	10	≥1.5 ounce equivalent per 1,000 kcal	No Whole Grains
Dairy[5]	10	≥1.3 cup equivalent per 1,000 kcal	No Dairy
Total Protein Foods[4]	5	≥2.5 ounce equivalent per 1,000 kcal	No Protein Foods
Seafood and Plant Proteins[4,6]	5	≥0.8 ounce equivalent per 1,000 kcal	No Seafood or Plant Proteins
Fatty Acids[7]	10	(PUFAs + MUFAs) / SFAs ≥2.5	(PUFAs + MUFAs)/SFAs ≤1.2
Moderation:			
Refined Grains	10	≤1.8 ounce equivalent per 1,000 kcal	≥4.3 ounce equivalent per 1,000 kcal
Sodium	10	≤1.1 grams per 1,000 kcal	≥2.0 grams per 1,000 kcal
Added Sugars	10	≤6.5% of energy	≥26% of energy
Saturated Fats	10	≤8% of energy	≥16% of energy

[1] Intakes between the minimum and maximum standards are scored proportionately.
[2] Includes 100% fruit juice.
[3] Includes all forms except juice.
[4] Includes legumes (beans and peas).
[5] Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.
[6] Includes seafood; nuts, seeds, soy products (other than beverages), and legumes (beans and peas).
[7] Ratio of poly- and mono-unsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).

A major characteristic of the HEI is that the scoring splits dietary quality from quantity using what is called a density approach. The components are usually calculated as a food group amount per 1,000 calories in the total mix of foods. In other words, diet quality is assessed independently of quantity. The Fatty Acids component is an exception; it is scored as a ratio of unsaturated to saturated fatty acids (USDA., 2018).

The HEI is appropriate for the assessment of diet quality among populations to which the USDA food pattern applies. However, the HEI is not suitable for children younger than age 2 years old or those consuming breast milk or infant formula (Kirkpatrick et al., 2018).

Advantages of the HEI score include providing high scores for diets known to be high in quality, being sensitive enough to show differences in scores between individuals with different food consumption patterns, and hence providing multiple dimensionalities of diet. However, similar to all assessment tools that rely on self-reported measures, and hence the HEI is subject to measurement error. Moreover, because the total HEI score does not emphasize components of diets or specific quantities of foods consumed, it is possible that a single or a few food component(s) could be inaccurately reported or excessively consumed (Colby et al., 2020).

3. Alternative Healthy Eating Index (AHEI)

The AHEI was later developed in 2002 as an alternative to the HEI. It is based on foods and nutrients which can prevent chronic disease risk (Chiuve et al., 2012). The AHEI-2010 is made up of 11 dietary components. 6 components for which the point value increases with increasing intake (adequacy principle) and 5 components for which the points value decreases with increasing intake (moderation principle) (Täger et al., 2016). Each component is given a score between 0 to 10. All the component scores are added to get a total AHEI-2010 score ranging between 0 to 110, with a higher score reflecting a healthier diet (Table 2) (Varraso et al., 2015).

Table 2: *AHEI-2010 components and scoring standards (Täger et al., 2016).*

Component	max. score	standard for max. point value	standard for point value of zero
evaluation principle: adequacy			
vegetables	10	≥ 5 portions/day[1]	0 portions/day[1]
fruit	10	≥ 4 portions/day[2]	0 portions/day[2]
whole grains	10	75 g/day (women) 90 g/day (men)	0 g/day
nuts and legumes	10	≥ 1 portion/day[3]	0 portions/day[3]
long-chain (n-3) fats (EPA + DHA)[7]	10	250 mg/day	0 mg/day
PUFA[8]	10	≥ 10 % of energy	≤ 2 % of energy
evaluation principle: moderation			
sugar-sweetened beverages and fruit juice	10	0 portions/day[4]	≥ 1 portions/day[4]
red/processed meat	10	0 portions/day[5]	≥ 1.5 portions/day[5]
trans fat	10	≤ 0.5 % of energy	≥ 4 % of energy
alcohol	10	0.5–1.5 drinks/day[6] (women) 0.5–2 drinks/day[6] (men)	≥ 2.5 drinks/day[6] (women) ≥ 3.5 drinks/day[6] (men)
sodium	10	lowest decile	highest decile

Portion sizes:
[1] 1 vegetable portion = 0.5 cup, green leaf vegetable = 1 cup; [2] 1 fruit portion = 1 medium-sized piece of fruit; berries = 0.5 cup; [3] 1 nuts portion = 1 oz.; peanut butter = 1 tablespoon; [4] 1 portion of sugared drinks and fruit juice = 8 oz.; [5] 1 portion of unprocessed meat = 4 oz.; processed meat = 1.5 oz.; [6] 1 portion of wine = 4 oz.; beer = 12 oz.; spirits = 1.5 oz.; [7] Omega-3 fatty acids (EPA = eicosapentaenoic acid, DHA = docosahexaenoic acid); [8] PUFA = polyunsaturated fatty acids

The AHEI-2010 showed more advantages than the HEI in predicting chronic disease and cardiovascular disease risk (Chiuve et al., 2012; McCullough & Willet., 2006). Higher AHEI scores are strongly linked to lower risks of chronic disease (Chiuves et al., 2012; Varraso et al., 2015), cancer (Park et al., 2017), and all-cause, cardiovascular, and cancer mortality (Onvani et al., 2017; Schwingschackl et al., 2018). However, the AHEI-2010 was not considered the gold-standard as a diet quality assessment tool (Springfield et al., 2020).

4. Diet Quality Index- International (DQI-I)

The DQI-I is a composite, individual-level diet quality indicator. It was developed in 2003 to allow cross-cultural diet quality comparisons. The DQI-I was formulated to incorporate the many aspects of a diet which contribute to quality,

including diversity, adequacy, moderation, and balance (INDDEX Project, 2018) . This indicator is created using scores from four components of diet quality, each calculated separately (INDDEX Project, 2018).

Table 3: *The Diet Quality Index – International components and scoring standards*

Diet quality component	Grouping of diet quality component	Scoring criteria	Score
Variety - food groups	5 food groups: meat/poultry/fish/egg, dairy/beans, grains, fruits, and vegetables	Each food group awarded 0 or 3 pts. 3 points awarded if at least 1 item from that group was consumed	0-15
Variety - protein sources	6 sources: meat, poultry, fish, dairy, beans, eggs	3 or more sources consumed: 5 pts 2 sources consumed: 3 pts 1 source consumed: 1 pts 0 sources consumed: 0 pts	0-5
Adequacy	8 groups: vegetables, fruit, grain, fiber, protein, iron, calcium, vitamin C	Between 0 and 5 points awarded for each of the 8 adequacy groups, depending on percentage of or Recommended Daily Allowances (RDA) met	0-40
Moderation	6 groups: total fat, saturated fat, cholesterol, sodium, empty calorie foods	Between 0 and 6 points awarded for each of the 5 moderation groups, depending on percentage of RDA met	0-30
Balance	2 groups: macronutrient ratio, fatty acid ratio	Between 0 and 6 points awarded, depending on ratio of macronutrients and between 0 and 4 points awarded depending on ratio of fatty acids	0-10

Moreover, this indicator consists of particular nutrients associated with chronic, diet-related diseases and includes specific food groupings, such as empty calorie foods, that make it a useful tool in assessing changes in diet quality associated with the nutrition transition. As an individual-level indicator, it can be paired with individual health outcomes or demographic information, such as religion, age, sex, education, or any other characteristics of interest (INDDEX Project, 2018).

The main advantage of the DQI-I is that it offers greater richness in its definition and evaluation of diet quality compared to other composite diet quality indices. For example, the HEI is based solely on food group consumption. However, the DQI-I uses

weights to proportionally score food based on its assumed nutritional importance and researchers have found that standardized weights may not be applicable in all scenarios. Moreover, because of the large amount of information needed to calculate this indicator, it is necessary to have multiple days of diet recall information from each respondent, which is not always feasible given resource constraints (INDDEX Project, 2018).

5. Global Diet Quality Score (GDQS)

The need for a standard, validated global metric that is feasible to collect in limited-resource settings and that can sensitively measure diet quality in terms of both nutritional adequacy and NCD risk was recently raised. In this context, the GDQS has been developed and proposed to overcome the limitations of other diet quality scores. The GDQS is a global measure of diet quality and is based entirely on 25 food groups: 16 healthy food groups (dark green leafy vegetables, cruciferous vegetables, deep orange vegetables, other vegetables, deep orange fruits, deep orange tubers, citrus fruits, other fruits, legumes, nuts and seeds, poultry and game meat, fish, whole grains, liquid oils, low fat dairy, and eggs), 7 unhealthy food groups (white roots and tubers, processed meats, refined grains and baked goods, sugar-sweetened beverages, sweets and ice cream, juices, and purchased deep fried foods), and 2 food groups (red meat and high-fat dairy) that are unhealthy when consumed in excessive amounts. The GDQS measures the risk for poor diet quality outcomes (nutrient inadequacy and NCDs risk) by scoring 25 food groups according to the adequacy of their intake. For 24 of the GDQS food groups, three ranges (low, medium, high) of quantity of consumption (in grams/day) are used in scoring the metric. For one food group (high-fat dairy), four ranges (low, medium, high, and very high) of quantity of consumption are used. The

GDQS provides points for higher consumption of 16 healthy food groups and gives negative points to higher consumption of 9 unhealthy food groups. Two food groups (red meat, high-fat dairy) receive points when consumed adequately up to a specific threshold of quantity of consumption, after which the points decrease (Table 4). The GDQS has a possible range of 0 to 49, where a total score ≥ 23 indicates a low risk of poor diet quality outcomes, a total score <15 indicates a high risk of poor diet quality outcomes, and a total score ≥ 15 and < 23 indicates a moderate risk of poor diet quality outcomes. The GDQS was intended to be appropriate for use among non-pregnant, non-lactating women of reproductive age in LMICs but has also been shown to be valid for use in high-income countries, thus providing a simple, standardized metric appropriate for population-based measurements and comparisons globally (Intake Center for Dietary Assessment., 2021).

Gathering data on the GDQS also permits for the tabulation of two GDQS sub-metrics: the GDQS positive (GDQS+) sub-metric and the GDQS negative (GDQS–) sub-metric. The GDQS+ is the total score of the 16 healthy GDQS food groups, with a possible range between 0 to 32. The GDQS− is the total score of the 7 unhealthy GDQS food groups and the 2 GDQS food groups that are unhealthy when consumed in excessive quantities, with a possible range between 0 to 17. The GDQS+ and GDQS− give value by providing more targeted information about the relative contribution of healthy and unhealthy food group intake to overall diet quality in a specific setting. GDQS data can also be analyzed to provide the percent of the population eating each GDQS food group in the reference 24-hour period and the percent of the population eating low, middle, and high (or very high, in the case of high-fat dairy) amounts of

consumption of each food group in the reference 24-hour period (Intake Center for Dietary Assessment., 2021).

Table 4: *GDQS and GDQS Sub-Metric food groups and scoring (Intake Center for Dietary Assessment., 2021).*

Inclusion in Metrics	Scoring Classification	Food Group	Categories of Consumed Amounts (g/day)				Points Assigned			
			Low	Middle	High	Very High	Low	Middle	High	Very High
GDQS and GDQS+	Healthy	Citrus fruits	<24	24–69	>69		0	1	2	
		Deep orange fruits	<25	25–123	>123		0	1	2	
		Other fruits	<27	27–107	>107		0	1	2	
		Dark green leafy vegetables	<13	13–37	>37		0	2	4	
		Cruciferous vegetables	<13	13–36	>36		0	0.25	0.5	
		Deep orange vegetables	<9	9–45	>45		0	0.25	0.5	
		Other vegetables	<23	23–114	>114		0	0.25	0.5	
		Legumes	<9	9–42	>42		0	2	4	
		Deep orange tubers	<12	12–63	>63		0	0.25	0.5	
		Nuts and seeds	<7	7–13	>13		0	2	4	
		Whole grains	<8	8–13	>13		0	1	2	
		Liquid oils	<2	2–7.5	>7.5		0	1	2	
		Fish and shellfish	<14	14–71	>71		0	1	2	
		Poultry and game meat	<16	16–44	>44		0	1	2	
		Low-fat dairy	<33	33–132	>132		0	1	2	
		Eggs	<6	6–32	>32		0	1	2	
GDQS and GDQS–	Unhealthy in excessive amounts	High-fat dairy* (in milk equivalents)	<35	35–142	>142–734	>734	0	1	2	0
		Red meat	<9	9–46	>46		0	1	0	
	Unhealthy	Processed meat	<9	9–30	>30		2	1	0	
		Refined grains and baked goods	<7	7–33	>33		2	1	0	
		Sweets and ice cream	<13	13–37	>37		2	1	0	
		Sugar-sweetened beverages	<57	57–180	>180		2	1	0	
		Juice	<36	36–144	>144		2	1	0	
		White roots and tubers	<27	27–107	>107		2	1	0	
		Purchased deep fried foods	<9	9–45	>45		2	1	0	

* Hard cheese should be converted to milk equivalents using a conversion factor of 6.1 when calculating total consumption of high-fat dairy for the purpose of assigning a GDQS consumption category. Refer to Annexes 2, 3, and 4, respectively, for details on how to apply this conversion factor appropriately, according to whether a quantitative 24-hour dietary recall survey, a FFQ, or the GDQS app was used to collect the data.

The GDQS is a population-based metric of diet quality. GDQS data are purposed to be reported and used at the population or sub-group level, not at the individual level. GDQS data can be used for population-based assessment, target-setting, program/policy design, and cross- or within-country comparison. The GDQS is also suitable for evaluating population-level changes in diet quality and hence can also be used for monitoring and evaluation of programs and policies that aim to improve diet quality (Intake Center for Dietary Assessment., 2021).

Different from other available diet quality-related metrics, the GDQS is intended to be sensitive to diet-related disease outcomes correlated with both undernutrition and overnutrition. The metric is entirely food-based and thus does not require the use of a food composition table for nutrient analysis. Moreover, the GDQS comprises an

expanded set of food groups and a measure of the amount of intake in the metric scoring, to permit for a sensitive assessment of diet qualities (Intake Center for Dietary Assessment., 2021).

Different data collection methods can be used to derive data for the GDQS. The selection of method relies on the availability of existing dietary data and the resources available to collect new data. Quantitative 24-hour dietary recall (24-HR) and Food Frequency Questionnaire (FFQ) can be used to derive data for the GDQS, however for FFQ data to be a robust data source for the GDQS, the FFQ instrument must comprehensively list the foods commonly consumed by the target population and allow for the quantity of consumption of each food to be derived for a 24-hour reference period. To ease routine data collection for the GDQS, Intake developed an electronic data collection tool, GDQS Application, to provide a simple method to collect population based GDQS data at relatively low cost and with low respondent burden (Intake Center for Dietary Assessment., 2021).

A validation study using cross-sectional and cohort data from nonpregnant, nonlactating women of reproductive age in 10 African countries as well as China, India, Mexico, and the United States showed that the GDQS performed similarly to the MDD-W indicator in capturing nutrient adequacy and anthropometric and biochemical indicators of undernutrition (including underweight, anemia, and serum folate deficiency), and the GDQS also performed similarly or better than the AHEI-2010 in capturing outcomes related to NCDs (including metabolic syndrome, change in weight and waist circumference, and incident type 2 diabetes) (Bromage et al., 2021).

A secondary analysis study among Chinese adults observed that a higher GDQS was inversely associated with a double burden of metabolic syndrome and nutrient inadequacy. These associations were consistent across different household income levels but were significantly stronger in younger than older individuals (<50 years old), females than males, urban than rural residents, and those with higher educational level (Yuna et al., 2021).

Another study among nonpregnant Indian women of reproductive age found that the GDQS was strongly associated with nutrient adequacy but less so with cardiometabolic outcomes. In precise, the GDQS and the GDQS+ submetric were positively associated with the macronutrients protein and fat and several micronutrients that are of nutritional concern in LMICs, such as folate, fiber, and iron. Whereas the GDQS− submetric was inversely associated with saturated fat. Although the GDQS and the GDQS+ submetric were adversely associated with anthropometric measures and lipid measures, higher scores on the GDQS− submetric was associated with a lower BMI, midupper arm circumference, and waist circumference values (Matsuzaki et al., 2021).

A secondary analysis study of rural men and nonpregnant nonlactating women of reproductive age in 10 African countries showed that the GDQS preformed similarly to the MDD-W in capturing nutrient adequacy- related outcomes. The GDQS was positively associated with overall nutrient adequacy, lower odds of low MUAC (Mid-upper arm circumference) and lower odds of anemia in both men and women. Moreover, the GDQS− was inversely associated with overweight and obesity in women (Bromage et al., 2021).

Another secondary analysis study among Mexican nonpregnant, nonlactating women of reproductive age showed that in comparison to other metrics (AHEI and MDD-W), the GDQS was able to capture the double burden of nutrient adequacy and health markers related to NCDs risk when using dietary data collected with a 24-HR or a past-week FFQ. Both instruments for data collection were beneficial to assess the performance of the GDQS, however the 24-HR appears to be more suitable for population-level descriptive studies for its ability to capture absolute nutrient intake, whereas the FFQ may be more suitable for analytical studies that prioritize the evaluation of long-term intake. The submetrics derived from the GDQS (GDQS+ and GDQS–) had an overall performance poorer to the GDQS but were useful for the characterization across subpopulations of the consumption of healthy and unhealthy dietary components in relation to overall dietary quality, which can provide helpful information for targeting interventions (Castellanos-Gutiérrez et al., 2021).

A longitudinal analysis study of Mexican nonpregnant, nonlactating women of reproductive age (25–49 years old) showed that improvement in diet quality over a 2-years period, measured by an increase in the GDQS, was associated with less weight and waist circumference gain. Food groups that were key in driving this association included increased intake of dark green leafy vegetables, cruciferous vegetables, deep orange vegetables, citrus fruits, low fat and high fat dairy, whole grains, and fish and decreased intake of refined grains, sugar-sweetened beverages, red meat, sweets and ice cream, and purchased deep fried foods. Moreover, the GDQS was shown to have a stronger association than the MDD-W with weight gain, and a stronger association than the AHEI-2010 with waist circumference gain (Angulo et al., 2021).

A secondary analysis study among US women found that improvement in diet quality over a 4-years period reflected by an increase in the GDQS was associated with less weight gain and lower risk of obesity. The association for weight change was stronger among women aged <50 y, however risk of obesity did not differ by age. Compared with other diet quality scores, the AHEI-2010 had somewhat stronger associations than the GDQS however the GDQS had stronger associations than the MDD-W (Fung et al., 2021).

A study that aimed to prospectively examine the ability of the GDQS to predict the risk of type 2 diabetes in the US found that higher GDQS was inversely associated with type 2 diabetes risk among US women of reproductive age or older, mostly from lower consumption of unhealthy foods. The GDQS performed well compared with the AHEI-2010 in predicting risk of diabetes (Fung et al., 2021).

B. Diet Quality in Lebanon

Studies conducted in Lebanon among university students aged 18-25 years old that assessed diet quality using the Mediterranean diet score showed poor to moderate adherence to the Mediterranean diet (Hajj & Julien., 2021; Karam et al., 2021). Karam et al. (2021) showed that the university students in Lebanon consumed legumes, vegetables, fruits, and nuts according to the Mediterranean diet standards, however fish consumption was lower than the recommended Mediterranean diet intake (Karam et al., 2021). A cross-sectional dietary survey that involved a Lebanese population sample aged 19 to 70 years showed low adherence to the Mediterranean dietary pattern where

the consumption of fruits, vegetables, dairy products, legumes and nuts of this Lebanese sample met the Mediterranean diet recommendations, while whole grains, poultry and fish consumption was lower than the recommended Mediterranean diet intake, and meat consumption was found to be much higher than what was recommended (Farhat et al., 2016). Naja et al. (2011) reported that among Lebanese adults some energy-dense foods such as whole-dairy products and refined grains were heavily consumed in the recent Lebanese dietary pattern (Naja et al., 2011). Yahia et al. (2008) indicated that in 2007, in Lebanon, there was a high intake of fried food among university students (Yahia et al., 2008).

C. Drivers of consumption

Dietary behaviors may be affected by a wide variety of social, cultural, and economic factors. Intra-individual determinants, for instance, physiological and psychological factors, food preferences, and dietary knowledge can be determined from interpersonal or social factors, such as family and partners influence (Contento., 2011).

Determinants of food choice are often leveled in four groups:

1. Biologically determined behavioral predispositions defined by one's inborn abilities related to food, specifically the liking for sweet and salty foods; the mechanisms that regulate hunger and satiety; and the sensory experience given by food. These are the most basic determinants of food choice, which means that individuals initially follow their preferences when selecting food or drinks (Contento., 2011).

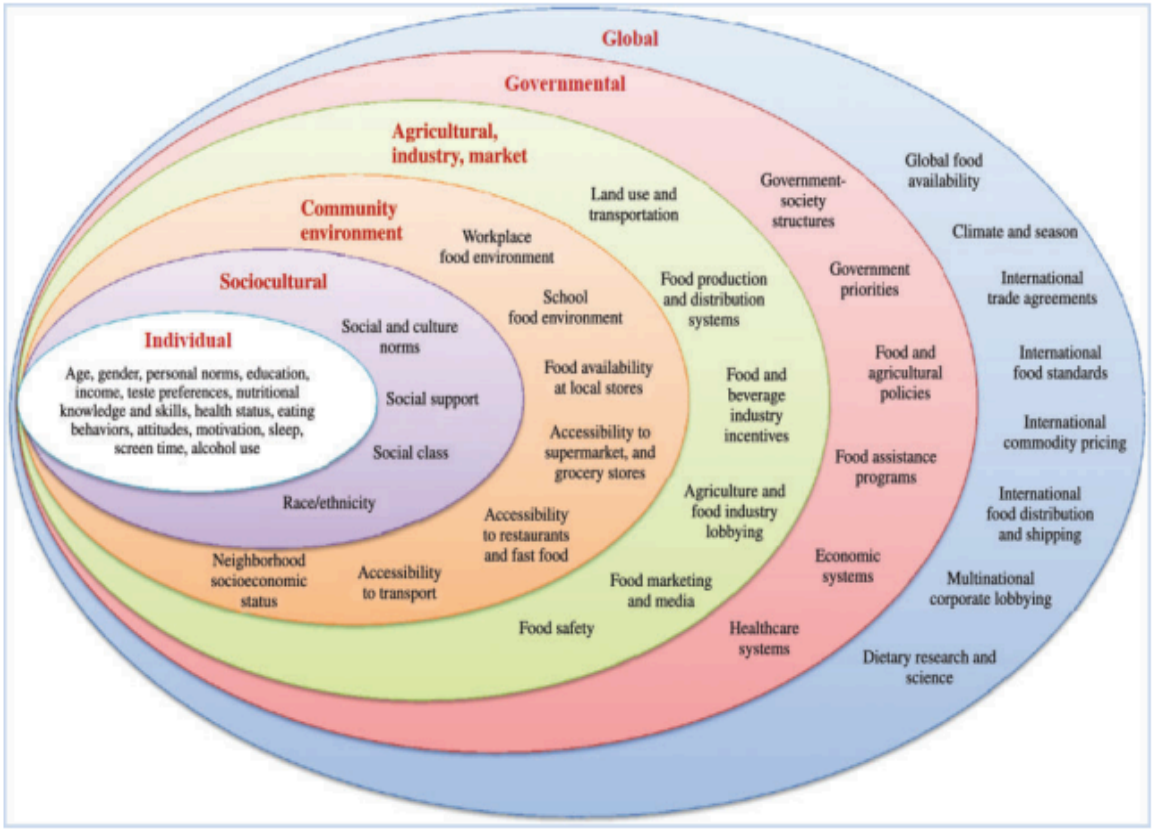
2. Sensory-affective factors defined by one's feelings and emotions in relative to food, as well as developed familiarity and capability to learn how to like something are at the second level (Contento., 2011).
3. Intrapersonal factors, which are related to one's beliefs, attitudes, dietary knowledge, cooking skills and social norms, follow the preceding factors in determining food choice, just like the interpersonal factors, which include family, friends and other social networks. Various authors have determined that food choices depend on the surrounding environment and are according to an individual knowledge and experience (Contento., 2011).
4. Environmental factors which precede the above levels but are the easiest to affect eating behaviors, environmental factors involve availability and accessibility to food; resources; economic environment; and social, environmental, cultural and food marketing practices. For instants, resources and economic environment establish food choice by food price or one's income. Based on previous studies, low-income groups are more likely to follow an unbalanced diet (Contento., 2011).

Moreover, a person's psychological state is also thought to be one of the main determinants of the food choice. Anxiety, stress, loneliness, and other psychological states can influence individual's eating behavior (Contento., 2011).

At the macro level, agriculture, market forces, land use, transportation, food production and distribution, issues of food safety, industry incentives, lobbying, marketing, and the media can all influence food choices. Governments are also

important factors, diet is formed by their main concerns, agricultural policies, food assistance programs, school lunch policies, and the healthcare system. Lastly, global influence is also important, such as multinational corporate lobbying, climate change, scientific research, and trade agreements (Figure 2) (Mozaffarian et al., 2017).

Figure 1: *Barriers and opportunities for healthy eating (Afshin et al., 2014).*



D. Research questions and objectives

Research questions:

1- What is the current diet quality (GDQS) among female university students?

2- What are the food groups that are driving a low GDQS score?

3- What are the current drivers of consumption of food groups contributing to a low GDQS?

4- What was the diet quality (GDQS) and GDQS food groups consumption of young Lebanese female adults in 2008/2009 national study?

5- Were there any changes in diet quality (GDQS) and GDQS food groups consumption among Lebanese young female adults between 2008/2009 and 2022?

Objectives:

This study aims to determine the diet quality using the GDQS among Lebanese female students at the American University of Beirut (AUB), identify the food groups that are driving a low GDQS score and explore the drivers of consumption of food groups contributing to a low GDQS score. A secondary aim was to assess the diet quality using GDQS among Lebanese young female adults in 2008/2009 and investigate trends in diet quality (GDQS) and GDQS food groups consumption among Lebanese young female adults between 2008/2009 and 2022.

CHAPTER III

METHODOLOGY

A. Study design and population

This study was implemented in 2 phases. Phase 1 was a cross-sectional dietary survey of AUB female students aged between 18-24 years based on GDQS in 2022, while phase 2 was a secondary analysis of dietary data stemming from a national nutrition survey conducted in 2008/2009 by the AUB.

1. Phase 1: 2022 Cross-sectional Dietary Survey of Female AUB students

A convenient sample of 384 AUB female students were recruited for the study (with 20% refusal rate) using flyers posted around AUB campus. The sample size of 384 was determined using the WHO sample size calculator, available at the following link: https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps/planning-sampling. To calculate the sample size, we set the level of confidence measure at 1.96, the margin of error at 0.05, the baseline levels of indicators at 0.5, the design effect at 1, the expected response rate at 1 and the number of age/sex estimates at 1; where we obtained a sample of 384 participants. Inclusion criteria required that participants were Lebanese female students at AUB aged between 18 to 24 years old. Males and pregnant and lactating women were excluded from this study.

GDQS App which is an electronic data collection tool developed by Intake for collecting data was used to evaluate diet quality. Socio-demographic, lifestyle factors

and drivers of consumption as well as self-reported anthropometric measurements were obtained using multi-component questionnaire.

2. Phase 2: 2008/2009 National Survey

For the purpose of this study, dietary data pertinent to females aged 18-24 years participating in the 2008/2009 national survey and who had complete data were included (*n=240*) and analyzed to assess diet quality (GDQS) in this group. The food groups contributing to a low GDQS score were identified and used for the evaluation of the drivers of consumption. Moreover, the diet quality (GDQS) in this group was also used to investigate changes in diet quality (GDQS) and GDQS food groups consumption among young Lebanese female adults between 2008/2009 and 2022. Dietary data among females aged 18-24 years were derived from the National Nutrition and Non-Communicable Disease Risk Factor Survey conducted in Lebanon between May 2008 and August 2009. Details about the design and protocol of this study are published elsewhere (Naja et al., 2011; Nasreddine et al., 2020). Briefly, this survey consisted of a nationally representative sample of Lebanese adults, adolescents, and children aged 6 years and above selected from households based on stratified cluster sampling. The strata were the Lebanese governorates, whereas districts within governates were considered clusters. Within clusters, households were randomly selected using probability proportional to size sampling and considering the distribution of the Lebanese population (by sex and 5-year age group) estimated by the Central Administration for Statistics in Lebanon (2004) (Lebanese Republic Ministry of Social Affairs and the Central Administration for Statistics & UNDP., 2004). Dietary intake was assessed using a 24-hour recall (24-HR) method.

B. Ethical Approval

The Institutional Review Board of the AUB approved this study protocol, and fieldwork was carried out between April and August 2022. Written informed consent was presented in English and obtained from subjects prior to participation (Appendix I).

C. Phase 1: Data collection: 2022 cross-sectional survey

A graduate student underwent extensive training in order to standardize interviewing techniques and minimize the interviewer's bias. The trained interviewer conducted data collection at the AUB campus using face-to-face interviews, with each interview lasting for around 20 minutes. All members of the research team had Collaborative Institutional Training Initiative (CITI) certification for human subjects' research as per the requirements of the Institutional Review Board of the AUB prior to the initiation of the study.

For data collection, female students at the AUB were randomly approached by the interviewer based upon their consent and availability. The interviewer explained to students briefly the purpose of the study and informed participants that their participation is completely voluntary and that they have the right to withdraw or discontinue participation at any time without penalty, and it would not affect their relationship with the AUB in any possible way. The tools used to collect data included an interviewer-administrated multi-component questionnaire and the GDQS App.

1. Multi-component questionnaire

The multicomponent questionnaire consisted of: (1) socio-demographic factors, (2) anthropometric measurements, (3) lifestyle habits and (4) drivers of eating behaviors of the selected GDQS food groups. The questionnaire was presented in English (Appendix II).

a. Socio-demographic factors

Demographic characteristics assessed included age, living arrangements (Living at parental home/ Living in student residence), place of residence (Urban area/ Rural area), major of study (Health related major/ non-health related major) and academic year of study (categorized as first year university, second year university, or ≥3 years university).

Socioeconomic status was assessed using the crowding index. Crowding index was calculated as the total number of persons in the household divided by the total number of rooms, excluding the kitchen, bathrooms, and balconies. Crowding index was coded into 2 categories: <1 Person/Room and ≥1 Person/Room.

b. Anthropometric measurements

Anthropometric measurements assessed included self-reported height and weight. The body mass index (BMI) was determined through self-reported weight and height. BMI is calculated by dividing the weight in kilograms by the height in meters squared. BMI was classified into underweight, normal weight, overweight and obesity according to the WHO BMI classification for adults (World Health Organization., 2010).

c. Lifestyle habits

Lifestyle habits assessed included smoking status (smoker/ non-smoker or past drinker), alcohol consumption status (drinker/ non-drinker or past drinker) and physical activity. Physical activity was assessed using the short version of the International Physical Activity Questionnaire (IPAQ). Three categories of physical activity (low, moderate, and high) were assigned based on METs-min/week (MET-min being the product of the resting metabolic rate for an activity and the number of minutes taken to perform it).

d. Drivers of eating behaviors

To identify the drivers and barriers of consumption of the food groups contributing to a low GDQS score, participants were asked pre-coded questions. Each question presented several options to be selected regarding the reasons for not consuming the selected healthy food groups and the reasons for consuming the selected unhealthy food groups. Options presented were chosen by searching the literature for the most common drivers and barriers of eating behavior.

2. The GDQS and GDQS Application

a. The GDQS

The GDQS is a global measure of diet quality and is based entirely on 25 food groups. The GDQS consists of 16 healthy food groups: dark green leafy vegetables,

cruciferous vegetables, deep orange vegetables, other vegetables (which are vegetables other than dark green leafy, cruciferous and deep orange vegetables) deep orange fruits, citrus fruits, other fruits (which are fruits other than deep orange and citrus fruits), deep orange tubers, legumes, nuts and seeds, poultry and game meat, fish, whole grains, liquid oils, low fat dairy, and eggs, 7 unhealthy food groups: white roots and tubers, processed meats, refined grains and baked goods, sugar-sweetened beverages, sweets and ice cream, juices, and purchased deep fried foods and 2 food groups that are unhealthy when consumed in excessive amounts (red meat, high-fat dairy). For 24 of the GDQS food groups, three ranges (low, medium, high) of quantity of consumption (in grams/day) are used in scoring the metric. For one food group (high-fat dairy), four ranges (low, medium, high, and very high) of quantity of consumption are used. The GDQS provides points for higher consumption of 16 healthy food groups and gives negative points to higher consumption of 7 unhealthy food groups. Two food groups (red meat, high-fat dairy) receive points when consumed adequately up to a specific threshold of quantity of consumption, after which the points decrease. For healthy food groups, score points between 0 to 4 are given to each level of intake depending on the food group, where higher intake receives more score points. For unhealthy food groups, 2, 1, or 0 score points are given for the intake levels, so that lower intake receives more score points. The GDQS is a sum of all 25 GDQS food group scores, with a possible score range of 0 to 49 points. A higher score indicates higher dietary quality. A GDQS ≥23 is considered a high score which was shown to be associated with a low risk of poor diet quality outcomes (nutrient inadequacy and NCD-related outcomes), GDQS ≥15 and <23 is considered a moderate score which was shown to be associated with moderate risk, and GDQS <15 is considered a low score which was shown to be

associated with high risk of poor diet quality outcomes (nutrient inadequacy and NCD-related outcomes). The GDQS+ is the total score of the 16 healthy GDQS food groups, with a possible range between 0 to 32. Higher GDQS+ score indicates higher consumption of the healthy food groups. The GDQS− is the total score of the 7 unhealthy GDQS food groups and the 2 GDQS food groups that are unhealthy when consumed in excessive quantities, with a possible range between 0 to 17. Higher GDQS- score indicates lower consumption of the unhealthy food groups (Intake Center for Dietary Assessment., 2021).

b. GDQS App

Diet quality was assessed using the GDQS App. The GDQS App is an electronic data collection tool developed by Intake to provide a standard, easy-to-use, low-cost and time-relevant method for collecting data on GDQS. The GDQS app uses an open recall method to record all foods and drinks consumed by a respondent during a 24- hour reference period and eliminates food group classification error by incorporating into the app an extensive database of foods, pre-classified into their corresponding GDQS food group. Therefore, when the respondent reports a food consumed during the open recall, the enumerator records the food in the app, and the app automatically classifies the food in the appropriate food group based on pre-classified information. When a food reported as consumed is missing from the master database of foods and the enumerator entered the food using free text, the enumerator must manually classify the food into the corresponding GDQS food group (Intake Center for Dietary Assessment., 2021).

The GDQS app involves 7 steps to collect data:

1. The first step includes demographic information including household ID, respondent ID and the respondent's date of birth and gender.
2. In the second step, the enumerator records all foods and beverages consumed during the previous 24-hour period by asking the respondent open-ended questions. To avoid underreporting and omission of foods, the enumerator proceeds from one eating occasion to another, including snacks in-between major eating occasions.
3. In the third step, in the case when respondents report consuming a mixed dish (foods with a specific culinary name and prepared using ≥2 ingredients), the enumerator asks the respondent to list the ingredients of the mixed dish. If they were unable to recall the list of all ingredients of the mixed dish, the enumerator asks the respondent to list only the major ingredients. However, there are some exceptions where some foods prepared with multiple ingredients such as bread and cakes are treated as single foods rather than mixed foods.
4. In the fourth step, the application asks for more detailed information about certain foods such as grains (whole or refined), dairy (high or low fat) and others so that the app will be able to classify the foods into their corresponding GDQS food group. For example, if the respondent reports consuming bread, the application uses that information to prompt the enumerator to ask the respondent if the bread reported as consumed was white or brown.
5. In the fifth step, the application asks about whether any of the foods reported as consumed were deep fried foods, with follow-up questions about whether these were purchased deep fried foods or were deep fried at home using pourable oil.

There is an additional question asking whether the respondent poured liquid oil on their food or used it in preparation of any food they have ate.

6. In the sixth step, the interviewer asks the respondent probing questions to know whether they used caloric sweeteners, that can be easily forgotten by respondents when reporting foods and beverages consumed.

   At the end of the steps described above, all foods and beverages will have been classified into their corresponding GDQS food groups.

7. In the seventh step, a set of 10 hollow 3D cubes in a range of predetermined sizes are used to collect quantity of consumption information at the food group level. These cubes are used as visual aids for the respondent. The enumerator read back to the respondent the list of foods and beverages reported as consumed per GDQS food group and asks the respondent to visualize the quantity of all food items consumed within a GDQS food group and to select which cube size best fit the quantity consumed (i.e., volume). In the case where the respondent selects a cube that corresponds to the exact cutoff of a GDQS food group, a follow-up question prompt to ask the respondent if the respondent consumed “as big or bigger” or “smaller” than the designated cube.

Data collection using the GDQS app require an average of approximately 10 minutes per respondent. The amount of time required for data collection varies between respondents depending on the complexity of the diet consumed. The GDQS app is programmed to send data to a CSWeb server, in order to extract data (Moursi et al., 2021; Intake., 2021). For each participant, data on the GDQS scores of each food group as well as the total GDQS, GDQS+ and GDQS- scores were obtained. Participants were

classified into low, moderate, and high total GDQS score based on their total GDQS score. Moreover, participants were classified into low, moderate, high, and very high intake category of each food group based on their GDQS score of each food group. The points system used to classify participants into low, moderate high and very high intake category of each food group is shown in Appendix III.

D. Phase 2: GDQS scoring for 2008/2009 National Survey

Overall diet quality in the 2008/2009 national survey was assessed using the GDQS. Using the national survey conducted in 2008/2009, the foods reported in the 24-HR were classified to their corresponding GDQS food group. Foods belonging to the purchased deep fried foods group were "double-counted", meaning that they were also included in the corresponding group according to their characteristics. For example, "French fries" were included in deep fried foods and in white roots and tubers. The mixed dishes included in the 24-HR were disaggregated into individual foods following a standard recipe (standardized recipes were added to the Nutritionist Pro software using single food items), which were then each classified into their corresponding GDQS food groups. For each individual, total daily intake in grams for each GDQS food group was estimated. Then the intake levels for each food group were categorized to low, moderate, or high based on the predefined cutoff levels. For high fat dairy, an additional "very high" consumption category was included. The 25 food groups were then given scores according to their level of consumption. The sum of all 25 GDQS food group scores was calculated to obtain the total GDQS score. Individuals were then ranked into low, moderate, and high total GDQS score. Additionally, GDQS+ and

GDQS− submetrics were computed by only including 16 and 9 food groups, respectively. The points system used to compute the GDQS is shown in Appendix III.

E. Statistical analysis

Descriptive statistics was presented as means and standard deviations (SD) for continuous variables or as frequencies (n) and proportions (%) for categorical variables. For the drivers of consumption analysis, subjects with low intake of each of the selected GDQS healthy food groups and subjects with high intake of each of the selected GDQS unhealthy food groups were selected, and the frequencies and proportions for the drivers of consumption were presented only among these subjects. Microsoft Excel (version; 16.67) was used to represent the drivers of consumption in bar charts. Due to the low percentage of subjects with high total GDQS score, total GDQS score levels was dichotomized into 2 categories: low total GDQS score, and moderate to high total GDQS score. Frequencies and proportions were used to represent subjects with low, moderate, high, and very high intake for each GDQS food group for subjects with low and subjects with moderate to high total GDQS score and the differences between the two groups were examined using chi- squared test and 2 sample z-test for proportion. BMI was dichotomized into 2 categories: BMI <25 and BMI ≥25. The mean differences in total GDQS, GDQS+ and GDQS- scores between two groups or more than two groups were tested by independent samples t-test and one-way analysis of variance (ANOVA) with Bonferroni corrections, respectively. Association between GDQS score levels (low, moderate and high) and socio-demographic, lifestyle and BMI characteristics were examined using chi-squared test. Intensity of physical activity was

dichotomized into 2 categories: low intensity physical activity, and moderate to high intensity physical activity. A binary logistic regression was carried out because the outcome variable, which is total GDQS score levels (low total GDQS and moderate to high total GDQS), is binary and many possible independent variables might predict total GDQS score. The reference category was moderate to high total GDQS score. Odds ratios (OR) with their 95% confidence intervals (CI) were obtained and presented in Model 1 (unadjusted). The analysis was then adjusted, based on the literature, for age and crowding index (Darmon & Drewnowski., 2008; Alkerwi et al., 2015; Ramón-Arbués et al., 2021) and further adjustment was generated by inclusion of significant variables at the chi-squared analysis and mean difference in GDQS scores analysis. Model 2 was adjusted for age and model 3 was adjusted for age, crowding index, living arrangements, place of residence, smoking status and physical activity using multivariate logistic regression. Frequencies and proportions were used to represent subjects with low, moderate, high, and very high intake for each GDQS food group for both surveys (2008/2009 and 2022) and the differences between the two years were examined using chi- squared test and 2 sample z-test for proportion. The Statistical Package for the Social Sciences (SPSS; version 25) was used for all computations and a p-value<0.05 was considered statistically significant.

CHAPTER IV

RESULTS

A. Phase 1: Results of Cross-sectional Survey 2022

1. Characteristics of the study sample

The sociodemographic, anthropometric and lifestyle characteristics of the study sample are presented in Table 5. The study sample consisted of 384 AUB female students aged between 18 and 24 years old. The average mean ± SD age was 19.78 ± 1.56 years. Most participants were living at parental home (75.5%), living in urban areas (85.9%) and studying a non-health related major (62.5%). Participants were predominantly non-drinkers/ past drinkers (69.8%) and non-smokers/ past smokers (86.2%). Of the study sample, 41.4%, 28.1% and 30.5% were in the first, second and third or more academic year of study, respectively. More than half of the participants (55.2%) had a crowding index ≥ 1 person/room, which indicates low socioeconomic status (Melki et al., 2004). Approximately half of the participants (51%) had moderate intensity physical activity compared to low intensity physical activity (37.8%) and high intensity physical activity (11.2%). The average mean ± SD weight, height and BMI were 60.27 ±11.11, 164.06 ±5.96 and 22.39 ±3.87, respectively. Most participants had a normal BMI (70.3%) whereas 10% were underweight and 19.5% were overweight/ obese.

Table 5: *Socio-demographic, anthropometric and lifestyle characteristics in the sample of AUB female students.*

Variable	Total (*n*=384)
Socio-demographic Characteristics	
Age (years), mean (SD)	19.78±1.56
Living Arrangement, *n* (%)	
Living at parental home	290(75.5)
Living in student residence	94(24.5)
Place Residence, *n* (%)	
Urban area	330(85.9)
Rural area	54(14.1)
Major Study, *n* (%)	
Health related major	144(37.5)
Non- health related major	240(62.5)
Academic year study, *n* (%)	
First year university	159(41.4)
Second year	108(28.1)
≥3 years	117(30.5)
Crowding index, *n* (%)	
<1 Person/Room	172(44.8)
≥1 Person/Room	212(55.2)
Lifestyle Characteristics	
Alcohol Consumption status, *n* (%)	
Drinker	116(30.2)
Non-Drinker/Past Drinker	268(69.8)
Smoking Status, *n* (%)	
Current Smoker	53(13.8)
Non-Smoker/Past smoker	331(86.2)
Intensity of Physical Activity (Mets), *n* (%)	
Low-intensity activity	145(37.8)
Moderate-intensity activity	196(51.0)
High-intensity activity	43(11.2)
Anthropometric Characteristic	
Weight (Kg), mean (SD)	60.27 ±11.11
Height (cm), mean (SD)	164.06 ±5.96
Body mass index (BMI), mean (SD)	22.39 ±3.87
BMI Classification, *n* (%)	
Underweight	39(10.2)
Normal	270(70.3)
Overweight	61(15.9)
Obese	14(3.6)
Overweight & Obese	75 19.5)

2. Evaluation of diet quality using GDQS and GDQS food groups consumption of study sample

Table 6 presents the total GDQS, GDQS+ and GDQS- scores as mean±SD and the percentages of subjects classified as low, moderate, and high total GDQS score. The mean average total GDQS, GDQS+ and GDQS- scores were 16.1±4.8, 7.0±3.7 and 9.1±2.9, respectively. Only 8.3% of the participants had a high GDQS score, whereas 48.4% had a moderate total GDQS score and 43.2% had a low total GDQS score.

Table 6: *Means of total GDQS, GDQS+, and GDQS- scores and the percentages of subjects with low, moderate, and high total GDQS score in the sample of AUB female students.*

	Total (*n*=384)
Total GDQS Score Points (Healthy –Unhealthy), mean (SD)	16.1±4.8
GDQS^{+} Score Points, mean (SD)	7.0±3.7
GDQS^{-} Score Points, mean (SD)	9.1±2.9
Total GDQS score levels, *n* (%)	
Low	166(43.2)
Moderate	186(48.4)
High	32(8.3)

In table 7, subjects were classified into low, moderate, and high intake categories for each food group based on their GDQS score points of each food group and the percentages of subjects classified as low, moderate, high, and very high intake category of each of the 25 GDQS food group in the total sample are presented.

The majority of the study sample had low intake of the following healthy food groups contributing to GDQS+ score: citrus fruits (99%), deep orange vegetables (97.7%), deep orange fruits (94.8%), fish and shellfish (89.3%), eggs (88.8%), low fat dairy (88.3%), deep orange tubers (87.5%), nuts and seeds (86.7%), legumes (85.2%), cruciferous vegetables (84.1%), dark green leafy vegetables (79.4%), whole grains

(78.6%) and other fruits (61.5%), expect for liquid oils and other vegetables, where most of the study sample had moderate to high intake of liquid oils (99.2%) and other vegetables (71.9%). Additionally, nearly half of the participants had low intake of poultry (51.6%).

Table 7 also showed that most of the study sample had a low intake of the following unhealthy food groups contributing to the GDQS- score: processed meat (90.1%), juice (84.1%), red meat (64.1%), purchased, deep fried foods (63.8%) and sugar sweetened beverages (56%) except for refined grains and sweets and ice cream where most participants had high intake of high refined grains (88.5%) and sweets and ice cream (57%). Additionally, nearly half of the participants had low intake of white root tubers (53.4%) and low to moderate intake of high fat dairy (53.1%).

Table 7: *The percentages of subjects with low, moderate, high & very high intake category of each GDQS food group in the sample of AUB female students.*

GDQS food groups	Category of intake			
	Low	Moderate	High	Very High
			***n* (%)**	
GDQS+ (Healthy):				
Citrus Fruits	380(99.0)	2(0.5)	2(0.5)	---
Deep Orange Fruits	364(94.8)	7(1.8)	13(3.4)	---
Other Fruits	236(61.5)	25(6.5)	123(32.0)	---
Dark Green Leafy Vegetables	305(79.4)	13(3.4)	66(17.2)	---
Cruciferous Vegetables	323(84.1)	13(3.4)	48(12.5)	---
Deep Orange Vegetables	375(97.7)	2(0.5)	7(1.8)	---
Other Vegetables	108(28.1)	121(31.5)	155(40.4)	---
Legumes	327(85.2)	6(1.6)	51(13.3)	---
Deep Orange Tubers	336(87.5)	21(5.5)	27(7.0)	---
Nuts, Seeds	333(86.7)	5(1.3)	46(12.0)	---
Whole Grains	302(78.6)	2(0.5)	80(20.8)	---
Liquid Oils	3(0.8)	2(0.5)	379(98.7)	---
Fish, Shellfish	343(89.3)	5(1.3)	36(9.4)	---
Poultry Game Meat	198(51.6)	3(0.8)	183(47.7)	---
Low Fat Dairy	339(88.3)	10(2.6)	35(9.1)	---
Eggs	341(88.8)	1(0.3)	42(10.9)	---
GDQS^{-} (Unhealthy in excessive amounts):				
High Fat Dairy	121(31.5)	83(21.6)	132(34.4)	48(12.5)
Red Meat	246(64.1)	23(6.0)	115(29.9)	0(0.0)
GDQS- (Unhealthy):				
Processed Meat	346(90.1)	3(0.8)	35(9.1)	---
Refined Grains, Baked Goods	41(10.7)	3(0.8)	340(88.5)	---
Sweets, Ice cream	138(35.9)	27(7.0)	219(57.0)	---
Sugar Sweetened Beverages	215(56.0)	11(2.9)	158(41.1)	---
Juice	323(84.1)	9(2.3)	52(13.5)	---
White Roots Tubers	205(53.4)	22(5.7)	157(40.9)	---
Purchased, Deep Fried Foods	245(63.8)	12(3.1)	127(33.1)	---

3. Determination of the food groups contributing to a low GDQS score.

In table 8, the study sample was divided into 2 groups, subjects with low and subjects with high/moderate total GDQS score. Subjects in both groups were classified into low, moderate, and high intake category of each food groups based on their GDQS score of each food group and the differences in the percentages of subjects with low,

moderate, high, and very high intake of each food group between subjects with low and subjects with high/moderate total GDQS score were presented.

For the healthy food groups (GDQS+), compared to subjects with moderate/high total GDQS score, subjects with low total GDQS score had a significantly lower consumption of other fruits, dark green leafy vegetables, and legumes. The percentages of subjects with low intake of these foods were significantly higher in low total GDQS subjects compared to moderate/high total GDQS subjects (other fruits: 77.1% vs. 49.5, dark green leafy vegetables: 95.2% vs. 67.4%, legumes: 95.8% vs. 77.1%, respectively) (All P-value<0.05), and the percentages of subjects with moderate to high intake of these foods were significantly lower in low total GDQS subjects compared with moderate/high total GDQS subjects (other fruits: 22.9% vs. 50.4%, dark green leafy vegetables: 4.8% vs. 32.5%, legumes: 4.2% vs. 23%, respectively) (All P-value<0.05).

Compared to subjects with moderate/high total GDQS score, subjects with low total GDQS score had a significantly lower consumption of deep orange tubers, nuts and seeds, whole grain, fish, and low-fat dairy. The percentages of subjects with low intake of these foods were significantly higher in low total GDQS subjects compared to moderate/high total GDQS subjects (deep orange tubes: 93.4% vs. 83%, nuts and seeds: 97% vs. 78.9%, whole grains: 93.4% vs. 67.4%, fish: 95.8% vs. 84.4%, low fat dairy: 94.6% vs. 83.5%, respectively) (All P-value< 0.05), and the percentages of subjects with high intake were significantly lower in low total GDQS subjects compared with moderate/high total GDQS subjects (deep orange tubers: 3.6% vs. 9.6%, nuts and seeds: 2.4% vs. 19.3%, whole grains: 6.6% vs. 31.7%, fish: 3.5% vs. 13.4%, low fat dairy: 1.8% vs. 14.7%, respectively) (All P-value<0.05).

Therefore, low consumption of other fruits, dark green leafy vegetables, legumes, deep orange tubers, nuts and seeds, whole grain, fish, and low-fat dairy are contributing to a low total GDQS score.

For the unhealthy food groups (GDQS-), compared to subjects with moderate/high total GDQS score, subjects with low total GDQS score had a significantly higher consumption of processed meat, refined grains, sugar sweetened beverages, juice, white roots tubers, and purchased deep fried foods. The percentages of subjects with low intake of these foods were significantly lower in low total GDQS subjects compared to moderate/high total GDQS subjects (Processed meat: 83.7% vs. 95%, refined grains: 4.8% vs. 15.1%, sugar sweetened beverages: 34.9% vs. 72%, juice: 78.3% vs. 88.5%, white roots tubes 33.7% vs. 68.3%, deep fried food: 45.2% vs. 78% respectively) (All P-value< 0.05), and the percentages of subjects with high intake of these foods were significantly higher in low total GDQS subjects compared with moderate/high total GDQS subjects (Processed meat: 15.1% vs. 4.6%, refined grains: 94.6% vs. 83.9%, sugar sweetened beverages: 62% vs. 25.2%, juice: 18.7% vs. 9.6%, white roots tubes 60.8% vs. 25.7%, deep fried food: 50.6% vs. 19.7% respectively) (All P-value< 0.05).

Compared to subjects with moderate/high total GDQS score, subjects with low total GDQS score had a significantly higher consumption of sweets. The percentages of subjects with moderate intake of sweets were significantly lower in low total GDQS subjects compared to moderate/high total GDQS subjects (3.6% vs. 9.6%, respectively; P-value<0.05), and the percentages of subjects with high intake of sweets were significantly higher in low total GDQS subjects compared with moderate/high total GDQS subjects (65.7% vs. 50.5%, respectively; P-value<0.05)

Therefore, high consumption of processed meat, refined grains, sugar sweetened beverages, juice, white roots tubers, sweets and purchased deep fried foods are contributing to a low total GDQS score.

Table 8: *Comparison of the percentage of subjects with low, moderate, and high intake category of each food group between subjects with low and subjects with moderate/high total GDQS score.*

Category of intake	Low total GDQS (*n*=166)	Moderate/ High total GDQS (*n*=218)	Pearson Chi-Square
	n (%)		
GDQS^{+} (healthy):			
Citrus Fruits	165(99.4) $_{a}$	215(98.6) $_{a}$	0.758
Low	0(0) $_{a}$	2(0.9) $_{a}$	
Moderate	1(0.6) $_{a}$	1(0.5) $_{a}$	
High			
Deep Orange Fruits			
Low	158(95.2) $_{a}$	206(94.5) $_{a}$	0.508
Moderate	4(2.4) $_{a}$	3(1.4) $_{a}$	
High	4(2.4) $_{a}$	9(4.1) $_{a}$	
Other Fruits			
Low	128(77.1) $_{a}$	108(49.5) $_{b}$	**0.000**
Moderate	6(3.6) $_{a}$	19(8.7) $_{b}$	
High	32(19.3) $_{a}$	91(41.7) $_{b}$	
Dark Green Leafy Vegetables			
Low	158(95.2) $_{a}$	147(67.4) $_{b}$	0.000
Moderate	2(1.2) $_{a}$	11(5) $_{b}$	
High	6(3.6) $_{a}$	60(27.5) $_{b}$	
Cruciferous Vegetables			
Low	138(83.1) $_{a}$	185(84.9) $_{a}$	0.758
Moderate	7(4.2) $_{a}$	6(2.8) $_{a}$	
High	21(12.7) $_{a}$	27(12.4) $_{a}$	
Deep Orange Vegetables			
Low	165(99.4) $_{a}$	210(96.3) $_{a}$	0.115
Moderate	0(0) $_{a}$	2(0.9) $_{a}$	
High	1(0.6) $_{a}$	6(2.8) $_{a}$	
Other Vegetables			
Low	50(30.1) $_{a}$	58(26.6) $_{a}$	0.061
Moderate	60(36.1) $_{a}$	61(28) $_{a}$	
High	56(33.7) $_{a}$	99(45.4) $_{a}$	
Legumes			
Low	159(95.8) $_{a}$	168(77.1) $_{b}$	**0.000**
Moderate	0(0) $_{a}$	6(2.8) $_{b}$	
High	7(4.2) $_{a}$	44(20.2) $_{b}$	
Deep Orange Tubers			
Low	155(93.4) $_{a}$	181(83) $_{b}$	**0.010**
Moderate	5(3) $_{a}$	16(7.3) $_{a}$	
High	6(3.6) $_{a}$	21(9.6) $_{b}$	

Note: Numbers in bold face a statistically significant (p-value <0.05).

$_{a,b}$ Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.

Table 8: *Continued. Comparison of the percentage of subjects with low, moderate, and high intake category of each food group between subjects with low and subjects with moderate/high total GDQS score.*

Category of intake	Low total GDQS (*n*=166)	Moderate/ High total GDQS (*n*=218)	Pearson Chi-Square
	n (%)		
Nuts, Seeds			
Low	161(97) $_a$	172(78.9) $_b$	**0.000**
Moderate	1(0.6) $_a$	4(1.8) $_a$	
High	4(2.4) $_a$	42(19.3) $_b$	
Whole Grains			
Low	155(93.4) $_a$	147(67.4) $_b$	**0.000**
Moderate	0(0) $_a$	2(0.9) $_a$	
High	11(6.6) $_a$	69(31.7) $_b$	
Liquid Oils			
Low	1(0.6) $_a$	2(0.9) $_a$	1.000
Moderate	1(0.6) $_a$	1(0.5) $_a$	
High	164(98.8) $_a$	215(98.6) $_a$	
Fish, Shellfish			
Low	159(95.8) $_a$	184(84.4) $_b$	**0.001**
Moderate	1(0.6) $_a$	4(1.8) $_a$	
High	6(3.5) $_a$	30(13.4) $_b$	
Poultry Game Meat			
Low	85(51.2) $_a$	113(51.8) $_a$	0.778
Moderate	2(1.2) $_a$	1(0.5) $_a$	
High	79(47.6) $_a$	104(47.7) $_a$	
Low Fat Dairy			
Low	157(94.6) $_a$	182(83.5) $_b$	0.000
Moderate	6(3.6) $_a$	4(1.8) $_a$	
High	3(1.8) $_a$	32(14.7) $_b$	
Eggs			
Low	154(92.8) $_a$	187(85.8) $_a$	0.057
Moderate	0(92.8) $_a$	1(0.5) $_a$	
High	12(7.2) $_a$	30(13.8) $_a$	
GDQS- (Unhealthy in excessive amounts):			
High Fat Dairy			
Low	61(36.7) $_a$	60(27.5) $_a$	0.200
Moderate	31(18.7) $_a$	52(23.9) $_a$	
High	52(31.3) $_a$	80(36.7) $_a$	
Very High	22(13.3) $_a$	26(11.9) $_a$	

Note: Numbers in bold face a statistically significant (p-value <0.05).

$_{a,b}$ Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.

Table 8: *Continued. Comparison of the percentage of subjects with low, moderate, and high intake category of each food group between subjects with low and subjects with moderate/high total GDQS score.*

Category of intake	Low total GDQS (*n*= 166)	Moderate/ High total GDQS (*n*=218)	Pearson Chi-Square
	n (%)		
Red Meat			
Low	103(62) $_{a}$	143(65.6) $_{a}$	0.618
Moderate	9(5.4) $_{a}$	14(6.4) $_{a}$	
High	54(32.5) $_{a}$	61(28) $_{a}$	
GDQS- (Unhealthy):			
Processed Meat			
Low	139(83.7) $_{a}$	207(95) $_{b}$	**0.001**
Moderate	2(1.2) $_{a}$	1(0.5) $_{a}$	
High	25(15.1) $_{a}$	10(4.6) $_{b}$	
Refined Grains, Baked Goods			
Low	8(4.8) $_{a}$	33(15.1) $_{b}$	**0.002**
Moderate	1(0.6) $_{a}$	2(0.9) $_{a}$	
High	157(94.6) $_{a}$	183(83.9) $_{b}$	
Sweets, Ice cream			
Low	51(30.7) $_{a}$	87(39.9) $_{a}$	**0.004**
Moderate	6(3.6) $_{a}$	21(9.6) $_{b}$	
High	109(65.7) $_{a}$	110(50.5) $_{b}$	
Sugar Sweetened Beverages			
Low	58(34.9) $_{a}$	157(72) $_{b}$	**0.000**
Moderate	5(3) $_{a}$	6(2.8) $_{a}$	
High	103(62) $_{a}$	55(25.2) $_{b}$	
Juice			
Low	130(78.3) $_{a}$	193(88.5) $_{b}$	**0.023**
Moderate	5(3) $_{a}$	4(1.8) $_{a}$	
High	31(18.7) $_{a}$	21(9.6) $_{b}$	
White Roots Tubers			
Low	56(33.7) $_{a}$	149(68.3) $_{b}$	**0.000**
Moderate	9(5.4) $_{a}$	13(6) $_{a}$	
High	101(60.8) $_{a}$	56(25.7) $_{b}$	
Purchased, Deep Fried Foods			
Low	75(45.2) $_{a}$	170(78) $_{b}$	**0.000**
Moderate	7(4.2) $_{a}$	5(2.3) $_{a}$	
High	84(50.6) $_{a}$	43(19.7) $_{b}$	

Note: Numbers in bold face a statistically significant (p-value <0.05).

$_{a,b}$ Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.

4. The association of sociodemographic, anthropometric and lifestyle characteristic with diet quality (GDQS)

Table 9 shows the differences in mean total GDQS, GDQS+ and GDQS- scores between different socio-demographic, lifestyle, and BMI characteristics.

Significant differences in mean total GDQS score was observed between different living arrangements, places of residence and intensity of physical activity. The mean average total GDQS score among participants living in student residence was statistically significantly lower than that among participants living at parental home (15.15 vs. 16.41, respectively; P-value=0.027). Urban residents had a statistically significantly lower mean average total GDQS score than rural residents (15.89 vs. 17.39, respectively; P-value=0.033). Furthermore, the mean average total GDQS score was also statistically significantly lower in participants with low and moderate intensity physical activity compared to those with high-intensity physical activity (15.61 and 16.03 vs. 18.09, respectively; P-value=0.011). There were no significant differences in the mean average total GDQS score between different majors of study, academic years, crowding index, alcohol consumption status, smoking status, and BMI classes.

There were no statistically significant differences in mean GDQS+ score for all the studied variables except for the intensity of physical activity. The mean average GDQS+ score was significantly higher in participants with high-intensity physical activity compared to those with low and moderate intensity physical activity, indicating that participants with high intensity physical activity had higher consumption of the healthy food groups (8.6 vs. 6.72 and 6.92, respectively; P-value=0.01).

Significant differences in mean GDQS- score was observed between different living arrangements, place of residence and smoking status. The mean average GDQS-

score among participants living in students' residence was statistically significantly lower than that among participants living at parental home, indicating that participants living at students' residents had higher consumption of unhealthy food groups (8.52 vs. 9.25, respectively; P-value=0.037). Urban residents had a statistically significantly lower mean average GDQS- score than rural residents, indicating that urban residents had higher consumption of unhealthy food groups (8.93 vs. 9.92, respectively; P-value=0.021). Moreover, smoker had a statistically significantly lower mean average GDQS- score than non-smokers/ past smokers, indicating that smoker had higher consumption of unhealthy food groups (8.15 vs. 9.22, respectively; P-value=0.014). There were no significant differences in the mean average GDQS- score between different majors of study, academic years, crowding index, alcohol consumption status, intensity of physical activity and BMI classes.

Table 9: *Mean GDQS, GDQS+ and GDQS- scores according to socio-demographic, lifestyle, and BMI characteristics in the sample of AUB female students.*

	Total GDQS	P Value*	GDQS+	P Value*	GDQS-	P Value*
	mean± SD		mean± SD		mean± SD	
Living Arrangement		**0.027**		0.223		**0.037**
Living at parental home	16.41±4.69		7.16±3.66		9.25±2.88	
Living in student residence	15.15±5.05		6.63±3.63		8.52±3.06	
Place Residence		**0.033**		0.347		**0.021**
Urban area	15.89±4.75		6.96±3.61		8.93±2.93	
Rural area	17.39±4.96		7.47±3.91		9.92±2.81	
Major Study		0.902		0.961		0.890
Health related major	16.14±4.86		7.04±3.78		9.10±3.12	
Non- health related major	16.08±4.77		7.03±3.59		9.05±2.82	
Academic year study		0.053		0.097		0.448
First year university	15.59±4.55		6.69±3.31		8.90±2.95	
Second year	15.91±4.42		6.90±3.64		9.01±2.95	
≥3 years	16.98±5.36		7.63±4.05		9.35±2.91	
Crowding index		0.479		0.102		0.381
<1 Person/Room	16.30±5.10		7.37±3.91		8.92±2.95	
≥1 Person/Room	15.95±4.55		6.76±3.42		9.19±2.92	
Alcohol Consumption status		0.720		0.724		0.304
Drinker	15.97±4.68		7.13±3.69		8.84±2.75	
Non-Drinker/Past Drinker	16.16±4.86		6.99±3.65		9.17±3.01	
Smoking Status		0.759		0.117		**0.014**
Current Smoker	15.91±4.95		7.76±4.25		8.15±2.99	
Non-Smoker/Past smoker.	16.13±4.78		6.92±3.54		9.22±2.90	
Intensity of Physical Activity (Mets)		**0.011**		**0.010**		0.495
Low-intensity activity	15.61±4.31[a]		6.72±3.10[a]		8.90±2.97	
Moderate-intensity activity	16.03±4.96[a]		6.92±3.84[a]		9.11±2.92	
High-intensity activity	18.09±5.23[b]		8.60±4.18[b]		9.49±2.90	
BMI		0.708		0.366		0.608
<25	16.15±4.81		7.12±3.70		9.03±2.93	
≥25	15.92±4.79		6.69±3.48		9.23±2.96	

Note. [a,b] Values with superscripts of the same letter are not significantly different; values with superscripts of different letters are significantly different at P< 0.05.

*P-value is derived from independent samples T-test and ANOVA for all continuous variables.

Numbers in bold face are statistically significant (p-value <0.05).

In table 10, the study sample was divided into low, moderate, and high total GDQS score and the association of sociodemographic, lifestyle and BMI characteristics with total GDQS score levels (low, moderate, high) was studied. The total GDQS score levels was significantly associated with intensity of physical activity (P-value=0.029). However, living arrangement, place of residence, major of study, academic year of

study, crowding index, alcohol consumption status, smoking status and BMI were not significantly associated with the total GDQS score levels (All P-value >0.05).

Table 10: *Distribution of socio-demographic, lifestyle, and BMI characteristics according to high, moderate, and low total GDQS score in the sample of AUB female students.*

Variables	High total GDQS	Moderate total GDQS	Low total GDQS	P-Value*
		***n* (%)**		
Living Arrangement				
Living at parental home	24(75)	147(79)	119(71.7)	0.277
Living in student residence	8(25)	39(21)	47(28.3)	
Place Residence				
Urban area	26(81.3)	155(83.3)	149(89.8)	0.163
Rural area	6(18.8)	31(16.7)	17(10.2)	
Major Study				
Health related major	13(40.6)	72(38.7)	59(35.5)	0.771
Non- health related major	19(59.4)	114(61.3)	107(64.5)	
Academic year study				0.354
First year university	13(40.6)	72(38.7)	74(44.6)	
Second year	6(18.8)	53(28.5)	49(29.5)	
≥3 years	13(40.6)	61 (32.8)	43(25.9)	
Crowding index				
<1 Person/Room	15(46.9)	83(44.6)	74(44.6)	0.97
≥1 Person/Room	17(53.1)	103(55.4)	92(55.4)	
Alcohol Consumption Status				
Drinker	7(21.9)	56(30.1)	53(31.9)	0.525
Non-Drinker/Past Drinker	25(78.1)	130(69.9)	113(68.1)	
Smoking Status				
Current Smoker	4(12.5)	27(14.5)	22(13.3)	0.92
Non-Smoker/Past smoker	28(87.5)	159(85.5)	144(86.7)	
Intensity of Physical Activity (Mets)				
Low-intensity activity	8(25)	71(38.2)	66(39.8)	**0.029**
Moderate-intensity activity	20(62.5)	86(46.2)	90(54.2)	
high-intensity activity	4(12.5)	29(15.6)	10(6)	
BMI				
<25	7(21.9)	39(21.0)	29(17.5)	0.669
≥25	25(78.1)	147(79.0)	137(82.5)	

Note. *P-value is derived from Pearson Chi-square test for all categorical variables.
Numbers in bold face are statistically significant (p-value <0.05).

Table 11 shows the association of socio-demographic, lifestyle, and BMI characteristics with low total GDQS score before and after adjusting for selected variables. High and moderate total GDQS score were combined and was considered as the reference category. Model 1 was unadjusted, model 2 was adjusted for age and model 3 was adjusted for age, crowding index, living arrangement, place of residence, smoking status, and physical activity.

In model 1 and 3, all studied independent variables (living arrangement, place of residence, major of study, academic year of study, crowding index, alcohol consumption status, smoking status, intensity of physical activity and BMI) were not significantly associated with low total GDQS score (All P-value >0.05).

However, in model 2, after adjusting for age, only living in rural area was significantly associated with lower odds of having a low total GDQS score compared to living in urban area (Adjusted OR=0.535; 95% CI: 0.29,0.99; P-value<0.05)

Table 11: *Association of sociodemographic, lifestyle and BMI characteristics with low total GDQS score in the sample of AUB female students.*

	Low total GDQS score					
	MODEL 1*		MODEL 2**		MODEL 3***	
	OR (95 %CI)	**P-value**	**OR (95 %CI)**	**P-value**	**OR (95 %CI)**	**P-value**
Living Arrangement						
Living at parental home	Ref		Ref		Ref	
Living in student residence	1.44(0.90-2.29)	0.128	1.441(0.90-2.30)	0.126	1.383(0.85-2.25)	0.192
Place Residence						
Urban area	Ref		Ref		Ref	
Rural area	0.56(0.30-1.03)	0.063	**0.535(0.29-0.99)**	**0.047**	0.559(0.30-1.06)	0.074
Major Study						
Health related major	Ref		Ref		Ref	
Non- health related major	1.16(0.76-1.76)	0.489	1.174(0.77-1.79)	0.455	1.178(0.77-1.80)	
Academic year study						0.448
First year university	Ref		Ref		Ref	
Second year	0.95(0.58-1.56)	0.851	0.899(0.53-1.53)	0.696	0.880(0.51-1.51)	0.643
≥3 years	0.67(0.41-1.09)	0.105	0.547(0.23-1.30)	0.171	0.509(0.21-1.22)	0.130
Crowding index						
<1 Person/Room	Ref		Ref		Ref	
≥1 Person/Room	1.015(0.68-1.52)	0.942	1.014(0.68-1.52)	0.947	0.942(0.62-1.43)	0.780
Alcohol Drinker						
Drinker	Ref		Ref		Ref	
Non-Drinker/Past Drinker	0.87(0.56-1.34)	0.522	0.825(0.51-1.34)	0.436	1.213(0.75-1.97)	0.436
Smoking Status						
Current Smoker	Ref		Ref		Ref	
Non-Smoker/Past smoker	1.085(0.60-1.95)	0.786	1.050(0.58-1.90)	0.873	1.171(0.64-2.16)	0.613
Intensity of Physical Activity						
Low-intensity activity	Ref		Ref		Ref	
Moderate-intensity activity	0.86(0.57-1.31)	0.481	0.852(0.56-1.29)	0.453	0.809(0.53-1.24)	0.326
BMI						
<25	Ref		Ref		Ref	
≥25	0.79(0.47-1.33)	0.375	0.792(0.47-1.33)	0.377	0.751(0.44-1.27)	0.285

Note. The reference category is high-moderate GDQS score.
* Model 1: Unadjusted (Crude) using binary logistic regression.
**Model 2: Adjusted for Age using multivariate logistic regression.
***Model 3: Adjusted for Age (years), Crowding Index, Living Arrangement, Place Residence, Smoking Status, Physical Activity (METs) using multivariate logistic regression.
Numbers in bold face are statistically significant (p-value <0.05).

5. Drivers of Eating Behaviors

Figure 2 and table 12 show the perceived barriers to consumption of healthy food groups. In general taste dislike, past eating habits, unavailability at home and local

markets and high cost were the most commonly reported barriers. High cost was mostly reported as a barrier to consumption of low-fat dairy. Unavailability at home and local markets was most commonly reported as a barrier to consumption of whole grain. Very few participants reported that they don't know the health benefits of the healthy foods.

For fruits, the most commonly reported barriers to eating fruits were "Past eating habits" (23.2%), "I don't like the taste/ texture" (22.4%) and "Not available at home" (18.9%). These were followed by "High cost" (9.2%) and "Not available at local markets" (8.3%). The least frequently reported barrier was "I don't know the health benefits" (1.8%).

For vegetables, the most commonly reported barrier to eating vegetables was "I don't like taste/texture" (23.4%). This was followed by "Past eating habits" (9.1%), "Not available at home" (6.5%) and "High cost" (5.2%). The least frequently reported barrier was " "Not available at local markets" (61.3%). None of the participants reported "I don't know the health benefits" as a barrier to eating vegetables.

For low- fat dairy, the most commonly reported barriers to consuming low fat dairy were "Past eating habits" (25.4%), "I don't like the taste/ texture" (21.2%), "Not available at home" (19.5%) and "High cost" (15.3%). These were followed by "I don't know the health benefits" (8.8%) and "Not available at local markets" (6.8%) .

For deep orange tubers, the most commonly reported barrier to eating deep orange tubers was "I don't like the taste/ texture" (19.3%), "Not available at home" (12.2%) and "past eating habits" (11.9%) ". The least frequently reported barriers were "Not available at local markets" (2.4%), "I don't know the health benefits" (1.8%), and "High cost" (1.2%).

For whole grains, the most commonly reported barriers to eating whole grains were “Not available at home” (32.1%), “Not available at local markets” (26.5%), “I don’t like the taste/ texture” (17.2%), and “Past eating habits” (17.2%). The least frequently reported barriers were “High cost” (10.6%)” and “I don’t know the health benefits” (5%).

Figure 2: *Perceived barriers to consumption of healthy food groups.*

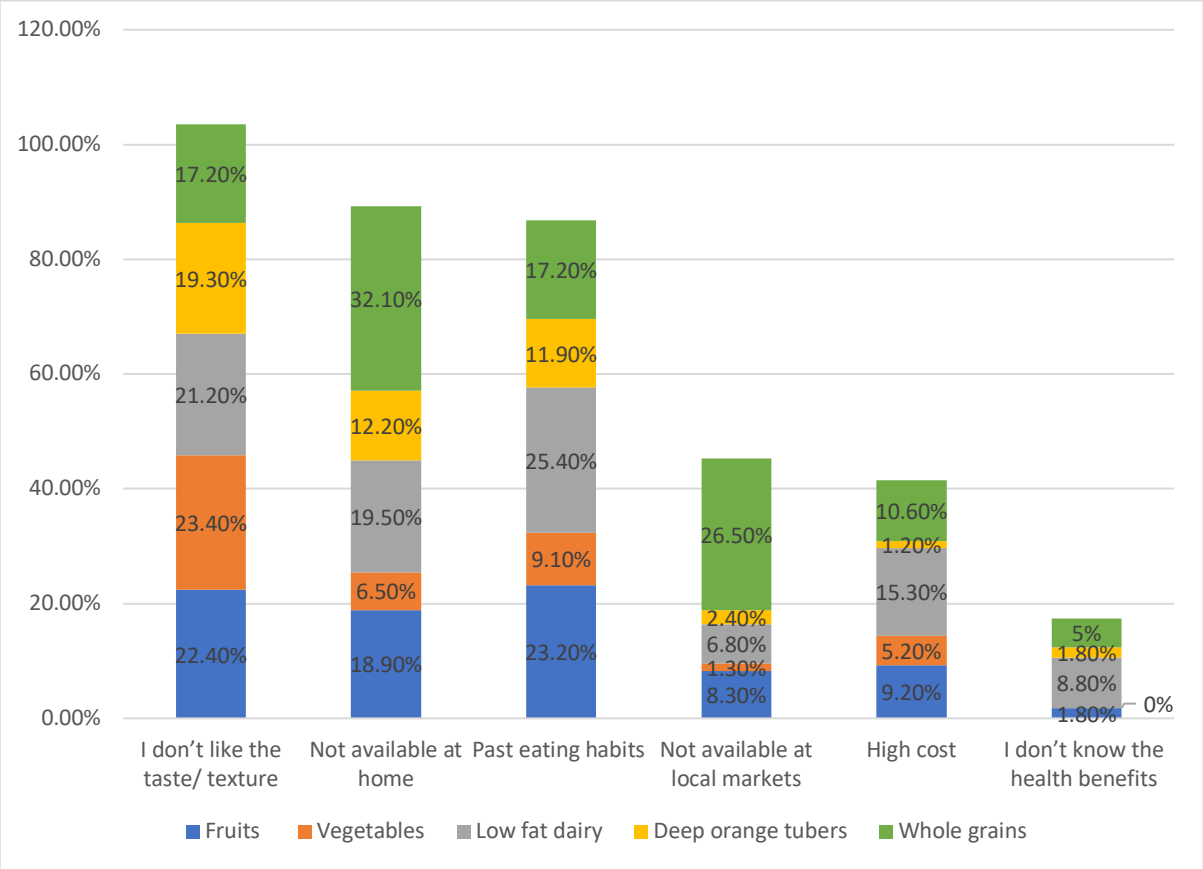


Table 12: *Perceived barriers to consumption of healthy food groups.*

Perceived Barriers	Fruits	Vegetables	Low Fat dairy	Deep orange tubers	Whole grains
			n (%)		
I don't like the taste/ texture	51(22.4)	18(23.4)	72(21.2)	65(19.3)	52(17.2)
High cost	21(9.2)	4(5.2)	52(15.3)	4(1.2)	32(10.6)
I don't know the health benefits	4(1.8)	0(0.0)	30(8.8)	6(1.8)	15(5.0)
Not available at home	43(18.9)	5(6.5)	66(19.5)	41(12.2)	97(32.1)
Not available at local markets	19(8.3)	1(1.3)	23(6.8)	8(2.4)	80(26.5)
Past eating habits	53(23.2)	7(9.1)	86(25.4)	40(11.9)	52(17.2)

Figure 3 and table 13 show the perceived facilitators to consumption of unhealthy food groups. In general, the most common facilitators to consumption of unhealthy food groups were taste, past eating habits and availability at home and local market. Convenient, advertising, and low cost was also frequently reported as facilitators to consumption of some unhealthy food groups. Convenient was mostly reported as a facilitator to sweets and sugar sweetened beverages consumption. Advertising was most commonly reported as a facilitator to sweets consumption. Low cost was most commonly reported as a facilitator to refined grains consumption. Very few participants reported that they don't know the adverse health effects of the unhealthy foods.

For refined grains the most commonly reported facilitators to eating refined grains were "I like the taste/ texture" (59.1%), "Available at home" (55.8%) and "Past eating habits" (27.6%). These were followed by, "Available at local markets" (26.8%), "Low cost" (16.2%) and "TV, social media ads" (15%). The least frequently reported facilitators were "I don't know the adverse health effects" (3.5%).

For sweets and ice cream, the most commonly reported facilitator to eating sweets and ice cream was "I like the taste/ texture" (83.1%). This was followed by

"Convenient" (45.7%), "Past eating habits" (39.3%), "Available at local markets" (33.3%), "TV, internet, social media" (27.4%) and "Available at home" (26.5%). The least frequently reported facilitators were "Low cost" (5.5%) and "I don't know the adverse health effects" (0.9%).

For sugar sweetened beverages, the most commonly reported facilitator to drinking sugar sweetened beverages was "I like the taste/texture" (55.7%). This was followed by "Convenient" (26.6%), "Past eating habits" (25.9%), "Available at local markets" (19.6%), "Available at home" (19.6%) and "TV, internet, social media ads" (13.3%). The least frequently reported facilitators were "Low cost" (9.5%) and "I don't know the adverse health effects" (0.6%).

For red meat, the most commonly reported facilitator to consuming red meat was "I like the taste/texture" (66.1%). This was followed by "Available at home" (47.8%), "Past eating habits" (38.3%) and "Available at local markets" (24.3%). The least frequently reported facilitator was "I don't know the adverse health effects" (5.2%).

Figure 3: *Perceived facilitators to consumption of unhealthy food groups.*

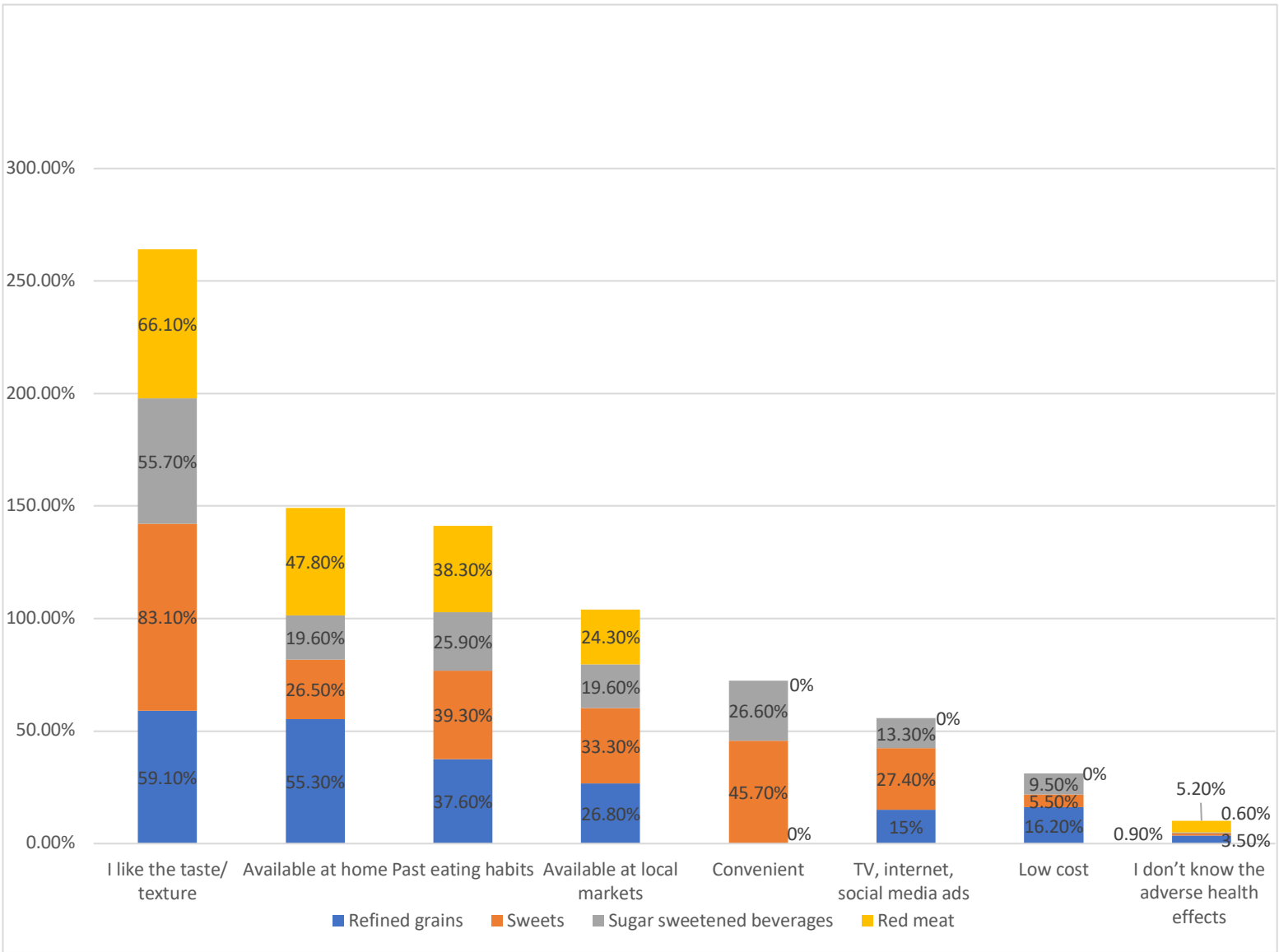


Table 13*: Perceived facilitators to consumption of unhealthy food groups.*

Perceived Facilitators	Refined grains	Sweets	Sugar sweetened beverages	Red meat
			n (%)	
I like the taste/ texture	201(59.1)	182(83.1)	88(55.7)	76(66.1)
Low cost	55(16.2)	12(5.5)	15(9.5)	0(0)
I don't know the adverse health effects	12(3.5)	2(0.9)	1(0.6)	6(5.2)
Available at home	188(55.3)	58(26.5)	31(19.6)	55(47.8)
Available at local markets	91(26.8)	73(33.3)	31(19.6)	28(24.3)
Past eating habits	128(37.6)	86(39.3)	41(25.9)	44(38.3)
Convenient (easy to prepare/ eat, long shelf life...)	0(0)	100(45.7)	42(26.6)	0(0)
TV, internet, social media ads	51(15.0)	60(27.4)	21(13.3)	0(0)

B. Phase 2: Results of 2008/2009 National study

1. Characteristics of Lebanese females aged 18-24 years in 2008/2009 national survey

The sociodemographic, anthropometric and lifestyle characteristics of the Lebanese females aged 18-24 years in the 2008/2009 national survey are presented in Table 14. The average mean ± SD age was 21.18±1.97 years. Nearly half of the participants were living in rural area (50.4%). Most of the participants attained a university degree or higher degree (60.8%). The majority of the participants (66.9%) had a crowding index ≥ 1 person/room, which indicates low socioeconomic status (Melki et al., 2004). Participants were predominantly non-drinkers/ past drinkers

(65.8%) and non-smokers/ past smokers (97.9%). Most of the participants had low intensity physical activity (64.6%). The average mean ± SD weight, height and BMI were 59.33 ±9.57, 162.39 ±6.23 and 22.52±3.57, respectively. Most participants had a normal BMI (70.8%) whereas 8.8% were underweight and 20.4% were overweight/ obese.

Table 14: *Socio-demographic, anthropometric and lifestyle characteristics of the Lebanese females aged 18-24 years in 2008/2009 national survey.*

Variable	**Total** (*n*=240)
Socio-demographic Characteristics	
Age (years), mean (SD)	21.18±1.97
Place Residence, *n* (%)	
Urban area	112(49.6)
Rural area	114(50.4)
Academic year study, *n* (%)	
Complimentary or less	30(12.5)
High School / Diploma	64(26.7)
University or higher	146(60.8)
Crowding index, *n* (%)	
<1 Person/Room	79(33.1)
≥1 Person/Room	160(66.9)
Lifestyle Characteristics	
Alcohol Consumption status, *n* (%)	
Drinker	82(34.2)
Non-Drinker/Past Drinker	158(65.8)
Smoking Status, *n* (%)	
Current Smoker	5(2.1)
Non-Smoker/Past smoker	235(97.9)
Intensity of Physical Activity (Mets), *n* (%)	
Low-intensity activity	155(64.6)
Moderate-intensity activity	71(29.6)
High-intensity activity	14(5.8)
Anthropometric Characteristic	
Weight (Kg), mean (SD)	59.33 ±9.57
Height (cm), mean (SD)	162.39 ±6.23
Body mass index (BMI), mean (SD)	22.52±3.57
BMI Classification, *n* (%)	
Underweight	21(8.8)
Normal	170(70.8)
Overweight	36(15.0)
Obese	13(5.4)
Overweight & Obese	49(20.4)

2. *Evaluation of diet quality using GDQS, and GDQS food groups consumption of Lebanese females aged 18-24 years in 2008/2009 national survey*

Table 15 presents the total GDQS, GDQS+ and GDQS- scores as mean±SD and the percentages of subjects classified as low, moderate, and high total GDQS score of the females aged 18-24 in 2008/2009 national survey. The mean average total GDQS, GDQS+ and GDQS- scores were 16.4±4.3, 6.5±3.8 and 9.9±2.3, respectively. Only 6.7% of the participants had a high GDQS score, whereas 55.8% had a moderate total GDQS score and 37.5% had a low total GDQS score.

Table 15: *Means of total GDQS, GDQS+, and GDQS- scores and the percentages of subjects with low, moderate, and high total GDQS score of the Lebanese females aged 18-24 in 2008/2009 national survey.*

	Total (*n*=240)
Total GDQS Score Points (Healthy –Unhealthy), mean (SD)	16.4±4.3
GDQS$^+$ Score Points, mean (SD)	6.5±3.8
GDQS$^-$ Score Points, mean (SD)	9.9±2.3
Total GDQS score, *n* (%)	
Low	90(37.5)
Moderate	134(55.8)
High	16(6.7)

In table 16, subjects were classified into low, moderate, high and very high intake categories for each food group based on their quantity of intake of each food group and the percentages of subjects classified as low, moderate, high, and very high intake category of each of the 25 GDQS food group are presented in table 16.

The majority of the subjects had low intake of the following healthy food groups contributing to GDQS+ score: low fat dairy (97.5%), deep orange vegetables (96.7%),

citrus fruits (94.4%), deep orange tubers (94.2%), fish (93.3%), deep orange fruits (92.1%), eggs (90.8), cruciferous vegetables (85%), legumes (83.3%), whole grain (81.7%), nuts and seeds (81.3%), poultry game meat (68.8%), other fruits (63.7%) and dark green leady vegetables (60%), expect for liquid oils and other vegetables, where most of the participants had moderate to high intake of liquid oils (74.6%) other vegetables (69.6%).

Table 16 also showed that most of the subjects had a low to moderate intake of the following unhealthy food groups contributing to the GDQS- score: juice (98.4%), deep fried food (94.2%), processed meat (93.8%), white root tubers (80.4%), red meat (71.3%), and high fat dairy (69.9%), except for refined grains and sweets and ice cream where most participants had high intake of refined grains (84.2%) and sweets and ice cream (56.7%). Additionally, nearly half of the participants had high consumption of sugar sweetened beverages (53.8%).

Table 16: *The percentages of subjects with low, moderate, high & very high intake category of each GDQS food group of the Lebanese females aged 18-24 in 2008/2009 national survey*

GDQS food groups	Category of intake			
	Low	Moderate	High	Very High
			***n* (%)**	
GDQS+ (Healthy):				
Citrus Fruits	226(94.4)	1(0.4)	13(5.4)	---
Deep Orange Fruits	221(92.1)	11(4.6)	8(3.3)	---
Other Fruits	153(63.7)	12(5)	75(31.3)	---
Dark Green Leafy Vegetables	144(60)	15(6.3)	81(33.8)	---
Cruciferous Vegetables	204(85)	18(7.5)	18(7.5)	---
Deep Orange Vegetables	232(96.7)	6(2.5)	2(0.8)	---
Other Vegetables	73(30.4)	73(30.4)	94(39.2)	---
Legumes	200(83.3)	17(7.1)	23(9.6)	---
Deep Orange Tubers	226(94.2)	4(1.7)	10(4.2)	---
Nuts, Seeds	195(81.3)	16(6.7)	29(12.1)	---
Whole Grains	196(81.7)	0(0.0)	44(18.3)	---
Liquid Oils	61(25.4)	27(11.3)	152(63.3)	---
Fish, Shellfish	224(93.3)	1(0.4)	15(6.3)	---
Poultry Game Meat	165(68.8)	11(4.6)	64(26.7)	---
Low Fat Dairy	234(97.5)	2(0.8)	4(1.7)	---
Eggs	218(90.8)	4(1.7)	18(7.5)	---
GDQS^{-} (Unhealthy in excessive amounts):				
High Fat Dairy	95(39.6)	80(33.3)	63(26.3)	2(0.8)
Red Meat	144(60.0)	27(11.3)	69(28.7)	
GDQS- (Unhealthy):				
Processed Meat	220(91.7)	5(2.1)	15(6.3)	---
Refined Grains, Baked Goods	27(11.3)	11(4.6)	202(84.2)	---
Sweets, Ice cream	86(35.8)	18(7.5)	136(56.7)	---
Sugar Sweetened Beverages	109(45.4)	2(0.8)	129(53.8)	---
Juice	221(92.1)	15(6.3)	4(1.7)	---
White Roots Tubers	124(51.7)	69(28.7)	47(19.6)	---
Purchased, Deep Fried Foods	215(89.6)	11(4.6)	14(5.8)	---

3. Differences in GDQS and GDQS food groups consumption between 2022 and 2008/2009

Table 17 presents the differences in mean total GDQS, GDQS+ and GDQS- scores between year 2022 and 2008/2009, and the differences in the percentages of

subjects with low, moderate, and high total GDQS scores between year 2022 and 2008/2009. There were no significant differences in the mean total GDQS and GDQS+ scores between the two years (2008/2009 and 2022) (All P-value >0.05). However, the mean GDQS- score was significantly lower in year 2022 compared to 2008/2009 (P-value<0.05), indicating that the consumption of unhealthy food groups had increased overtime. Furthermore, there was no significant difference in the percentages of subjects with low, moderate, and high total GDQS score, between the two year (2008/2009 and 2022) (P-value >0.05).

Table 17: *Comparison of mean total GDQS, GDQS+ and GDQS- scores and the percentages of subjects at low, moderate, and high total GDQS score between 2022 and 2008/2009.*

	Survey year		**P-Value***
	2022 (*n*=384)	**2008-09 (*n*=240)**	
	Mean± SD		
Total GDQS Score	16.1±4.8	16.4±4.3	.421
GDQS^{+} Score Points	7.0±3.7	6.5±3.8	.107
GDQS^{-} Score Points	9.1±2.9	9.9±2.3	**.000**
	***n* (%)**		
Total GDQS score levels			
Low	166(43.2) $_{a}$	90(37.5) $_{a}$	.193
Moderate	186(48.4) $_{a}$	134(55.8) $_{a}$	
High	32(8.3) $_{a}$	16(6.7) $_{a}$	

Note. *p-value is derived from Pearson Chi-Square for categorical variables and from independent samples T-test for continuous variables.
$_{a,b}$ Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.
Numbers in bold face are statistically significant (p-value <0.05).

In table 18, subjects in both surveys (2022 and 2008/2009) were classified into low, moderate, and high intake category of each food groups based on their GDQS score of each food group and the differences in the percentages of subjects with low,

moderate, high, and very high intake of each food group between 2008/2009 and 2022 were presented.

For the healthy food groups, the consumption of citrus fruits and dark green leafy vegetables significantly decreased overtime, where the percentages of subjects with low intake of these food groups were significantly higher in 2022 compared to 2008/2009 (citrus fruits: 99% in 2022 vs. 94.2% in 2008/2009, dark green leafy vegetables: 79.4% in 2022 vs. 60% in 2008/2009) (All P-value <0.05), and the percentages of subjects with high intake of these food groups were significantly lower in 2022 compared to 2008/2009 (citrus fruits: 0.5% in 2022 vs. 5.4% in 2008/2009, dark green leafy vegetables: 17.2% in 2022 vs. 33.8% in 2008/2009) (All P-value <0.05).

Moderate consumption of legumes and nuts and seeds significantly decreased overtime, where the percentages of subjects with moderate intake of these food groups were significantly lower in 2022 compared to 2008/2009 (legumes: 1.6% in 2022 vs. 7.1% in 2008/2009, nuts and seeds: 1.3% in 2022 vs. 6.7% in 2008/2009) (All P-value <0.05).

The consumption of cruciferous vegetables and poultry significantly increased overtime, where the percentages of subjects with moderate intake of these foods were significantly lower in 2022 compared to 2008/2009 (cruciferous vegetables: 3.4% in 2022 vs. 7.5% in 2008/2009, poultry: 0.8% in 2022 vs. 4.6% in 2008/2009) (All P-value<0.05), and the percentages of subjects with high intake of these food groups were significantly higher in 2022 compared to 2008/2009 (cruciferous vegetables: 12.5% in 2022 vs. 7.5% in 2008/2009, poultry: 47.7% in 2022 vs. 26.7% in 2008/2009) (All P-value <0.05).

The consumption of low-fat dairy significantly increased overtime, where the percentages of subjects with low intake of low-fat dairy were significantly lower in 2022 compared to 2008/2009 (88.3% vs. 97.4%, respectively; P-value<0.05), and the percentages of subjects with high intake of low-fat dairy were significantly higher in 2022 compared to 2008/2009 (9.1% vs. 1.7%, respectively; P-value<0.05).

The consumption of deep orange tubers significantly increased overtime, where the percentages of subjects with low intake of deep orange tubers were significantly lower in 2022 compared to 2008/2009 (87.5% vs. 94.2%, respectively; P-values <0.05), and the percentages of subjects with moderate intake of deep orange tubers were higher in 2022 compared to 2008/2009 (5.5% vs. 1.7%, respectively; P-value<0.05).

The consumption of liquid oils significantly increased overtime. The percentages of subjects with low intake of liquid oils were significantly lower in 2022 than 2008/2009 (0.8% vs. 25.4%, respectively; P-value < 0.05). Also, the percentages of subjects with moderate intake of liquid oils were significantly lower in 2022 than 2008/2009 (0.5% vs. 11.3%, respectively, P-value <0.05). However, the percentages of subjects with high intake of liquid oils were significantly higher in 2022 than 2008/2009 (98.7% vs. 63.3% respectively; P-values <0.05).

For the unhealthy food groups, the consumption of high fat dairy significantly increased overtime. The percentages of subjects with low intake of high fat dairy were significantly lower in 2022 than 2008/2009 (31.5% vs. 39.6%, respectively; P-value < 0.05). Also, the percentages of subjects with moderate intake of high fat dairy were significantly lower in 2022 than 2008/2009 (21.6% vs. 33.3%, respectively; P-value <0.05). However, the percentages of subjects with high intake of high fat dairy were significantly higher in 2022 than 2008/2009 (34.4% vs. 26.3%, respectively; P-values

<0.05). Additionally, the percentages of subjects with very high intake of high fat dairy were significantly higher in 2022 compared to 2009 (12.5% vs. 0.8%, respectively; P-value <0.05).

Consumption of juice significantly increased overtime. The percentages of subjects with low intake of juice were significantly lower in 2022 than 2008/2009 (84.1% vs. 92.1%, respectively; P-value < 0.05). Also, the percentages of subjects with moderate intake of juice were significantly lower in 2022 than 2008/2009 (2.3% vs. 6.3%, respectively; P-value <0.05). However, the percentages of subjects with high intake of juice were significantly higher in 2022 than 2008/2009 (13.5% vs. 1.7%, respectively; P-values <0.05).

Consumption of white roots tubers significantly increased overtime, where the percentages of subjects with moderate intake of white roots tubers were significantly lower in 2022 compared to 2008/2009 (5.7% vs. 28.7%, respectively; P-value<0.05), and the percentages of subjects with high intake of white roots tubers were significantly higher in 2022 compared to 2008/2009 (40.9% vs. 19.6%, respectively; P-value <0.05).

Consumption of purchased deep fried foods significantly increased overtime, where the percentages of subjects with low intake of purchased deep fried foods were significantly lower in 2022 compared to 2008/2009 (63.8% in 2022 vs. 89.6%, respectively; P-value < 0.05), and the percentages of subjects with high intake of purchased deep fried foods were significantly higher in 2022 compared to 2008/2009 (33.1% in 2022 vs. 5.8% in 2008/2009, respectively; P-value<0.05).

Moderate consumption of refined grains significantly decreased overtime, where the percentages of subjects with moderate intake of refined grains were significantly lower in 2022 compared to 2008/2009 (0.8% vs. 4.6%, respectively; P-value<0.05).

Consumption of sugar sweetened beverages significantly decreased overtime, where the percentages of subjects with low intake of sugar sweetened beverages were significantly higher in 2022 compared to 2008/2009 (56% vs. 45.4%, respectively; P-value<0.05), and the percentages of subjects with high intake of sugar sweetened beverages were significantly lower in 2022 compared to 2008/2009 (41.1% vs. 53.8% respectively; P-value<0.05).

Table 18: *The percentage of subjects with low, moderate, and high intake category of each food group and their comparison between 2008/2009 and 2022.*

Category of intake	Survey year		Pearson Chi-Square
	2022 (*n*=384)	2008-09 (*n*=240)	
	n (%)		
GDQS+ (healthy):			
Citrus Fruits			
Low	380(99) a	226(94.2) b	**0.000**
Moderate	2(0.5) a	1(0.4) a	
High	2(0.5) a	13(5.4) b	
Deep Orange Fruits			
Low	364(94.8) a	221(92.1) a	0.142
Moderate	7(1.8) a	11(4.6) a	
High	13(3.4) a	8(3.3) a	
Other Fruits			
Low	236(61.5) a	153(63.7) a	0.697
Moderate	25(6.5) a	12(5) a	
High	123(32) a	75(31.3) a	
Dark Green Leafy Vegetables			
Low	305(79.4) a	144(60) b	**0.00**
Moderate	13(3.4) a	15(6.3) a	
High	66(17.2) a	81(33.8) b	
Cruciferous Vegetables			
Low	323(84.1) a	204(85) a	**0.014**
Moderate	13(3.4) a	18(7.5) b	
High	48(12.5) a	18(7.5) b	
Deep Orange Vegetables			
Low	375(97.7) a	232(96.7) a	0.063
Moderate	2(0.5) a	6(2.5) a	
High	7(1.8) a	2(0.8) a	
Other Vegetables			
Low	108(28.1) a	73(30.4) a	0.828
Moderate	121(31.5) a	73(30.4) a	
High	155(40.4) a	94(39.2) a	
Legumes			
Low	327(85.2) a	200(83.3) a	**0.001**
Moderate	6(1.6) a	17(7.1) b	
High	51(13.3) a	23(9.6) a	
Deep Orange Tubers			
Low	336(87.5) a	226(94.2) b	**0.017**
Moderate	21(5.5) a	4(1.7) b	
High	27(7) a	10(4.2) a	

Note: Numbers in bold face a statistically significant (p-value <0.05).

a,b Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.

Table 18: *Continued. The percentage of subjects with low, moderate, and high intake category of each food group and their comparison between 2008/2009 and 2022.*

Category of intake	Survey year		Pearson Chi-Square
	2022 (*n*=384)	2008-09 (*n*=240)	
	n (%)		
Nuts, Seeds			
Low	333(86.7) $_a$	195(81.3) $_a$	**0.001**
Moderate	5(1.3) $_a$	16(6.7) $_b$	
High	46(12) $_a$	29(12.1) $_a$	
Whole Grains			
Low	302(78.6) $_a$	196(81.7) $_a$	0.390
Moderate	2(0.5) $_a$	0(0.0) $_a$	
High	80(20.8) $_a$	44(18.3) $_a$	
Liquid Oils			
Low	3(0.8) $_a$	61(25.4) $_b$	**0.00**
Moderate	2(0.5) $_a$	27(11.3) $_b$	
High	379(98.7) $_a$	152(63.3) $_b$	
Fish, Shellfish			
Low	343(89.3) $_a$	224(93.3) $_a$	0.199
Moderate	5(1.3) $_a$	1(0.4) $_a$	
High	36(9.4) $_a$	15(6.3) $_a$	
Poultry Game Meat			
Low	198(51.6) $_a$	165(68.8) $_a$	**0.00**
Moderate	3(0.8) $_a$	11(4.6) $_b$	
High	183(47.7) $_a$	64(26.7) $_b$	
Low Fat Dairy			
Low	339(88.3) $_a$	234(97.5) $_b$	**0.00**
Moderate	10(2.6) $_a$	2(0.8) $_a$	
High	35(9.1) $_a$	4(1.7) $_b$	
Eggs			
Low	341(88.8) $_a$	218(90.8) $_a$	0.063
Moderate	1(0.3) $_a$	4(1.7) $_a$	
High	42(10.9) $_a$	18(7.5) $_a$	
GDQS$^-$ (Unhealthy in excessive amounts): High Fat Dairy			
Low	121(31.5) $_a$	95(39.6) $_b$	**0.000**
Moderate	83(21.6) $_a$	80(33.3) $_b$	
High	132(34.4) $_a$	63(26.3) $_b$	
Very High	48(12.5) $_a$	2(0.8) $_b$	

Note: Numbers in bold face a statistically significant (p-value <0.05).

$_{a,b}$ Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.

Table 18: *Continued. The percentage of subjects with low, moderate, and high intake category of each food group and their comparison between 2008/2009 and 2022.*

Category of intake	Survey year		Pearson Chi-Square
	2022 (*n*=384)	2008-09 (*n*=240)	
	n (%)		
Red Meat			
Low	246(64.1) $_a$	144(60.0) $_a$	.062
Moderate	23(6.0) $_a$	27(11.3) $_b$	
High	115(29.9) $_a$	69(28.7) $_b$	
GDQS- (Unhealthy):			
Processed Meat			
Low	346(90.1) $_a$	220(91.7) $_a$	0.173
Moderate	3(0.8) $_a$	5(2.1) $_a$	
High	35(9.1) $_a$	15(6.3) $_a$	
Refined Grains, Baked Goods			
Low	41(10.7) $_a$	27(11.3) $_a$	**0.007**
Moderate	3(0.8) $_a$	11(4.6) $_b$	
High	340(88.5) $_a$	202(84.2) $_a$	
Sweets, Ice cream			
Low	138(35.9) $_a$	86(35.8) $_a$	0.976
Moderate	27(7) $_a$	18(7.5) $_a$	
High	219(57) $_a$	136(56.7) $_a$	
Sugar Sweetened Beverages			
Low	215(56) $_a$	109(45.4) $_b$	**0.004**
Moderate	11(2.9) $_a$	2(0.8) $_a$	
High	158(41.1) $_a$	129(53.8) $_b$	
Juice			
Low	323(84.1) $_a$	221(92.1) $_b$	**0.00**
Moderate	9(2.3) $_a$	15(6.3) $_b$	
High	52(13.5) $_a$	4(1.7) $_b$	
White Roots Tubers			
Low	205(53.4) $_a$	124(51.7) $_a$	**0.00**
Moderate	22(5.7) $_a$	69(28.7) $_b$	
High	157(40.9) $_a$	47(19.6) $_b$	
Purchased, Deep Fried Foods			
Low	245(63.8) $_a$	215(89.6) $_b$	**0.00**
Moderate	12(3.1) $_a$	11(4.6) $_a$	
High	127(33.1) $_a$	14(5.8) $_b$	`

Note: Numbers in bold face a statistically significant (p-value <0.05).

$_{a,b}$ Subscripts are statistically significant at P-value < 0.05 using comparison of column proportions (z-tests) for categorical variables.

CHAPTER V

DISCUSSION

A. Major findings of the study

To our knowledge this is the first study conducted in Lebanon that assessed diet quality in relation to nutrient adequacy and NCDs using the GDQS. This study is a cross-sectional study that assessed the diet quality as related to NCDs and nutrient adequacy using the GDQS among female university students aged 18-24 years, determined the food groups contributing to a low GDQS score, and explored the drivers of consumption of these food groups. This study also conducted secondary analysis of previous data from females aged 18-24 years old and investigated whether changes in this diet quality has occurred over time using the GDQS. Unlike most existing diet quality indices, the GDQS is a simple metric that could capture both dimensions of diet quality related to risk of NCDs and nutrient adequacy and that can be easily tabulated without the need for food composition tables.

This study was conducted among young university women using the GDQS which was originally developed and validated on nonpregnant, nonlactating women of reproductive age. Adequate nutrition in young women is not only important for their health but also due to the important effect of maternal nutrition on the health and development of the next generations. It has been reported that nutrition status and lifestyle habits of women of reproductive age before pregnancy have a lasting impact on maternal and child health (Juan & Yang., 2021). It has been also reported that, in the

age range of 18 to 24 years of many university students, the establishment of healthy lifestyle behaviors, including eating behavior, may have a lasting impact on the health of these individuals and consequently on the health of their future families (Dingee & Waigandt., 1997).

The study revealed that the average total GDQS of the study sample was 16.1±4.8 with only 8.3% having a high GDQS score indicating low risk of NCDs and nutrient inadequacy. Most of the population had a low and moderate total GDQS score suggesting high and moderate risk of NCDs and nutrient inadequacy in this population, respectively. Compared to other similar studies, using the GDQS, young Lebanese females were shown to consume a diet that is mostly nutritionally inadequate and predisposing to NCDs, which was comparable to results obtain in Mexican women of reproductive age, where a slightly lower average GDQS and GDQS- scores in Lebanon as compared to Mexican women. A slightly higher GDQS+ score was found in Lebanon as compared to Mexico.

The low consumption of fruits and most vegetables among female AUB students found in our study is a point of concern given that fruits and vegetables are rich in dietary fiber, antioxidants and phytochemicals and have been consistently associated with improved cardiometabolic health and reduced NCD-related morbidity and mortality (Afshin et al., 2015). In contrast to our findings, a study conducted in Lebanon among university students showed that the consumption of vegetables and fruits of both males and females were according to the Mediterranean diet standards (Karam et al., 2021). The inconsistent findings may be due to the variations in data collection methodology and different diet quality indices used to assess diet quality

Our study population had low intake of whole grains and high intake of refined grains. This finding highlight carbohydrate quality as a potential point of concern in the population's diet, given the effect of refined grains on the glycemic response, insulin excursions and NCD risk (Naja et al., 2012). Low consumption of whole grains was previously reported as one of the leading risk factors for CMD (Cardiometabolic diseases) mortality in Lebanon (Afshin et al., 2015). The observed high consumption of refined grains and low consumption of whole grains in our study population might be due to the fact that whole grains are more costly than refined grains, and this was also reported by some of the female students in our study. Therefore, increasing the affordability of whole grain might be beneficial in this aspect. Previous studies conducted on Lebanese adults have found similar results, where whole grains consumption was lower than the recommended Mediterranean diet intake in both males and females (Farhat et al., 2016). Moreover, Naja et al. (2011) indicated that among Lebanese adults refined grains were heavily consumed in the Lebanese dietary pattern (Naja et al., 2011).

Low consumption of fish and shellfish was also reported in our study sample. Fatty fish are rich in long chain n-3 polyunsaturated fatty acids, which have been linked to anti-atherosclerotic and anti-thrombotic effects (Bechthold et al., 2019). Low intake of seafood ω-3 fatty acids was, in fact, found to be among the leading risk factors for CMD mortality in Lebanon (Afshin et al., 2015). Similar studies conducted in Lebanon among university students showed that the consumption of fish was lower than the recommended Mediterranean diet intake in both males and females (Karam et al., 2021).

Most of our study population had low intakes of plant-based proteins (legumes, nuts, and seeds). Plant-based proteins are rich in fiber, vitamins and minerals and have been shown to have beneficial effect on cardiovascular health (Bechthold et al., 2019). In contrast to our findings, a study conducted in Lebanon among university students showed that legumes and nuts were consumed according to the Mediterranean diet standards in both males and females (Karam et al., 2021).

Compared to a study done in southern India among women of reproductive age using GDQS, some similarities and differences in food group consumption are evident. Similar to the our findings, Matsuzaki et al (2021) found that most women of reproductive age in southern India had low consumption of cruciferous vegetables, deep orange vegetables, citrus fruits, deep orange fruits, deep orange tubers, fish and shellfish, low fat dairy, eggs, processed meat, red meat, sugar sweetened beverages, juice and white roots tubers and moderate to high consumption of other vegetables, liquid oils, refined grains and sweets and ice cream. However, in contrast to our study findings regarding low consumption of dark green leafy vegetables, other fruits, legumes, nuts and seeds, whole grains, purchased deep fried foods, Matsuzaki et al. (2021) study found moderate to high consumption of these food groups among women of reproductive age in southern India (Matsuzaki et al., 2021).

The observed unhealthy eating pattern in our study sample might be due to the fact that young generations might be more inclined towards trying “modern” and “trendy” food items and are therefore more likely to adopt to “modern” or “westernized” eating habits (Hu et al., 2013). Additionally, those female university students might be practicing unhealthy eating patterns because of their busy schedules,

lack of nutrition knowledge, living in dorms, or even consuming unhealthy food products for their cheaper price. Sogari et al. (2018) found that common barriers to healthy eating among US college students included time constraints, unhealthy snacking, convenience high-calorie food, stress, high prices of healthy food, and easy access to junk food. (Sogari et al., 2018). However, although the eating pattern of our study sample is unhealthy, very few participants reported that they don't know the health benefits of the healthy foods and the adverse health effects of the unhealthy foods. Similar to our finding, a cross-sectional study, conducted at in Malaysia found that most university students had poor eating habits, although the majority had good nutrition knowledge (Yun et al., 2018).

Our study showed that rural residents had a higher total GDQS score and GDQS- score (indicating lower consumption of unhealthy food groups) compared to urban residents. One possible explanation for this, is that traditional diet is more common in rural areas whereas western style diet is more common in urban areas (Fernandes et al., 2018; Casari et al., 2022). It has been previously documented that in Lebanon, urban diets are becoming more westernized by which traditional meals are progressively being replaced by fast-food and snack-foods, with a high content of fat, added sugars (FAO., 2007). Studies that compared diet quality between urban and rural settings among women showed conflicting results. For instance, while some studies in Australia, Canada, Mexico and Poland showed better diet quality in urban women, compared to rural women, other studies conducted in Greece and Africa showed the contrary, whereas other studies reported insignificant differences. The inconsistent findings may be driven by the variations in data collection methodology, assessment of diet quality, urban and rural definitions and socioeconomic differences between

developed and developing countries. However, as these studies are not specific to women of reproductive age, it is unknown if diet quality differs in younger women in urban and rural settings (Martin et al., 2017). Nevertheless, in contrast to our findings, He et al (2021) found that urban residents in China had a significantly higher GDQS score compared with rural residents (He et al., 2021).

In this study, young female participants with high-intensity physical activity had a higher average GDQS and GDQS+ scores (indicating higher consumption of healthy food groups) compared to others with low and moderate intensity physical activity. Several studies have previously suggested that physical activities act as strong motivating factors for healthy dietary habits among university students (Kabir et al., 2018; Downes., 2015). This finding is consistent with a study conducted in US among women of reproductive age that showed women with a higher average GDQS tended to be more physically active (Fung et al., 2021).

Participants living at parental home had a higher average GDQS score and GDQS- score (indicating lower consumption of unhealthy food groups) compared to participants living at students' residence showing that students who live away from their families purchase and prepare their own food and this might negatively affect their dietary quality. Several factors such as lack of cooking skills, limited time, academic stress and socioeconomic factors might have played a role in this respect. Students tend to consume less home-cooked meals and more convenient food and food away from home due to the lack of time, lack of cooking skills and/or lack of resources to prepare food. Students living at parental home do not have to pay for food and thus do not suffer from financial limitations in this respect (El Ansari., 2012). However, food prices

become more important when making food decisions for students living in a student residence (Deliens et al., 2014). Parents can also inspire their children's food intake positively through role modeling and the food environment they provide at home (El Ansari et al., 2012). Similar to our finding, other studies in Greece and Saudi Arabia showed that students living away from home developed more unhealthy eating behaviors than students living at parental home (Papadaki et al., 2007; Alghamdi et al., 2018).

This study showed that non-smokers and past-smokers had a higher GDQS-score (indicating lower consumption of unhealthy food groups) compared to smokers. It has previously been shown that the intensity of tobacco consumption is inversely associated with overall diet quality (Alkerwi et al., 2017). Similar to our finding, several other studies have shown that smokers have less healthful diets than nonsmokers. A study conducted in US among women of reproductive age showed that women with a higher average GDQS were less likely to be smoker (Fung et al., 2021). Studies conducted in Chilean and Spain among university students found that smoking was associated with unhealthy eating patterns in both sexes (Vera et al., 2021; Ramón-Arbués et al., 2021).

To our knowledge this study is the first to explore the drivers of consumption of unhealthy food groups in Lebanon. Interventions to improve diet quality should recognize and address the factors that influence eating behaviors therefore we explored the barriers to consuming healthy foods and facilitators to consuming unhealthy foods. Several factors were found to influence the consumption of different food groups among university students in our study. Taste, past eating habits, availability and cost,

were the most commonly reported factors influencing consumption of almost all food groups. Other factors such as convenience and advertising were also reported as a factor influencing consumption of some food groups.

Preference for tastes was notably mentioned by many of our participants as a major factor influencing consumption of all food groups. Research has consistently shown that taste is a major driver of eating behaviors in children, adolescents, and adults (McGinnis et al., 2006). Similar to our findings, studies conducted in Belgium and Bangladesh among university students found that students reported taste as an important factor influencing their food choices (Deliens et al., 2014; Kabir et al., 2018). Therefore, unhealthy food products reformulation (such as gradual sugar reduction in sweets) and portion size reduction could be effective intervention strategies to improve eating behaviors in this population.

Most students in this study also frequently reported past eating habits as a factor influencing the consumption of all the food groups. Habits are preferences shaped by past choices. Habits are an important determinant of eating behaviors and can be hard to change. Habit strength and level of self-control will differ between individuals, which will impact their capability to be able to make the food choices they would rationally desire to, for example, to consume more healthily (D'Angelo et al., 2020). Similar to our finding, Kabir et al. (2018) documented past dietary habits as a factor influencing food choices of university students in Bangladesh (Kabir et al., 2018).

Food availability at home and local markets was frequently reported by participants as a factor influencing consumption of most food groups. Results in our study revealed that one of the main barriers to consumption of the healthy food groups

especially whole grains was the lack of availability at home and local markets. Possible explanation for this finding might be that other members might be influencing what food to buy and thus preventing the availability of certain foods at home. Moreover, it is difficult to provide certain foods at home if these foods are not available at local markets (Contento., 2011). Lack of availability of whole grain might be associated with the lack of familiarity with whole grains products. When individuals are only familiar with famous whole grain products, these are the only whole grains they will be searching for in local markets. If these are not available, then they claim that whole grains are not accessible or available (Chea & Mobley., 2019). These findings are consistent with results from other studies in Belgium and Bangladesh, which have also showed that university students' food choices are influenced by the availability and accessibility of healthy foods (Deliens et al., 2014; Kabir et al., 2018). Moreover, Meynier et al (2020) showed that the most effective ways to facilitate whole grains consumption in both adults and children would be to increase their availability, affordability and sensory appeal (taste, texture and appearance) (Meynier et al., 2020). On the other hand, the availability of the unhealthy food groups at home and local markets was also reported by our participants to be a facilitator to their consumption. Similar to our finding, a study in Jamaica revealed that one of the reasons for unhealthy dietary choices was greater availability and accessibility of unhealthy foods (La foucade et al., 2022). Therefore, interventions to increase the availability of healthy food options while limiting the availability of unhealthy food products must be considered.

Some participants mentioned food prices as one of the factors influencing their eating behaviors. Mainly, the high cost of low-fat dairy and whole grains and the low cost of refined grains affected their consumption in some participants. There is strong

evidence in the literature that the price of food influences consumer purchases, with increasing price reducing the possibility of eating specific food products (D'Angelo et al., 2020). Similar to our findings, a study in Bangladesh among university students revealed that food prices were found to be influential in determining eating habits (Kabir et al., 2018). Intervention studies in other populations have shown that price reductions increase purchases (French et al., 1997; French et al., 2001). Given the importance of price in university students' food choices, price reduction of healthy foods might be an effective strategy in improving dietary behaviors in this population.

Students in the current study frequently reported convenience as a facilitator to consuming sweets and sugar-sweetened beverages. A possible explanation for this is that consuming healthy food and preparing healthy meals might become low priorities when compared to other commitments. Thus, students might be more likely to buy foods that are fast and convenient (Deliens et al., 2014). Marquis et al (2005) found that college students often prioritize convenience over health (Marquis et al., 2005).

Some participants reported TV, internet, and social media ads as a facilitator to consuming sweets and ice cream and sugar sweetened beverages. In fact, there is some high-quality evidence in the literature on the negative influences that advertising has on children and young people. Marketing and advertising increase the intake of unhealthy foods in children, adolescents, and young adults (D'Angelo et al., 2020). Therefore, interventions to reduce the marketing and advertising of these foods across all media could be effective in improving dietary behaviors.

The results of this study have documented significant changes in food groups consumption among Lebanese female aged 18-24, between 2008/2009 and 2022.

Overall, a downward trend was observed in the daily consumption of citrus fruits, dark green leafy vegetables, and sugar sweetened beverages, whereas the consumption of juice, white roots tubers, high fat dairy, low fat dairy, poultry, liquid oils, deep orange tubers, cruciferous vegetables and purchased deep fried foods followed an increasing trend over the 13-years period.

Although the consumption of deep orange tubers and cruciferous vegetables increased and the consumption of citrus fruits and dark green leafy vegetables decreased over time, it is worth noting that, the consumption of deep orange tubers, all fruits and all vegetables remained low. On the other hand, the observed increase in liquid oils intake is considered as a favorable dietary change, even though it remained high over the years. Most oils are high in monounsaturated fats or polyunsaturated fats. More recent evidence suggests that a diet high in healthy fat, rich in unsaturated fatty acids, may, in fact, prevent the development of cardiometabolic disease (Billingsley et al., 2018). Nutrition transition is usually characterized by increases in animal-based products. In our study, the intake of poultry significantly increased over time, however the consumption of red meat and processed meat remained quite stable. The results of our study have also documented that the consumption of both high fat dairy and low-fat dairy increased over time. However, although the consumption of low-fat dairy increased over time, yet it remained too low. Additionally, over the same period of time, the consumption of white roots tubers and purchased deep fried foods increased, showing that young female adults are moving towards a more westernized diet and lifestyle. There is strong evidence suggesting a higher risk of developing NCD when fried foods are consumed more frequently (Gadiraju et al., 2015). Moreover, the observed decrease in sugar sweetened beverages consumption in Lebanon is considered

as a favorable dietary change given that sugar sweetened beverages have been shown to be associated with cardiometabolic disease mortality (Afshin et al., 2015), but the increase in the consumption of juice is a point of concern (defined as any unsweetened or sweetened drink at least partly composed of fruit juice). Juice may contain significant concentrations of nutrients, however juicing leads to a significant reduction in dietary fibers, which may reduce satiety and enhance hunger, resulting in moderately high glycemic index and contributing to additional intake of foods (Mozaffarian., 2017).

The mean GDQS- score was significantly lower in year 2022 compared to 2008/2009, showing an increasing trend in the consumption of unhealthy food groups over the years.

In many aspects, the observed changes in the food groups' consumption are consistent with the hallmarks of the nutrition transition, which is characterized by increased intake of energy, added sugar, animal fat, and salty foods (typical of the westernized dietary pattern) and decreased intake of fruits, vegetables, dietary fibers, and complex carbohydrates. Nutrition transition have been shown to be associated with increases in the prevalence of diet related NCDs (Popkin., 2001). These findings highlight the need for population- based interventions and nutrition policies aimed at promoting healthier and more balanced diets.

It is important to note that our findings should be carefully interpreted in view of the reported drivers of consumption revealed in our study and the expanding literature portraying the complex environmental, socioeconomic, and individual-lifestyle factors contributing to the transition away from the traditional Mediterranean diet. These factors entail the potentially higher costs of healthy food options (such as fruits and vegetables), unavailability of healthy food options, the aggressive marketing of cheaper

yet energy-dense foods and beverages, and increased urbanization and modernization. (Naja el al., 2020).

We compared our study findings to a previous study conducted in Lebanon which investigated temporal trends in food consumption among Lebanese adults between 1997 and 2008/2009 (Nasreddine et al., 2019). The previous study showed a significant decrease in eggs consumption among females aged 20-39.9, which could not be observed in our study. Additionally, in contrast to our findings regarding the increase in poultry, low fat dairy and high fat dairy consumption and the decrease in sugar sweetened beverages between 2008/2009 and 2022, no change was found between 1997 and 2008/2009 in the consumption of these food groups among females aged 20-39.9 in the previous study. Similar to our findings, the previous study found that between 1997 and 2008/2009 there was no change in the consumption of processed meat, red meat, fish, legumes, nuts and seeds and sweets among females aged 20-39.9.

The shift in food group consumption in Lebanon share some similarities with that reported from other countries. In agreement with our study findings concerning the increase in low fat and high fat dairy consumption over time, the consumption of dairy in Korea increased over time among both males and females adults (Kweon et al., 2021). However, contrary to our study finding regarding no change in eggs consumption over time, egg consumption in Korea was found to increase over time among both males and females adults (Kweon et al., 2021). In contrast to our finding regarding the decrease in sugar sweetened beverages consumption, a study found that sugar sweetened beverages consumption rates are rising rapidly among South Koreans regardless of sex and age (Lim et al., 2018).

B. Strengths and limitations of the study

The present study has several strengths. First, the GDQS is entirely food-based and therefore does not require the use of a food composition table for analysis. Second, data was collected by trained nutritionist who underwent extensive training to reduce judgmental communication and minimize social desirability bias. Third, the ability of GDQS to correlate with both nutrient adequacy and diet related NCD among women of reproductive age has been previously validated from a range of countries with different prevailing diet patterns, profiles of disease burden, and levels of economic development. However, the results of the study ought to be considered in light of the following limitations. First, collecting data using the GDQS app prevented the use of standardized recipes in the case where respondents could not recall the ingredients of mixed dishes. Second, assessing the quantity of consumption per GDQS food group level is a difficult mental exercise and challenging for the respondent to recall a reliable and valid estimate of the quantity consumed. This may be particularly challenging when several different foods are consumed within a food group and when sharing plates. It is unknown whether respondents can successfully visualize accurate amounts at the group level. Third, different sampling strategies (university students vs. national sample) and different dietary assessment tools (GDQS App and 24-HR) were used in the two studies (2008/2009 and 2022), and therefore the observed trends in diet quality and food groups consumption could be affected. Fourth, Our study findings cannot be generalize to the whole female population as our study sample are AUB female students and constitute in general a higher socioeconomic status than the rest of the population.

CHAPTER V

CONCLUSION

This study found that the majority of young Lebanese female AUB students have a low and moderate GDQS score. Participants living at parental home, living in rural areas and with high-intensity physical activity had a higher GDQS score compared to participants living at student residence, living in urban areas and with low and moderate-intensity physical activity. This study showed that taste was the most influential determinant of eating behaviors, followed by past eating habits, availability and cost. Other factors, such as convenience, and advertising were also reported as factors influencing consumption of some food groups. This study showed that between 2008/2009 and 2022, the diet of Lebanese female adults slightly deteriorated. Findings of this study must be taken into consideration for the development of interventions and nutrition polices aiming to promote healthier eating behaviors among university students for mitigating the increase in NCDs in the country. Increasing the availability of affordable healthy foods especially whole grains might be beneficial in improving the eating behaviors among university students.

APPENDIX I

Consent Form:

Principle Investigator:
Dr Nahla Hwalla – Professor Faculty of Agricultural and Food Sciences – AUB

Co-Principal-Investigator:
Dr Lara Nasreddine – Associate professor Faculty of Agricultural and Food Sciences – AUB

Co-Investigators:
Dr Samer Kharroubi, Rana Ibrahim - Faculty of Agricultural and Food Sciences - AUB

Address: Department of Nutrition and Food Sciences- American University of Beirut - Bliss Street

Phone: (01) 350000 Ext: 4443

Site Where the Study will be Conducted:

American University of Beirut, Faculty of Agricultural and Food Sciences, Department of Nutrition and Food Sciences

You are being invited to participate in a study entitled: "Diet Quality Associated with Risk of Non-communicable Diseases and Nutrient Inadequacy among Female University Students using the Global Diet Quality Score", conducted by the American University of Beirut which will include 384 university students recruited from the American University of Beirut (AUB).

Please take time to read the following information carefully before you decide whether you want to participate in this study or not. This statement describes the objectives, procedures, benefits, risks, discomforts, and precautions related to the study. Alternative procedures, if any, available to you, as well as your right to withdraw from the study at any time are also described. Please feel free to ask any questions if you need any clarification about what is stated in this form or if you need any additional information.

1) **Purpose of the Research Study and Overview of Participation:**

In Lebanon, unhealthy diets are among the recognized modifiable risk factors for several non-communicable disease (NCDs) including diabetes, cardiovascular disease, and certain types of cancer. Understanding the drivers of eating behaviors and assessing the diet quality of the population is important in order to select the most effective interventions aiming to promote healthy eating behaviors and thus mitigating NCDs. The Global Diet Quality Score (GDQS) is an entirely food-based metric, consisting of 25 food groups. The GDQS provide a simple, standardized metric appropriate for population-based measurement of diet quality globally. Studies exploring the drivers of eating behaviors and assessing the diet quality among young adults are scarce in

Lebanon. Therefore, this study aims to assess diet quality and explore the drivers of consumption among 384 university students using the Global Diet Quality Score (GDQS) for mitigating NCDs.

2) **Recruiting strategy:**

Participation in this study is completely voluntary and an informed consent will be sought from eligible students who have the right to accept or decline participation on their own. Their consent will be obtained during the screening stage. The recruitment methodology, approved by the ethical board, will be performed in two stages:

- Stage 1 – Screening Stage: Flyers will be posted around AUB (American University of Beirut), Subjects were invited to visit the Department of Nutrition and Food Sciences at AUB, at a specific date and time. The subjects were briefed about the study, its objectives, and methodology, in private. Eligibility of the participant will be confirmed based on age (ages between 18-24 years old will be recruited), nationality, if they live in Lebanon and whether they are females and whether they are pregnant or lactating women. This screening stage will require around 5 minutes of your time

After signing the informed consent and ensuring your eligibility for participation, data collection will start right away after the screening stage, however if you prefer to meet later for data collection, you will then be contacted to set a date and time convenient for you to meet or visit the Department.

- Stage 2 – Recruitment Stage: The recruitment stage requires a total of 384 students, that will be selected based on specific sampling and recruitment protocols.

3) **Project Description and Duration:**

If you decide to participate in this study, you will be interviewed at AUB, on a date and time that is convenient for you. You will be asked to stay for a face-to-face interview that would take approximately 6 minutes for data collection. In case face-to-face data collection was not feasible at the time of project initiation, interviews will be done via zoom meetings. Data will be obtained through the application of an interviewer-administrated questionnaire. This questionnaire includes questions about your demographic, socioeconomic, lifestyle factors, anthropometric measurements and drivers of consumption. In addition to the GDQS App, which is an electronic data collection tool developed by Intake that ask respondents to recall all foods and drinks consumed during a 24- hour reference period. Data collection was by trained nutritionists.

4) **Risks and Discomforts:**

Although any study may be associated with any unforeseeable risk, this study has minimal risk and no major risks results from the participation in this study. None of the data collection measures bare any long-term or short-term hazards. The only possible concerns may include discomfort or stress when asked certain questions such as socioeconomic status. You may feel uncomfortable participating in weight and height

measurements. To minimize the risks, questions will be asked individually rather than in a group interview context where you may not want to disclose any information and if any of the questions make you feel uncomfortable, you are not required to answer. You are free to skip any questions and refrain from answering. Moreover, all collected data and results will be kept strictly confidential and measures will be taken to ensure no breach of privacy.

Considering the COVID-19 situation, all the necessary safety measures (masks, gloves, preventive gear...), will be ensured at all times at the Department of Nutrition and Food Sciences and elsewhere in other universities (according to the IRB guidance document).

5) **Potential Benefits:**

By participating in this study, you will be contributing to science. All findings will be conveyed to you by the end of the study. There are benefits from participation in this study whereby you will learn about your diet quality score and what food items appear to contribute to the score and increase risk of NCDs. Moreover, since the study aims to understand drivers of eating behavior and the diet quality among university students, this study will inform the design of future interventions and policies aiming to promote healthy eating behaviors. There are no anticipated expenses for you to pay if you participate in the study. If you don't want to take part in the study anymore for a reason of your own, then the study investigators will terminate your participation.

6) **Other ways to reach the aim of the study:**

There is no other way to reach the aim of the study.

7) **Confidentiality:**

All procedures will take place in a private room to ensure your privacy. The investigators are committed to preserve anonymity of the participant, to keep the results confidential, and to give results only to the participant involved. If you agree to participate, all collected data will be kept strictly confidential and measures will be taken to ensure no breach of your privacy. Also, all participants will be assigned by random identifiers to further assure the confidentiality of records. A sheet will be prepared whereby each ID will be linked to the name of the participant. All data used for research purposes, however, will be based on the IDs only. Only the members of the research group will have access to the data that will only be used for research purposes. Records will be monitored, without violating confidentiality. The data collection sheets will be locked in a cabinet at the principal investigator's office. Electronic versions of the data will also be secured and locked by a password. This data will be stored on the principal's investigator computer. Only the PI will have access to the complete data set. Proper measures will be taken to keep the individually identifiable information confidential, only shared with the researchers listed in this IRB application, and only used for the purposes of this research project. All identifiers (name, DOB, address, etc.) will be de-identified once the data merging at the institution is complete. Your contact information will be securely stored at AUB for internal use during the study. The research data will not include your identifying information. Identifiers will be collected

for study purposes; however, all data will be de-identified and identifiers will not be disclosed. Please acknowledge that participation in this study is completely voluntary.

Participant Rights:

Participation in this study is completely voluntary and informed consent will be sought from eligible students who have the right to accept or decline participation on their own. Refusing to participate will not involve any loss of benefits offered in the future. Moreover, you are entitled to withdraw from the study at any time without any loss of benefits at any time. All the consent content will be shared with you prior to filling the survey.

A) If you prefer to meet later for data collection, can we contact you to set a date and time convenient for you to visit the Department?

Yes **No**

If your answer is yes, please provided us with your contact telephone number:

_____

We may store and use part or all of the collected data in the future. This might include sharing the collected data with other researchers. Before doing so, we will make sure to destroy all links between the identity and the data about you. Also, we would like to contact you to invite you to participate in future studies.

B) I agree to allow the storage and use of the collected information with other researchers and/or in future research. I agree to share data with investigators at AUB or outside AUB.

Yes **No**

C) Can we contact you to invite you for future studies?

Yes **No**

Investigator's Statement:

I have reviewed, in detail, the informed consent document for this research study with

---------- (Name of the participant), the purpose of the study, and its risks and benefits. I have answered all the participant's questions clearly. I will inform the participant in case of any changes to the research study.

_____ _____

Name of Investigator or designee **Signature of Investigator or designee**

_____

Date & Time

Participant's Consent:

I have read and understood all aspects of the research study and I had enough time to have all my questions answered. I voluntarily agree be a part of this research study and I know that I can contact Dr. Nahla Hwalla at 01-350000 Ext 4443 or any of her designee involved in the study in case of any questions at any time during and after the conduction of the study. If I felt that my questions have not been answered, I can contact the Institutional Review Board for human rights at 01-350000 Ext 5445. I understand that I am free to withdraw this consent and discontinue participation in this project at any time, even after signing this form, and it will not affect my care or benefits. I know that I will receive a copy of this signed informed consent.

_____ _____

Name of Participant **Signature**

_____

Date & Time

_____ _____

Witness's name **Witness's Signature**

(If participant is illiterate)

_____

Date & Time

APPENDIX II

Multi-component questionnaire:

1. PERSONAL & HOUSEHOLD INFORMATION

1. **Age (years):** _____

2. **Living arrangement:**
   - ☐ 1. Living at parental home
   - ☐ 2. Living in student residence

3. **Place of Residence:**
   - ☐ 1. Urban area
   - ☐ 2. Rural area

4. **Major of study:**
   - ☐ 1. Health related major (Biomedical, Nutrition, Food science, Medicine, Public health, and nursing)
   - ☐ 2. non-health related major

5. **Academic year of study:** _____

6. **Total Family members number who usually sleep in this house:** _____

7. **How many rooms are there in your house other than the kitchen, the bathroom, the parking, the open-air balcony?** _____

2. ANTHROPOMETRIC MEASUREMENTS

8. **Height (cm):** _____

9. **Weight (Kg):** _____

3. ALCOHOL CONSUMPTION

10. **Alcohol drinker:**
   - ☐ 1. Drinker
   - ☐ 2. Non-drinker
   - ☐ 3. Past drinker. From when did you stopped drinking alcohol? _____ (years/ months/ weeks/ days)

4. SMOKING

11. **Smoking status?**
   - ☐ 1. Current smoker

☐ 2. Non-smoker
☐ 3. Past-smoker. From when did you stopped smoking? _____ (years/ months/ weeks/ days)

5. PHYSICAL ACTIVITY

12. **During the past 7 days, how many days did you do strenuous physical activity such as: heavy loads, digging, construction work, brisk cycling, brisk running, aerobics, etc., for at least 10 consecutive minutes per day?**

☐ 1. _____ day(s)
☐ 2. I didn't do anything of them (skip question 13)

13. **How much time do you spend doing this average physical activity per day (hour, minute)?**

_____ hour(s)
_____ minutes(s)

14. **During the past 7 days, how many days did you do moderate physical activity (such as carrying light items, riding a bike, playing volleyball, or jogging) for at least 10 consecutive minutes per day? (Does not include walking)**

☐ 1. _____ day(s)
☐ 2. I didn't do anything of them (skip question 15)

15. **How much time do you spend doing this average physical activity per day (hour, minute)?**

_____ hour(s)
_____ minutes(s)

16. **During the past 7 days, how many days did you walk for at least 10 continuous minutes at each time?**

☐ 1. _____ day(s)
☐ 2. I didn't walk (skip question 17)

17. **On average, how many hours/minutes did you walk each time?**

_____ hour(s)
_____ minutes(s)

18. **On average, over the past 7 days, how much time did you spend sitting in a day? (Hour, minute)?**

_____ hour(s)

_____ minutes(s)

6. DRIVERS OF CONSUMPTION OF HARMFUL AND PROTECTIVE FOODS:

19. **What sorts of things makes it harder to consume Fruits?** *(Multiply answers possible)*

I don't like the taste/ texture	High cost	I don't know the health benefits	Not available at home	Not available at local markets	Past eating habits (Not used to eat fruits frequently)	High spoilage rate	**None**, no barriers, I eat Fruits frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	

20. **What sorts of things make it harder to consume Vegetables?** *(Multiply answers possible)*

I don't like the taste/ texture	High cost	I don't know the health benefits	Not available at home	Not available at local markets	Past eating habits (Not used to eat vegetables frequently)	High spoilage rate	**None**, no barriers, I eat vegetables frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	

21. **What sorts of things makes it harder to consume Low-Fat Dairy products?** *(Multiply answers possible)*

I don't like the taste/ texture	High cost	I don't know the health benefits	Not available at home	Not available at local markets	Past eating habits (Not used to eat low-fat dairy products frequently)	Lactose intolerant	**None**, no barriers, I eat Low-Fat Dairy products frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	

22. **What sorts of things makes it harder to consume Deep Orange Tubers (carrots)?** *(Multiply answers possible)*

I don't like the taste / texture	High cost	I don't know the health benefits	Not available at home	Not available at local markets	Past eating habits (Not used to eat deep orange tubers frequently)	High spoilage rate	**None**, no barriers, I eat Deep Orange tubers frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	

23. **What sorts of things makes it harder to consume Whole Grains?** *(Multiply answers possible)*

I don't like the taste/ texture	High cost	I don't know the health benefits	Not available at home	Not available at local markets	Past eating habits (Not used to eat whole grains frequently)	I am unable to identify whole grain products	**None**, no barriers, I eat whole grains frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	

24. **What sorts of things make it easier to consume Refined Grains (White bread, pasta, rice…)?** *(Multiply answers possible)*

I like the taste/ texture	Low cost	I don't know the adverse health effect	Available at home	Available at local markets	Past eating habits (Used to eat refined grains frequently)	TV, internet, social media ads	**None**, no facilitators, I don't eat Refined Grains frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	

25. **What sorts of things makes it easier to consume Sweets and Ice cream?** *(Multiply answers possible)*

I like the taste/ texture	Low cost	I don't know the adverse health effect	Available at home	Available at local markets	Past eating habits (Used to eat sweets frequently)	Convenient (easy to prepare/ eat, long shelf life...)	TV, internet, social media ads	**None**, no facilitators, I don't eat Sweets and Ice cream frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	

26. **What sorts of things makes it easier to drink Sugar Sweetened Beverages?** *(Multiply answers possible)*

I like the taste/ texture	Low cost	I don't know the adverse health effect	Available at home	Available at local markets	Past eating habits (Used to drink sugar sweetened beverages frequently)	Convenient (easy to prepare/ eat, long shelf life...)	TV, internet, social media ads	**None**, no facilitators, I don't drink Sugar Sweetened Beverages frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	7. ☐	8. ☐	9. ☐	

27. **What sorts of thing makes it easier to consume Red Meat?** *(Multiply answers possible)*

I like the taste/ texture	I don't know the adverse health effect	Available at home	Available at local markets	Past eating habits (Used to eat red meat frequently)	**None**, no facilitators, I don't eat Red Meat frequently	Others:
1. ☐	2. ☐	3. ☐	4. ☐	5. ☐	6. ☐	

APPENDIX III

Table 1. GDQS and GDQS Sub-Metric Food Groups and Scoring

			Categories of Consumed Amounts (g/day)				Points Assigned			
Inclusion in Metrics	**Scoring Classification**	**Food Groups**	**Low**	**Middle**	**High**	**Very High**	**Low**	**Middle**	**High**	**Very High**
GDQS & GDQS+	HEALTY	Citrus Fruits	<24	24-69	>69		0	1	2	
		Deep Orange Fruits	<25	25-123	>123		0	1	2	
		Other Fruits	<27	27-107	>107		0	1	2	
		Dark Green Leafy Vegetables	<13	13-37	>37		0	1	4	
		Cruciferous Vegetables	<13	13-36	>36		0	0.25	0.5	
		Deep Orange Vegetables	<9	9_45	>45		0	0.25	0.5	
		Other Veegetables	<23	23-114	>114		0	0.25	0.5	
		Legumes	<9	9_42	>42		0	2	4	
		Deep Orange Tubers	<12	12_63	>63		0	0.25	0.5	
		Nuts, Seeds	<7	7_13	>13		0	2	4	
		Whole Grains	<8	8_13	>13		0	1	2	
		Liquid Oils	<2	2_7.5	>7.5		0	1	2	
		Fish, Shellfish	<14	14_71	>71		0	1	2	
		Poultry, Game Meat	<16	16_44	>44		0	1	2	
		Low Fat Dairy*	<33	33_132	>132		0	1	2	
		Eggs	<6	6_32	>32		0	1	2	
GDQS & GDQS-	**UNHEALTHY** (in excessive amounts)	High Fat Dairy*	<35	35_142	>142-734	>734	0	1	2	0
		Red Meat	<9	9_46	>46		0	1	0	
	UNHEALTHY	Prossessed Meat	<9	9_30	>30		2	1	0	
		Refined Grain, Baked Goods	<7	7_33	>33		2	1	0	
		Sweets, Icecream	<13	13_37	>37		2	1	0	
		Sugar Sweetened Beverages	<57	57_180	>180		2	1	0	
		Juice	<36	36_144	>144		2	1	0	
		White Roots Tubers	<27	27_107	>107		2	1	0	
		Purchased Deep Fried Foods	<9	9_45	>45		2	1	0	

* Hard cheese is converted to milk equivalents using a conversion of 6.1 when calculating total consumption of high-dairy for the purpose of assigning a GDQS consumption category.

REFERENCES

Afshin, A., Micha, R., Khatibzadeh, S., Fahimi, S., Shi, P., Powles, J., Singh, G., Yakoob, M. Y., Abdollahi, M., Al-Hooti, S., Farzadfar, F., Houshiar-Rad, A., Hwalla, N., Koksal, E., Musaiger, A., Pekcan, G., Sibai, A. M., Zaghloul, S., Danaei, G., . . . Mozaffarian, D. (2015). The impact of dietary habits and metabolic risk factors on cardiovascular and diabetes mortality in countries of the Middle East and North Africa in 2010: a comparative risk assessment analysis. *BMJ open*, *5*(5), e006385. https://doi.org/10.1136/bmjopen-2014-006385

Afshin, A., Micha, R., Khatibzadeh, S., Schmidt, L. A., & Mozaffarian, D. (2014). Dietary Policies to Reduce Non-Communicable Diseases. In G. W. Brown, G. Yamey, & S. Wamala (Eds.), *The Handbook of Global Health Policy* (pp. 175-193). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118509623.ch9

Alghamdi, E. S., Farrash, M. S., Bakarman, M. A., & Mukhtar, A. M. (2018). Dietary Habits of University Students Living at Home or at University Dorm: A Cross-Sectional Study in Saudi Arabia. *Global Journal of Health Science*.

Alkerwi, A., Baydarlioglu, B., Sauvageot, N., Stranges, S., Lemmens, P., Shivappa, N., & Hébert, J. R. (2017). Smoking status is inversely associated with overall diet quality: Findings from the ORISCAV-LUX study. *Clin Nutr*, *36*(5), 1275-1282. https://doi.org/10.1016/j.clnu.2016.08.013

Alkerwi, A., Vernier, C., Sauvageot, N., Crichton, G. E., & Elias, M. F. (2015). Demographic and socioeconomic disparity in nutrition: application of a novel Correlated Component Regression approach. *BMJ open*, *5*(5), e006814. https://doi.org/10.1136/bmjopen-2014-006814

Angulo, E., Stern, D., Castellanos-Gutiérrez, A., Monge, A., Lajous, M., Bromage, S., Fung, T. T., Li, Y., Bhupathiraju, S. N., Deitchler, M., Willett, W. C., & Batis, C. (2021). Changes in the Global Diet Quality Score, Weight, and Waist Circumference in Mexican Women. *J Nutr*, *151*(12 Suppl 2), 152s-161s. https://doi.org/10.1093/jn/nxab171

Arabi, A., Chamoun, N., Nasrallah, M. P., & Tamim, H. M. (2021). Vitamin D Deficiency in Lebanese Adults: Prevalence and Predictors from a Cross-Sectional Community-Based Study. *Int J Endocrinol*, *2021*, 3170129. https://doi.org/10.1155/2021/3170129

Bechthold, A., Boeing, H., Schwedhelm, C., Hoffmann, G., Knüppel, S., Iqbal, K., De Henauw, S., Michels, N., Devleesschauwer, B., Schlesinger, S., & Schwingshackl, L. (2019). Food groups and risk of coronary heart disease, stroke and heart failure: A systematic review and dose-response meta-analysis of prospective studies. *Crit Rev Food Sci Nutr*, *59*(7), 1071-1090. https://doi.org/10.1080/10408398.2017.1392288

Billingsley, H. E., Carbone, S., & Lavie, C. J. (2018). Dietary Fats and Chronic Noncommunicable Diseases. *Nutrients*, *10*(10). https://doi.org/10.3390/nu10101385

Bromage, S., Batis, C., Bhupathiraju, S. N., Fawzi, W. W., Fung, T. T., Li, Y., Deitchler, M., Angulo, E., Birk, N., Castellanos-Gutiérrez, A., He, Y., Fang, Y., Matsuzaki, M., Zhang, Y., Moursi, M., Gicevic, S., Holmes, M. D., Isanaka, S., Kinra, S., . . . Willett, W. C. (2021). Development and Validation of a Novel Food-Based Global Diet Quality Score (GDQS). *J Nutr*, *151*(12 Suppl 2), 75s-92s. https://doi.org/10.1093/jn/nxab244

Bromage, S., Zhang, Y., Holmes, M. D., Sachs, S. E., Fanzo, J., Remans, R., Sachs, J. D., Batis, C., Bhupathiraju, S. N., Fung, T. T., Li, Y., Stampfer, M. J., Deitchler, M., Willett, W. C., & Fawzi, W. W. (2021). The Global Diet Quality Score Is Inversely Associated with Nutrient Inadequacy, Low Midupper Arm Circumference, and Anemia in Rural Adults in Ten Sub-Saharan African Countries. *J Nutr*, *151*(12 Suppl 2), 119s-129s. https://doi.org/10.1093/jn/nxab161

Bukman, A. J., Ronteltap, A., & Lebrun, M. (2020). Interpersonal determinants of eating behaviours in Dutch older adults living independently: a qualitative study. *BMC Nutr*, *6*(1), 55. https://doi.org/10.1186/s40795-020-00383-2

Casari, S., Paola, M. D., Banci, E., Diallo, S., Scarallo, L., Renzo, S., Mast, Q. d., Kabore, B., Cavalieri, D., & Lionetti, P. (2022). Changing Dietary Habits: The Impact of Urbanization and Rising Socio-Economic Status in Families from Burkina Faso in Sub-Saharan Africa. *Nutrients*, *14*(9), 1782. https://doi.org/10.3390/nu14091782

Castellanos-Gutierrez, A., Rodriguez-Ramirez, S., Bromage, S., Fung, T. T., Li, Y., Bhupathiraju, S. N., Deitchler, M., Willett, W., & Batis, C. (2021). Performance of the Global Diet Quality Score with Nutrition and Health Outcomes in Mexico with 24-h Recall and FFQ Data. *J Nutr*, *151*(12 Suppl 2), 143S-151S. https://doi.org/10.1093/jn/nxab202

Chea, M., & Mobley, A. R. (2019). Factors Associated with Identification and Consumption of Whole-Grain Foods in a Low-Income Population. *Current developments in nutrition*, *3*(7), nzz064-nzz064. https://doi.org/10.1093/cdn/nzz064

Chiuve, S. E., Fung, T. T., Rimm, E. B., Hu, F. B., McCullough, M. L., Wang, M., Stampfer, M. J., & Willett, W. C. (2012). Alternative dietary indices both strongly predict risk of chronic disease. *J Nutr*, *142*(6), 1009-1018. https://doi.org/10.3945/jn.111.157222

Colby, S., Zhou, W., Allison, C., Mathews, A. E., Olfert, M. D., Morrell, J. S., Byrd-Bredbenner, C., Greene, G., Brown, O., Kattelmann, K., & Shelnutt, K. (2020). Development and Validation of the Short Healthy Eating Index Survey with a

College Population to Assess Dietary Quality and Intake. *Nutrients*, *12*(9). https://doi.org/10.3390/nu12092611

Contento, I. R. (2011). Overview of Determinants of Food Choice and Dietary Change: Implications for Nutrition Education. In *Nutrition Education: Linking Research, Theory, and Practice* (2nd ed., pp. 26-42). Jones & Bartlett Learning LLC.

D'Angelo, C., Gloinson, E. R., Draper, A. K., & Guthrie, S. (2020). Food consumption in the UK: Trends, attitudes and drivers.

Darmon, N., & Drewnowski, A. (2008). Does social class predict diet quality? *Am J Clin Nutr*, *87*(5), 1107-1117. https://doi.org/10.1093/ajcn/87.5.1107

Deliens, T., Clarys, P., De Bourdeaudhuij, I., & Deforche, B. (2014). Determinants of eating behaviour in university students: a qualitative study using focus group discussions. *BMC Public Health*, *14*(1), 53-53. https://doi.org/10.1186/1471-2458-14-53

Dinger, M. K., & Waigandt, A. (1997). Dietary intake and physical activity behaviors of male and female college students. *Am J Health Promot*, *11*(5), 360-362. https://doi.org/10.4278/0890-1171-11.5.360

Downes, L. (2015). Physical Activity and Dietary Habits of College Students. *Journal for nurse practitioners*, *11*(2), 192-198.e192. https://doi.org/10.1016/j.nurpra.2014.11.015

El Ansari, W., Stock, C., & Mikolajczyk, R. T. (2012). Relationships between food consumption and living arrangements among university students in four European countries - a cross-sectional study. *Nutrition journal*, *11*(1), 28-28. https://doi.org/10.1186/1475-2891-11-28

El Hajj, J. S., & Julien, S. G. (2021). Factors Associated with Adherence to the Mediterranean Diet and Dietary Habits among University Students in Lebanon. *Journal of Nutrition and Metabolism*, *2021*, 6688462. https://doi.org/10.1155/2021/6688462

FAO and FHI 360. (2016). Minimum Dietary Diversity for Women: A Guide for Measurement. https://www.fao.org/3/i5486e/i5486e.pdf

FAO. (2007). Lebanese Republic Nutrition Profile https://www.fao.org/3/aq041e/aq041e.pdf

Farhat, A. G., Jaalouk, D., & Francis, S. (2016). Adherence to the Mediterranean diet in a Lebanese sample. *Nutrition & Food Science*, *46*(2), 272-281. https://doi.org/10.1108/NFS-09-2015-0108

Fernandes, M. P., Bielemann, R. M., & Fassa, A. G. (2018). Factors associated with the quality of the diet of residents of a rural area in Southern Brazil. *Revista de*

saúde pública, *52*(suppl 1), 6s-6s. https://doi.org/10.11606/S1518-8787.2018052000267

Food and Agriculture Organization of the United Nations. (2021a). *Minimum Dietary Diversity for Women*. https://doi.org/https://doi.org/10.4060/cb3434en

Food and Agriculture Organization of the United Nations. (2021b). *Minimum Dietary Diversity for Women*. https://www.fao.org/3/cb3434en/cb3434en.pdf

French, S. A., Jeffery, R. W., Story, M., Breitlow, K. K., Baxter, J. S., Hannan, P., & Snyder, M. P. (2001). Pricing and promotion effects on low-fat vending snack purchases: the CHIPS Study. *Am J Public Health*, *91*(1), 112-117. https://doi.org/10.2105/ajph.91.1.112

French, S. A., Story, M., Jeffery, R. W., Snyder, P., Eisenberg, M., Sidebottom, A., & Murray, D. (1997). Pricing strategy to promote fruit and vegetable purchase in high school cafeterias. *J Am Diet Assoc*, *97*(9), 1008-1010. https://doi.org/10.1016/s0002-8223(97)00242-3

Fung, T. T., Li, Y., Bhupathiraju, S. N., Bromage, S., Batis, C., Holmes, M. D., Stampfer, M., Hu, F. B., Deitchler, M., & Willett, W. C. (2021). Higher Global Diet Quality Score Is Inversely Associated with Risk of Type 2 Diabetes in US Women. *The Journal of nutrition*, *151*(Supplement_2), 168S-175S. https://doi.org/10.1093/jn/nxab195

Fung, T. T., Li, Y., Bromage, S., Bhupathiraju, S. N., Batis, C., Fawzi, W., Holmes, M. D., Stampfer, M., Hu, F. B., Deitchler, M., & Willett, W. C. (2021). Higher Global Diet Quality Score Is Associated with Less 4-Year Weight Gain in US Women. *The Journal of nutrition*, *151*(Supplement_2), 162S-167S. https://doi.org/10.1093/jn/nxab170

Gadiraju, T. V., Patel, Y., Gaziano, J. M., & Djoussé, L. (2015). Fried Food Consumption and Cardiovascular Health: A Review of Current Evidence. *Nutrients*, *7*(10), 8424-8430. https://doi.org/10.3390/nu7105404

He, Y., Fang, Y., Bromage, S., Fung, T. T., Bhupathiraju, S. N., Batis, C., Deitchler, M., Fawzi, W., Stampfer, M. J., Hu, F. B., Willett, W. C., & Li, Y. (2021). Application of the Global Diet Quality Score in Chinese Adults to Evaluate the Double Burden of Nutrient Inadequacy and Metabolic Syndrome. *The Journal of nutrition*, *151*(Supplement_2), 93S-100S. https://doi.org/10.1093/jn/nxab162

Herforth, A. W., Wiesmann, D., Martínez-Steele, E., Andrade, G., & Monteiro, C. A. (2020). Introducing a Suite of Low-Burden Diet Quality Indicators That Reflect Healthy Diet Patterns at Population Level. *Current developments in nutrition*, *4*(12), nzaa168-nzaa168. https://doi.org/10.1093/cdn/nzaa168

Hu, E. A., Toledo, E., Diez-Espino, J., Estruch, R., Corella, D., Salas-Salvado, J., Vinyoles, E., Gomez-Gracia, E., Aros, F., Fiol, M., Lapetra, J., Serra-Majem, L.,

Pintó, X., Portillo, M. P., Lamuela-Raventos, R. M., Ros, E., Sorli, J. V., & Martinez-Gonzalez, M. A. (2013). Lifestyles and risk factors associated with adherence to the Mediterranean diet: a baseline assessment of the PREDIMED trial. *PloS one*, *8*(4), e60166. https://doi.org/10.1371/journal.pone.0060166

INDDEX Project. (2018). *Data4Diets: Building Blocks for Diet-related Food Security Analysis.* Tufts University, Boston, MA. https://inddex.nutrition.tufts.edu/data4diets.

Intake Center for Dietary Assessment. (2021). *The Global Diet Quality Score: Data Collection Options and Tabulation Guidelines*.

Jahns, L., McDonald, L., Wadsworth, A., Morin, C., Liu, Y., & Nicklas, T. (2015). Barriers and facilitators to following the Dietary Guidelines for Americans reported by rural, Northern Plains American-Indian children. *Public health nutrition*, *18*(3), 482-489. https://doi.org/10.1017/S136898001400041X

Juan, J., & Yang, H. (2021). Early life 1000 days: opportunities for preventing adult diseases. *Chinese medical journal*, *135*(5), 516-518. https://doi.org/10.1097/CM9.0000000000001920

Kabir, A., Miah, S., & Islam, A. (2018). Factors influencing eating behavior and dietary intake among resident students in a public university in Bangladesh: A qualitative study. *PloS one*, *13*(6), e0198801-e0198801. https://doi.org/10.1371/journal.pone.0198801

Karam, J., Bibiloni, M. D. M., Serhan, M., & Tur, J. A. (2021). Adherence to Mediterranean Diet among Lebanese University Students. *Nutrients*, *13*(4). https://doi.org/10.3390/nu13041264

Kirkpatrick, S. I., Reedy, J., Krebs-Smith, S. M., Pannucci, T. E., Subar, A. F., Wilson, M. M., Lerman, J. L., & Tooze, J. A. (2018). Applications of the Healthy Eating Index for Surveillance, Epidemiology, and Intervention Research: Considerations and Caveats. *Journal of the Academy of Nutrition and Dietetics*, *118*(9), 1603-1621. https://doi.org/10.1016/j.jand.2018.05.020

Kweon, S., Park, J. Y., Park, M., Kim, Y., Yeon, S. Y., Yoon, L., Yun, S., Park, S., Yang, J. E., Kim, Y., Park, O., & Oh, K. (2021). Trends in food and nutrient intake over 20 years: findings from the 1998-2018 Korea National Health and Nutrition Examination Survey. *Epidemiology and health*, *43*, e2021027-e2021027. https://doi.org/10.4178/epih.e2021027

La Foucade, A., Gabriel, S., Beharry, V., Laptiste, C., Metivier, C., Samuels, T. A., Theodore, K., & Edwards-Wescott, P. (2022). Assessing the determinants of unhealthy dietary habits among a sample of survey participants in Jamaica. *Revista panamericana de salud pública*, *46*(72), e72-e72. https://doi.org/10.26633/RPSP.2022.72

Lebanese Republic Ministry of Social Affairs and the Central Administration for Statistics and the United Nations Development Programme. (2004). *Living Conditions of Households—The National Survey of Household Living Conditions.*

Lim, H., Lee, H. J., Choue, R., & Wang, Y. (2018). Trends in Fast-Food and Sugar-Sweetened Beverage Consumption and Their Association with Social Environmental Status in South Korea. *Journal of the Academy of Nutrition and Dietetics*, *118*(7), 1228-1236.e1221. https://doi.org/10.1016/j.jand.2017.08.001

Marquis, M. (2005). Exploring convenience orientation as a food motivation for college students living in residence halls. *International journal of consumer studies*, *29*(1), 55-63. https://doi.org/10.1111/j.1470-6431.2005.00375.x

Martin, J. C., Moran, L. J., Teede, H. J., Ranasinha, S., Lombard, C. B., & Harrison, C. L. (2017). Exploring Diet Quality between Urban and Rural Dwelling Women of Reproductive Age. *Nutrients*, *9*(6), 586. https://doi.org/10.3390/nu9060586

Matsuzaki, M., Birk, N., Bromage, S., Bowen, L., Batis, C., Fung, T. T., Li, Y., Stampfer, M. J., Deitchler, M., Willett, W. C., Fawzi, W. W., Kinra, S., & Bhupathiraju, S. N. (2021). Validation of Global Diet Quality Score Among Nonpregnant Women of Reproductive Age in India: Findings from the Andhra Pradesh Children and Parents Study (APCAPS) and the Indian Migration Study (IMS). *The Journal of nutrition*, *151*(12 Suppl 2), 101S-109S. https://doi.org/10.1093/jn/nxab217

McCullough, M. L., & Willett, W. C. (2006). Evaluating adherence to recommended diets in adults: the Alternate Healthy Eating Index. *Public health nutrition*, *9*(1A), 152-157. https://doi.org/10.1079/PHN2005938

McGinnis, J. M., Gootman, J. A., Kraak, V. I., Institute of Medicine Committee on Food, M., the Diets of, C., Youth, Food, Nutrition, B., Committee on Food, M., the Diets of, C., Youth, Board on Children, Y., Families, & Institute of, M. (2006). *Food marketing to children and youth: threat or opportunity?* National Academies Press. https://doi.org/10.17226/11514

Melki, I. S., Beydoun, H. A., Khogali, M., Tamim, H., & Yunis, K. A. (2004). Household crowding index: a correlate of socioeconomic status and inter-pregnancy spacing in an urban setting. *J Epidemiol Community Health*, *58*(6), 476-480. https://doi.org/10.1136/jech.2003.012690

Meynier, A., Chanson-Rollé, A., & Riou, E. (2020). Main Factors Influencing Whole Grain Consumption in Children and Adults-A Narrative Review. *Nutrients*, *12*(8), 2217. https://doi.org/10.3390/nu12082217

Miller, V., Webb, P., Micha, R., Mozaffarian, D., & Global Dietary, D. (2020). Defining diet quality: a synthesis of dietary quality metrics and their validity for

the double burden of malnutrition. *The Lancet. Planetary health*, *4*(8), e352-e370. https://doi.org/10.1016/S2542-5196(20)30162-5

Moshfegh, A. J., Rhodes, D. G., Baer, D. J., Murayi, T., Clemens, J. C., Rumpler, W. V., Paul, D. R., Sebastian, R. S., Kuczynski, K. J., Ingwersen, L. A., Staples, R. C., & Cleveland, L. E. (2008). US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *The American journal of clinical nutrition*, *88*(2), 324-332. https://doi.org/10.1093/ajcn/88.2.324

Moursi, M., Bromage, S., Fung, T. T., Isanaka, S., Matsuzaki, M., Batis, C., Castellanos-Gutiérrez, A., Angulo, E., Birk, N., Bhupathiraju, S. N., He, Y., Li, Y., Fawzi, W., Danielyan, A., Thapa, S., Ndiyoi, L., Vossenaar, M., Bellows, A., Arsenault, J. E., . . . Deitchler, M. (2021). There's an App for That: Development of an Application to Operationalize the Global Diet Quality Score. *The Journal of nutrition*, *151*(Supplement_2), 176S-184S. https://doi.org/10.1093/jn/nxab196

Mozaffarian, D. (2017). Foods, obesity, and diabetes-are all calories created equal? *Nutrition Reviews*, *75*(suppl 1), 19-31. https://doi.org/10.1093/nutrit/nuw024

Naja, F., Hwalla, N., El Zouhbi, A., Abbas, N., Chamieh, M. C., Nasreddine, L., & Jomaa, L. (2020). Changes in Environmental Footprints Associated with Dietary Intake of Lebanese Adolescents between the Years 1997 and 2009. *Sustainability (Basel, Switzerland)*, *12*(11), 4519. https://doi.org/10.3390/su12114519

Naja, F., Hwalla, N., Itani, L., Salem, M., Azar, S. T., Zeidan, M. N., & Nasreddine, L. (2012). Dietary patterns and odds of Type 2 diabetes in Beirut, Lebanon: a case-control study. *Nutr Metab (Lond)*, *9*(1), 111. https://doi.org/10.1186/1743-7075-9-111

Naja, F., Itani, L., Hwalla, N., Sibai, A. M., & Kharroubi, S. A. (2019). Identification of dietary patterns associated with elevated blood pressure among Lebanese men: A comparison of principal component analysis with reduced rank regression and partial least square methods. *PloS one*, *14*(8), e0220942-e0220942. https://doi.org/10.1371/journal.pone.0220942

Naja, F., Nasreddine, L., Itani, L., Chamieh, M. C., Adra, N., Sibai, A. M., & Hwalla, N. (2011). Dietary patterns and their association with obesity and sociodemographic factors in a national sample of Lebanese adults. *Public health nutrition*, *14*(9), 1570-1578. https://doi.org/10.1017/S136898001100070X

Naja, F., Nasreddine, L., Itani, L., Chamieh, M. C., Adra, N., Sibai, A. M., & Hwalla, N. (2011). Dietary patterns and their association with obesity and sociodemographic factors in a national sample of Lebanese adults. *Public Health Nutr*, *14*(9), 1570-1578. https://doi.org/10.1017/s136898001100070x

Nasreddine, L., Ayoub, J. J., & Al Jawaldeh, A. (2018). Review of the nutrition situation in the Eastern Mediterranean Region. *East Mediterr Health J*, *24*(1), 77-91.

Nasreddine, L., Ayoub, J. J., Hachem, F., Tabbara, J., Sibai, A. M., Hwalla, N., & Naja, F. (2019). Differences in Dietary Intakes among Lebanese Adults over a Decade: Results from Two National Surveys 1997-2008/2009. *Nutrients*, *11*(8), 1738. https://doi.org/10.3390/nu11081738

Nasreddine, L., Chamieh, M. C., Ayoub, J., Hwalla, N., Sibai, A.-M., & Naja, F. (2020). Sex disparities in dietary intake across the lifespan: the case of Lebanon. *Nutrition journal*, *19*(1), 24-24. https://doi.org/10.1186/s12937-020-00543-x

Nasreddine, L., Naja, F., Tabet, M., Habbal, M.-Z., El-Aily, A., Haikal, C., Sidani, S., Adra, N., & Hwalla, N. (2012). Obesity is associated with insulin resistance and components of the metabolic syndrome in Lebanese adolescents. *Annals of human biology*, *39*(2), 122-128. https://doi.org/10.3109/03014460.2012.655776

Nnanyelugo, D. O., & Okeke, E. C. (1987). Food habits and nutrient intakes of Nigerian University students in traditional halls of residence. *Journal of the American College of Nutrition*, *6*(5), 369-374. https://doi.org/10.1080/07315724.1987.10720201

Onvani, S., Haghighatdoost, F., Surkan, P. J., Larijani, B., & Azadbakht, L. (2017). Adherence to the Healthy Eating Index and Alternative Healthy Eating Index dietary patterns and mortality from all causes, cardiovascular disease and cancer: a meta-analysis of observational studies. *Journal of human nutrition and dietetics*, *30*(2), 216-226. https://doi.org/10.1111/jhn.12415

Papadaki, A., Hondros, G., A. Scott, J., & Kapsokefalou, M. (2007). Eating habits of University students living at, or away from home in Greece. *Appetite*, *49*(1), 169-176. https://doi.org/10.1016/j.appet.2007.01.008

Park, S.-Y., Boushey, C. J., Wilkens, L. R., Haiman, C. A., & Le Marchand, L. (2017). High-quality Diets Associate With Reduced Risk of Colorectal Cancer: Analyses of Diet Quality Indexes in the Multiethnic Cohort. *Gastroenterology (New York, N.Y. 1943)*, *153*(2), 386-394.e382. https://doi.org/10.1053/j.gastro.2017.04.004

Popkin, B. M. (2001). The nutrition transition and obesity in the developing world. *The Journal of nutrition*, *131*(3), 871S-873S. https://doi.org/10.1093/jn/131.3.871S

Ramón-Arbués, E., Granada-López, J.-M., Martínez-Abadía, B., Echániz-Serrano, E., Antón-Solanas, I., & Jerue, B. A. (2021). Factors Related to Diet Quality: A Cross-Sectional Study of 1055 University Students. *Nutrients*, *13*(10), 3512. https://doi.org/10.3390/nu13103512

Ramón-Arbués, E., Granada-López, J. M., Martínez-Abadía, B., Echániz-Serrano, E., Antón-Solanas, I., & Jerue, B. A. (2021). Factors Related to Diet Quality: A Cross-Sectional Study of 1055 University Students. *Nutrients*, *13*(10). https://doi.org/10.3390/nu13103512

Rinaldi, A. E. M., de Oliveira, E. P., Moreto, F., Gabriel, G. F. C. P., Corrente, J. E., & Burini, R. C. (2012). Dietary intake and blood lipid profile in overweight and obese schoolchildren. *BMC research notes*, *5*(1), 598-598. https://doi.org/10.1186/1756-0500-5-598

Schwingshackl, L., Bogensberger, B., & Hoffmann, G. (2018). Diet Quality as Assessed by the Healthy Eating Index, Alternate Healthy Eating Index, Dietary Approaches to Stop Hypertension Score, and Health Outcomes: An Updated Systematic Review and Meta-Analysis of Cohort Studies. *Journal of the Academy of Nutrition and Dietetics*, *118*(1), 74-100.e111. https://doi.org/10.1016/j.jand.2017.08.024

Sogari, G., Velez-Argumedo, C., Gómez, M. I., & Mora, C. (2018). College Students and Eating Habits: A Study Using An Ecological Model for Healthy Behavior. *Nutrients*, *10*(12). https://doi.org/10.3390/nu10121823

Springfield, S., Cunanan, K., Heaney, C., Peng, K., & Gardner, C. (2020). The WELL diet score correlates with the alternative healthy eating index-2010. *Food science & nutrition*, *8*(6), 2710-2718. https://doi.org/10.1002/fsn3.1558

Steinfeldt, L., Anand, J., & Murayi, T. (2013). Food Reporting Patterns in the USDA Automated Multiple-Pass Method. *Procedia food science*, *2*, 145-156. https://doi.org/10.1016/j.profoo.2013.04.022

Täger, M., Peltner, J., Thiele, S. (2016). Evaluation of diet quality by means of the Healthy Eating Index and its modified variants. *Ernaehrungs Umschau*, 110-118. https://doi.org/10.4455/eu.2016.023

Tan, M. S., Cheung, H. C., McAuley, E., Ross, L. J., & MacLaughlin, H. L. (2022). Quality and validity of diet quality indices for use in Australian contexts: a systematic review. *British journal of nutrition*, *128*(10), 2021-2045. https://doi.org/10.1017/S0007114521004943

United Nations International Children's Emergency Fund (2022). *Nutrition in Times of Crisis*. https://www.unicef.org/mena/reports/nutrition-in-times-of-crisis

United States Department of Agriculture. (2018). How the HEI is Scored. https://www.fns.usda.gov/how-hei-scored

United States Department of Agriculture. (2020). Healthy Eating Index. https://www.fns.usda.gov/healthy-eating-index-hei

Varraso, R., Chiuve, S. E., Fung, T. T., Barr, R. G., Hu, F. B., Willett, W. C., & Camargo, C. A. (2015). Alternate Healthy Eating Index 2010 and risk of chronic obstructive pulmonary disease among US women and men: prospective study. *BMJ (Online)*, *350*(feb03 7), h286-h286. https://doi.org/10.1136/bmj.h286

Vera, V., Oñate, G., Fernández, M., Valladares, M., Crovetto, M., Espinoza, V., Mena, F., & Agüero, S. D. (2021). Tobacco consumption in Chilean university students and associations with anthropometry, eating habits and sleep quality multicentric study. *Journal of preventive medicine and hygiene*, *62*(2), E430-E438. https://doi.org/10.15167/2421-4248/jpmh2021.62.2.1868

Waijers, P. M. C. M., Feskens, E. J. M., & Ocké, M. C. (2007). A critical review of predefined diet quality scores. *British journal of nutrition*, *97*(2), 219-231. https://doi.org/10.1017/S0007114507250421

World Health Organization. *Noncommunicable Disease Surveillance, Monitoring and Reporting*. https://www.who.int/teams/noncommunicable-diseases/surveillance/systems-tools/steps/planning-sampling

World Health Organization. (2010). *A healthy lifestyle - WHO recommendations*. https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations

World Health Organization. (2011). *Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity* https://apps.who.int/iris/bitstream/handle/10665/85839/WHO_NMH_NHD_MNM_11.1_eng.pdf

World Health Organization. (2017a). *Prevalence of obesity among adults, BMI >= 30 (age-standardized estimate) (%)*. https://www.who.int/data/gho/data/indicators/indicator-details/GHO/prevalence-of-obesity-among-adults-bmi-=-30-(age-standardized-estimate)-(-)

World Health Organization. (2017b). WHO STEPwise Approach for Non-communicable diseases Risk Factor Surveillance Lebanon, 2016-2017. https://cdn.who.int/media/docs/default-source/ncds/ncd-surveillance/data-reporting/lebanon/steps/lebanon-steps-report-2016-2017.pdf?sfvrsn=b67a627f_3&download=true

World Health Organization. (2018). Noncommunicable diseases country profiles 2018. https://apps.who.int/iris/handle/10665/274512

Yahia, N., Achkar, A., Abdallah, A., & Rizk, S. (2008). Eating habits and obesity among Lebanese university students. *Nutr J*, *7*, 32. https://doi.org/10.1186/1475-2891-7-32

Yun, T. C., Ahmad, S. R., & Quee, D. K. S. (2018). Dietary Habits and Lifestyle Practices among University Students in Universiti Brunei Darussalam. *Malays J Med Sci*, *25*(3), 56-66. https://doi.org/10.21315/mjms2018.25.3.6