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DIETARY CHANGES OVER TIME IN LEBANESE URBAN ADULTS AND THEIR ASSOCIATION WITH ANTHROPOMETRIC AND CARDIOMETABOLIC CHARACTERISTICS

by
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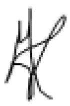

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ABSTRACT

OF THE THESIS OF

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Title: Dietary Changes Over Time in Lebanese Urban Adults and their Association with Anthropometric and Cardiometabolic Characteristics

Background and objectives: The etiology of obesity is complex and multifactorial in nature, where both genetic and environmental factors come to play. While the majority of available studies have evaluated current behaviors in relation to body weight, longitudinal changes in lifestyle may in fact be more relevant in terms of their impact on weight gain and their translation into preventive strategies. It is in this context that we have conducted this study, with the aim of investigating longitudinal changes in food consumption patterns in a sample of Lebanese urban adults and examining their association with changes in anthropometric characteristics and cardiometabolic risk factors.

Methods: This is a longitudinal study of Lebanese adults aged ≥18 years residing in the Greater Beirut Area. The baseline survey was conducted in 2014 while the follow-up in 2019. The baseline sample n=501 was composed of 179 males (35.7%) and 322 females (64.3%) with a mean age of 45.4 ± 15.1, compared to the follow up sample which consisted of 186 subjects, with 59 males (31.6%) and 127 females (67.9%) and a mean age of 52.4 ± 13.0 SD. In both the original as well as the follow-up component, anthropometric measurements were obtained using standardized techniques and biochemical analyses were performed. Dietary intake was assessed using a culture-specific, semi-quantitative food frequency questionnaire. Intakes of energy and macronutrients were assessed using the Nutritionist Pro software, and food groups' intakes were evaluated as g/day, % kcal and servings/day. The quality of the overall diet was assessed using the Healthy Eating Index (HEI).

Results: The 5 year follow up revealed a 2.6cm (0.52cm/year) increase in waist circumference and a 0.9% decrease in percent body fat, while the change in body weight was not significant (0.9kg during the study period; 0.18kg/year) Fasting blood glucose, SBP and DBP have significantly increased over time in the study population with a mean change (5^{th}, 95^{th} percentile) of 8.5 (-21, 59.4), 2.5 (-28.3, 41.7) and 2.4 (-15.5, 22.5) respectively. Macronutrient composition of the diet changed significantly, whereby total fat intake decreased by 2.4% EI, while carbohydrate intake increased by 2.3% EI. Other significant changes in dietary intakes were for fresh/dried fruits and whole grains, the consumption of which has increased by approximately one serving/day for each. On the other hand, a significant decrease in the consumption of fats and oils, sugar sweetened beverages, processed meat, and refined grains (-1.6, -0.2, -0.1 and -1.9 servings/day, respectively) was observed. Multivariate regression models showed an association between dairy products and changes in WC, whereby each increase in one serving of low fat dairy products decreased WC by 1.5 cm, while each increase in one serving of full-fat dairy products increased WC by 1.4-1.6 cm respectively. In addition, each increase in one serving of 100% fruit juices was associated with a 1.1% decrease in percent body fat. The results showed that HEI score increased significantly with a mean (5^{th}, 95^{th} percentile) of 2.4(-14, 19.6) over the study period. Each increment increase in HEI was significantly associated with a 0.3 decrease in SBP.

Conclusion: The present study is amongst the first in the Middle-East to assess changes in dietary intakes and quality over time, and investigate their association with anthropometry and cardiometabolic risk factors. It documented significant changes in macronutrient composition, food groups' intake and overall diet quality, and showed an association between changes in diet and long-term changes in waist circumference, body fat and blood pressure, thus highlighting specific dietary changes that might be prioritized in obesity-prevention strategies. Further studies should be done to better understand the predictors of dietary changes in the Lebanese population, in order to formulate appropriate preventive strategies.

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CHAPTER I

INTRODUCTION

Obesity has become a global epidemic, causing a substantial economic burden in both developed and developing countries (Tremmel et al., 2017). Similar to other parts of the world, the MENA region has also witnessed alarming increases in the burden of obesity, a trend that may be linked to the rapid urbanization in countries of the region and the concurrent changes in lifestyle and dietary habits (Papandreou et al., 2008). This is of concern given that obesity is associated with an increased risk of cardiometabolic abnormalities and serval chronic diseases, including Type 2 Diabetes (T2D), Cardiovascular diseases (CVD), and certain types of cancer (Fruh et al., 2017).

The etiology of obesity is complex and multifactorial in nature, where both genetic and environmental factors come to play (Hruby et al., 2016). The genetic component of obesity is now better understood, and various studies targeting twin and adopted family members, have estimated the contribution of genetics towards obesity as much as 50-80% (Hinney et al., 2010). The role of environmental, dietary and lifestyle factors in fueling the obesity epidemic is also being increasingly acknowledged, especially that such factors are considered modifiable, and hence can be used as tools to reduce the burden of obesity. According to Poveda et al., the predictive accuracy of lifestyle risk factors was similar to that yielded by genetic information for obesity (AUC 68% and 73%, respectively), which increased significantly when both factors were combined, yielding an AUC of 79% (Poveda et al., 2015).

Despite the large number of studies investigating food consumption patterns and obesity risk, there remains an ongoing debate about the robustness of existing evidence (Hruby et al., 2016).   Many of the available studies have focused on single nutrients or food groups as a risk factor for obesity and cardiometabolic abnormalities, an approach that does not take into consideration the potential interactions or synergies that may exist between various nutrients or food groups constitutive of the diet (Liese et al., 2015). Different lifestyle behaviors have also been evaluated separately, thus limiting the comparisons and assessment of the magnitude of the combined effects. In addition, most studies of long-term weight gain have evaluated current behaviors; however the changes that may occur over time may be more relevant in terms in identifying their effects on anthropometry and cardiometabolic risk factors (Mozaffarian et al., 2011). Dietary assessment tools used to evaluate the overall quality of the diet through scoring food groups intakes based on specific dietary guidelines, are proposed as alternatives to the evaluation of single food groups or nutrient intakes in relation to obesity (Wirt et al., 2009). The Healthy eating Index is an example of such dietary scores that have proved to be useful in assessing dietary quality and identifying potential associations with adiposity and cardiometabolic risk factors, although conflicting findings have been reported (George et al., 2014 , Kord-Varkaneh et al., 2020).

An additional layer of complexity in the investigation of diet as a risk for obesity is the fact that weight gain occurs in a gradual manner over time (around 1 lb per year), which makes it difficult for most people, as well as for researchers, to identify the specific causes (Mozaffarian et al., 2011). While the majority of available studies have evaluated current behaviors in relation to body weight, longitudinal changes in lifestyle may in fact be more relevant in terms of their impact on weight gain and their translation into preventive strategies (Mozaffarian et al., 2011). Changes in food consumption and dietary patterns may in fact occur throughout the lifetime, as changes in age, health perceptions and socio-economic factors may influences ones' dietary and lifestyle habits (Drewnowski et al., 2001), which in turn can have an impact on weight status. There is scarcity of evidence on changes or stability of the diet over time, and whether such changes are associated with weight status on the long-term. Mozaffarian et al (2011) have conducted a prospective investigation based on 3 separate cohorts that encompassed 120,877 healthy adult women and men from the US. The associations between changes in diet and lifestyle factors on one hand and changes in body weight on the other, have been examined at 4-year intervals, with multivariable adjustments made for age, baseline BMI for each period, and all lifestyle factors simultaneously. The results showed that 4-year weight change was significantly and positively associated with the intake of potatoes, potato chips, sugar-sweetened beverages, unprocessed and processed red meats, while an inverse association was observed for the intake of vegetables, whole grains, fruits, nuts and yogurt. The study called for more investigations examining longitudinal changes in diet and lifestyle factors as a risk factor for obesity in various populations and age groups (Mozaffarian et al., 2011).

It is in this context that we have conducted this study, with the aim of investigating longitudinal changes in food consumption patterns in a sample of Lebanese urban adults and examining their association with anthropometric changes and cardiometabolic risk factors. The investigation of dietary changes over time was based not only on the evaluation of macronutrients and food groups' intakes, but also on examining the overall quality of the diet, using specific dietary scores. The study builds on data stemming from the Greater Beirut Area Cardiovascular cohort (GBACC), which was conducted on a representative sample of Lebanese adults aged ≥18 years residing in the Greater Beirut area. Baseline data collection was conducted in 2014 and the follow-up assessment was conducted in 2019, using the same standardized data collection protocol. The specific objectives of the present study are first to investigate changes, over a five year period, in food consumption patterns, in terms of energy, macronutrients, food groups intakes, and in dietary quality expressed as healthy eating index (HEI). Second, assess longitudinal changes in anthropometric measures (BMI, waist circumference and percent body fat) and cardiometabolic risk factors (lipid profile, glycaemia and hypertension). Third, examine the association between changes in macronutrient intakes, food groups' intakes, HEI scores and anthropometric characteristics. Finally, investigate the association of the magnitude of change in HEI scores with changes in cardiometabolic risk factors.

CHAPTER II

LITTERATURE REVIEW

A. Obesity overview

Obesity has become a global epidemic with an alarming worldwide increase, nearly tripling since 1975 (World Health Organization .,2016). In the United States of America, approximately 300,000 yearly deaths are associated with obesity, which is second to smoking as a leading cause of preventable death (Kushner., 2002). Excessive weight gain, which leads to numerous non-communicable diseases (NCDs), has been itself classified as a non-communicable disease, causing a substantial economic burden in both developed and developing countries (Tremmel et al., 2017).

Weight gain is a multifactorial process that leads to an increase in fat mass, which in turn affects many metabolic processes and results in the manifestation of chronic diseases such as: Type 2 Diabetes (T2D), Cardiovascular diseases (CVD), Dyslipidemia (DL) and certain types of cancer (Fruh ., 2017). Obesity is the result of an imbalance between energy intake and energy expenditure in addition to an underlying genetic predisposition. The genetic component of obesity is now better understood, and its contribution to obesity-related phenotypes was estimated to range from 30 to 70 percent (Comuzzie et al., 1993, 1994, 1996). Although genetic factors have been shown to contribute to the etiology of obesity, the role of environmental factors in fueling the obesity epidemic is well-established, especially that such factors can be controlled and used as a tool to reduce the prevalence of obesity. According to Poveda et al., the predictive accuracy of lifestyle risk factors was similar to that yielded by genetic information for obesity (AUC 68% and 73%, respectively), which increased significantly when both factors were combined, yielding an AUC of 79% (Poveda et al., 2016). Changes in food consumption patterns, such as the increased consumption of added sugars and saturated fatty acids, in addition to the decrease in physical activity have been associated with the increased prevalence of obesity (Maier et al., 2015). Comprehensive lifestyle modifications that focus on changing dietary quality and increasing physical activity have been considered to be the first line of defense in treating obesity (Wadden et al., 2007).

B. Prevalence of obesity

The prevalence of obesity has been on the rise for the last 50 years; and according to recent estimates, the numbers of those who are obese are two-fold higher than those who are normal weight (Ogden et al., 2014). According to the World Health Organization (WHO), estimates of 1.9 billion adults aged above 18 years were overweight in 2016, of whom over 650 million were obese (World Health Organization ., 2016).

It is important to note that the prevalence of obesity may differ between countries, given that this condition results from a complex interplay between sociodemographic, behavioral and cultural factors (Endalifer et al., 2020). Similar to other parts of the world, the MENA region has also witnessed alarming increases in the burden of obesity, a trend that may be linked to the rapid urbanization in countries of the region and the concurrent changes in lifestyle and dietary habits (Papandreou et al., 2008). According to Al Nohair, the 2010 prevalence of overweight and obesity(as percentages) in Middle Eastern countries for men and women respectively were as follows: Kuwait (36;48), KSA (28;44), UAE (25;42), Bahrain (21;38), Qatar (19;32) and Lebanon (15;27) (Al Nohair ., 2014).

C. Assessment of Obesity

Obesity is defined by the World Health Organization as excessive fat accumulation that may hinder the quality of life and result in many health complications (World Health Organization ., 2000). Assessment of obesity can be done by several methods, and each method is characterized by its own set of advantages and disadvantages. The method chosen should depend on the scope, availability and the clinical setting. Anthropometric measurements, which rely on the assessment of body weight and body dimensions, are widely used in large epidemiological studies, because they provide a rapid and cheap method of assessment.

1. Body Mass Index

Body mass index has been used traditionally as a simple method to classify individuals who are most likely to be overweight or obese (Nutall ., 2015). The Body Mass Index value is calculated by dividing the weight (in kilograms) by the height (in meters) squared. BMI categories and cut-offs (found in table 1) serve as a guide for subject assessment and patient management. However, the Body Mass Index has a drawback because it does not differentiate between fat mass and lean body mass and may thus result in the misclassification of certain individuals, such as athletes (Ghosh et al., 2021). In a study done by Mullie et al., among a cohort of 448 male military candidates, and where classification of obesity was based on percent body fat measured by bipolar bioelectrical impedance analysis or on BMI, a statistically significant difference between classifications of normal weight versus overweight was recorded (Mullie et al., 2008).

Table 1: *BMI chart with obesity classifications adopted from the WHO 1998 report*.

WHO Classification of Weight Status based on BMI	
Weight Status	Body Mass Index Kg/m^2
Underweight	<18.5
Normal Range	18.5 - 24.9
Overweight	25.0 - 29.9
Obese	≥30
Class I	30.0 - 34.9
Class II	35.0 – 39.9
Class III	≥40

Contributed by the World Health Organization - "Report of a WHO consultation on obesity. Obesity Preventing and Managing a Global Epidemic."

2. Waist Circumference

In 1956, the importance of fat distribution and its correlation with various diseases was first describes by Jean Vague, who also differentiated between android and gynoid types of fat distribution (Ross et al.,2020). Waist circumference is an indirect measure of intra-abdominal adiposity and studies have shown that an increase in Waist Circumference (WC) is correlated with an increased risk of cardiometabolic disease and insulin resistance (Blizzard et al.,2017). The first threshold of Waist Circumference as suggested by Michael Lean and colleagues was ≥88 cm in women and ≥102 cm in men (Lean et al.,1995). More recently, ethnic-specific cutoffs of WC have been proposed, as shown in Table 2. It has been postulated that waist circumference might be increasing across populations beyond what is expected according to BMI (Jansen et al.,2012), and that the phenotype of obesity might be changing over time, reflecting an increase in abdominal adiposity.

According to Jansen et.al, Waist Circumference increased by 1.1cm for men and 4.9cm form women for a given Body Mass Index in 2007 compared to 1981 (Jansen et al.,2012). Elevated waist circumference, which may reflect intra-abdominal fat accumulation, has been recognized as a significant risk factor for NCDs, namely type 2 DB, cardiovascular diseases and certain types of cancer (Jansen et al.,2012).

Table 2: *Ethnic specific cut-off values for the identification of elevated waist circumference*

Country/Ethnic Group	Gender	Waist Circumference
Europids In the USA, the ATP III values (102 cm form males and 88cm for females) are likely to be used for clinical purposes	Male	≥94 cm
	Female	≥80 cm
South Asians	Male	≥90 cm
	Female	≥80 cm
Chinese	Male	≥90 cm
	Female	≥80 cm
Japanese	Male	≥90 cm
	Female	≥80 cm
Ethnic South and Central Americans	Use South-Asian recommendations until more specific data are available	
Sub-Saharan Africans	Use European data until more specific data are available	
Eastern Mediterranean and Middle East (Arab) populations	Use European data until more specific data are available	

(International Diabetes Federation, 2006)

3. Body Fat Percentage

The percentage of body fat is considered as a more accurate measurement to determine obesity because it is a direct measure of the adipose mass (Klein et al.,2004). Several methods have been proposed for the measurement or estimation of body fat. Methods such as underwater weighing, dual energy x-ray absorptiometry (DEXA) and magnetic resonance imaging (MRI) are used to directly measure body fat (Akindele et al.,2016). Although these methods provide accurate estimates, they are unsuitable for epidemiological studies since they require specialized equipment, skilled manpower and they are expensive (Akindele et al.,2016).

Body fat percentage estimated by skinfold thickness is also widely accepted. The skinfold measurements of subcutaneous fat are made to the nearest 0.2 mm, and are at sites such as biceps, triceps, subscapular and suprailiac, and finally used in age- and gender-specific equations (Siri , 1961). Errors using this method might arise from technician skill, type of calipers used and the prediction equations.

Bioelectrical impedance analysis is also commonly used to estimate body composition based on the principal of electrical conductive properties of the body. Estimations of total body water (TBW), fat-free mass (FFM), and fat mass is done by measuring the resistance of the body as a conductor to a very small alternating electrical current (Duren et al.,2008). The possible sources of error in this technique are physical activity, limb length, hydration status, ovulation, blood chemistry and placement of electrodes (Siri , 1961).

D. Health risks and complications associated with obesity

Obesity is associated with a wide range of complications and metabolic changes that affect the overall human physiology. According to Berrington de Gonzalez et al. a significant increase in mortality is associated with obesity, and a decrease of 5-10 years in life expectancy (Berrington de Gonzalez et al.,2011). There is also evidence indicating that all-cause mortality related to CVD, T2D and cancer are significantly increased in obese patients (Berrington de Gonzalez et al., 2011). Obesity is also associated with chronic inflammation which is characterized by increased levels of leptin, interleukin (IL-6), tumor necrosis factor-α (TNF-α), monocyte chemoattractant protein-1 (MCP-1), hypoxia and resistin resulting from adipose cells and (Lafontan , 2005).

1. Insulin Resistance and Diabetes mellitus

Currently there is no controversy that obesity leads to the development of insulin resistance, further leading to T2D. The increase of adipocytes in obese patients, and particularly abdominal adipocytes, which are highly lipolytic, results in increased release of free fatty acids in addition to an impaired secretion of adipokines (increased leptin and resistin, decreased adiponectin etc.) into the circulation (Castro et al.,2015). Currently, two hypotheses explain the relationship between the increase in free fatty acids and the development of insulin resistance: the portal hypothesis and the spillover hypothesis (Castro et al.,2015). The increase in central abdominal fat tissue, leading to an increase in the flux of free fatty acids to the liver through the portal vein is the main point of the portal theory; consequently, hepatic insulin resistance is developed and leads to an increase in hepatic glucose production (Castro et al.,2015). On the other hand, according to the “spillover hypothesis” due to a positive energy state, a decrease in the storage ability of adipose tissue would lead to a spillover of free fatty acids to non-adipose tissues (Castro et al.,2015). Consequently insulin resistance may develop in the designated organs due to the limited ability of fat oxidation and the accumulation of free fatty acids metabolites causing lipotoxicity and apoptosis (Castro et al.,2015).

2. Hypertension

The development of hypertension in obese patients depends on several factors. Vascular and systemic insulin resistance resulting from adipocyte dysfunction and inflammation in obese patients contributes to a dysregulation of the sympathetic nervous system and the renin–angiotensin–aldosterone system (Cabandugama et al.,2018). Structural and functional changes in the kidneys (e.g. activation of intrarenal angiotensin II) are also important factors in the development of the obesity associated hypertension. In addition, the association between the elevation of free-fatty acids and the inhibition of the Na+, K+ ATPase and the sodium pump also leads to the elevation of the vascular smooth muscle tone and resistance (DeMarco et al., 2014).

3. Dyslipidemia

Lipid metabolism abnormalities are very common in patients with obesity. Lipid abnormalities include; elevated serum triglyceride, VLDL, apolipoprotein B, and non-HDL-C levels. The increased production of hepatic VLDL particles and the decrease clearance of triglycerides rich particles lead to an elevation of serum triglycerides (Klop et al., 2013). Chylomicrons and VLDL are responsible for the delivery of Free Fatty Acids (FFA) to the heart, skeletal muscle and adipose tissue for energy expenditure and storage. The release of FFA in the circulation is dependent on the adequate lipolysis of TG-rich particles, which is regulated by several enzymes and proteins acting as co-factors. The primary enzyme responsible for the release of FFA is Lipoprotein lipase (LPL) and is strongly expressed in tissues that require large amounts of FFA like the heart, skeletal muscle and adipose tissue (Goldberg et al., 2009). In obesity, lipolysis of triglyceride rich lipoproteins is suboptimal due to the reduction of mRNA expression levels of LPL in the adipose tissue (Clemente-Postigo et al., 2011). In addition, the increase of chylomicrons and VLDL levels, together with impaired lipolysis, affect HDL metabolism. The increase in TG-rich lipoproteins leads to increased CETP activity, responsible for the exchange of cholesteryl ester from HDL to VLDL and LDL in exchange for triglyceride (Subramanian et al., 2011). The increased lipolysis of these TG-rich HDL leads to the formation of small HDL with a reduced affinity for apo A-I, leading to the dissociation of apo A-I from HDL, and thus leading to lower levels of HDL-C and impaired reverse cholesterol process (Deeb et al., 2003).

4. Metabolic Syndrome

The metabolic syndrome is defined as a cluster of metabolic abnormalities including: central obesity, hypertension, insulin resistance, and dyslipidemia. Studies have shown a strong association between the metabolic syndrome and the risk of developing T2D and CVD. Recent studies have shown that the dysregulation in the production of adipocytokines seen in overweight and obese patients is critically involved in the pathogenesis of metabolic syndrome (Matsuzawa et al.,2003). The pathogenic mechanisms of the metabolic syndrome are complex and remain unclear (Rochlani et al., 2017).

E. Predisposing Factors:

Obesity prevalence may differ between countries and between different population groups, given that the condition of obesity arises from a complex interplay between various factors, including genetic, demographic, socioeconomic and lifestyle/behavioral factors.

1. Genetic Factors

More than 250 genes/loci, in which an association with obesity was proven, have been identified (Ndiaye et al.,2020). Of these genes both, the fat mass- and obesity-associated gene, have showed an important role in the increased risk of development of obesity and T2D. A study conducted among adults showed a positive correlation between these genes and an increased body mass index, fat mass index, and leptin levels (Choquet et al.,2011).

2. Demographic and Socioeconomic Factors

Several studies have identified demographic factors that may be highly correlated with obesity, including; older age (Ford et al., 2016, Al Kibriya et al.,2019), marital status (Addo et al.,2015) and gender (Ford et al., 2016, Adom et al.,2019).

Socio-economic status can affect dietary and lifestyle patterns and hence modulate obesity risk. Low income (Al Kibriya et al.,2019, Baalwa et al.,2010), urbanization (Al Kibriya et al.,2019, Baalwa et al.,2010, Dos Santos etal.,2019) and rural to urban migration which is accompanied with a replacement of local traditional food produce with cheaper processed food items (Popkin et al.,2020) have been associated with increased obesity risk. Families of lower socio-economic backgrounds often report having lower quality diets, unhealthy cooking and shopping practices as well as poor physical activity (Willett , 2002). In this context, early life undernutrition which is seen in many developing countries can be a potential factor to obesity later on and metabolic disorders, thus propagating the inter-generational cycle of undernutrition and obesity (Ford et al., 2016).

Significant disparities have been reported in the availability of food stores between neighborhoods of varying socioeconomic strata. For instance, in the USA, Hispanic and African American neighborhoods had about 50 to 70% less supermarkets than White and non-Hispanic neighborhoods (Hilmers et al.,2012). The availability of supermarkets has been associated with fewer rates of obesity due to the availability of healthier food choices, fruits and vegetables. In addition, these groups have had fewer opportunities to access gym facilities and participate in recreational activities leading to physical inactivity which is further associated with obesity (Powell et al.,2007).

3. *Physical Activity*

Physical inactivity is an important contributor to the increasing obesity epidemic (Gray et al.,2018). Being physically inactive and engaging in long periods of sedentary activities such as watching television was associated with an increased risk of obesity (Al-Raddadi et al.,2019). In fact, weight gain occurs when energy intake exceeds energy expenditure and this energy imbalance is more likely to occur when physical activity is lacking (Thomas et al.,2012). According to Williamson et al., low levels of self-reported recreational PA increased the odds of excessive weight gain by 3-foldr in men and almost 4-fold in women (Williamson et al.,1993). Recommendations of physical activity for all adults are 150-300min per week of moderate intensity physical activity or 75-150 min per week of vigorous intensity, as per the 2018 Physical Activity Guidelines for Americans. (Stone et al.,2021)

4. Sleep

Although the main factors acting as drivers of the obesity epidemic which are excess dietary intake and physical inactivity, sleeping habits has emerged also a new factor (Ding et al., 2017). Many epidemiological studies are reporting a worldwide trend linking suboptimal sleep duration and poor sleep quality to this obesity epidemic (Ding et al., 2017). Sleep duration declines during transition from infancy, puberty to late adulthood (Ding et al., 2017). Recent consensus of the American Academy of Sleep Medicine on optimal sleep duration has defined short sleep duration as <8–10 hours and <7 hours per day in adolescents and adults aged 18–60 years respectively, considering the potential risks of poor sleep in association with the development of cardiometabolic disease (Watson et al., 2015). According to the 2014 U.S. Behavioral Risk Factor Surveillance System, an estimate of more than one-third of adults were short sleepers, which is prevalent in those who were young, obese (body mass index [BMI] ≥30 kg/m^2) or with low education and poor socioeconomic status (Liu et al., 2016). In contrast, long sleep duration which is defined as >9 hours per day was also observed in 23%–37% of the general population in developed countries, and a meta-analysis of 137 prospective cohort studies reported a dose-response relationship attesting a U shaped relationship with incident cardiovascular disease and sleep duration across all age groups (Jike et al., 2018). In addition, poor sleep quality which is defined by the global Pittsburgh Sleep Quality Index score >5 was also independently associated with poor glycemic control and an increase in BMI (Huey Lee et al., 2017). The mechanisms of the effect of inadequate sleep and obesity are complex and include: alterations in eating behavior such as skipping meals, snacking, and irregular meal times, in addition to increased ghrelin to leptin ratio and activation of hedonic pathways (Dashti et al., 2015). Recent evidence suggests that disruption in normal sleeping habits act at the hypothalamic level interfering with the feeding and satiety signals (M.Arble et al., 2015).

5. Behavioral/Lifestyle Factors

"We are what we eat "is the best way to describe the effect of dietary habits. Scientifically, the nature and composition of the food consumed can either have a positive or negative effect on energy balance and whole body metabolism. Increased consumption of energy-dense food, were shown to be highly correlated with obesity and chronic diseases (Hruby et al.,2016).

F. Food consumption patterns and obesity

Despite the large number of studies investigating food consumption patterns and obesity risk, there remains an ongoing debate about the robustness of available evidence (Hruby et al., 2016). Many of the available studies have focused on single nutrients or food groups as a risk factor for obesity and cardiometabolic abnormalities. For instance, several prospective cohort studies have identified a link between increased whole-grain intake and reduced risk of obesity, coronary heart disease, stroke, CVD, cancer, and all-cause mortality (Aune et al.,2016). In addition, fresh fruits and vegetables act as good dietary fiber sources, promoting the feeling of satiety, modulating gastrointestinal functions, improving cholesterol levels, and glycemic control (McRorie et al.,2017). In addition, fruits and vegetables are rich sources of phytochemicals which are bioactive compounds believed exert positive health effects (Probst et al.,2017).Several observational studies have indicated that the increase in consumption of energy dense food, that are often high in saturated and trans-fatty acids, processed starches, and added sugars increased the risk of overweight and obesity (Romieu et al., 2017). In a study done in Spain, the consumption of fast food products increased the risk of being obese by 129% compared with non-consumers- after controlling other lifestyle factors (Schroder et al.,2007).

It is important to note that the single nutrient approach does not take into consideration the potential interactions or synergies that may exist between various nutrients or food groups that constitute the diet (Tapsell et al., 2016). Accordingly, this approach in nutrition research has recently shifted to the identification and analysis of dietary or food consumption patterns as a whole (Cespedes et al.,2015). A healthy diet, characterized by an appropriate intake of macronutrients and an optimal balance between the various food groups, is recommended to support energetic and physiologic needs and prevent excessive caloric intakes (Cena et al.,2020).

G. Dietary Quality and Obesity

Because diet quality has a direct relation with overweight and obesity development, scores developed to assess overall diet quality have been receiving increasing attention in relation to disease etiology. Since foods are not consumed in isolation, dietary scores of overall dietary quality can be of great benefit in disease prevention and treatment, compared to analyzing single dietary components. Commonly used dietary scores include those based on the Dietary Approaches to Stop Hypertension and Mediterranean diet patterns, as well as the Healthy Eating Index (HEI).

1. The Healthy eating Index (HEI)

The HEI assesses dietary quality and its compatibility with the Dietary Guidelines for Americans (DGA). The Dietary Guidelines for Americans are updated every 5 years leading to changes in the healthy eating scoring. The Healthy Eating Index assesses the overall quality of diet by attributing a score, revealing a pattern of quality regarding multiple dietary components (Kres-Smith et al.,2019). It is composed of nine adequacy components including: Total Fruits, Whole Fruits, Total Vegetables, Greens and Beans, Whole Grains, Dairy, Total Protein Foods, Seafood and Plant Proteins, and Fatty Acids (those recommended to be included in a healthy diet). In addition, four moderation components including: Refined Grains, Sodium, Added Sugars, and Saturated Fats (those recommended to be consumed in limited amounts). What differentiated the 2015 Healthy Eating Index from previous versions is the addition of added Sugars as a distinct component, addressing new quantitative recommendations. In addition, the exclusion of Empty Calories, which was a component in the 2010 index and Saturated Fats, was reintroduced from the 2005 version (Reedy et al.,2019).

Components are typically scored with a maximum of 10 points each, and 5 points for those divided in to two sub-components (e.g., Total fruits and whole fruits). According to Yosaee et.al, participants whose weight was healthy (66.85kg) had the highest HEI-2010; obese/overweight participants without/with METS had lower HEI-2010 score of 52.25 and 47.51 respectively. In addition, the odds of having obesity and Metabolic Syndrome were significantly lower when HEI was higher (Yosaee et al.,2016). Another study done by Nicklas TA et al. showed that people with the highest diet quality compared to those with lowest diet quality were more likely to be overweight/obese (34%) (Nicklas et al.,2012).

H. Dietary change over time and its potential link with obesity

Changes in dietary patterns may happen throughout the lifetime, as changes in health perceptions and socio-economic factors may influences ones' dietary and lifestyle habits (Drewnowski et al.,2010). Despite growing interest in the investigation of dietary or food consumption patterns in nutritional epidemiology, little is known about the stability of these patterns over time (Weismayer et al., 2006). Until now there is no consensus about dietary changes over time, and while some epidemiological studies report changes, other studies report the opposite.

In a study following a large cohort of undergraduate women over the college years, a latent class structure of concerns related to eating habits, weight, and shape demonstrated associations with etiologically and clinically relevant covariates and relatively high stability over four measurement occasions over four years (Cain et al., 2010). These finding suggest that such changes are not likely to happen over the traditional years of college (Cain et al., 2010). In addition, the Swedish Mammography cohort including women aged 40–74 years identified three dietary patterns (healthy, Western and alcohol) which had correlation coefficients ranging from 0.63 to 0.73 after 1 year (Khani et al., 2004). Continued follow-up over a seven-year period of the women in the Swedish Mammography cohort, has allowed an evaluation of the internal stability of their dietary patterns (Weismayer et al., 2006). Dietary assessment was repeated 4 times after baseline (4, 5, 6, and 7 years after baseline) in subsamples of 1000 women. Data showed no evidence on instability at 4 and 5 years after baseline in any of the three dietary patterns identified in the study. In addition, after 7 years there was no instability in the healthy pattern, but instability was recorded in the 'alcohol' pattern (high intakes of alcohol and snacks) and the ‘Western’ pattern (high intakes of meat, processed meat, fried potatoes, soft drinks and sweets) after 6 and 7 years, respectively (Weismayer et al., 2006). Findings about the comparison of dietary changes between younger and older age groups suggests that nutrient intakes tend to stabilize with increasing age (Bertheke et al., 2001). According to the SouthHampton’s women survey, two dietary patterns, labeled ‘Prudent’ and ‘High Energy’, have been seen in the population of young women included in this study and have been shown to be reasonably stable over a 2-year period (Borland et al., 2007).

According to Mozaffarrian et.al, such changes in dietary habits may lead to changes in anthropometric status, especially weight gain (Mozaffarian et al.,2011). More specifically, Mozaffarian et al(2011) identified particular dietary and lifestyle factors that may lead to long term changes in body weight, including the consumption of specific foods and beverages, physical activity, alcohol intake, smoking status and television watching (Mozaffarian et al.,2011). The average weight gain in the studied cohorts was about 0.8 lb per year which was evaluated at a 4 year interval , with follow-up periods from 1986 to 2006, 1991 to 2003, and 1986 to 2006 (Mozaffarian et al.,2011). This gradual increase in weight can accumulate over time, and lead to the development of adiposity in non-obese individuals or worsen an existing state of overweight or obesity, increasing the risk of comorbidities (Mozaffarian et al.,2011). It has been argued that although most studies have evaluated current behaviors in relation to weight gain, longitudinal changes in lifestyle may in fact be more relevant in terms of the understanding of both biologic effects and their translation into preventive strategies (Mozaffarian et al.,2011). For example, the increased consumption of sugar sweetened foods and beverages, and processed foods may make it harder to maintain energy balance due to the fact that these do not induce satiety, whereas the consumption of fruits, vegetables and whole grains might make it easier (Buijsse et al.,2009). Physical activity should improve weight balance, but evidence has been inconsistent in this regard (Min-Lee et al.,2010). In addition, a sedentary lifestyles characterized by increase television viewing and changes in sleeping patterns may influence both energy consumption and energy expenditure (Must et al.,2013). Studies evaluating dietary changes over time and their influence on weight gain are particularly important to develop new dietary recommendations and update older ones.

CHAPTER III

MATERIALS AND METHODS

A. Study Design:

This study is based on the Greater Beirut Area Cardiovascular Cohort (GBACC), which was conducted on a representative sample of Lebanese adults aged ≥18 years residing in the Greater Beirut. Baseline data collection was conducted in 2014 and the follow-up assessment was conducted in 2019. The same protocol and methodologies for data collection were used in both the baseline and follow-up components. Data collection was based on the use of a multi-component questionnaire inquiring about medical history, demographic, socioeconomic, and lifestyle-related characteristics, in addition to anthropometric measures, blood pressure measurements and the collection of biological samples (blood and urine) for biochemical assessment.

For the baseline survey of 2014, a multistage probability sampling was used for the recruitment of the study participants whereby the strata were the districts of the Greater Beirut Area. The second stage included the selection of neighborhoods within each of the strata, then selecting households based on systematic random sampling in each selected neighborhood according to the estimated number of buildings in the neighborhood, and finally sampling a primary respondent within each household based on the most recent birthday.

The recruitment process was done over a 3-month period from March until May 2014. The eligibility criteria included: older than 18 years old, Lebanese, and residing in the Greater Beirut area. Exclusion criteria included: being on dialysis, pregnant women, subjects with mental disability, and/or working in a plastic or other chemical company (given that the initial study aimed at assessing the association between BPA exposure and cardiometabolic risk). The baseline sample included 501 Lebanese adults, composed of 179 males (35.7%) and 322 females (64.3%) with a mean age of 45.4 ± 15.1 years.

The Institutional Review Board of the American University of Beirut approved this study. Written informed consents were collected from all participants for the initial survey and subjects were also asked to provide their consent or refusal to participate in the follow-up study. The follow-up was conducted five years after the initial data collection, from February to May 2019. Written consents were also obtained from participants. The follow up sample consisted of 186 subjects, with 59 males (31.6%) and 127 females (67.9%), with a mean age of 47.8 ± 12.9 years.

B. Study procedures

Only the participants who had agreed during the baseline study to participate in the follow-up component were contacted by phone. Participants were invited to visit the department of Nutrition and Food Sciences at AUB, for a follow-up visit. Participants who were unable or unwilling to participate in the follow-up assessment were administered a brief health questionnaire over the phone. Trained personnel who had obtained the Collaborative Institutional Training Initiative (CITI) certification were responsible for administering all questionnaires and conducting data collection based on standardized protocols, while respecting the subject’s privacy and confidentiality.

C. Data collection

Data collection was done through face-to-face interviews, and was performed by trained personnel, using the same standardized protocol in the baseline as well as the follow-up components. It included the following:

1. Demographic and socioeconomic characteristics

Age, gender, area of residence, marital status (categorized as married, single, or other being separated/divorced/widowed), education (divided into no schooling/primary school, intermediate, secondary/technical, or university), occupation, crowding index (defined as the average number of people per room, excluding kitchen and bathroom (19), and income bracket per family (categorized less than <600, 600-999.9, or more than 1000) USD per month.

2. Dietary and lifestyle habits

The study assessed dietary intake (using a validated 80-item culture-specific semi-quantitative Food Frequency Questionnaire (FFQ), physical activity (using the short version of the International Physical Activity Questionnaire (IPAQ) (IPAQ Research Committee, 2005), smoking (with current defined as any daily smoking, regardless of the number of cigarettes, narghileh, or e-cigarettes), alcohol intake (defined as any intake), and caffeine intake. Sleep assessment was done using the Berlin questionnaire for obstructive sleep apnea (Sharma et al., 2006) and the Epworth Sleepiness scale.

3. Anthropometric measures

Standing body height (cm) was measured to the nearest 0.5 cm with a portable wall stadiometer (Seca 213, Germany)., WC was measured using a plastic, inelastic measuring tape to the nearest 0.5cm (Seca 201, Germany). Body weight (to the nearest 0.11 kg) and body composition were as measured using a bioimpedance analyzer (Inbody 3.0, Biospace Co. Ltd, Alpha-Tec s.a.r.l.). Body mass index (BMI) was calculated and categorized according to the World Health Organization classification for overweight and obesity (World Health Organization .,2021).

4. Biochemical Assessment and Blood Pressure measurement

Ten milliliters of blood were withdrawn from each participant and divided into EDTA and chemistry tubes. EDTA tubes were stored at -20 ºC whereas chemistry tubes were centrifuged and then stored at -80 ºC. All tubes were kept frozen until analysis. Serum triglycerides, HDL-C, LDL-C, and glucose were measured by an enzymatic spectrophotometric technique using Vitros 350 analyzer (Ortho-Clinical Diagnostics, Johnson and Johnson, 50–100 Holmers Farm Way, High Wycombe, Buckinghamshire, HP12 4DP, United Kingdom) at the department of NFSC. As for hemoglobin A1c (HbA1c) analysis, the Department of Pathology and Laboratory Medicine at the American University of Beirut Medical Center (AUBMC) performed the test according to the high-performance liquid chromatography method, using the BioRad Variant Hemoglobin Analyzer. Blood pressure was measured in the seated position after a ten-minute rest with a standard digital sphygmanometer. Measurements were repeated twice and the mean of the two values was calculated and used.

5. Cardiometabolic risk factors:

Cardiometabolic risk factors were assessed using the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) and the new International Diabetes Federation guidelines (Zimmet et al., 2005). elevated TG (≥ 150 mg/dL); low levels of HDL (< 40 mg/dL for males and < 50 mg/dL for females); high systolic blood pressure (SBP) (≥ 130 mmHg) or high diastolic blood pressure (DBP) (≥ 85 mmHg); high fasting glucose (≥ 100 mg/dL) (Zimmet et al., 2005).

6. Dietary intake analysis

Dietary intake assessment was conducted using a semi-quantitative Food Frequency Questionnaire (FFQ). The e FFQ consisted of 86 food items "as normally consumed". A reference portion, expressed in household measures or grams, was specified for each food item in the FFQ. Each participant was asked to estimate the number of times per day, week, month or year he/she consumed this particular food product and the amount usually eaten per food item by making comparisons with the specified reference portion.

The FFQ has been designed to include culture - specific recipes and dishes by a panel of nutritionists and was tested to check for cultural sensitivity and clarity. Energy and macronutrient intakes were estimated using the Nutritionist Pro software. Food items listed on the FFQ were categorized into 24 food groups based on similarities in nutritional composition and culinary use. Food groups' intakes were evaluated as g/day, % kcal and servings/day.

Overall diet quality was assessed using the Healthy Eating Index score (HEI) (USDA, 2020).

The HEI-2015, which measures the compliance with the 2015–2020 Dietary Guidelines for Americans, is a 100-point scale, with a higher score indicating a better quality and adherence of overall diet. The HEI is composed of nine adequacy components and four moderation components. Intake was converted from grams per day to cups and ounces (USDA , 2017), and the intake of each food group was standardized for 1000Kcal. Scores of each food group were given as per the standards of scoring mentioned in the table below. (USDA , 2020)

Table 3: *Healthy Eating Index-2015 components, point values, and standards for scoring*

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Adequacy			
Total Fruits	5	≥0.8 c equivalents/1,000 kcal	No fruit
Whole Fruits	5	≥0.4 c equivalents/1,000 kcal	No whole fruit
Total Vegetables	5	≥1.1 c equivalents/1,000 kcal	No vegetables
Greens and Beans	5	≥0.2 c equivalents/1,000 kcal	No dark green vegetables or beans and peas
Whole Grains	10	≥1.5 oz equivalents/1,000 kcal	No whole grains
Dairy	10	≥1.3 c equivalents/1,000 kcal	No dairy
Total Protein Foods	5	≥2.5 oz equivalents/1,000 kcal	No protein foods
Seafood and Plant Proteins	5	≥0.8 c equivalents/1,000 kcal	No seafood or plant proteins
Fatty Acids	10	(PUFAs+MUFAs)/SFAs ≥2.5	(PUFAs+MUFAs)/SFAs ≤1.2
Moderation			
Refined Grains	10	≤1.8 oz equivalents/1,000 kcal	≥4.3 oz equivalents/1,000 kcal
Sodium	10	≤1.1 g/1,000 kcal	≥ 2.0 g/1,000 kcal

Added Sugars	10	≤6.5% of energy	≥26% of energy
Saturated Fats	10	≤8% of energy	≥16% of energy

D. Statistical analysis

Data collected were entered into the Statistical Package for Social Sciences (SPSS, version 22) which was used for data cleaning, management and analyses. Characteristics of participants were described using number and percent frequency for categorical variables, and Mean ± SD for continuous variables. Significant differences between participants and non-participants were examined using independent t-test for continuous variables, and chi square tests for categorical variables.

Macro nutrient intakes and food groups were calculated as grams/day, percent Kcal/day and serving/day (the latter being for food groups only). Mean changes over the 5 year period were also calculated for continuous variables. Comparison of continuous and categorical variables at two time points were represented and carried out using paired sample t-tests and McNemar test, respectively. The relationship between dietary intake changes of food groups (as percent Kcal/day and serving/day) and each of BMI, waist circumference and percent body fat were assessed using the generalized linear regression model. The analysis was adjusted, based on the literature, for age at follow-up, gender, baseline sleep duration, as well as for changes in physical activity, smoking/narjilah status, in model 1, in addition to baseline BMI in model 2 (Mozaffarian et al., 2011).

Changes in dietary quality were evaluated using the Healthy Eating Index. Characteristics and changes of dietary scores were represented as Mean± SD and Mean Difference (5^{th}, 95^{th} percentile) over the 5 year period. Paired t-test was made to check for significant change in HEI, in addition, a generalized linear model was made to test for the association between anthropometric measures and HEI. The analysis was adjusted for age at follow-up, gender, baseline sleep duration, as well as for changes in physical activity, smoking/narjilah status at follow-up, and each dietary score in model 1 and in addition to baseline BMI in model 2.

Incidence of cardiometabolic risk factors was evaluated using Binary Logistic regression for categorical variables, and Generalized Linear Regression for continuous variables. Results were reported as OR (95 CI) for categorical variables and beta for continuous variables, in addition to p value for both. The analysis was adjusted for age at follow-up, gender, baseline sleep duration, as well as for changes in physical activity, smoking/narjilah status at follow-up, and each dietary score in model 1 and in addition to baseline BMI in model 2.

Significance was reported as $p < 0.05$.

CHAPTER IV

RESULTS

A. Characteristics of the study population at baseline and at follow-up

1. Socio-demographic characteristics:

The socio-demographic characteristics of the study participants in the follow-up component are presented in Table 4, in comparison with non-participants. The results show that there were significant differences between those who participated and those who did not participate in the GBACC follow-up in age, educational level, monthly family income marital status and alcohol drinking. Mean age of participants was significantly higher in participants than non-participants, and there was a lower proportion of married subjects in the non-participant group. The proportion of subjects reporting to drink alcohol was also significantly higher in the participants group.

Table 4: *Comparison of participants and non-participants in the GBACC (2019) follow-up examination*

Baseline characteristics	**Total**	**Participants**	**Non-participants**	**p-value**
	n (%)	**n (%)**	**n (%)**	
Total	**501 (100)**	**198 (36.5)**	**303 (60.5)**	
Socio-demographic characteristics				
Age *(mean ± SD)*	45.4 ± 15.1	46.9 ± 13.3	44.4 ± 16.0	**0.046**
Gender				0.961
Female	322 (64.3)	127 (64.1)	195 (64.4)	
Male	179 (35.7)	71 (35.9)	108 (35.6)	
Educational level				**0.039**
Intermediate school or lower	317 (63.6)	138 (70.1)	179 (59.5)	
Secondary school/Technical School	127 (25.5)	44 (22.3)	83 (27.6)	

University degree or higher	54 (10.8)	15 (7.6)	39 (13.0)	
Monthly family income				**0.006**
<600$	153 (33.8)	68 (36.8)	85 (31.7)	
600-999$	170 (37.5)	79 (42.7)	91 (34.0)	
≥1000$	130 (28.7)	38 (20.5)	92 (34.3)	
Marital status				**0.001**
Married	332 (66.3)	148 (74.7)	184 (60.7)	
Not married[1]	169 (33.7)	50 (25.3)	119 (39.3)	
Employment status				0.088
Employed	212 (42.3)	93 (47.0)	119 (39.3)	
Unemployed[2]	289 (57.7)	105 (53.0)	184 (60.7)	
Lifestyle characteristics				
Cigarette smoking				0.174
Current smoker	216 (43.1)	78 (39.4)	138 (45.5)	
Not current smoker	285 (56.9)	120 (60.6)	165 (54.5)	
Waterpipe smoking				0.981
Current smoker	142 (28.3)	56 (28.3)	86 (28.4)	
Not current smoker	359 (71.7)	142 (71.7)	217 (71.6)	
Alcohol drinking				**0.026**
Yes	95 (19.0)	28 (14.1)	67 (22.1)	
No	406 (81.0)	170 (85.9)	236 (77.9)	

[1] Includes single, widowed, divorced, and
[2] Includes those who are unemployed, housewives, retired, and students
*p-value is derived from Pearson Chi-Square test for all categorical variables

2. *Lifestyle characteristics at baseline and follow up*

Lifestyle characteristics of subjects who participated in the follow-up component are shown, at baseline and follow up, in Table 5. Change within 5 years is displayed as mean (5th, 95th percentile) for physical activity and total daily sleep, and as proportions (n, %) for alcohol consumption and smoking.

Table 5: *Lifestyle characteristics of the study participants at baseline and follow-up, and Mean change (5th to 95th) over the 5 years study period (n=184)*

Variable		Baseline	Follow-up	Change within 5 years	p-value*
		Mean ± SD		Mean (5th percentile, 95th percentile)	
Physical activity[1] (MET-hr/wk)		31.8 ± 36.1	27.2 ± 51.5	-4.6 (-75.0, 139.5)	0.365
Total daily sleep[1] (hr)		6.4 ± 1.6	6.5 ± 1.6	0.1 (-2.9, 3.5)	0.369
	N (%)				
Alcohol consumption[2]	Yes	20 (10.8%)	18 (9.7%)		1
	No	166 (89.2%)	168 (90.3%)		
Nargileh[2]	Yes	52 (28%)	59 (31.7%)		0.143
	No	134 (72%)	127 (68.3%)		
Cigarette smoking[2]	Yes	73 (39.2%)	74 (39.8%)		1
	No	113 (60.8%)	112 (60.2%)		

1 Continuous variable

2 Categorical variable

*p-value is derived from Pearson Chi-Square for categorical variables and from paired samples T-test for all continuous variables

3. Anthropometric measurements at baseline and follow up

Anthropometric measurements of subjects who participated in the follow-up component are shown, at baseline and follow up, in Table 6, in addition to the mean change including 5^{th} and 95^{th} percentile.

Mean age at baseline and follow up were 47.8 ± 12.9 and 52.4 ± 13.0 respectively. Mean weight change over the 5-years-period for the GBACC cohort was of + 0.9Kg (5^{th} to 95^{th} percentile, -9.7 to 10.6), however the increase was not statistically significant. There was significant increase in Waist Circumference (WC) with a mean change of + 2.6 (5th to 95^{th}percentile, -13.2, 20.4). In contrast, mean change in percent body fat was estimated at -0.9 (5^{th} to 95^{th}, -10.8, 6.7), and the change was found to be significant.

Table 6: *Anthropometric characteristics of the study participants at baseline and follow-up, and Mean change (5th to 95th) over the 5 years study period (n=184)*

Variable	**Baseline**	**Follow-up**	**Change within 5 years**	**p-value***
	Mean ± SD		**Mean (5th percentile, 95th percentile)**	
Anthropometric Characteristics				
Weight (kg)	78.3 ± 16.2	79.1 ± 16.1	0.9 (-9.7, 10.6)	0.086
BMI (Kg/m²)	30.3 ± 5.8	30.4 ± 6.1	0.1 (-4.6, 4.1)	0.653
Waist circumference (cm)	98.1 ± 17.3	100.6 ± 14.5	2.6 (-13.2, 20.4)	**0.005**
Body fat (%)	38.7 ± 10.1	37.7 ± 9.9	-0.9 (-10.8, 6.7)	**0.024**

*p-value is derived from paired samples T-test for all continuous variables

4. Cardiometabolic risk factors: at baseline and at follow up

The analysis of cardiometabolic risk factors, presented below in table 7, shows that both Fasting Blood Glucose and Diastolic Blood Pressure, have significantly increased over the 5 year period with a p value of <0.001 and 0.003 respectively. The other components did not change significantly over the 5 year period.

Table 7: *Change in cardiometabolic risk factors represented as Mean±SD and Mean change (5th to 95th) over 5 year period*

Variable	**Baseline**	**Follow-up**	**Change within 5 years**	**p-value***
	Mean ± SD		**Mean (5th percentile, 95th percentile)**	
Cardiometabolic risk factors				
Fasting Blood Glucose mg/dL	109.4 ± 30.4	118.2 ± 40.8	8.5 (-21 , 59.4)	**<0.001**
Triglycerides mg/dL	140.7 ± 73.3	147.9 ± 71.1	5.9 (-108.6 , 124.1)	0.239

HDL mg/dL	50.1 ± 14.1	49.1 ± 13	-0.7 (-20 , 17)	0.341
SBP	121.1 ± 18.4	123.8 ± 19.3	2.5 (-28.3 , 41.7)	0.070
DBP	75.2 ± 9.9	77.7 ± 9.7	2.4 (-15.5 , 22.5)	**0.003**

*p-value is derived from paired samples T-test for all continuous variables

5. *Energy and macronutrient intakes at baseline and follow up*

As shown in Table 8, energy intake has significantly decreased over the 5-years-study period, with a mean difference of -311 Kcal/day (5^{th} to 95^{th} percentile, -2421, and 1437). Significant changes were noted in CHO and fat intakes. These changes were similar in magnitude but were of opposite directions: +2.3%EI (-12.4, 18.2) for CHO and -2.4%EI (-18.5, 11.9) for fat. I n parallel to the increase in total CHO, the intake of total sugars was also found to significantly increase, with a mean difference of 1.5%EI (5^{th} to 95^{th} percentile, -110.1, 119.4). Similarly, and in agreement with the observations for total fat, the intakes of saturated fat, MUFA and PUFA have significantly decreased over time. The intake of dietary cholesterol was also found to decrease (mean change= -33.3 mg (-330.9, 223.4). The macronutrient with the least change over the 5 year period was protein, with a mean difference of 0.49%EI (5^{th} to 95^{th} percentile, -4.9, 6.9) (borderline significant).

Table 8: *Intakes of energy and macronutrient intakes of the study participants at baseline and follow-up, and mean change (5^{th} to 95^{th}) over the 5 years study period (n=184)*

Variable	**Baseline**	**Follow-up**	**Change within 5 years**	**p-value***
	Mean ± SD		**Mean (5th percentile, 95th percentile)**	
Energy and macronutrient				

s intake				
Energy intake (Kcal/d)	2925 ± 1169	2613 ± 1089	-311.5 (-2421 , 1437)	**<0.001**
Protein				
Grams/day	96.8 ± 46.7	89.4 ± 44.8	-7.4 (-69 , 51)	**0.016**
As %EI	13.2 ± 2.8	13.7 ± 3.4	0.49 (-4.9 , 6.9)	0.059
Carbohydrates				
Grams/day	351.0 ± 140	326.1 ± 131.3	-24.8 (-262.3, 183.3)	**0.017**
As %EI	48.6 ± 7.8	50.9 ± 8.4	2.3 (-12.4 , 18.2)	**0.001**
Total sugars				
Grams/day	109.9 ± 64.3	111.5 ± 62.3	1.5 (-110.1 , 119.4)	0.770
As %EI	15.1 ± 5.6	16.6 ± 9.7	1.5 (-11.1 , 19)	**0.032**
Total Fat				
Grams/day	129.5 ± 62.1	109.8 ± 57.5	-19.7 (-135.1 , 71.8)	**<0.001**
As %EI	39.4 ± 7.9	36.9 ± 7.4	-2.4 (-18.5 , 11.9)	**<0.001**
Saturated Fat				
Grams/day	36.0 ± 18.6	31.1 ± 17.5	-4.9 (-35.3 , 23.3)	**<0.001**
As %EI	10.8 ± 2.7	9.9 ± 4.5	-0.9 (-8.2 , 7.5)	**0.008**
MUFA				
Grams/day	47.7 ± 25.7	40.7 ± 26.2	-7 (-50.3 , 27.1)	**0.001**
As %EI	14.5 ± 4.2	13.2 ± 7.3	-1.2 (-12.7 , 11.2)	**0.030**
PUFA				
Grams/day	33.7 ± 19.1	27.3 ± 16	-6.4 (-49.9 , 25.7)	**<0.001**
As %EI	10.3 ± 3.7	9.1 ± 5.4	-1.2 (-11.7 ,11.2)	**0.009**
Cholesterol (mg/d)	296.2 ± 208.3	262.8 ± 176.8	-33.3 (-330.9 , 223.4)	**0.009**
Dietary fiber (g/d)	27.4 ± 12.5	27.7 ± 11.4	0.22 (-18.8 , 21.6)	0.829

*p-value is derived from paired samples T-test for all continuous variables

6. Food groups intake at baseline and follow up

Food groups' intakes as grams per day, percent Kcal per day and servings per day are shown in Table 9, at baseline and at follow up. Changes in intake levels were also presented as mean ± SD and difference in means with 5th to 95th percentile over the 5 year period. The food groups that showed a significant difference in terms of grams per day, percent Kcal per day and servings per day were: Fats and oils, processed meats, sugar sweetened beverages, refined grains and cereals and whole grain cereals. Overall, a significant decrease was observed in the intakes of fats and oils, processed meat, refined grains, and SSBs, while the intakes of fast food, fresh/dried fruits, and whole grains have increased over the 5-year study period.

Table 9: *Food group intakes represented as Mean±SD and Mean change (5^{th} to 95^{th}) over 5 year period*

Variable	Baseline			Follow-up			Change within 5 years			p-value*		
	Mean ± SD						Mean (5th percentile, 95th percentile)					
Food intake	**g/d**	**%Kcal/d**	**servings/d**	**g/d**	**%Kcal/d**	**servings/d**	**g/d**	**%Kcal/d**	**servings/d**	**g/d**	**%Kcal/day**	**servings/d**
100% Fresh fruit juices	41.3 ± 69.0	0.7 ± 1.3	0.34 ± 0.6	51.7 ± 101.5	0.9 ± 2	0.43 ± 0.84	10.3 (-93.4 , 128.3)	0.2 (-1.5 , 2.6)	0.1 (-0.77 , 1)	0.201	0.157	0.201
Fresh/Dried fruits	229.6 ± 172.7	8.6 ± 6.8	4.2 ± 3.6	328.0 ± 220.2	9.5 ± 6.6	5.9 ± 4.1	98.4 (-160.0, 390.9)	0.9 (-10.4 , 11.3)	1.7 (-3.4, 7.5)	**<0.001**	0.077	**<0.001**
Canned fruits	0.94 ± 4.4	0.02 ± 0.1	0.0157 ± 0.1	2.1 ± 9.9	0.04 ± 0.2	0.03 ± 0.16	1.2 (-3.5 , 6.8)	0.0 (-0.08 , 0.18)	0.0 (-0.05 , 0.11)	0.109	0.094	0.109
Vegetables (raw/cooked/canned)	245.4 ± 166.6	3.2 ± 2.3	2.4 ± 1.6	241.8 ± 169.3	3.4 ± 2.2	2.4 ± 1.6	-3.6 (-289.8 , 320.8)	0.2 (-3.5 , 4.6)	-0.04 (-2.9, 3.1)	0.793	0.251	0.735
Legumes	55.4 ± 117.1	2.4 ± 2.6	0.5 ± 1.1	39.8 ± 45.7	2.3 ± 2.3	0.4 ± 0.4	-15.6 (-112.9 , 81.3)	-0.1 (-4.5 , 4.4)	-0.1 (1.1, 0.84)	0.078	0.600	0.078
Refined grains and cereals	293.6 ± 178.0	23.4 ± 12.9	9.5 ± 6.4	234.2 ± 147.6	21.2 ± 11.6	7.6 ± 5	-59.3 (-353 , 165.3)	-2.1 (-27.5 , 17.1)	-1.9 (-12.0, 6.5)	**<0.001**	**0.026**	**<0.001**
Whole-grain cereals	49.8 ± 77.7	3.3 ± 6	1.5 ± 2.6	68.3 ± 89.4	5.6 ± 7.7	2.3 ± 3.2	18.5 (-134 , 198)	2.3 (-7.5 , 20.5)	0.8 (-3.5, 7.5)	**0.010**	**<0.001**	**0.002**
Low fat dairy products	31.7 ± 53.7	2.2 ± 2.8	0.7 ± 1	31.7 ± 52.7	2.2 ± 2.9	0.7 ± 1	0.0 (-115.0, 119.0)	0.0 (-5.9 , 6.2)	-0.1 (-2.2, 1.9)	0.994	0.870	0.495
Whole-fat dairy products	136.7 ± 156.5	4.5 ± 4.7	1.4 ± 1.3	126.8 ± 125.0	4.5 ± 3.3	1.3 ± 1.2	-9.9 (-303.0, 200.7)	0.06 (-7.6 , 7.3)	-0.1 (-2.5, 2.3)	0.336	0.849	0.593
Eggs	18.4 ± 21.7	1.1 ± 1.2	0.041 ± 0.0	17.7 ± 18.7	1.3 ± 1.3	0.4 ± 0.4	-0.7 (-38.5, 37.0)	0.2 (-2.2 , 2.7)	-0.01 (-0.8, 0.8)	0.686	0.160	0.686
Poultry	33.3 ± 34.8	2.0 ± 4.6	0.5 ± 0.6	32.5 ± 41.7	2.2 ± 2.6	0.5 ± 0.7	-0.8 (-67.1 , 88.2)	0.1 (-4.5 , 5.4)	-0.01 (-1.1, 1.4)	0.815	0.627	0.815
Red/organ meats	47.1 ± 67.3	3 ± 3.4	0.8 ± 1.1	38.8 ± 65.8	2.8 ± 4	0.6 ± 1	-8.3 (-108.3 , 78.9)	-0.1 (-6.9 , 6.9	-0.1 (-1.8, 1.3)	0.097	0.603	0.097

Processed meat	8.3 ± 14.5	0.7 ± 1.1	0.1 ± 0.2	4.8 ± 7.9	0.4 ± 0.7	0.1 ± 0.13	-3.5 (-22.7 , 10.7)	-0.2 (-2.2 , 1.1)	-0.1 (-0.3, 0.18	**<0.001**	**0.004**	**<0.001**
Fresh/canned Fish & Seafood	18.9 ± 31.4	1 ± 1.4	0.3 ± 0.5	19.8 ± 24.4	1.2 ± 1.4	0.3 ± 0.4	0.9 (-34.5, 38.2)	0.2 (-2.2 , 2.9)	0.0 (-0.6, 0.6)	0.682	0.043	0.682
Fats & oils	53.3 ± 38.8	13.2 ± 8.7	7.3 ± 6.7	37.7 ± 32.1	10.4 ± 7.6	5.7 ± 6.2	-15.5 (-89.0, 42.1)	-2.7 (-19.6 , 10.5)	-1.6 (-14.1 , 6.1)	**<0.001**	**<0.001**	**0.005**
Nuts & seeds	15.5 ± 29.0	2.8 ± 4.5	0.5 ± 0.9	18.2 ± 35.5	3.7 ± 6.3	0.6 ± 1.1	2.7 (-45.3 , 78.1)	0.9 (-7.9 , 12)	0.1 (-1.5, 2.6)	0.379	0.113	0.379
Fast food	109.7 ± 87.8	11.6 ± 7	0.1 ± 0.0	99.4 ± 79.5	11.1 ± 6.6	0.2 ± 0.4	-10.2 (-150.5 , 139.2)	-0.4 (-14.6 , 10.8)	0.1 (-0.2, 0.9)	0.137	0.422	**<0.001**
Potato chips/Tortilla	12.6 ± 27.8	2.1 ± 4.6	0.0 ± 0.0	10.0 ± 18.9	1.9 ± 3.5	0.0 ± 0.0	-2.6 (-63.2 , 31.1)	0.2 (-10.4 , 5.2)	0.0 (0.0, 0.0)	0.189	0.579	**
Sweets and deserts	106.5 ± 117.8	12.2 ± 9.5	4.1 ± 4.1	92.3 ± 96.4	11.5 ± 8.5	4.5 ± 5.9	-14.0 (-176 , 167.5)	-0.7 (-15.4 , 13.4)	0.4 (-8.0, 9.6)	0.122	0.374	0.376
Alcohol	20.5 ± 169.5	0.36 ± 1.7	0.0028 ± 0.0	14 ± 79.4	0.4 ± 1.9	0.004 ± 0.01	-6.5 (-12.2 ,21.3)	0.04 (-0.25 , 0.6)	0.001 (0 , 0)	0.402	0.641	0.206
Diet Soft drinks	17.9 ± 83.2	0.6 ± 2.4	0.0 ± 0.0	8.2 ± 36.2	0.0 ± 0.0	0.0 ± 0.0	-9.7 (-80.6, 10.8)	-0.5 (-4.1 , 0.003)	0.0 (0.0, 0.0)	0.057	**0.001**	0.686
Caffeinated beverages and tea	320.6 ± 335.0	0.8 ± 1.6	0.0 ± 0.0	316.6 ± 366.9	0.6 ± 1.9	0.0 ± 0.0	-4.0 (-506.7 , 427.5)	-0.2 (-3.7, 1.3)	0.0 (0.0, 0.0)	0.897	0.212	**
Sugar Sweetened Beverages	154.4 ± 199.4	2.5 ± 2.8	0.8 ± 0.9	100.0 ± 182.1	1.7 ± 2.7	0.5 ± 0.9	-54.3 (-371.8 , 181.2)	-0.7 (-6.1 , 3.6)	-0.2 (-1.9, 1.1)	**<0.001**	**<0.001**	**<0.001**
Water	1103.0 ± 920.0	0.0 ± 0.0	0.0 ± 0.0	1208.0 ± 801.0	0.0 ± 0.0	0.0 ± 0.0	105.3 (-914.9 , 1322.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.063	**	**

*p-value is derived from paired samples T-test for all continuous variables

7. Dietary Quality Evaluation at Baseline and Follow-up

Dietary quality was assessed using the Healthy Eating Index (HEI). HEI scores are represented in table 10, as Mean ±SD, in addition the Mean Change (5^{th}, 95^{th}) over the 5 years period.

The HEI examines the intake of specific food groups/nutrients expressed per 1000 kcal. This has shown significant changes in the intakes of fruits, vegetables, whole grains, total protein foods, as well as in the fatty acid ratio, saturated fat intake and added sugar intake (Appendix 1). HEI food group scores and total HEI score are shown in table 10. Total HEI score increased significantly (p value = 0.001) over the 5 year period with a mean change of 2.4 (-14, 19.6).

Table 10: *Healthy Eating Index evaluation represented as Mean±SD and Mean change (5^{th} to 95^{th}) over 5 year period.*

Variable	**Baseline**	**Follow-up**	**Change within 5 years**	**p-value***
	Mean ± SD		**Mean (5th percentile, 95th percentile)**	
HEI Scores				
Total Fruits	3.1 ± 1.89	3.9 ± 1.69	0.8(-3 , 5)	**<0.001**
Whole Fruits	3.9 ± 1.35	4.4 ± 1.16	0.5(-1.6 , 3)	**<0.001**
Total Vegetables	4.2 ± 1.12	3.8 ± 1.35	-0.4(-3 , 2)	**<0.001**
Greans and Peaas	4.4 ± 1.2	4.4 ± 1.3	-0.08(-3 , 3)	0.468
whole Grains	2 ± 2.7	3.3 ± 3.4	1.3(-4 , 9)	**<0.001**
Dairy	2.1 ± 1.6	2.2 ± 1.3	0.06(-3 , 3)	0.606
Total Proteins	1.2 ± 0.6	1.1 ± 0.5	-0.09(-1 , 1)	0.060
Seafood and Plant Proteins	2.3 ± 1.3	2.1 ± 1.2	-0.2(-3 , 2)	**0.027**
Fatty Acids	10 ± 0	10 ± 0	0	-
Refined Grains	4.3 ± 3.7	4.8 ± 3.8	0.5(-8.6 , 8.6)	0.087
Sodium	7.5 ± 3.5	7.9 ± 3.5	0.45(-9 , 9)	0.171
Added Sugars	9.7 ± 1.4	9.2 ± 2.3	-0.4(-9 , 0)	**0.017**
Saturated FA	10 ± 0	10 ± 0	0	-
Total	65.2 ± 9.6	67.7 ± 9.3	2.4(-14 , 19.6)	**0.001**

*p-value is derived from paired samples T-test for all continuous variables

B. Investigation of the associations between changes in dietary intakes and changes in anthropometric characteristics and cardiometabolic risk factors

1. Dietary changes and association with Waist Circumference and Body Fat Percent change

A multivariate model was adopted to assess the association of increased intake of different food groups as serving per day and percent Kcal per day with each of waist circumference and percent body fat. These models were adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and all the dietary factors in table 9 simultaneously in Model 1 and further adjusted to baseline BMI in model 2.

Results showed that each increase in one serving of low fat dairy products was significantly associated with a 1.5 cm decrease in waist circumference within the 5 years period. In contrast each increase in one serving of whole fat dairy products was significantly associated with a 1.6 and 1.4 cm increase in Waist circumference in model 1 and model 2 respectively. Results are displayed in Tables 11 and 12.

Table 11: *Multivariable-Adjusted Results for the Relationships between Changes in Food groups Intakes as servings per day and Waist Circumference changes* (n=184)*

Increased Dietary Intake (servings/day)	**Waist Circumference change (in cm) within 5-Year Period (95% CI)**			
	Model 1	**p-value**	**Model 2**	**p-value**
100% Fresh fruit juices	0.6 (-1.6, 3)	0.5	0.7 (-1.6, 3)	0.5
Fresh/Dried fruits	0.05 (-0.3, 0.5)	0.8	-0.02 (-0.4, 0.4)	0.9
Canned fruits	1.5 (-9.2, 12.2)	0.7	2.4 (-8.2, 13)	0.6
Vegetables (raw/cooked/canned)	-0.3 (-1.6, 0.7)	0.5	-0.2 (-1.5, 0.8)	0.6
Legumes	1.7 (-1.6, 5.1)	0.3	1.4 (-2, 4.8)	0.4
Refined grains and cereals	-0.1 (-0.4, 0.2)	0.5	-0.1 (-0.4, 0.2)	0.4
Whole-grain cereals	-0.4 (-1, 0.1)	0.1	-0.3 (-0.9, 0.2)	0.3
Low fat dairy products	-1.3 (-2.9, 0.1)	**0.07**	-1.5 (-3.1, -0.05)	**0.04**
Whole-fat dairy products	1.6 (0.1, 3)	**0.03**	1.4 (0.04, 2.9)	**0.04**
Eggs	0.5 (-3.1, 4.2)	0.7	0.1 (-3.4, 3.8)	0.9

Poultry	2 (-0.6, 4.7)	0.1	2 (-0.7, 4.6)	0.1
Red/organ meats	0.4 (-1.6, 2.5)	0.6	0.6 (-1.4, 2.6)	0.5
Processed meat	3.5 (-5.6, 12.6)	0.4	4.2 (-4.8, 13.2)	0.3
Fresh/canned Fish & Seafood	-1.9 (-5.7, 1.8)	0.3	-2 (-5.7, 1.6)	0.2
Fats & oils	0.1 (-0.2, 0.4)	0.5	0.1 (-0.1, 0.4)	0.3
Nuts & seeds	-0.8 (-2.1, 0.5)	0.2	-0.9 (-2.2, 0.4)	0.1
Fast food	4.3 (-2.3, 10.9)	0.2	4.1 (-2.6, 10.6)	0.2
Potato chips/Tortilla	-	-	-	-
Sweets and deserts	0.1 (-0.2, 0.4)	0.5	0.1 (-0.1, 0.5)	0.3
Alcohol	-104.2 (-253, 45)	0.1	-91 (-239, 56)	0.2
Diet Soft drinks	-	-	-	-
Caffeinated beverages and tea	-	-	-	-
Sugar Sweetened Beverages	0.7 (-1.6, 3.1)	0.5	0.5 (-2, 2.8)	0.7
Water	-	-	-	-

*Increase in Waist circumference

Model 1 was adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and further adjusted to baseline BMI in model 2

Multivariate logistic linear regression for continuous variables reported as change (95% CI)

Table 12: *Multivariable-Adjusted Results for the Relationships between Changes in Food groups Intakes as Percent Kcal per day and Waist Circumference changes* (n=184)*

Increased Dietary Intake (%Kcal/day)	**Waist Circumference change (in cm) within 5-Year Period (95% CI)**			
	Model 1	**p-value**	**Model 2**	**p-value**
100% Fresh fruit juices	0.4 (-0.5, 1.4)	0.4	0.4 (-0.5, 1.4)	0.3
Fresh/Dried fruits	0.06 (-0.3, 0.4)	0.7	0.07 (-0.3, 0.4)	0.7
Canned fruits	1.5 (-6.5, 9.6)	0.7	2.1 (-5.8, 10.3)	0.6
Vegetables (raw/cooked/canned)	-0.2 (-1.2, 0.5)	0.5	-0.2 (-1.1, 0.6)	0.5
Legumes	0.5 (-0.3, 1.2)	0.2	0.5 (-0.3, 1.3)	0.2
Refined grains and cereals	0.02 (-0.3, 0.4)	0.8	0.04 (-0.3, 0.4)	0.8
Whole-grain cereals	-0.05 (-0.5, 0.3)	0.8	-0.09 (-0.4, 0.4)	0.9
Low fat dairy products	-0.2 (-0.8, 0.3)	0.3	-0.2 (-0.8, 0.3)	0.3
Whole-fat dairy products	0.5 (-0.01, 1)	**0.05**	0.5 (-0.007, 1)	**0.05**
Eggs	-0.2 (-1.4, 1)	0.7	-0.2 (-1.4, 0.9)	0.7
Poultry	0.6 (-0.1, 1.3)	0.1	0.6 (-0.4, 0.6)	0.08
Red/organ meats	0.2 (-0.4, 0.8)	0.4	0.2 (-0.3, 0.9)	0.4
Processed meat	0.4 (-1.3, 2.1)	0.6	0.5 (-1.2, 2.2)	0.5
Fresh/canned Fish & Seafood	-0.9 (-2.2, 0.3)	0.1	-0.8 (-2.1, 0.3)	0.1
Fats & oils	-0.01 (-0.4, 0.4)	0.9	-0.005 (-0.4, 0.4)	0.9

Nuts & seeds	-0.1 (-0.6, 0.3)	0.7	-0.06 (-0.5, 0.3)	0.7
Fast food	0.1 (-0.2, 0.6)	0.3	0.2 (-0.2, 0.6)	0.3
Potato chips/Tortilla	-0.02 (-0.5, 0.3)	0.9	0.06 (-0.5, 0.3)	0.7
Sweets and deserts	0.1 (-0.2, 0.5)	0.4	0.1 (-0.2, 0.5)	0.3
Alcohol	-1.1 (-2.6, 0.4)	0.1	-1.1 (-2.6, 0.4)	0.1
Diet Soft drinks	0.1 (-0.6, 0.9)	0.7	0.1 (-0.6, 0.8)	0.7
Caffeinated beverages and tea	0.5(-0.5, 1.6)	0.3	0.5(-0.5, 1.5)	0.3
Sugar Sweetened Beverages	0.4 (-0.4, 1.2)	0.3	0.3 (-0.5, 1.1)	0.4
Water	-	-	-	-

*Increase in Waist circumference

Model 1 was adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and further adjusted to baseline BMI in model 2

Multivariate logistic linear regression for continuous variables reported as change (95% CI)

The same models were adopted to examine the association between changes of food groups' intakes with Body Fat Percent. For Food groups as servings per day, fresh juice intake showed significant association with Body Fat Percent in model 1 and 2 whereby an increase in one serving of 100% fresh juice decreased Body fat percentage by 1.1 in both models 1 and 2. Diet Soft Drinks and red organ meats showed significant association in model 1 as Percent Kcal per day whereby body fat percentage increased by 0.3 and decreased by 0.2 respectively. Results are listed in tables 13 and 14.

The same multivariable design was used to test the association between macronutrient intake, Waist Circumference and Body Fat percentage. Results from this analysis reported no significant association and results are listed in Appendix 2 and 3.

Table 13: *Multivariable-Adjusted Results for the Relationships between Changes in Food Groups' Intakes as servings per day and Percent Body Fat changes* (n=159)*

Increased Dietary Intake	Percent Body Fat change within 5-Year Period (95% CI)

(servings/day)	Model 1	p-value	Model 2	p-value
100% Fresh fruit juices	-1.1 (-2.1, -0.09)	**0.03**	-1.1 (-2.1, -0.08)	**0.03**
Fresh/Dried fruits	0.1 (-0.04, 0.3)	0.1	0.1 (-0.06, 0.3)	0.1
Canned fruits	-1.5 (-6.1, 3.1)	0.5	-1.3 (-6, 3.3)	0.5
Vegetables (raw/cooked/canned)	0.1 (-0.3, 0.6)	0.5	0.1 (-0.3, 0.6)	0.4
Legumes	0.1 (-1.3, 1.6)	0.8	0.08 (-1.4, 1.5)	0.9
Refined grains and cereals	-0.06 (-0.2, 0.08)	0.4	-0.06 (-0.2, 0.08)	0.4
Whole-grain cereals	-0.02 (-0.2, 0.2)	0.8	-0.002 (-0.2, 0.2)	0.9
Low fat dairy products	-0.2 (-0.8, 0.4)	0.5	-0.2 (-0.8, 0.4)	0.5
Whole-fat dairy products	0.4 (-0.1, 1)	0.1	0.4 (-0.2, 1)	0.1
Eggs	-0.6 (-2.2, 0.9)	0.4	-0.7 (-2.3, 0.8)	0.3
Poultry	0.1 (-1, 1.2)	0.8	0.08 (-1.1, 1.2)	0.9
Red/organ meats	-0.7 (-1.6, 0.1)	0.09	-0.7 (-1.6, 0.1)	0.1
Processed meat	-2.2 (-6.2, 1.7)	0.2	-2.1 (-6.1, 1.9)	0.3
Fresh/canned Fish & Seafood	0.7 (-0.9, 2.3)	0.4	0.6 (-0.9, 2.3)	0.4
Fats & oils	-0.06 (-0.2, 0,07)	0.4	-0.04 (-0.1, 0.09)	0.5
Nuts & seeds	0.07 (-0.5, 0.6)	0.8	0.06 (-0.5, 0.6)	0.8
Fast food	1.2 (-1.6, 4)	0.4	1.1 (-1.6, 3.9)	0.4
Potato chips/Tortilla	-	-	-	-
Sweets and deserts	0.005 (-0.1, 0.1)	0.9	0.01 (-0.1, 0.1)	0.8
Alcohol	-31.3 (-95.7, 33)	0.3	-29 (-93.5, 35.4)	0.3
Diet Soft drinks	-	-	-	-
Caffeinated beverages and tea	-	-	-	-
Sugar Sweetened Beverages	-0.5 (-1.6, 0.4)	0.2	-0.6 (-1.6, 0.4)	0.2
Water	-	-	-	-

*Decrease in Percent Body Fat

Model 1 was adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and further adjusted to baseline BMI in model 2

Multivariate logistic linear regression for continuous variables reported as change (95% CI)

Table 14: *Multivariable-Adjusted Results for the Relationships between Changes in Food Groups' Intakes as Percent Kcal per day and Percent Body Fat changes* (n=159)*

Increased Dietary Intake (%Kcal/day)	Percent Body Fat change within 5-Year Period (95% CI)			
	Model 1	p-value	Model 2	p-value
100% Fresh fruit juices	-0.2 (-0.7, 0.1)	0.1	-0.2 (-0.7, 0.1)	0.2
Fresh/Dried fruits	0.01 (-0.1, 0.1)	0.9	0.01 (-0.1, 0.1)	0.8
Canned fruits	-0.9 (-4.3, 2.5)	0.5	-0.7 (-4.1, 2.7)	0.6
Vegetables (raw/cooked/canned)	-0.1 (-0.5, 0.2)	0.4	-0.1 (-0.4, 0.2)	0.5
Legumes	-0.04 (-0.3, 0.2)	0.7	-0.05 (-0.3, 0.2)	0.7
Refined grains and cereals	-0.1 (-0.2, 0.04)	0.1	-0.1 (-0.2, 0.05)	0.1

Whole-grain cereals	-0.09 (-0.2, 0.09)	0.3	-0.07 (-0.2, 0.1)	0.4
Low fat dairy products	-0.1 (-0.3, 0.1)	0.4	-0.1 (-0.3, 0.1)	0.4
Whole-fat dairy products	-0.02 (-0.2, 0.2)	0.8	-0.02 (-0.2, 0.2)	0.8
Eggs	-0.2 (-0.7, 0.2)	0.2	-0.2 (-0.7, 0.2)	0.2
Poultry	-0.008 (-0.3, 0.3)	0.9	0.003 (-0.3, 0.3)	0.9
Red/organ meats	-0.2 (-0.5,-0.002)	**0.05**	-0.2 (-0.5, 0.02)	0.07
Processed meat	-0.2 (-0.9, 0.5)	0.5	-0.1 (-0.9, 0.5)	0.6
Fresh/canned Fish & Seafood	-0.09 (-0.6, 0.4)	0.7	-0.07 (-0.6, 0.4)	0.7
Fats & oils	-0.1 (-0.3, 0.03)	0.1	-0.1 (-0.3, 0.03)	0.1
Nuts & seeds	-0.1 (-0.3, 0.03)	0.1	-0.1 (-0.3, 0.05)	0.1
Fast food	0.05 (-0.1, 0.2)	0.5	0.06 (-0.1, 0.2)	0.5
Potato chips/Tortilla	0.02 (-0.2, 0.2)	0.8	0.06 (-0.1, 0.2)	0.6
Sweets and deserts	-0.1 (-0.2, 0.06)	0.2	-0.09 (-0.2, 0.07)	0.2
Alcohol	-0.3 (-1, 0.2)	0.2	-0.3 (-1, 0.2)	0.2
Diet Soft drinks	0.3 (0.007, 0.6)	0.04	0.3 (-0.01, 0.6)	0.05
Caffeinated beverages and tea	-0.005(-0.4, 0.4)	0.9	-0.02(-0.4, 0.4)	0.9
Sugar Sweetened Beverages	-0.2 (-0.5, 0.1)	0.2	-0.2 (-0.6, 0.1)	0.1
Water	-	-	-	-

*Decrease in Percent Body Fat

Model 1 was adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and further adjusted to baseline BMI in model 2
Multivariate logistic linear regression for continuous variables reported as change (95% CI)

2. *Dietary Score changes and association with Waist Circumference and Body Fat Percent change*

A multivariate model was adopted to assess the association between the changes in HEI scores and changes in Waist Circumference and Body Fat Percentage. These models were adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up in Model 1 and further adjusted to baseline BMI in model 2. The results shown in Tables 15 of the multivariate model showed no significant association between the dietary scores and WC and BF%.

Table 15: *Multivariable-Adjusted Results for the Relationships between Changes in Dietary Scores, Waist Circumference* and percent body fat& (n=159)*

Dietary score evaluation	Waist Circumference and Percent Body Fat change (in cm* and %&) within 5-Year Period (95% CI)			
	Model 1	p-value	Model 2	p-value
HEI total score difference*	-0.02(-0.2 , 22.3)	0.832	-0.004 (-0.1 , 0.1)	0.967
HEI total score difference&	0.02(-0.06 , 0.1)	0.574	0.03(-0.05 , 0.1)	0.477

*Increase in Waist Circumference

& Decrease in Percent Body Fat

Model 1 was adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and further adjusted to baseline BMI in model 2

Multivariate logistic linear regression for continuous variables reported as change (95% CI)

3. Dietary Score changes and association with cardiometabolic risk factors

The same model was also used to assess the association between the HEI scores with changes in each cardiometabolic risk factor. The results showed no significant association except for the Systolic Blood Pressure, in which the increase in one unit HEI score decreased SBP by 0.3 mmHg in both models.

Results of both models are reported in table 16.

Table 16: *Multivariable-Adjusted Results for the Relationships between HEI and cardiometabolic risk factors (n=159)*

HEI total score difference	Cardiometabolic Risk Factors and their Incidence within 5-Year Period (95% CI)			
	Model 1	p-value	Model 2	p-value
Incidence of Hyperglycemia[1]	0.2 (-19.3 , 43.1)	0.392	2.6 (-35.6 , 41)	0.449
Incidence of low HDL[1]	0.09 (-0.07 , 0.2)	0.282	0.09 (-0.07 , 0.2)	0.272
Incidence of high TG[1]	0.5 (-0.4 , 1.4)	0.272	0.4 (-0.4 , 1.4)	0.337
Incidence of high SBP[1]	-0.3(-0.6 , -0.06)	**0.015**	-0.3 (-0.6 , -0.05)	**0.02**
Incidence of high DBP[1]	-0.1 (-0.3 , 0.03)	0.123	-0.09 (-0.2 , 0.06)	0.253
Incidence of Hyperglycemia[2]	0.967	0.155	0.967	0.147

Incidence of low HDL²	1.015	0.585	1.01	0.734
Incidence of high TG²	1.001	0.958	1.002	0.945
Incidence of high SBP²	1.006	0.786	1.004	0.878
Incidence of High DBP²	0.986	0.509	0.985	0.483

¹ Multivariate logistic linear regression for continuous variables reported as change (95% CI)

² Binary logistic regression for categorical variables reported as OR

Model 1 was adjusted for age (follow-up), gender, baseline sleep duration, changes in physical activity, cigarette smoking status at follow-up, nargile smoking status at follow-up and further adjusted to baseline BMI in model 2

CHAPTER V

DISCUSSION

This study has investigated longitudinal changes in dietary intakes over a 5 year period in Lebanese Urban Adults, and examined their association with changes in anthropometric characteristics as well as cardiometabolic risk factors (Fasting Blood Glucose, HDL, TG, SBP and DBP). Our results showed that the intakes of total fat and its specific subtypes have significantly decreased, while that of carbohydrates increased during the study period, with the magnitude of change being of approximately 2%EI. In parallel, the intakes of fats and oils, processed meat, refined grains, and SSBs, decreased over time, while that of fresh/dried fruits, whole grains and fast food have increased. The total HEI score was found to significantly increase, from 65.2 ± 9.6 to 67.7 ± 9.3. The study also documented a significant association between changes in the intakes of specific food groups, or diet quality (HEI) and changes in WC, percent body fat and SBP.

Our findings showed that, in a period of 5 years, body weight increased by 0.9kg (0.18kg/year), however this increase did not reach statistical significance. In addition, and in line with the findings on body weight, there were no significant changes in the study population's BMI. These estimates fall within the range of those described in the literature. Mozaffarian et al., have reported an increase of 0.36kg/year, and Cespedes et al., reported a 0.17 kg increase per year (Mozaffarian et al., 2011) (Cespedes et al., 2017). The fact that total body fat decreased in our study by close to 1%, while WC increased by 2.6cm (0.52cm/year). , suggest that a change in body fat accumulation pattern may have occurred over time, favoring the deposition of abdominal fat. In fact, previous studies have reported that regardless of gender, subcutaneous fat decreases while abdominal fat increases with age (Kuk et al. 2009). These age-specific changes in body composition may occur independent of changes in total adiposity or body weight, and represent a phenotype that may increases the risk of morbidity and mortality risk (Kuk et al. 2009).

The observed significant increase in WC in our study, and which exceeds in magnitude that reported by other studies (e.g. 0.31 cm increase per year) (Cespedes et al., 2017), is of concern given the direct association between abdominal adiposity, cardiometabolic abnormalities and NCDs (Balkau et al., 2007; Janiszewski et al., 2007). The average WC at follow up was of 100.6 ± 14.5 cm, which is higher than the cut-off point set by the international Diabetes Federation for Middle-Eastern Arabs (94cm in men and 80cm in women) and hence highlight a risk for developing cardiometabolic diseases (Alberti et al., 2009; NCEP , 2002)).). In fact our study findings showed that fasting blood glucose, SBP and DBP have significantly increased over time in the study population with a mean change (5^{th}, 95^{th} percentile) of 8.5 (-21, 59.4), 2.5 (-28.3, 41.7) and 2.4 (-15.5, 22.5) respectively. Our results are in accordance with those reported by other studies. Cross-sectional data from the 2007–2018 National Health and Nutrition Examination Survey revealed that the relative risk for hypertension was significantly higher in those with WC gain >5% (for males, relative risk = 1.34, 95%CI = 1.15–1.57; for females, relative risk = 1.28, 95% CI = 1.10–1.50) compared with the reference group (−2.5-2.5%) (Sun et al., 2021). According to the 1993-2015 China Health and Nutrition Survey (5,742 men and 5,972 women aged 18-66 years with no history of antihypertension medication use), each 1-cm annual increase in WC in men and women was associated with a 0.98-mm Hg and a 0.97-mm Hg annual increase in systolic blood pressure and a 1.13-mm Hg and a 0.74-mm annual increase in diastolic blood pressure, respectively, independent of annual BMI change (Wang et al., 2020).

In line with the observed decrease in percent body fat, our results showed a decrease in total energy intake (by approximately 300 kcal/day). Data from both cohort and cross-sectional surveys in many countries are consistent in indicating a decline in energy intake with age (Block et al., 1988; Wakimoto et al., 2001). Mean energy intake was shown to decline on average by 1000 to 1200 kcal in men and by 600 to 800 kcal in women between those aged in their 20s and those in their 80s (Wakimoto et al., 2001). Energy intake is also shown to decline with age due to body composition changes that eventually decrease energy needs (Volpi et al., 2010; Cho et al., 2020). In addition, an apparent increase in health and dietary consciousness among older people, and women in specific, has been suggested in the literature (Wakimoto et al., 2001). It is important to note that, in our study, we did not evaluate dietary changes in relation to the participants' perception towards diet or health.

The observed decrease in total energy intake can be the result of the decreased consumption of energy-dense foods. Our dietary intake analysis has in fact shown a significant decrease in the consumption of fats and oils, sugar sweetened beverages, processed meat, and refined grains over the five-year study period (-1.6, -0.2, -0.1 and -1.9 servings/day, respectively). In parallel, a significant decrease in total fat intake, the macronutrient with the highest energy density was observed, with a magnitude of 2.4% EI. Other significant changes in dietary intakes were for fresh/dried fruits and whole grains, the consumption of which has increased by approximately one serving/day for each. This was accompanied by a significant increase in carbohydrates' intakes

(+2.3%EI). In agreement with our findings, a 9-year longitudinal study showed significant decreases in total fat and cholesterol consumption in women and a decrease in fat intake and energy in men (Garry et al., 1992). The changes in food groups' intakes as observed in our study were reflected in a significant increase in the HEI in the study sample, suggesting an improvement in the overall quality of the diet. In a study done by Wang et al. assessing dietary quality among adults in the US from 1999 to 2010, improvement in HEI scores were accompanied with a decrease in fat consumption and empty caloric foods (Wang et al., 2018). In agreement with our study findings, Jankovic et al. showed, based on data stemming from the Zutphen Elderly Study (n=467 men, aged 64–85 years), a trend towards a healthier diet over the 5 year period, characterized by a significant decrease in high-fat meat and meat products and a significant increase in fruit intake, low-fat milk products and healthy fats, (Jankovic et al., 2014). In contrast to our findings, Borland et al., have reported stability in dietary patterns over a 2 year period in young women from the Southampton Women's Survey (Borland et al., 2007).

Our findings highlight the association of a number of changes in dietary factors that are independently associated with changes in anthropometry, namely waist circumference and percent body fat. Based on our multivariate regression models, our study showed an association between dairy products and changes in WC. More specifically, each increase in one serving of low fat dairy products was significantly associated with a 1.5 cm decrease in WC within the 5 years period, while each increase in one serving of whole fat dairy products was significantly associated with 1.4-1.6 cm increase in WC. In agreement with our findings, a cross-sectional study conducted in the UK (n=12 065 adults aged 30—65 years) reported that low-fat dairy intake was inversely associated with visceral: subcutaneous fat ratio estimated with dual-energy X-ray absorptiometry, the latter being directly related with abdominal obesity (Trichia et al., 2019). Similarly, Trichia et al (2020) showed, based on the EPIC study, that longitudinal increases in low-fat yogurt and cheese were associated with a lower increase in adiposity markers (body weight and BMI). In contrast, an increase in full-fat milk, high-fat cheese, and total high-fat dairy was significantly associated with higher increases in body weight and BMI (Trichia et al, 2020]. Evidence from randomized controlled trials on the link between whole fat dairy products and adiposity markers has yielded inconclusive evidence, highlighting the need for further confirmatory studies.

In our multivariable regression analyses, we observed an association between the consumption of fresh fruit juice intake and a decrease in body fat percentage. The increase in one serving of fresh fruit juices was in fact associated with a decrease in -1.1 percent body fat, which remained the same after adjusting for BMI. Consumers perceive 100% fruit juice as a healthier alternative to SSBs (Munsel et al., 2016), although these juices are high in free sugars and some studies have suggested that it would exert negative health effects similar to SSBs (Shefferly et al., 2016; Moaffarian et al.,2011). Although, fruit juice often contains similar nutrients compared to whole fruit, juicing leads to a significant reduction in dietary fibers, which may reduce satiety and enhance hunger, which causes them to have moderately high glycemic indexes and contributing to additional intake of foods (Atkinson et al.,2008; Camhi et al.,2015). Interestingly, and based on data collected from the 2003–2006 NHANES, the Healthy Eating Index (HEI) 2005 score was significantly higher ($P < 0.0001$) for consumers of fresh juices vs. non-consumers across age all groups (O’Neil et al., 2011). We can infer that reverse association between fruit juices and percent body fat may reflect other healthy eating behaviors.

Although previous studies have identified an inverse relation between HEI scores and anthropometry, our analysis did not identify such an association. However, our analyses showed an inverse association between HEI and Systolic blood pressure, in which a 0.3 mmHg decrease in Systolic Blood pressure was observed for a 2.4 increase in HEI. According to the cross-sectional Isfahan Healthy Heart program (IHHP), women in the highest quintile of HEI had the lowest mean values of systolic blood pressure (Haghighatdoost et al., 2013). In addition, Motamedi et al. reported a significant protective effect of high scores for HEI-2015 against hypertension for both genders, (Motamedi et al., 2021). The HEI-2015 recommendations emphasize on lowering added sugars, refined grains, and sodium, all of which were shown to be positively associated with hypertension in the literature (Krebs et al., 2018). At the same time, the HEI favors diets that are low energy dense and include rich sources of fiber, phytochemicals, vitamins, magnesium, potassium and antioxidants, and these factors are protective against hypertension (Gopinath et al., 2012). Moreover, data from the China health and nutrition survey, suggest that on average, men who were diagnosed with hypertension decreased their sodium intake by 251 mg/d and their Na/K ratio by 0.19 within 2 to 4 years after diagnosis, suggesting that people adopt a healthier lifestyle according to their health status (Abruto et al., 2019).

Although our longitudinal study is one of the first to investigate dietary changes of a Middle-Eastern population over time and our cohort included both men and women from the Greater Beirut Area, this study had several limitations worth mentioning. First, the duration of the follow up was probably too short to identify a strong association of many dietary factors and dietary scores with anthropometric measures and cardiometabolic risk factors. In addition, our sample was considered small and the level of dropouts was high. The second limitation is related to misreporting of dietary intakes (using the FFQ) or physical activity level (using IPAQ). Although the administration of these questionnaires in an interview setting may lead to social desirability bias, it is important to note that all the personnel involved in data collection had received extensive training to reduce judgmental verbal and nonverbal communication in order to minimize any social desirability bias. Both the FFQ and the IPAQ were not validated in our population; but these instruments were previously used in dietary and physical assessment studies among Lebanese adults and the findings of these studies yielded plausible associations with obesity, metabolic syndrome, diabetes and metabolic health (Nasreddine et al., 2006; Naja et al., 2013; Naja et al., 2011; Chamieh et al., 2015; Jomaa et al., 2016): it is also important to note that while the assessment of dietary intake via the FFQ, may be limited by measurement errors, reliance on memory and the number of food items included in the food list (Louzada et al., 2015), the FFQ was shown to be one of the most suitable approaches to be used in epidemiological studies , as it provides information on the participants' habitual diet over longer periods of time (Caan et al., 1999) . Another limitation is the fact that, our analysis did not take into consideration medications used to treat cardiometabolic diseases (if any) which could have diluted the findings related to the changes in cardiometabolic risk factors and their association with the diet. In addition, accounting for reverse causality between the development of diseases and improvements in diet, resulting in a health conscious mindset was not taken into account during the analysis, Finally, the present study was restricted to the urban setting of the Greater Beirut area; hence, findings pertinent to the consumption levels of foods and their changes over time may not be representative of less urban settings in the country. The choice of Beirut may be explained by the fact that it hosts 40 % of the Lebanese population and is usually considered a melting pot of the country (Nasreddine et al., 2018).

CHAPTER VI

CONCLUSION

The present study is amongst the first studies in the Middle-East to assess changes in dietary intakes and quality over time, and investigate their association with anthropometry and cardiometabolic risk factors. The study showed that the intakes of total fat and its specific subtypes have significantly decreased, while that of carbohydrates increased during the study period. In parallel, the intakes of fats and oils, processed meat, refined grains, and SSBs, decreased over time, while those of fresh/dried fruits and whole grains have increased. In parallel, total HEI score was found to significantly increase in the study population. The study documented a significant association between changes in the intakes of specific food groups, or diet quality (HEI) and changes in WC, percent body fat and SBP.

One of the barriers to adopting a healthy diet is missing the concept of integration between lifestyle behaviors and its influence on healthier dietary choices. Further studies should be done to better understand dietary changes and their predictors in the Lebanese population. For example, more research is needed to understand the sociodemographic characteristics that were associated with improvements in dietary intakes and whether these changes were linked to changes in health/disease status, to finally further formulate preventive strategies for overweight/obesity.

APPENDIX

1. **Healthy Eating Index Score food group evaluation represented as Mean±SD and Mean change (5th to 95th) over 5 year period.**

Variable	Baseline	Follow-up	Change within 5 years	p-value*
	Mean ± SD		Mean (5th percentile, 95th percentile)	
HEI Food Group				
Total Fruits cup/1000KCAL	0.82 ± 1.2	1.2 ± 1	0.4(-0.9 , 1.8)	<0.001
Whole Fruits cup/1000KCAL	0.52 ± 0.42	0.83 ± 0.57	0.3(-0.4 , 1.1)	<0.001
Total Vegetables cup/1000KCAL	1.5 ± 1	1.1 ± 0.76	-0.3(-1.9 , 1.2)	<0.001
Greens and beans cup/1000KCAL	0.54 ± 0.69	0.61 ± 0.5	0.07(-0.5 , 1)	0.224
Whole Grains cup/1000KCAL	0.3 ± 0.59	0.54 ± 0.76	0.2(-0.7 , 2)	<0.001
Dairy cup/1000KCAL	0.24 ± 0.28	0.24 ± 0.19	0.0(-0.4 , 0.3)	0.998
Total Proteins cup/1000KCAL	0.53 ± 0.69	0.42 ± 0.33	-0.1(-0.7 , 0.6)	0.047
Seafood and Plant Proteins cup/1000KCAL	0.4 ± 0.69	0.35 ± 0.3	-0.09(-0.7 , 0.5)	0.084
Fatty Acids RATIO	48.7 ± 25.7	41.6 ± 26.2	-7(49.9 , 27)	0.001
Refined Grains oz/1000KCAL	3.6 ± 1.8	3.2 ± 1.7	-0.3(-3.8 , 2.6)	0.015
Sodium grams/1000KCAL	0.97 ± 0.22	0.96 ± 0.21	-0.01(-0.5 , 0.4)	0.507
Added Sugars %EI	3.6 ± 1.3	4.2 ± 1.5	0.5(-1.5 , 3.6)	<0.001
Saturated FA %EI	1.2 ± 0.3	1.1 ± 0.27	-0.06(-0.6 , 0.4)	0.010

2. **Multivariable-Adjusted Results for the Relationships between Changes in Macronutrient Intake as Percent Energy Intake per day and Waist Circumference (n=184)**

Increased Dietary Intake (%EI/day)	Waist Circumference change (in cm) within 5-Year Period (95% CI)			
	Model 1	p-value	Model 2	p-value
Proteins	-0.009 (-1.5 ,1.4)	0.9	0.1 (-1.3 ,1.6)	0.8

CHO	-0.06 (-1.3 ,1.1)	0.9	0.04 (-1.1 ,1.2)	0.9
Fat	-0.1 (-1.3 ,1.1)	0.8	-0.01 (-1.2 ,1.2)	0.9

3. **Multivariable-Adjusted Results for the Relationships between Changes in Macronutrient Intake as Percent Energy Intake per day and Percent Body Fat (n=159)**

Increased Dietary Intake (%EI/day)	**Percent Body fat change within 5-Year Period (95% CI)**			
	Model 1	**p-value**	**Model 2**	**p-value**
Proteins	0.2 (-0.4 ,0.8)	0.5	0.2 (-0.3 ,0.9)	0.5
CHO	0.3 (-0.2 ,0.8)	0.2	0.3 (-0.1 ,0.9)	0.1
Fat	0.2 (-0.2 ,0.8)	0.3	0.3 (-0.2 ,0.8)	0.2

4. Consent Form to Participate in a Research Study

Protocol # Bio-2018-0386 (February 2019)

<u>Consent to participate in a research study</u>

Cardiovascular profiles and mental health conditions in a Lebanese community-based cohort

Principal Investigator: Dr. Martine Elbejjani
Phone: (01) 350 000 ext 5446

Co-investigators:
Hussain Isma'eel
Nathalie Khoueiry-Zgheib
Mona Nasrallah
Lara Nasreddine
Hani Tamim

Address: Halim and Aida Daniel Academic and Clinical Center
American University of Beirut Medical Center

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Site where the study will be conducted: AUB

You are being asked to participate in the follow-up examination of a clinical research study conducted at the American University of Beirut. Please take time to read the following information carefully before you decide whether you want to take part in this study or not. Feel free to ask the study research team for more information or clarification about what is stated in this form and the study as a whole.

This study is the follow-up assessment of the study entitled "Assessment of BPA levels and their association with the health status among Lebanese population" [IM.HT.03], which gave rise to the Greater Beirut Area CardioVascular Cohort study, and which you have participated in in February-June 2014.

Your participation and data were of immense value and have helped us to further our understanding of Bisphenol A (BPA) levels and cardiovascular health in Lebanon. We contacted you by phone, as per your consent in 2014, to participate in the follow-up stage of the study, which will follow the same process as the baseline study.

This follow-up study aims to assess the predictors and consequences of midlife changes in cardiovascular and metabolic health in Lebanon, and to investigate the relationships between cardiovascular risk factors and mental health.

The follow-up study will be conducted, just like the baseline examination, at AUB, and will include the same assessments that were conducted at baseline:

- questionnaires on medical history, demographic and socioeconomic factors, lifestyle factors (smoking, coffee and alcohol consumption, physical activity), sleep habits; (20-30 minutes)
- questionnaire on diet and food consumption (20-30 minutes);physical exam to measure weight, height, waist circumference, blood pressure, and heart rate (10 minute);
- blood sugar test with a fingerstick (1 minute);

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- 15 ml blood sample and a urine sample will be collected for several clinical markers (including HBA1c, fasting blood sugar, creatinine, lipid profile, TSH, SGPT, GGT, fasting insulin, urinary creatinine, microalbuminuria, 25 OH vit D, Cortisol, C-peptide, prolactin), (10-15 minutes);
- with the addition of questionnaires on depression, anxiety, and migraine (10-15 minutes).

All study exams will be performed by trained and certified research assistants.
The exams will take around an hour and a half to be completed and your total visit time to AUB will be no longer than 3 hours visit to the AUB.
The study aims to include around 350 participants from the baseline study, and participants will be secured transport to complete the visit or reimbursed for transportation fees (10,000LBP).

Potential risk: The above mentioned measures have minimal risk: None have any long-term hazards and all blood withdrawal will be done under sterile hygienic conditions at the AUB by trained and certified research personnel. There may be unforeseeable risks. Possible side effects include mild pain, bleeding, bruising at the site of the needle insertion. Fainting or light-headedness can sometimes occur, but usually last only a few minutes.

Adverse events coverage: AUBMC will cover the cost of treating, on its premises, medical adverse events resulting directly from the procedures of this research study. Otherwise, it will not cover for the costs of medical care for any medical condition or issue.

Participation benefits: The results of previous and new tests conducted will be freely provided to the participants. Participants will be advised if needed to follow-up with their treating physicians regarding significant findings. Participants will receive travel expenses and incentives (30,000 LBP) upon arriving to AUB. In addition, we will provide the participants with breakfast the same day.

Confidentiality & privacy:
If you agree to participate in this research study, the information will be kept confidential. Unless required by law, only the study doctor and designee, the ethics committee and inspectors from governmental agencies will have direct access to your data.

All data and biological samples collected will be stored in a confidential manner. These measures will all be conducted ensuring there is no breach of participants' privacy. Moreover, the remaining blood and urine samples will be stored securely indefinitely in the study investigators' laboratories at the AUB. If you elect to withdraw your consent for the study, your samples will be destroyed.
You may ask that we provide you with the genetic results and explain their significance to you. The information will be kept confidential.

Your participation in the study is greatly appreciated and will help in obtaining invaluable data. You have the right to accept or decline participation. Refusing to participate will not involve any loss of benefits offered in the future by AUB or AUB Medical Center (AUBMC). Moreover, you are entitled to withdraw from the study at any time without any loss of benefits offered by AUB or AUBMC at any time. The study PIs can withdraw subject's participation at anytime during the course of the study.

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I agree to participate in this study and the procedures explained above:

YES ……….   NO…………

Your data are invaluable to us and you are helping us build a unique cohort with repeated data. We would like to contact you for potential future studies and follow-up examinations.

I agree to be contacted for future studies:

YES ……….   NO…………

I would like to be contacted if the genetic test results are significant:

YES ……….   NO…………

Using remaining blood and urine for other future studies

We would like to keep the remaining blood and urine samples for potential use in other future studies. To do so, there might be future collaborators at AUB, at other institutions in Lebanon and/or outside Lebanon. The stored blood and urine samples will be coded (*this means that blood* and urine *samples will be unidentified for research purposes but can be linked to their source through the use of codes; however, the principal investigators will be the only ones to have the list linking participants to the codes assigned).*

I agree to permit the use of the remaining blood and urine sample for future studies:

YES ……….   NO…………

Your coded blood and urine samples may be shared with other investigators for related studies. These investigators will not know your identity.

I agree to have my coded blood and urine samples shared with other investigators for related studies:

YES ……….   NO…………

I permit coded use of my genetic materials (blood, saliva, DNA) for the proposed study and future genetic or DNA methylation studies (similar to the baseline IM.HT.03 study). I specify the use of the samples in the following manner (please check on of the following):

a. **I permit further contact to seek permission to do further studies on the samples……….**
   OR
b. **I do not allow use of my biological samples for further studies……….**
   OR
c. **I permit anonymized (samples cannot be linked to subject) use of my biological materials for other studies without contact……….**

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Subject's Participation:
I have read and understood all aspects of the research study and all my questions have been answered. I voluntarily agree to be a part of this research study and I know that I can contact Dr. Martine Elbejjani at____(01) 350 000 extension _5446______or any of his/her designee involved in the study in case of any questions. If I feel that my questions have not been answered, I can contact the Institutional Review Board for human rights at __01-350000 -extension 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 Subject or Legal Representative or Parent/Guardian — Signature

____

Date & Time

______________________________ ______________________________

Witness's Name (if subject, representative or parent do not read) — Witness's Signature

____

Date & Time

Investigator's Statement:

I have reviewed, in detail, the informed consent document for this research study with ________ ______________________ (name of subject, legal representative, or parent/guardian) the purpose of the study and its risks and benefits. I have answered to all the subject's questions clearly. I will inform the participant in case of any changes to the research study.

______________________ __________________

Name of Investigator or designee — Signature

____

Date & Time

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5. Data Collection Form

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BIO-2018-0386

Cardiovascular and mental health profiles at middle age: the longitudinal Greater Beirut Area CardioVascular Cohort

Name: Initials:	BPA ID Number:	GBACC ID Number:
Tel number:		Date:

Demographic Factors:

Date of birth:	Gender: □ Male □ Female
Marital status: □ Married □ Single □ Widow □ Divorced □ Engaged	

Socioeconomic:

Have you lived outside Lebanon for the past year: □ Yes □ No	
If yes, where____________________ and for how long ____	
Which area do you live? What is the address? Street: ....next to	
What do you work?	
What is your income per family:	□<600$ □600- 999.9$ □1000-2000$ □>2000$ □ I don't know/ Not sure □ I prefer not to answer
What is your highest achieved level of education?	□ No schooling □ Primary school □ Intermediate school □ Secondary school □ Technical diploma □ University degree □ I prefer not to answer
What is the total number of individuals living in your house? (Including relatives, family members and maids that frequently live with you on a semi-permanent basis)	
Is your residence owned by a household member?	□ Yes □ No
How many rooms are there in your house? (Excluding kitchens, bathrooms, hallways, balconies, and garage)	

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Lifestyle:

Smoking history			
Cigarette	Do you currently smoke cigarettes?	□ Yes □ No	If yes, how many cigarettes/day? Since when?
	If no, are you a previous cigarette smoker?	□ Yes □ No	If yes, how many cigarettes/day did you use to smoke? If yes, when did you stop?
Narghileh	Do you currently smoke narghileh?	□ Yes □ No	If yes, how many narghileh/day? Since when?
	If no, are you a previous narghileh smoker?	□ Yes □ No	If yes, when did you stop?

Alcohol		
Did you drink any alcohol in the past year?	□ Yes □ No	
If yes	Do you currently drink alcohol? □ Yes □ No	
	If yes Since when? _______ How many bottle/can of beer per week? _______________ How many glass of wine per week? ___________________ How many drink of hard liquor per week? ______________ In the past month, what is the largest number of drinks you had in one occasion?_____________ drinks	
If no	Previous drinker? □ Yes □ No	If yes, when did you stop?
Coffee		
Do you currently drink coffee?	□ Yes □ No If yes how many cups/day?_______________	
Physical activity		
During the last 7 days, on how many days did you do **vigorous** physical activities like heavy lifting, aerobics, or fast bicycling for at least 10 minutes (or any activity that take hard physical effort and make you breathe harder than normal)?	---------------- days/week □ None - How much time in total did you usually spend on one of those days doing vigorous physical activities? _____ hours ______ minutes? - How many weeks did you spend doing vigorous physical activities during the last 3 months? ---------------weeks	
During the last 7 days, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or tennis (or any activity that take hard physical effort and make you breath harder than normal)? Do not include walking.	---------------- days/week □ None - How much time in total did you usually spend on one of those days doing moderate physical activities? _____ hours ______ minutes? -How many weeks did you spend doing moderate physical activities during the last 3 months? ---------------weeks	

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During the last 7 days, on how many days did you **walk** for at least 10 minutes at a time? This includes walking at work and at home, walking to travel from place to place, and any other walking that you did solely for sport, exercise or leisure.	--------------- days/week □None - How much time in total did you usually spend walking on one of those days? _____ hours ______ minutes? -How many weeks did you spend walking during the last 3 months? --------------weeks
During the last 7 days, how much time in total did you usually spend sitting on a week day? This includes time spent sitting at a desk, visiting friends, reading traveling on a bus or sitting or lying down to watch television.	_____ hours ______ minutes? -How many weeks have you been spending the same time in terms of sitting during the last 3 months? ---------------weeks

Medical History:

Coronary artery disease:

Do you have any family member who has been diagnosed with coronary artery disease or died suddenly?	□ Yes □ No If yes: specify who	At what age:
Have you been told by a doctor that you had a heart attack?	□ Yes If yes when: □ No	
Did you undergo cardiac catheterization?	□ Yes If yes when: □ No	
Was a stent placed?	□ Yes If yes when: □ No	
Did you have coronary heart bypass surgery?	□ Yes If yes when: □ No	
Did you have heart valve replacement surgery?	□ Yes If yes when: □ No	

Hypertension:

Have you been told by a doctor or a health care worker that you have high blood pressure?	□ Yes If yes when: □ No
Have you had your blood pressure measured by a doctor or a health care worker?	□ Yes If yes when: What was it? □ No
Are you taking any treatment for high blood pressure?	□Yes If yes specify: □ Life style modifications □Drugs: □ No
Family history of hypertension:	Father: □ Yes □ No Mother: □ Yes □ No **Siblings:** Sister: □ Yes - if yes, how many? □ No Brother: □ Yes - if yes, how many? □ No

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Diabetes Mellitus:

Have you been told by a doctor or a health care worker that you have raised blood sugar or diabetes?	□ Yes If yes when: □ No
Have you had your blood sugar measured by a doctor or a health care worker?	□ Yes If yes when: What was it? □ No
Are you taking any treatment for high blood sugar or diabetes?	□ Yes If yes specify: □ Life style modifications □ Drugs: □ No
Family history of diabetes:	Father: □ Yes □ No Mother: □ Yes □ No **Siblings:** Sister: □ Yes - if yes, how many? □ No Brother: □ Yes - if yes, how many? □ No

Dyslipidemia:

Have you been told by a doctor or a health care worker that you have raised cholesterol or triglycerides?	□ Yes If yes when: □ No
Have you had your cholesterol measured by a doctor or a health care worker?	□ Yes If yes when: What was it? □ No
Are you taking any treatment for dyslipidemia?	□ Yes If yes specify: □ Life style modifications □ Drugs: □ No
Family history of Dyslipidemia:	Father: □ Yes □ No Mother: □ Yes □ No Siblings: Sister: □ Yes - if yes, how many? □ No Brother: □ Yes - if yes, how many? □ No

Thyroid disease:

Have you ever been told by a doctor or a health care worker that you have thyroid disease?	□ Yes If yes when? What was the disease? □ No
Have you had your thyroid hormones measured by a doctor or a health care worker?	□ Yes If yes when? What was it? □ No
Are you taking any thyroid drug?	□ Yes If yes specify: □ No
Do you have any family history of thyroid disease? (Parents, siblings and grandparents)	□ Yes If yes specify who: □ No

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Cancer history:

Have you ever been told by a doctor or a health care worker that you have cancer?	□ Yes If yes when? What was the disease? □ No
Are you taking any chemotherapy or other treatment for cancer?	□ Yes If yes specify: □ No
Do you have any family history of cancer? (Parents, siblings and grandparents)	□ Yes If yes specify the disease: Specify who: □ No

Fracture history:

Did you ever sustain a fracture?	□Yes □No
If yes:	Where? Age at onset? How did it happen? (fall from height, accident…)?

Other diseases:

Have you been told by a doctor or a health care worker that you have any?	
Stroke?	□Yes If yes when: □No
Family history of stroke:	Father: □ Yes □ No Mother: □ Yes □ No Siblings: Sister: □ Yes - if yes, how many? □ No Brother: □ Yes - if yes, how many? □ No
Arthritis?	□Yes If yes when: □No
Asthma?	□Yes If yes when: □No
Chronic bronchitis or emphysema? Meaning: COPD- (Did you suffer from a cough and did you require cortisone and ventoline ?)	□Yes If yes when: □No
Liver disease?	□Yes If yes when: □No
Family history of dementia:	Father: □ Yes □ No Mother: □ Yes □ No Siblings: Sister: □ Yes - if yes, how many? □ No Brother: □ Yes - if yes, how many? □ No

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Do you have any other illnesses?

Does illness limit your ability to perform activities at home, school, work, or during free and leisure time?	□Yes □No

Medications (if not brought, call the participant later)

Generic Name	Brand Name	Dose	Date started

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Review of system:

<table>
<tr><td colspan="2">Do you have any weight changes during the last 3 months?</td><td>□ Stable weight
□Lost weight How many Kgs?
□Gained weight How many Kgs?</td></tr>
<tr><td rowspan="8">For women:</td><td>When was your last menstrual period?</td><td></td></tr>
<tr><td>What was your age at the first menstruation?</td><td></td></tr>
<tr><td rowspan="2">Are you
□ premenopausal
□ postmenopausal</td><td>If premenopausal

Do you have regular menses?
□ All the months
□ Most of the months
□ Rarely

Are you currently pregnant?
□ Yes
□ No</td></tr>
<tr><td>If postmenopausal

Are you currently taking hormone replacement therapy?

□ Yes
□ No
if yes, since when?____________</td></tr>
<tr><td>Have you been pregnant before?</td><td>□ Yes
□ No
If yes,
what is the number of previous pregnancies?______
Age at first pregnancy?_____</td></tr>
<tr><td>Have you ever taken birth control pills regularly?</td><td>□ Yes
□ No

If yes,

From when _______ until when _________?

What was the name of the pill?

Are you still taking them regularly?
□ Yes
□ No</td></tr>
<tr><td colspan="2">Do you have?

□ Acne
□ Hirsutism</td></tr>
</table>

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Sleep Habits, Epworth &Berlin questionnaires

1- **At what time do you usually FALL ASLEEP on weekdays or your work days?**
Hour _ _ : Min _ _ (in 24 hours)

2- **At what time do you usually FALL ASLEEP on weekends or your non-work days?**
Hour _ _ : Min _ _ (in 24 hours)

3- **How many minutes does it usually take you to fall asleep at bedtime? ____ minutes**

4- **At what time do you usually WAKE UP on weekdays or your work days?**
Hour _ _ : Min _ _ (in 24 hours)

5- **At what time do you usually WAKE UP on weekends or your non-work days?**
Hour _ _ : Min _ _ (in 24 hours)

6- **How many hours of sleep do you usually get at night (or your main sleep period) on weekdays or workdays? _____ hours**

7- **How many hours of sleep do you usually get at night (or your main sleep period) on weekends or your non-work days? ______hours**

8- **Reasons for sleeping late during weekdays?**
a. Working Night Shift
b. Reading / Studying
c. Watching TV
d. Social Media / Video games
e. Socializing
f. Others ______________________________

9- **Reasons for sleeping late during weekends?**
a. Working Night Shift
b. Reading / Studying
c. Watching TV
d. Social Media / Video games
e. Socializing
f. Others ______________________________

10- **During a usual week, how many times do you nap? (Write in "0" if do not take any naps.)**
_______ naps/week

11- **How long do you nap usually? _____._____ hours**

12- **Do you feel that you are not getting enough sleep?**

	Never		Rarely (1 / month)		Sometimes (2-4 / month)		Frequently (5-15 /month)		Almost Always (16-30 / month)

13- **Do you have Trouble falling asleep?**

	Never		Rarely (1 / month)		Sometimes (2-4 / month)		Frequently (5-15 /month)		Almost Always (16-30 / month)

14- **Do you wake up during the night and have difficulty resuming sleep?**

	Never		Rarely (1 / month)		Sometimes (2-4 / month)		Frequently (5-15 /month)		Almost Always (16-30 / month)

15- **Do you wake up too early in the morning and be unable to resume sleep?**

	Never		Rarely (1 / month)		Sometimes (2-4 / month)		Frequently (5-15 /month)		Almost Always (16-30 / month)

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Epworth scale

16- How likely are you to fall asleep in the following situations (in contrast to feeling just tired)?

	0: never	1: low	2: moderate	3: high
Sitting and reading				
Watching TV				
Sitting inactive in a public place (theatre, meeting)				
As a passenger in a car for an hour without a break				
Lying down to rest in the afternoon				
Sitting and talking to someone				
Sitting quietly after a lunch without alcohol				
In a car, while stopped for a few minutes in traffic				
Total Score				

Berlin questionnaire

17- Did your doctor tell you that you have sleep apnea?

Yes		No		

18- Do you snore?

Yes		No		Don't Know	

19- If you snore, your snoring is?

	a. Slightly louder than breathing		b. As loud as talking		c. Louder than talking		d. Very loud-can be heard in adjacent rooms

20- If you snore, how often do you snore?

	a. Nearly every day		b. 3-4 times a week		c. 1-2 times a week		d. 1-2 times a month		e. Never or nearly never

21- If you snore, has your snoring ever bothered other people?

	Yes		No		Don't Know

22- Has anyone noticed that you quit breathing during sleep?

a. Nearly every day		b. 3-4 times a week		c. 1-2 times a week		d. 1-2 times a month		e. Never or nearly never

23- How often do you feel tired or fatigued after you sleep?

a. Nearly every day		b. 3-4 times a week		c. 1-2 times a week		d. 1-2 times a month		e. Never or nearly never

24- During your waking time do you feel tired, fatigued or not up to par?

a. Nearly every day		b. 3-4 times a week		c. 1-2 times a week		d. 1-2 times a month		e. Never or nearly never

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25-Have you ever nodded off or fallen asleep while driving a vehicle?										
	Yes		No							
	26- If yes, how often does this occur?									
		a. Nearly every day		b. 3-4 times a week		c. 1-2 times a week		d. 1-2 times a month		e. Never or nearly never

Mental Health

Self-Perceived Stress In the past year, would you say that most days were:	□ At most, a bit stressful □ Quite a bit or extremely stressful

PATIENT HEALTH QUESTIONNAIRE (PHQ-9) – Depression Module

Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
	0	1	2	3
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so figety or restless that you have been moving around a lot more than usual	0	1	2	3
9. Thoughts that you would be better off dead, or of hurting yourself	0	1	2	3

Column totals: ___ + ___ + ___ + ___ = Total Score _____

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all _________ Somewhat difficult _________

Very difficult _________ Extremely difficult _________

If score=10 or above, please check the 'Depression' Box on the last page of this questionnaire.

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Generalized Anxiety Disorder 7-item (GAD-7) scale

Over the <u>last 2 weeks</u>, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
	0	1	2	3
1. Feeling nervous, anxious or on edge	0	1	2	3
2. Not being able to stop or control worrying	0	1	2	3
3. Worrying too much about different things	0	1	2	3
4. Trouble relaxing	0	1	2	3
5. Being so restless that it is hard to sit still	0	1	2	3
6. Becoming easily annoyed or irritable	0	1	2	3
7. Feeling afraid as if something awful might happen	0	1	2	3

Column totals: ___ + ___ + ___ + ___ = Total Score _____

If you checked off any problems, how difficult have these made it for you to do your work, take care of things at home, or get along with other people?

Not difficult at all __________

Somewhat difficult _________

Very difficult _____________

Extremely difficult _________

If score=10 or above, please check the 'Anxiety' Box on the last page of this questionnaire.

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Headaches	
Have you ever had a headache **in your lifetime**?	□ Yes □ No
Have you had a headache **during the last 12 months**?	□ Yes □ No
During **the last 30 days**, on how many of these days did you have a headache?	____ days*(please enter number of days between 0 and 30)*
How long do these headaches usually last? (please enter number of minutes or hours, or tick the box)	____min or ___ hour ☐ Never goes away
Do you take **any medication to treat** these headaches?	□ Yes □ No
Altogether, on how many days in the last 30 days did you take these medications?	_____ days*(please enter number of days between 0 and 30)*

AMPP/AMS Migraine diagnostic module

Please rate how frequently you experience the following symptoms with your most severe type of headache:

	Never	Rarely	Less than Half the Time	Half the Time or More
	1	2	3	4
1. The pain is worse on one side	1	2	3	4
2. The pain is pounding, pulsating, or throbbing	1	2	3	4
3. The pain has moderate or severe intensity	1	2	3	4
4. The pain is made worse by routine activities . such as walking or climbing stairs	1	2	3	4
5. You feel nauseated or sick to your stomach or vomit (throw up)	1	2	3	4
6. Light bothers you (more than when you do not have a headache)	1	2	3	4
7. Sound bothers you (more than when you do .....not have a headache)	1	2	3	4

Item Scoring for algorithm:
Symptoms scored 1-4 for:1=never ;2=rarely ; 3=less than half the time; 4=half the time or more.
Modified ICHD criteria:
Respondent meets criteria for migraine if:

1. 2/4 pain features (items 1-4) with score of ≥3
2. AND nausea (5) score ≥3 OR BOTH photophobia (6) AND phonophobia (7) score ≥3.

Respondent meets criteria for probable migraine if:

1. 1/4 pain features (items 1-4) with score of ≥3
2. AND nausea (5) score ≥3 OR BOTH photophobia (6) AND phonophobia (7) score ≥3.

OR

3. 2/4 pain features (items 1-4) with score of ≥3
4. AND photophobia (6) AND phonophobia (7) score ≥3

If participant meets criteria for migraine and/or probable migraine, please check the 'Migraine' box on the last page of the questionnaire.

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Have you been told by a doctor or a health care worker that you have migraine headaches?	□ Yes , if yes, when:________ □ No
Are you <u>currently</u> taking medication for migraine?□ Yes □ No	Have you <u>ever</u> taken medication for migraine? □ Yes □ No
Family history of migraine:	Father: □ Yes □ No Mother:□ Yes □ No Siblings: □ Yes □ No if yes, how many:_______

Mental Health history		
Have you been told by a doctor or a health care worker that you have depression?		□ Yes , if yes, when:________ □ No
Treatment for depression	Are you <u>currently</u> being treated without medication (psychotherapy) for depression? □ Yes □ No Are you <u>currently</u> being treated with medication (prescribed by a doctor) for depression? □ Yes If yes, since when?____ □ No	Have you <u>ever</u> been treated without medication (psychotherapy) for depression in the past? □ Yes □ No Have you <u>ever</u> been treated with medication (prescribed by a doctor) for depression in the past? □ Yes If yes, for how long:________ □ No
Have you been told by a doctor or a health care worker that you have an anxiety disorder?		□ Yes , if yes, when:________ □ No
Treatment for anxiety	Are you <u>currently</u> being treated without medication (psychotherapy)for anxiety? □ Yes □ No Are you <u>currently</u> being treated with any medication (prescribed by a doctor) for anxiety? □ Yes If yes, since when?____ □ No	Have you <u>ever</u> been treated without medication (psychotherapy)for anxiety in the past? □ Yes □ No Have you <u>ever</u>been treated with medication (prescribed by a doctor)for anxiety in the past? □ Yes If yes, for how long:________ □ No
Do you currently take any psychotropic medication without a prescription?		□ Yes , if yes, since when:________ □ No
Have you ever taken in the past any psychotropic medication without a prescription?		□ Yes , if yes, for how long:________ □ No
Have you been told by a doctor or a health care worker that you have insomnia or a sleep disorder?		□ Yes , if yes, when:________ □ No
Treatment for sleep	Are you <u>currently</u> taking any medication to help you sleep? □ Yes If yes, since when?________ how many times/month? ________ □ No	Have you ever <u>taken</u> any medication to help you sleep in the past? □ Yes □ No

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Family history		
Family history of depression?	Father: □ Yes □ No Mother: □ Yes □ No	Siblings: □ Yes □ No if yes, how many:_______
Family history of anxiety?	Father: □ Yes □ No Mother: □ Yes □ No	Siblings: □ Yes □ No if yes, how many:_______
Family history of insomnia or sleep problems?	Father: □ Yes □ No Mother: □ Yes □ No	Siblings: □ Yes □ No if yes, how many:_______

Environmental Exposure Questions

Does your house overlook a traffic street?	□ Yes □ No If yes, in what apartment level are you? _________
How long have you been living in this apartment?	______ years
Are there shops at the street level?	□ Yes □ No
Is your house close to a local diesel generator?	□ Yes □ No
Can you see the exhaust of a diesel generator from one of your balconies or windows?	□ Yes □ No
How long have you been living/ever lived near a local diesel generator?	□ Never Or ______ **years**
What are your indoor residential heating options in winter (e.g. chimney, wood/diesel burning stove, electric heater, water heater)**?**	_______________
What kind of transportation do you use most often to go to work?	□ **Own car** □ **Bus** □ **Taxi** □ **Bicycle** □ **Motorbike** □ **Walking** □ **Others, specify**
How long does it take you to get from:	Home to work ------hr ------min Work to home ------hr ------min
If participant do not work: **Do you walk on the street next to traffic on a daily basis?**	□ Yes □ No **If yes:** What time during the day? ________ For how long? ____Hour ____ minutes

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Self-rated health

1. In general, how would you rate your health these days? Is it excellent, very good, good, fair or poor?	☐ Excellent ☐ Very good ☐ Good ☐ Fair ☐ Poor
2. Compared to others your age, would you say your health is much better, better, about the same, worse, or much worse?	☐ Much better ☐ Better ☐ About the same ☐ Worse ☐ Much worse

FOOD FREQUENCY QUESTIONNAIRE

Name of the participant:---------------------------------- Initials:----------------------------- Study ID number: ----------------------------------

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

Code	Food item	Reference Portion	Serving Size	Day	Week	Month	Rarely/Never
	Examples:						
	Rice, white, cooked	*A side*	*½ A 11*		*3*		
	Cheese, regular	*B side/ Thickness*	*B1 / Th. 2*	*4*			
	Legumes, canned (beans, peas)	*Side A/ Page 4*	*1.5 cups*		*2*		
1	**Bread and Cereals**						
1.1	Bread, white	1 large Arabic loaf					
		1 medium Arabic loaf					
		1 French baguette					
		1 pain de mie/ toast					
1.2	Bread, brown	1 large Arabic loaf					
		1 medium Arabic loaf					
		1 French baguette					
		1 pain de mie/ toast					
1.3	Traditional breads(markouk/tannour)	1 loaf					
1.4	Breakfast cereals, regular/ sugar coated/ chocolate/ bran	Side A					
		Carton (35 g)					
1.5	Kaak	Finger size Small round / Page 13					

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1.6	Rice, white, cooked	Side A/ Page 5					
1.7	Pasta/ Noodles, plain, cooked	Side A/ Page 5					
1.8	Wheat/ Bulgur, cooked	Side A/ Page 5					
1.9	Rice/Pasta/Cereals, whole grain	Side A / Page 5					
2	**Dairy Products**						
2.1	Milk, skim/low-fat (0-2%)	Side A					
2.2	Milk, whole-fat	Side A					
2.3	Yogurt, fat-free/low-fat	Side A					
		Bottled ayran					
2.4	Yogurt, whole-fat	Side A					
		Bottled ayran					
2.5	Cheese, regular / yellow	Side A Side B / Thickness Cube/ triangular portion					
2.6	Cheese, low fat / white	Side A Side B / Thickness Cube/ triangular portion					
2.7	Labneh, regular	Side A					
2.8	Labneh, low fat	Side A					
3	**Fruits and Fruit Juices**						
3.1	Citrus orange/ grapefruit	Side A / 1 medium					
3.2	Peach, plum, prunes	Side A / 1 medium					
3.3	Strawberries	Side A / 10 strawberries					
3.4	Grapes	Side A / 10 grapes					
3.5	Banana/ Apples	Side A / 1 medium					
3.6	Dried Fruits	Raisins= 1tbsp Dates: 1 portion Apricots: 1 portion					
3.7	Fruit juice, fresh	Side A					
3.8	Fruit juice, canned	1 can					
3.9	Fruit juice, bottled	1 bottle/ carton					
3.10	Fruits, canned	Peach/ apricot = ½ fruit Pineapple = 1 slice					
4	**Vegetables**						
4.1	Salad, green: lettuce, mint, cucumber, green pepper, rocket, purslane, etc.	Side A/ Page 8					
4.2	Dark green or deep yellow (spinach, Swiss Chard, Jew's mellow, carrots..)	Side A/ Page 4					
4.3	Tomatoes, fresh	1 medium / 10 cherry					

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4.4	Corn / Green peas, fresh	Side A/ Page 4					
4.5	Corn/ Green peas, canned	Side A/ Page 4					
4.6	Potatoes, baked / boiled/ mashed	Side A / 1 medium					
4.7	Zucchini/ Eggplants, cooked	Side A/5 med. stuffed					
4.8	Cauliflower/ Cabbage/ Broccoli	Side A/ Page 4					
4.9	Other canned vegetables (Mushroom, palmetto, asparagus, etc.)	Side A/ Page 4					
4.10	Vegetable juice, fresh	Side A					
5	**Meat and Meat Alternatives**						
5.1	Legumes: lentils, beans, chickpeas, etc., dried, cooked	Side A/ Page 4					
5.2	Legumes, canned (beans, peas)	Side A/ Page 4					
5.3	Nuts & seeds: walnuts, peanuts, almonds, sunflower seeds, etc.	Side A/ Page 4 Pre-packed small bag					
5.4	Red meat, beef/ lamb/goat	Side A/ Ground					
		Steak - Side B/ Thickness					
5.5	Poultry	Leg/thigh/breast/wings Side B					
5.6	Fish/ Seafood, fresh	Side B/ Thickness					
		Shrimp: 1 medium					
		Calamari: 1 medium					
		Crab: 1 medium					
5.7	Fish, canned (tuna, sardines)	1 large can/ 1 small can Page 19					
5.8	Eggs	1 medium					
5.9	Organ meats (liver, kidney, brain)	Side B/ Thickness					
5.10	Luncheon meats (mortadelle, turkey, salami, ham, etc.)	Side B/ Thickness Regular slice					
5.11	Sausages, makanek, uncanned	Side B/ Thickness Makanek size					
5.12	Sausages, makanek, hotdogs, canned	Hotdog size Makanek size Side B/ Thickness					
6	**Added Fats and Oils – Salads/ Cooking / Fries**						
6.1	Vegetable oil, corn/ sunflower/ soya	Side A					
6.2	Olive oil (including with thyme)	Side A					
6.3	Olives	5 olives					
6.4	Butter	Side A					
6.5	Ghee	Side A					

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6.6	Mayonnaise	Side A					
6.7	Tahini	Side A					
7	**Sweets and Desserts**						
7.1	Cakes / Cookies/ Doughnuts / Muffins/ Croissant / Biscuits	Side B / Thickness Page 14-15-16					
7.2	Ice cream	1 scoop/ 1 stick/ Page 9					
7.3	Chocolate bar	1 medium					
7.4	Sugar, honey, jam, molasses, chocolate spread	Side A					
7.5	Arabic sweets Baklava, maamoul, knefe	Side B					
8	**Beverages**						
8.1	Soft drink, regular	Side A / 1 can (330 mL)					
8.2	Soft drink, diet	Side A / 1 can (330 mL)					
8.3	Turkish coffee	Side A					
8.4	Instant coffee / Tea	Side A					
8.5	Cocoa / Hot chocolate	Side A					
8.6	Beer	Side A / 1 bottle					
8.7	Wine, red / white/ blush	Side A					
8.8	Liquor, whiskey/ vodka/ gin/ rum	Side A					
8.9	Water	Side A / Bottle (0.5 L)					
9	**Miscellaneous**						
9.1	Manaeesh, zaatar/ cheese	1 regular / 1 bouché Page 17- 18					
9.2	French fries	Side A Page 4					
9.3	Potato chips / Tortilla	XS/ S/ M/ L/ XL bag Page 20					
9.4	Falafel, without bread	1 medium falafel					
9.5	Shawarma	1 medium sandwich					
9.6	Burgers (beef, chicken, fish)	1 medium burger					
9.7	Pizza	Side B / Thickness					
9.8	Canned/ Pre-packed soups	Side A / Page 3					
9.9	Ketchup	Side A					
9.10	Mustard	Side A					

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10.1. How many times do you ***season your food with a tomato-based sauce*** (tomato, onion, garlic and simmered with olive oil)?
---------------------------------- number of times per day / week / month?

10.2. Do you actually consume chicken or turkey meat ***instead of*** veal, pork, hamburger, or sausage?
------ Yes ------ No

* Are there any other foods/supplements that you regularly consume **[at least once per week]** and that were not mentioned in the FFQ list above?

Food Item	Usual serving size	Frequency of intake per week

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Supplements

Do you use any supplements and products for weight loss and control? □ No □ Yes

If yes, how frequently: _____ days per month

24-Hours Dietary Recalls

Date: (dd/mm/yyyy) ----/----/--------- **Day of the week:** ----------------------

Time	Food eaten	Amount	Method of preparation

*** Was yesterday a usual eating day?**

- Yes
- No, please specify --

- When was the last meal taken?

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Lab work data collection

Name of the participant: ------------------------ Initials:--------------------- GBACC ID number:-----------

Test	Unit	Result
Hba1c		
Fasting Blood Glucose		
Fasting insulin		
LDL		
HDL		
Triglycerides		
Total cholesterol		
Urinary Creatinine		
Serum Creatinine		
TSH		
Microalbumin		
CRP		
Serum Creatinine		

Time of urine collection	وقت جمع البول	
Time of blood withdrawal	وقت سحب الدم	

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Name of the participant: ---------------------------- GBACC ID number: -----------------

النتائج الحاليّة (2019): البيانات التي تم جمعها ب: _____/_________ (الشهر / السنة)،
جزء من الدراسة ، التي أجريت في الجامعة الأميركية في بيروت

Current results (2019): Data collected on: _____/________ (month/year),
Part of the Greater Beirut Area Cohort follow-up study, conducted at AUB

		Results النتائج 2019	**Healthy ranges** النطاقات الصحية
Body weight (kg):	*الوزن*		
Height(cm):	*الطول*		
BMI (kg/m^2):	*مؤشر البدانة*		*18.5-24.9 kg/m^2*
Waist circumference (cm):	*قياس دائرة الخصر*		نساء*<80 cm,* رجال*<94 cm*
Percentage Body fat (%):	*نسبة الدهون في الجسم*		نساء*<32%;* رجال*<25%*
Percentage Muscle mass (%):	*نسبة العضل في الجسم*		*24-30 %* نساء *;33-40%* رجال
Heart rate (bpm):	*قياس نبض القلب*		*60-100 bpm*
Blood Pressure – Measurement # 1	*قياس ضغط الدم 1*		
Systolic blood pressure (mmHg):	العالي		*120 mmHg*
Diastolic blood pressure(mmHg):	الواطي		*80 mmHg*
Blood Pressure – Measurement # 2	*قياس ضغط الدم 2*		
Systolic blood pressure (mmHg):	العالي		*120 mmHg*
Diastolic blood pressure(mmHg):	الواطي		*80 mmHg*

بناءً على زيارة اليوم، ننصحك بمتابعة طبيبك بشأن الشروط التالية (إذا تم تحديد مربّعاتها):

Based on today's visit, we recommend that you follow-up with your physician regarding the following conditions (if their boxes are checked):

Weight problems مشاكل وزن وبدانة	☐
Blood pressure ضغط الدم	☐
Depression أعراض الاكتئاب	☐
Anxiety أعراض القلق	☐
Migraine صداع نصفي	☐

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