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INTAKES AND SOURCES OF FAT, FREE SUGARS AND SALT AMONG LEBANESE CHILDREN AND ADOLESCENTS

by

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AN ABSTRACT OF THE THESIS OF

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Lebanon, a small country of the Eastern Mediterranean region, is currently witnessing a high burden of non-communicable diseases (NCDs).There is increasing evidence linking unhealthy dietary practices in children and adolescent to nutrition-related NCDs later in life. This study aims to determine the intake levels and main dietary sources of fat, sugar and salt among Lebanese children and adolescents, to benchmark the estimated intake levels against the World Health Organization (WHO) recommendations and to investigate the socioeconomic and anthropometric factors that are associated with high intakes of these nutrients

The study is based on secondary analyses of data stemming from two observational, cross-sectional national surveys conducted among under-five children (survey 1) and 5-18 year old children and adolescents (survey 2) in Lebanon. In both of these surveys, data on dietary intake (24-hr recall), socio-demographic and anthropometric characteristics were collected. For the purpose of this study, intakes of fat, saturated fat (SFA), free sugars and sodium were estimated using the Nutritionist Pro software (version 5.1.0, 2014) and the intake estimates were benchmarked against the WHO recommendations. The main food sources of dietary fat, saturated fat and sugar were identified by age group. Regression analyses were used to investigate the association of anthropometric and socioeconomic factors with high intakes of these nutrients (defined as exceeding the WHO upper limits).

Intakes of free sugars among under-five children and those aged 6-18 years were estimated at 6.3-11.9% and 12.6-12.9% of energy intake (EI), respectively. In these age groups, 24.8-54.2% and 58.1-62.2% of children exceeded the WHO upper limit for free sugar (10% EI), respectively. The main dietary contributors to free sugar intake included sweetened juices (14.9-21.2%) and sweetened dairy products (9.8%) in under-five children, while in5-18 year old children, the main sources were comprised of sweetened juices (15.1-22.2%), regular soft drinks (13.8-25.2%) and “biscuits, wafers and chocolate” (10.6-14%).

Mean intakes of total fat and SFA were estimated at 38.6-40 % and 12.5-12.7% among under-five children, respectively, with 68.7-76.9% and 85-86.7% exceeding the

WHO upper limits for these nutrients. Similarly, a high intake of total fat and SFA was noted in 5-18 year old children and adolescents (38.9-40% and 9.9-10.7% respectively) with 68.1-73.2% and 63.4-68.3% having intakes above the WHO recommendations. In under-five children, the main dietary contributor to total fat and SFA was non-sweetened milk (13.8-49.3% and 22.9-58.2% respectively), while in 5-18 year older children, the main dietary contributor to total fat and SFA was desserts (20.2-21.4% and 25.8-27.3% respectively). Mean intake of sodium among under-five children and those aged 6-18 years were estimated at 0.9-1.7 g/d and 1.9-2.3 g/d, respectively, with 7-30.1% of under-five children and 40.1-56.4% of 6-18 year old children exceeding the upper limit of 2 g/d.

The odds of exceeding the WHO upper limits for the various nutrients were examined using multivariate regression analyses, where the independent variables were the demographic, socioeconomic and anthropometric characteristics. Accordingly, among under-five children, children aged 3-5 years were 3.47 (CI= 2.58-4.65) and 5.66 times (CI= 3.64-8.81) more likely to exceed the WHO upper limits of free sugar (defined as above 10% EI) and sodium (>2 g/d), respectively. As for the socioeconomic factors, after adjustment (a) for other variables, children with higher maternal education were less likely (OR_a=0.61; CI= 0.38-0.98) to exceed the WHO upper limit of free sugars, while children with higher family income were more likely to exceed the SFA WHO recommendations. The associations between BMI status and nutrients' intakes were not significant, except for overweight, which was associated with higher odds (OR_a= 1.91; CI= 1.02-3.59) of exceeding the WHO upper limit of total fat.

Among 5-18 year old children and adolescents, child' age was associated with higher odds (OR_a= 1.92; CI= 1.43-2.57) of exceeding sodium intake above WHO upper limit, while female gender was associated with lower odds of exceeding the WHO upper limit of this nutrient. In agreement to what was observed among under-five children, children with higher family income were more likely to exceed the WHO recommendation of SFA (OR_a=1.39; CI= 1.02-1.87).

This study is the first to characterize the intakes of free sugars, total fat, SFA and sodium among Lebanese children and adolescents. It showed that a high proportion of children and adolescents exceed the WHO upper limits for these nutrients and highlighted processed foods such as sweetened juices, soft drinks, sweetened milk and desserts as the major sources of free sugars, total fat and SFA in this population group. This study has also importantly identified specific demographic and socio-economic factors that are associated with high intakes of these atherogenic nutrients. Taken together, the findings of this study could be viewed as a stepping stone for the development of culture-specific interventions and programs aimed at improving the dietary habits of children and adolescents and at curbing the NCDs epidemic in the country.

CONTENTS

ILLUSTRATIONS

TABLES

ABBREVIATIONS

%	Per Cent
/	Per
&	and
±	Plus or Minus
=	Equal
<	Less than
>	Greater than
≤	Less than or equal
≥	Greater than or equal
AAP	American Academy of Pediatrics
ACAT	Acyl-CoA: cholesterol acyltransferase
AHA	American Heart Association
AMP	Adenosine monophosphate
ANOVA	Analysis of variance
apo	apolipoprotein
ATP	Adenosinetriphosphate
BMI	Body mass index
CDC	Centers for Disease Control and Prevention
CETP	Cholesterol ester transfer protein
CHO	Carbohydrates
ChREBP	Carbohydrate response element-binding protein
CI	Confidence interval
Ci	Crowding index

Cm	Centimeter
CVD	Cardiovascular diseases
d	day
DGAT1	Diacylglycerol acyltransferase-1
EI	Energy intake
EMR	Eastern Mediterranean Region
et al.	And Others
FDA	Food and Drug Administration
g	gram
GLUT4	Glucose transporter type 4
HDL	High density lipoprotein
HFCS	High fructose corn syrup
HHS	Health and Human Services
Ht	Height
HTN	Hypertension
IL-6	Interleukin 6
IOM	Institute of medicine
IR	Insulin resistance
IRS	Insulin receptors substrates
JNK-1	Jun N-terminal kinase-1
Kg	Kilogram
L.L	Lebanese Lira
LDL	Low density lipoprotein
LPL	Lipoprotein lipase

MS	Metabolic syndrome
MTP	Triglyceride-transfer protein
MUFA	Monounsaturated fatty acids
n	Number
NCDs	Non-communicable diseases
NO	Nitric oxide
OR	Odd ratio
P	P value
PUFA	Polyunsaturated fatty acids
ROS	Reactive oxygen species
SCAN	Scientific Advisory Committee on Nutrition
SD	Standard Deviation
SE	Standard Error
SFA	Saturated fatty acids
SNS	Sympathetic nervous system
SPSS	Statistical Package for Social Sciences
SREBP1	Sterol regulatory element-binding protein-1
SSBs	Sugar sweetened beverages
T2D	Type 2 diabetes
TFA	Trans fatty acids
TG	Triglycerides
TLR4	Toll-like receptor 4
TNF	Tumor necrosis factor
UK	United Kingdom

US(A)	United States (of America)
USDA	Unites States Department of Agriculture
VLDL	Very low density lipoprotein
vs.	Versus
WHO	World Health Organization
Wt	Weight
yrs	years

To My

Beloved Family

To My

Best Friends

Dr. Jhonny Hanna

Tracy Moawad

For always standing by me

CHAPTER I

INTRODUCTION

Non-communicable diseases (NCDs) are the leading cause of death worldwide (Alwan, 2011). Around 60% of the 52.8 million deaths around the world were caused by NCDs in 2010 (Rahim et al., 2014). According to the World Health Organization (WHO), NCDs will account for 80% of the global burden of disease by 2020 (Islam et al., 2014), and the estimated deaths due to NCDs may reach 44 million in 2020 if the trend continues as it is (Boutayeb, Boutayeb, & Boutayeb, 2013). In the Eastern Mediterranean Region (EMR) more than 2.3 million deaths are due to NCDs per year, and 1.2 million of them are caused specifically by cardiovascular diseases (CVD) (Boutayeb et al., 2013). Furthermore, six Arab countries were found to be among the top ten countries with the highest diabetes prevalence in the world (Rahim et al., 2014). This high burden of NCDs is one of the major challenges that the EMR is currently facing due to its great impact on the social and economic development of its countries (Boutayeb et al., 2013; Islam et al., 2014).

This high prevalence of NCDs in EMR countries may be attributed to the fast rates of development, mechanization and urbanization, with concomitant shifts in physical activity, body composition and dietary habits, (Nasreddine, Naja, Sibai, et al., 2014). In addition, the gap between the epidemiological prevalence data and effective policies and legislation to alleviate NCDs risk factors is another contributor to this phenomenon (Rahim et al., 2014). Children and adolescents are the most vulnerable population group to the ongoing shifts in lifestyle & diet, away from the high fiber, low fat traditional diet, and toward westernized food consumption pattern characterized by high intake of fat, sugar and salt (Rahim et al., 2014).

The harmful metabolic effects of excessive consumption of sugar is manifested by increased risk of CVD risk factors among children and adolescents through increased energy intake, adiposity, and blood lipids (Vos et al., 2017). Similarly, high dietary fat intake, especially saturated fatty acids (SFA), have been suggested to increase the level of low density lipoprotein (LDL) and inflammatory pathways, insulin resistance and other NCDs (Sacks et al., 2017; Setayeshgar et al., 2016). There is also an association between salt intake in children and high blood pressure which is considered the major risk factor for CVD and strokes (Nishida, Uauy, Kumanyika, & Shetty, 2004; Quader et al., 2017).In Lebanon, a small country of the EMR where NCD-related death was estimated at 84% (Boutayeb et al., 2013), little is known about the intake levels and specific food sources of fat, sugar and salt in the pediatric population. To address this knowledge gap, we propose to evaluate the dietary intakes and the major sources of fat, sugar and salt among Lebanese children and adolescents.

A. Thesis Objectives

This study aims to determine the intake levels and identify the main sources of fat, sugar and salt among Lebanese children and adolescents, to benchmark the estimated intake levels against the WHO recommendations and to investigate the socioeconomic and anthropometric factors that are associated with high intakes of these nutrients. It specifically aims to:

- Determine the intake levels of total fat, saturated fat, free sugars and sodium among Lebanese children and adolescents as gram per day and percent of energy intake.
- Benchmark the intake levels of total fat, saturated fat, free sugars and sodium against the WHO recommendations/upper limits.
- Identify the main sources of total fat, saturated fat and free sugars among Lebanese children and adolescents.
- Investigate the association of demographic, socioeconomic and anthropometric characteristics with high dietary intakes of fat, sugar and sodium in this age group.

CHAPTER II

LITERATURE REVIEW

A. Epidemic of Non Communicable Diseases (NCDs)

The burden of non-communicable diseases (NCDs) in the EMR represents a major public health challenge, compromising social and economic development in its countries (Boutayeb et al., 2013). Overall, it is estimated that NCDs account for over 50% of annual deaths (2.2 million deaths) and 60% of the disease burden in the EMR (WHO, 2008a). According to the WHO, it is projected that deaths from NCDs would increase by 25% in the region between 2008 and 2018, recording the second highest projected increase among the six WHO regions (WHO, 2009, 2011). This shift in NCDs burden was mainly referred to the ongoing nutrition transition in many developing countries including Lebanon, where nutrition-related diseases, most notably CVDs account for 60% of all mortality in persons aged 50 years old (Sibai et al., 2010). It has been found that dietary intake and nutrition behaviors in childhood and adolescence may ultimately carry on affecting adult cardiovascular health (Bull & Northstone, 2016).

B. Unhealthy Diet and NCDs

Unhealthy dietary practices in children and adolescent are among the most contributors to cardio-metabolic abnormalities in youth (Slining & Popkin, 2013). Such dietary practices may start in early childhood. For instance, in the United States, French fries become the dominant vegetables consumed as early as the second year of life. In addition, the diet of older American children is characterized by high intakes of fried, nutrient-depleted foods and sugar sweetened beverages (SSBs) (Gidding et al., 2006).With the ongoing nutrition transition in the EMR, unhealthy dietary habits among children and adolescents have become increasingly common in Arab countries, especially in Gulf countries where the diet of children and adolescents relies heavily on fast-foods, sweets and carbonated beverages (AbdulrahmanO Musaiger, Bader, Al-Roomi, & D'Souza, 2011; Rahim et al., 2014), with low intakes of fruits and vegetables (Sibai et al., 2010). Data from Lebanon showed that, unlike adherence to the traditional Lebanese dietary pattern, adherence to the “westren” pattern was associated with a higher risk of overweight and obesity in children and consequently higher cardio-metabolic risks. The westren dietary pattern is in fact characterized by high intakes of fat, saturated fat, sugars and energy dense foods, which explains the observed outcomes (Naja et al., 2015).

The shift in dietary habits away from the traditional diet and towards westernized food consumption patterns among children and adolescents in developing countries amy be linked to several factors, including urbanization and open market economy as shown in Figure 1 (Gupta, Goel, Shah, & Misra, 2012).

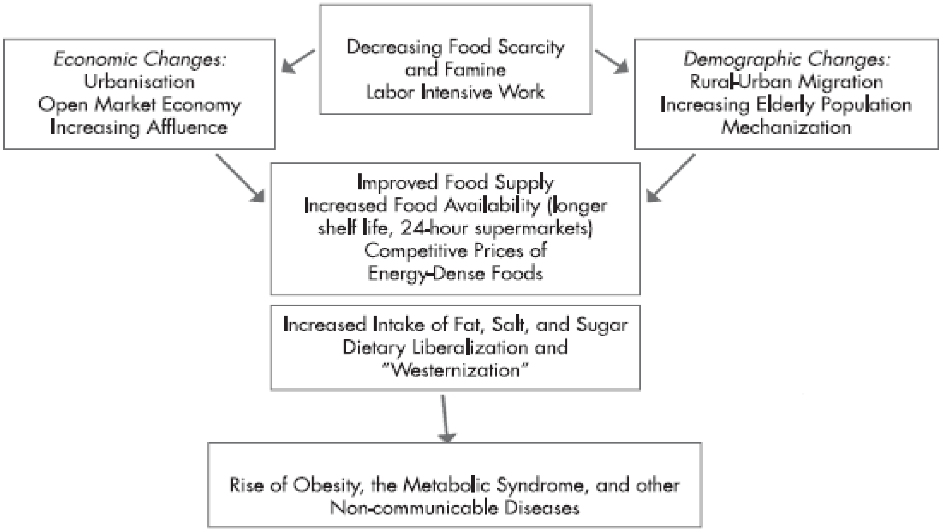


Figure 1: Relationship between nutrition transition, urbanization and the rise in obesity and metabolic syndrome in developing countries.(Gupta et al., 2012).

1. Dietary Sugars

High consumption of sugar among children and adolescents became a public health problem in the recent years (Farajian, Risvas, Panagiotakos, & Zampelas, 2016). It has been suggested that sugar intake is associated with increased risk for hypertension, dyslipidemis and insulin resistance (Hur et al., 2015). Sugar is a sweet, crystalline substance, obtained mainly from sugarcane and beet juice (Vos et al., 2017).

a. Terms of Sugars

The term sugar refers usually to sucrose (glucose plus fructose) and high fructose corn syrup (HFCS) (MacDonald, 2016). Other terms have been suggested also in the literature, including total sugars, added sugars and free sugars. Below is a description of each of these terminologies.

i. Total Sugars

"Total sugars" is a term referral to all monosaccharides (glucose, fructose and galactose) and disaccharides (sucrose, lactose and maltose) that exist in food, including intrinsic and extrinsic sugar. For example, total sugars include fructose and lactose that are naturally occurring in fruits and milk in addition to all types of sugars that are added during food preparation (Sluik, van Lee, Engelen, & Feskens, 2016; Vos et al., 2017). No recommendation has been set so far regarding the intake of total sugars due to lack of sufficient evidence to limit the intake of all sources of sugars (Erickson & Slavin, 2015; Pawellek et al., 2017).

ii. Added Sugars

The FDA defined added sugars as sugars and syrups that are added to food during food processing and preparation (Vos et al., 2017). Added sugars include all types of sugar such as white sugar, brown sugar, sucrose and high fructose corn syrup that are widely added during food manufacturing (Erickson & Slavin, 2015; Vos et al., 2017). They are not chemically different than the sugars that are naturally found in food, and consequently it is not possible to measure separately. Therefore, the amount of added sugars is usually calculated. However, most of food composition tables and food products labels do not include the amount of added sugars (Hess, Latulippe, Ayoob, & Slavin, 2012; Sluik et al., 2016). Hence, the FDA revised the format of nutrition facts labeling and proposed that added sugars should be declared in order to achieve healthy dietary practices and prevent nutrition related conditions (Food & Drug Administration, 2016). The situation is more complex in developing countries and the EMR where limited information on added sugars is included in the nutrition facts labels.

Several epidemiological studies have linked high consumption of added sugars to increased risk for NCDs as well as cardio-metabolic risk factors such as hypertension, dylipidemia and T2D (Rippe & Angelopoulos, 2016). Therefore, various organizations have developed recommendations to limit the intake of foods that are rich in added sugars. In 2005, the Institute of Medicine (IOM) recommended that added sugar should not exceed 25% of total daily caloric intake (Trumbo, Schlicker, Yates, & Poos, 2002). More recently, the United States Department of Agriculture (USDA) and the Department of Health and Human Services (HHS) have developed the 2015-2020 Dietary Guidelines for Americans that included for the first time a clear recommendation for children above 2 years of age and adolescents to limit the intake of added sugar to less than 10% of total daily caloric intake (Mitka, 2016). The American Heart Association (AHA) went further with the recommendation for the consumption of added sugars among children and adolescents. It advised children under the age of 2 to totally avoid food and beverages containing added sugar, and for those aged 2 to 18 to limit their intake of added sugar to less than 25 grams which means no more than 6 teaspoons per day (Best, 2016). Many European and even Arab countries have given attention to the consumption of added sugar which is reflected in their local dietary recommendations. Some of these recommendations are quantitative like in United Kingdom (UK) and Italy where it is suggested to limit the total caloric intake of added sugar to maximum 10% and 15% respectively (Hess et al., 2012). Most other countries have qualitative recommendations emphasizing the importance of reducing the intake of added sugars (Hess et al., 2012). For instance, the dietary guidelines for Arab countries recommended that the intake of food and drinks rich in added sugars should be reduced among children and adolescents (AO Musaiger, 2012).

iii. Free Sugars

The term “total sugars” does not differentiate between sources of sugars such as intact fruits, vegetables or milk. Also, the term “added sugars” could not be a better alternative to describe the harmful health outcomes of all sugar sources due to the fact that 100% fruit juices may have similar metabolic impact to SSBs (Mela & Woolner, 2018). Thus, the term “free sugars” was proposed to capture all potential adverse health risks associated with high sugar consumption (Mela & Woolner, 2018).

Free sugars is a term used by the WHO and it refers to all monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, in addition to sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates (WHO, 2015). The WHO recommends reducing the intake of free sugars for all age groups including children and adolescents to less than 10% of total daily energy intake (WHO, 2015). Recently the WHO has suggested further reduction of free sugars intake below 5% of total energy intake as conditional recommendation for additional benefits in reducing the risk of NCDs, excess weight gain and dental caries (Vos et al., 2017; WHO, 2015). In 2015, the Scientific Advisory Committee on Nutrition (SACN) in UK adopted the term “free sugars” in the dietary recommendation for sugars (Pyne & Macdonald, 2016). Based on strengthened level of evidence that links several detrimental health problems to high intake of free sugars, SCAN recommendation specified that the intake of free sugars should not exceed 5% of daily energy intake for all population above the age of 2 years (Pyne & Macdonald, 2016).

Several studies have investigated the relationship between free sugars and cardio-metabolic risk. Data from Asia showed that the high consumption of free sugars is positively correlated with the prevalence of diabetes especially in India (Kalra &

Gupta, 2014). Similarly, data from Iraq has showed that the incidence of obesity, T2D and dental caries increased with higher consumption of free sugars (Tappuni, Al-Kaabi, & Joury, 2016).

b. Intake Levels of Free Sugars

The following table presents the intake levels of free sugars among children and adolescents in some western countries.

Table 1: *Free sugars intake of children and adolescents in some western countries*

Country	Age Range	% of Subjects exceeded WHO Recommendations of Free Sugars	Mean Sugar Intakes
Australia (Louie, Moshtaghian, Rangan, Flood, & Gill, 2016)	2-16 yrs (n=4140)	More than 80% exceeded 10% EI 1% within 5% EI	For all age groups 14% EI 2-3 yrs 12.3% EI 4-8 yrs 13.7% EI 9-13 yrs 14.6% EI 14-16 yrs 14.8% EI
United Kingdom (Gibson, Francis, Newens, & Livingstone, 2016)	1.5-18 yrs (n=2073)	88% exceeded 10% EI 99-96% exceeded 5% EI	1.5-3 yrs 11.8% EI 4-10 yrs 14.7% EI 11-18 yrs 15.4% EI
Dutch (Sluik et al., 2016)	7-18 yrs 19-69 yrs (n=3819)	95% exceeded 10% EI 100% exceeded 5% EI	7-8 yrs 19.9-20.7% EI 9-13 yrs 19.7-19.8% EI 14-18 yrs 17.6-18.2% EI
Greece (Farajian et al., 2016)	10-12 yrs (n=3089)	44.2% exceeded 10% EI	10-12 yrs 11.2% EI
Spain (Ruiz et al., 2017)	9-17 yrs 18-75 yrs (n=2285)	25% exceeded 10% EI 75% exceeded 5% EI	9-12 yrs 9.8% EI 13-17 yrs 10% EI

c. Sugars and Nutrition-Related Diseases

i. Sugars and Insulin Resistance

Insulin resistance (IR) is a condition in which the normal function of insulin is disturbed which increases the risk of T2D and other NCDs (Ma et al., 2016). Several studies have indicated a positive association between diets rich in sugars, such as sugar sweetened beverages (SSBs), and the risk of insulin resistance (IR) and T2D in all age groups, including adolescents, independently of energy intake and adiposity (MacDonald, 2016; Rodríguez, Madsen, Cotterman, & Lustig, 2016). It has been suggested that hyperglycemia and hyperinsulinemia, due to high consumption of sugars, impair insulin receptors substrates (IRS) and induce IR (Patel et al., 2016). Moreover, high glucose intake stimulate higher insulin secretion that generates reactive oxygen species (ROS) through activation of NADPH oxidase (Prasad & Dhar, 2014). Therefore, inflammatory pathways are activated and impede insulin function at the level of adipose tissue leading to peripheral IR (Samuel & Shulman, 2016).

Fructose has received considerable attention in metabolic research since, unlike glucose, it is metabolized independently of insulin control and stimulates denovolipogenesis and fat deposition in live which may lead to hepatic IR (MacDonald, 2016). In addition, it promotes hepatic release of fatty acids which also result in intramyocellular lipid accumulation and peripheral IR (DiNicolantonio, O'keefe, & Lucan, 2015). Moreover, fructose-1-phosphatestimulates c-jun N-terminal kinase-1 (JNK-1) which inactivates IRS leading to hepatic IR (Lustig, 2016). In addition, fructose, due to Maillard reaction, generates excessive amounts of ROS that lead to cellular apoptosis and hepatic metabolic dysfunction and IR (Lustig, 2016). On the long term, high intake of both glucose and fructose activate certain transcription factors, including the carbohydrate response element-binding protein (ChREBP) and the sterol regulatory element-binding protein 1c (SREBP1c) that are responsible for hepatic de novo lipogenesis and consequently altered hepatic insulin sensitivity (Samuel & Shulman, 2016; ter Horst & Serlie, 2017).

ii. Sugars and Fatty Liver

It has been observed that the majority of patients with fatty liver consume larger amounts of added sugars and SSBs compared to other segments of population (Tappy & Lê, 2012). The mechanism by which high sugar intake may lead to hepatic ectopic fat accumulation is mainly due to the imbalance between hepatic lipid input and output (ter Horst & Serlie, 2017). High consumption of sugars leads to fructose flux to the liver which rapidly generates lipogenic substrates in an uncontrolled manner. This may overwhelm the liver's export capacity, leading to intra-hepatic fat deposition and hepatic steatosis (Lustig, 2016).

iii. Sugars and Dyslipidemia

An accumulation body of evidence from several longitudinal studies confirmed the association between high consumption of sugars among children and adolescents and increased risk of dyslipidemia, particularly high serum TG and low HDL level (Vos et al., 2017). For example, in a cohort study that included 1433 adolescents in Australia, results have showed that the consumption of 1.3 cups of SSBs per day over 3 years increases serum TG by more than 10% and decreases HDL by 5% independently of weight status (Ambrosini et al., 2013). This could be mainly due to the fructose component of sugar. Consuming large amounts of sugar, and particularly fructose, may result in hepatic overproduction of fatty acids (FAs) (Stanhope, 2016). This is also accompanied by altered hepatic function and increased in apolipoprotein (apo) B production, apo C III synthesis and up-regulation of microsomal triglyceride-transfer protein expression (MTP). MTP is responsible for the assembly of TG and apo B into VLDL, while apo CIII inhibits lipoprotein lipase (LPL) activity that hydrolyzes the TG carried by VLDL. These metabolic changes exacerbate VLDL production and secretion, while also suppressing VLDL clearance. This will lead to increased TG levels and dyslipidemia (Stanhope, 2016). Hypertriglycerides activate cholesterol ester transfer protein (CETP) which is an enzyme responsible for moving cholesterol esters and TG between VLDL, LDL and HDL. This will increase the TG content of HDL which may activate hepatic lipase and promotes significant reduction in HDL particle size that rapidly cleared by the kidneys (Rashid, Uffelman, & Lewis, 2002).

iv. Sugars and Uric Acid

Prospective cohort studies have shown a considerable link between consumption of SSBs and elevated blood uric acid concentration (Carran, White, Reynolds, Haszard, & Venn, 2016). This is mainly due to the fact that high sugars intake leads to over-conversion of fructose to fructose-1-phosphate by fructokinase (uncontrolled step) in the liver. This is accompanied with depletion of inorganic phosphate due to the conversion of adenosinetriphosphate (ATP) to adenosine monophosphate (AMP). Therefore, uric acid production increases through the purine degradation pathway mediated, by xanthine oxidase (Stanhope, 2016). Elevated uric acid can act as pro-oxidant and induce intracellular oxidative stress and pro-inflammatory effects. Therefore, it impairs vascular endothelial function and reduces nitric oxide (NO) availability that stimulates vasodilation resulting in the development of HTN (Caliceti, Calabria, Roda, & Cicero, 2017). It has been suggested that high plasma uric acid is strongly associated with increased risk of CVD (Stanhope, 2016).

v. Sugars and Hypertension (HTN)

Numerous studies have emphasized that high consumption of sugars especially SSBs is associated with higher risk for HTN (Xi et al., 2015). Several hypotheses explain the mechanism by which high sugars intake induce HTN. High consumption of sugars leads to elevated serum insulin which stimulates the sympathetic nervous system (SNS) (DiNicolantonio & Lucan, 2014). Thus, this leads to increases in heart rate and therefore high cardiac output. And also SNS trigger srennin-angiotensin system that increases renal sodium retention and vascular resistance (DiNicolantonio & Lucan, 2014). In addition, high sugars intake may elevate blood pressure by uric acid production that inhibits the vasodilation effect of NO (Malik, Akram, Shetty, Malik, & Njike, 2014).

2. Dietary Fat

Dietary fat plays significant role in the cause and prevention of CVD (Michas, Micha, & Zampelas, 2014). Although the vast majority of intervention studies focus on the metabolic role of different types of fatty acids in improving dyslipidemia among adults, many studies have concluded that dietary fat influences plasma lipid the same way in children as in adults (Harika, Cosgrove, Osendarp, Verhoef, & Zock, 2011). Studies have indicated that total fat consumption exceeding 35% to 37% of total caloric intake among children and adolescents is highly associated with increased risk of hypertension, elevated waist circumference, obesity and cardio-metabolic risk factors (Setayeshgar et al., 2016). In particular, intakes of SFA and trans fatty acids (TFA) are well established to represent a significant risk factor for CVD (Estadella et al., 2013). Therefore, WHO has recommended that SFA and TFA should not exceed 8% and 1% of total energy intake in children and adolescents above the age of 2 years (WHO, 2008b).

a. Intake Levels of Total Fat & SFA

Total Fat referred to all type of dietary fatty acids (saturated and unsaturated fatty acids). The most SFA consumed in the diet are myristic, palmitic and stearic acids that are found in animal fats (meats and dairy products), certain plant fats (palm and coconut oils) and most processed food (cookies, cakes, pastries and pies) (Michas et al., 2014). TFA are primary produced by partial hydrogenation of vegetables oils (Michas et al., 2014). The following table presents the intake levels of total fat and SFA among children and adolescents in different countries.

Table 2**:** *Total fat & SFA intake of children and adolescents in different countries*

Country	**Age Range**	**Mean Total Fat Intakes**	**Mean SFA Intakes**
United states (Kris-Etherton et al., 2012)	3-19 yrs (n=16669)	3-5 yrs 32.4% EI 6-11 yrs 33.1% EI 12-19 yrs 32% EI	3-5 yrs 10.2% EI 6-11 yrs 10.3% EI 12-19 yrs 9.9% EI
Bahrain (Gharib & Rasheed, 2011)	7-18 yrs (n=500)	All age 33.6% EI 7-10 yrs 33.3-34.3% EI 11-14 yrs 32.5-33.9% EI 15-18 yrs 31.1-32.7% EI	All age 10.8% EI 7-10 yrs 10.6-10.9% EI 11-14 yrs 9.9-10.9% EI 15-18 yrs 9.3-10.1% EI
Scotland, UK (McNeill et al., 2010)	3-17 yrs (n=1398)	3-17 yrs 32.9% EI	3-17 yrs 13.8% EI
Canada (Mulder, Ferdinands, Richardson, & Innis, 2013)	5.5-6.5 yrs (100)	5.5-6.5 yrs 33.8% EI	5.5-6.5 yrs 12.4% EI
Australia (Whitrow et al., 2016)	9-10 yrs (n=436)	9-10 yrs 31.6% EI	9-10 yrs 14.5% EI

b. SFA, TFA and Nutrition-Related Diseases

i. SFA, TFA and Dylipidemia

Diets rich in SFA and TFA are strongly associated with increased LDL-cholesterol levels among children and adolescents (Rauber, Campagnolo, Hoffman, & Vitolo, 2015; Sacks et al., 2017).

SFA modulates plasma LDL level by reducing LDL receptors activity, protein content and mRNA abundance (expression) of LDL receptors synthesis which may decrease plasma LDL catabolism and clearance (Lottenberg, da Silva Afonso, Lavrador, Machado, & Nakandakare, 2012). Moreover, dietary SFA suppress the activity of hepatic acyl-CoA: cholesterol acyltransferase (ACAT), serves as a regulator of hepatic intracellular cholesterol homeostasis, which leads to down regulate LDL receptors and diminish plasma LDL uptake by the liver (Lottenberg et al., 2012). High SFA intakes mayalsoincrease plasma TG level due to increase the production of hepatic apo B100and VLDL in addition to up regulate the SREBP1c transcription factor which involves in hepatic TG production (Lottenberg et al., 2012). Further, SFA enriched lipoproteins may also slow down the activity of LPL that hydrolysis TG, especially in chylomicrons, and consequently reduce postprandial TG clearance (Perona, 2017).

It has been found that the impact of TFA on lipid profile is worse than SFA because TFA adversely lower HDL. The possible mechanism is that TFA may induce catabolism of apoA1, the protein component of HDL lipoprotein, and also may activate CETP (Lottenberg et al., 2012). Thus, TG enriched HDL production is increased that activates lipolytic enzymes and HDL catabolism (Rashid et al., 2002). Furthermore, both high SFA and TFA intakes increase small dense LDL particles which are strongly associated with increased risk of CVD comparing to large LDL particles (Chiu, Williams, & Krauss, 2017).

Atherosclerotic lesions due to high LDL level, can begin to appear during childhood (Te Morenga & Montez, 2017). Thus, maintain a normal lipid level during childhood may slow and prevent the progression of atherosclerosis and decrease the risk of CVD during adulthood (Harika et al., 2011).

ii. SFA, TFA and Insulin Resistance

Several observational studies have documented a strong association between insulin sensitivity and the lipid composition of cell membranes (Perona, 2017). High

SFA and TFA intakes alter the phospholipids composition of cell membranes thus decreasing their fluidity and resulting in rigid, unresponsive cell membranes (Estadella et al., 2013; Lottenberg et al., 2012; Perona, 2017). Therefore, insulin receptor activity is decreased, especially in the liver and skeletal muscles, which negatively affects insulin signaling pathway, down regulates insulin receptors and decreases insulin affinity. Also, high cell membrane stiffness counteracts the ability of glucose transporter type 4 (GLUT4) to translocate to cell membrane, further contributed to IR (Estadella et al., 2013; Lottenberg et al., 2012; Perona, 2017).

SFA act as ligands of toll-like receptor 4 (TLR4) which stimulates the inflammatory pathways and increase expression and secretion of cytokines such as IL-6, TNF-α. Together they inhibit phosphorylation of IRS and impair GLUT4 translocation in muscle cells (Estadella et al., 2013; Lottenberg et al., 2012; Perona, 2017).

iii. SFA, TFA and Endothelial Function

SFA and TFA have been associated with reduced endothelial and smooth muscle function (Estadella et al., 2013). The impact of SFA and TFA on the cell membrane fluidity and systemic inflammatory response may induce endothelial cells dysfunction, reduce NO secretion or stimulate endothelial cells injury and apoptosis. As a consequence, SFA and TFA increase risk of CVD (Estadella et al., 2013).

iv. SFA, TFA and Fatty Liver

It has been suggested that consumption of diets rich in SFA and TFA may lead to increase de novo lipogenesis through activation of lipogenic gene expression viaSREBP-1c and diacylglycerol acyltransferase-1 (DGAT1) (Lottenberg et al., 2012). Further, SFA and TFA decrease MTP expression and activity and thus impair the liver's capacity to export TG, eliciting lipid production and accumulation in hepatic tissues. Moreover, SF promotes liver injury and a pro-apoptosis environment (Lottenberg et al., 2012).

More recently, recently several randomized control trials have shown that the harmful effect of SFA is possibly due to their replacement of other beneficial nutrients. For example, replacement of 5% of total energy intake from SFA in the diet by poly unsaturated fatty acid (PUFA) reduces the risk of CVD by 10%. Whereas replacement of SFA by carbohydrates and sugars is highly associated with higher CVD risk (de Souza & Anand, 2016; Michas et al., 2014).

3. Sodium Intake

Sodium intake is the predominant risk factor for hypertension which is in turn risk factor for CVD, stroke and renal disease (Mulder, Zibrik, & Innis, 2011). Processed foods are the major source of salt. One teaspoon of salt (5 grams) contains 2 grams of sodium (Tan, Azlan, & Noh, 2016). According to Centers for Disease Control and Prevention (CDC), 90% of school-aged American children consume excess amount of sodium and 1 in 6 children in US have high blood pressure level (Ibarra, 2014). Those children are in higher risk of being hypertensive adults (Quader et al., 2017). Some individuals are "salt sensitive', so they are more susceptible to have elevated blood pressure in response to an acute or chronic sodium intake. This phenomena is mediated by rennin-angiotensin-aldosterone system that stimulates vasoconstriction in response to change in sodium intake (Drenjančević-Perić et al., 2011).

Several studies were carried out to assess sodium intake among children. Lebanese cross sectional study showed that children aged 6-11 years old had mean sodium intake of 2.22 grams/day which was higher than the IOM upper limit (El Mallah et al., 2017). In United States, sodium intake among children and adolescents aged 6-18 years ranged between 3.05 - 3.56 grams/day (Quader et al., 2017). Among Australian children aged 4-12 years, 32% to 51%had sodium intake above the upper limit of Australian national dietary recommendations (Grimes et al., 2017).

CHAPTER III

MATERIALS AND METHODS

A. Study Design

This project is based on secondary analyses of data stemming from two observational, cross-sectional national surveys conducted among under-five children (survey 1) and 5-18 year old children and adolescents (survey 2) in Lebanon.

B. Study Setting and Data Sources

This study is based on data collected by two national surveys conducted in Lebanon, in all of its six governorates. The first survey, “Early Life Nutrition and Health”, which was conducted in 2012, targeted under-five children and aimed at evaluating feeding and dietary practices and assessing the prevalence of underweight and overweight in this age group. The second survey, “Dietary Intake, Lifestyle, and Food Security Status of Lebanese Children and Adolescent in Relation to Overweight and Obesity”, which targeted 5-18 year old children, was conducted in 2014 and aimed at evaluating food security, dietary practices, and the prevalence of overweight and obesity in this population group. The two surveys were conducted using similar protocols for sampling and data collection, including socio-demographic characteristics, anthropometric measurements and dietary assessment.

C. Study Population

- Survey 1: The survey included a representative sample of Lebanese children (0-5 years) and their mothers.

- Survey 2: The survey included a representative sample of Lebanese children aged 5-18 years and their mothers.

D. Sample Size

Survey 1: Sample size calculation was based on one of the main outcomes of interest, i.e. overweight and obesity among under-five children. Accordingly, based on a prevalence of 13% of preschool overweight and obesity (De Onis, Blössner, & Borghi, 2010), a sample of 1,030 under-five children was needed to assess the prevalence of overweight/obesity with a 2% error and a 95% confidence interval. The survey was conducted in 2012, with a final sample size of 1029 children. More information about the sampling of this survey is found in (Nasreddine, Hwalla, Saliba, Akl, & Naja, 2017).

Survey 2: Sample size calculation was based on an obesity prevalence of 10.9% among children aged 5-19 years (Nasreddine et al., 2012). In order to estimate the prevalence of obesity among Lebanese children/adolescents with a 1.8% margin of error (d) and a 95% confidence interval (Z=1.96), a sample size (n) of 1152 was needed. Considering a refusal rate of 10.7% based on the last Lebanese nutrition national survey (Nasreddine et al., 2012), as well as the need for 25 participants to serve a pilot test for the survey, 1200 households with at least one child/adolescent (age 5-18) were invited to participate in the survey. The survey was conducted in 2014, with a final sample size of 1106 children aged 5-18 years. More information about the sampling of this survey is found in (Jomaa, Hwalla, Constant, Naja, & Nasreddine, 2016).

E. Sampling Method

In both surveys, the primary sampling unit was the household. The selection of households followed a stratified cluster sampling strategy, whereby the strata were the six Lebanese governorates and the clusters were selected further at the level of districts.

- Inclusion and exclusion criteria for Survey 1 (under-five children):

The survey included Lebanese children (0-5 years) and their mothers. Children and their mothers were not included in the survey if children: were of a non-Lebanese nationality, were born preterm (<37 weeks) or suffered from any chronic illness, inborn errors of metabolism or physical malformations that may alter normal dietary intake or body composition. For the purpose of the present study, children aged 0-6 months were excluded.

- Inclusion and exclusion criteria for Survey 2:

Eligibility criteria for survey 2 included households having a Lebanese nationality (mothers and children), having a child present between the ages of 5 and 18 years who does not have any medical conditions that may impair his/her growth.

F. Data Collection

In both surveys, data was obtained through face to face interviews. For children aged less than 10 years, the interview was conducted with the mother, as a proxy, in the presence of the child. For children aged 10 years or above, the interview was conducted directly with the child, in the presence of the mother for assistance. Written informed consent was obtained from mothers prior to enrollment in the study.

Interviews were held in the household setting and lasted for approximately one hour. Trained nutritionists collected data, using age-specific multi-component questionnaires covering information on demographic, socioeconomic, eating habits and dietary intakes. The content validity of the survey instruments was confirmed by an expert panel consisting of a clinical nutritionist, a nutrition epidemiologist and a community nutritionist. The questionnaires inquired about socio-demographic and lifestyle characteristics, including the following variables: age of the child (in years), sex of the child, marital status of the mother, mother's and father's education levels and employment status, monthly income, number of rooms in the household and the type of school the child attends (private vs. public). Crowding index, one of the indicators of socioeconomic status, was calculated as the total number of co-residents per household divided by the total number of rooms, excluding the kitchen and bathrooms. Anthropometric measurements (length/height & weight) were also obtained using standard protocols.

Dietary intake data was obtained using the United States Department of Agriculture (USDA) multiple pass 24-hr recall (24-HR) method (WHO, 2016). This approach has consistently showed attenuation in the 24-HRs' limitations (Cole, Bellizzi, Flegal, & Dietz, 2000). The steps followed included 1) quick food list recall, 2) forgotten food list probe 3) time and occasion at which foods were consumed, 4) detailed overall cycle and 5) final probe review of the foods consumed. While collecting the dietary data, specific reference was made to solicit information about foods that were consumed at daycare or school.

G. Data Management and Statistical Analysis

Overweight and obesity identified among under-five children were interpreted based on the 2008 World Health Organization, training Course on Child Growth

Assessment (overweight BMI z-score of > 2 SD; obesity BMI z-score of >3 SD)(WHO, 2008c). While anthropometric measurements for 5-18 years old children and adolescents were interpreted based on the World Health Organization, growth reference data for 5-19 years, 2007 (overweight BMI z-score of >1 SD; obesity BMI z-score of >2 SD) (WHO, 2007).

The Nutritionist Pro software (version 5.1.0, 2014, First Data Bank, Nutritionist Pro, Axxya Systems, San Bruno, CA, USA) was used for the analysis of dietary intake data. For composite and mixed dishes, recipes were added to the Nutritionist Pro software using single food items. Within the Nutritionist Pro, the USDA database was selected for analysis. Food compositions of specific Lebanese foods (not included in the Nutritionist Pro software database) were obtained from the food composition tables for the Middle East (Moshfegh et al., 2008).

Dietary data was analyzed to determine energy intake in kilocalories (kcal), protein, total fat, saturated fat (SFA), MUFA, PUFA, carbohydrates, total sugars, free sugars in grams (g) as well as percentages of energy intake (% EI). Free sugar content of foods was defined as 100% of added sugars for non-fruit juice sources and 100% of total sugars for fruit juice and drinks (Louie et al., 2016; WHO, 2015). Accordingly, free sugars were calculated as total sugars minus the sugars contents of milk, fruits and vegetables. Dietary intake data was also analyzed to estimate sodium intake (g/day).

In order to determine the contribution of various dietary sources to fat, sugar and salt intakes in the study population, food items were grouped into food groups based on similarities in ingredients and nutritional profile. The contribution of each food group to fat, saturated fat and sugar intake was estimated as a percent value. The main food sources of dietary fat, saturated fat and sugar were identified by age group.

Continuous variables were presented as means and standard errors (SE) for dietary variables and standard deviation (SD) for anthropometric variables, whereas categorical variables were reported as proportions and percentages. Mean intakes of energy, total fat, saturated fat, PUFA, carbohydrates, total sugars, free sugars and salt were presented by age group, gender, socioeconomic and anthropometric characteristics. Associations of nutrients intakes with demographic, socioeconomic and anthropometric characteristics were examined using student t-tests and analysis of variance (ANOVA) with Bonferroni corrections. Mean intakes of fat, saturated fat, free sugars and salt were compared to the respective WHO recommendations, and the proportions of children exceeding the recommendations were determined. Also, Simple logistic regression was used to determine the association between dependent variables including nutrients intake exceeding the WHO benchmarks and independent variables including socio-demographic and anthropometric factors that may affect this association. Dependent variables that show statistical significant association in the simple logistic regression were added to the multiple logistic regressions. Data analysis was carried out using Statistical Package for Social Sciences 24.0 (SPSS for Windows, 2013, Chicago: SPSS Inc.). P-value less than 0.05 was considered statistically significant.

H. Ethical Considerations

The present study, which consists of secondary data analysis, was approved by the Institutional review Board of the American University of Beirut (as attached). For the data analyses that were undertaken in this study, de-identified data sets were used to ensure subjects' confidentiality.

The parent studies' protocols (survey 1 and survey 2) were also approved by the IRB and all mothers provided written informed consent prior to their enrollment in the study.

CHAPTER IV

RESULTS

A. Descriptive Data

1. Socio-Demographic Characteristics

The study was based on two national surveys with a total of 2002 children and adolescents, distributed as follows: Survey 1 included 888 infants and children aged 6 months to 5 years old with a mean age of 29.47 ± 15.08 months. Survey 2 included 1106 children and adolescents aged 5-18 years, with a mean age of 11.53 ± 3.6 years. As shown in Table 3, the majority of mothers in surveys 1 and 2 had Intermediate, High school or Technical educational level (64.3% - 59.5%). Likewise, more than 64% of fathers in the 1st survey and 58% of fathers in the 2nd survey had attained Intermediate, High school or Technical education level. Based on crowding index, the vast majority of households in both surveys had a crowding index ≥1 person/room. Regarding the monthly income, the households in both surveys have reported approximately similar results: Around 42% earned between 1,000,000 and 3,000,000 Lebanese Lira (L.L.) per month. Only 10.2% and 8.5% of households earned more than 3,000,000 L.L. per month in surveys 1 and 2 respectively.

Table 3: *Socio-demographic, parental and household characteristics of Lebanese children and adolescents, based on two nationally representative surveys (survey 1: under five children; survey 2: 5-18 year old children and adolescents)*

	Survey 1	**Survey 2**
	6 months – 5 years **n=888**	**5 – 18 years** **n=1106**
	Mean ± SD	
Child's age	29.47 ± 15.08 months	11.53 ± 3.6 years
Mother's age (years)	31.78 ± 6.27	40.26 ± 7.52
	n (%)	
Mother's education		
Primary school or less	134 (15)	240 (21.7)
Intermediate, High school or Technical diploma	576 (64.3)	658 (59.5)
University degree	186 (20.8)	208 (18.8)
Mothers who specialized in a health-related major	37 (4.2)	36 (5.8)
Mothers' employment status		
Employed	150 (16.7)	247 (23.8)
Housewife	746 (83.3)	791 (76.2)
Father's education		
Primary school or less	187 (21.2)	310 (28.4)
Intermediate, High school or Technical diploma	566 (64.1)	633 (58)
University degree	130 (14.7)	149 (13.6)
The house that you live in is		
Self-owned	539 (60.2)	783 (70.8)
Other	357 (39.8)	323 (29.2)
Crowding index		
≥1 person/room	779 (86.9)	995 (90)
<1 person/room	117 (13.1)	110 (10)
Number of children in the family		
1-2	502 (56)	350 (33.7)
3-5	353 (39.4)	631 (60.7)
>5	41 (4.6)	58 (5.6)
Type of school that children in the household attend		
Private school	419 (46.9)	682 (62.2)
Public school	124 (13.9)	294 (26.8)
Both	5 (0.6)	97 (8.8)
None	345 (38.6)	24 (2.2)
Infants who attend day-care	51 (5.7)	N/A
Do you have a paid helper?		
No	746 (83.6)	N/A
Yes	146 (16.4)	N/A
Monthly income		
<1,000,000 L.L.	307 (42.4)	433 (42.4)
1,000,001-3,000,000 L.L.	343 (47.4)	498 (48.8)
>3,000,000 L.L.	74 (10.2)	90 (8.8)

2. Anthropometric Measurements& Nutritional Status

The anthropometric characteristics of the study subjects for both surveys are presented in Table 4. Mean weight of children under 5 years old was 13.5 ± 4.51kg with no statistically significant difference between boys and girls. The mean weight of 5-18 years old children and adolescents was 45.15 ± 20.04 kg with also no statistically significant difference between genders. The prevalence of wasting and thinness in children and adolescents according to WHO growth charts did not exceed 1.4% in both surveys. Among under-five children, 26.9% of boys and 25.8% of girls were at risk of overweight with no statically significant difference. The prevalence of overweight was 8.3% in under-five children and 21.1% in children and adolescents aged 5-18 years old. Obesity was observed among 2.7% of under-five children and 20.5% of children and adolescents aged 5-18 years old with no statistical difference between genders.

Table 4: *Anthropometric characteristics of Lebanese children aged less than five years (survey 1) and of children and adolescents aged 5-18 years (survey 2), by gender.*

Survey 1 Children 6 month to 5 years old				
	Total (n= 888)	**Boys (n= 456)**	**Girls (n= 432)**	**P-value**
Mean ± SD				
Weight (kg)	13.5 ± 4.51	13.76 ± 3.5	13.24 ± 5.4	0.9
Height (cm)	90.22 ± 45	89.14 ± 13.1	91.4 ± 63.2	0.46
BMI for age n (%)*				
Severely wasted& Wasted [a]	13 (1.4)	8 (1.7)	5 (1.1)	0.84
Normal [b]	543 (61.1)	271 (59.3)	272 (63.1)	
At risk of overweight[c]	234 (26.4)	123 (26.9)	111 (25.8)	
Overweight [d]	74 (8.3)	42 (9.2)	32 (7.4)	
Obese[e]	24 (2.7)	13 (2.8)	11 (2.6)	

Survey 2 Children 5 -18 years old				
Mean ± SD				
	Total (N= 1106)	**Boys (N= 527)**	**Girls (N= 579)**	**P-value**
Weight (kg)	45.15 ± 20.04	45.01 ± 21.13	45.28 ± 19.01	0.83
Height (cm)	144. 3 ± 18.79	144.36 ± 20.2	144.25 ± 17.43	0.92
BMI for age n (%)**				
Severe thinness &Thinness [a]	15 (1.4)	9 (1.7)	6 (1.1)	0.08
Normal [b]	630 (57.1)	283 (53.8)	347 (60)	
Overweight [c]	233 (21.1)	109 (20.7)	124 (21.5)	
Obese [f]	226 (20.5)	125 (23.8)	101 (17.5)	

[a.] BAZ score <-2, [b.] -2 < BAZ <=1, [c.] 1< BAZ <=2, [d.] 2 < BAZ<=3, [e.] BAZ > +3.
[f.]BAZ score> +2.
*World Health Organization. Training Course on Child Growth Assessment. Geneva, WHO,2008.
** World Health Organization. Growth reference data for 5-19 years. 2007.

3. Dietary Intake data

The following Tables present mean intakes of sodium (g/d) and of macronutrients as percentage of total energy (% EI) for all age groups by gender, BMI status, maternal education and family income. Mean intakes of macronutrients in grams per day are shown in appendix 1.

a. Macronutrients and Sodium Intake by Gender

Among infants and children aged less than 2 years, girls had significantly higher mean intake of carbohydrates (CHO) as percentage of total energy intake (50.87% EI ± 0.6) compared to boys (49.06% EI ± 0.6). Similar results were observed among children aged 6- 8 years old (49.26% EI ± 0.74 vs.51.43% ± 0.76). Moreover, as shown in Table 5, girls had significantly higher intake of free sugars (6.98% EI ± 0.49) compared to boys (5.5 % EI ± 0.41) among infants and children less than 2 years old, and higher intake of total fat among children aged 3-5 years (39.37% EI ± 0.52) vs. (37.85% EI ± 0.47).

On the other hand, 3-5 years old boys had significantly higher intakes of free sugars (12.62% EI ± 0.47) vs. (11.11% EI ± 0.46). Boys had also significantly higher intake of total fat (40.06% EI ± 0.67) compared to girls (37.78% EI ± 0.67) among 5-8 years old children. In addition, sodium intake was significantly higher in boys among 9-13 years old (2.45 g/d ± 0.08 vs. 2.16 g/d ± 0.08) and 14 - 18 years old children and adolescents (2.75 g/d ± 0.15 vs. 1.84 g/d ± 0.1).

Table 5: *Mean intake of energy, sodium (g/d) and macronutrients as percent of total energy intake (EI) among Lebanese children and adolescents by age group and gender.*

Intake/day	**6 months-2 years (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
	Mean ± SE				
Energy (Kcal)					
Total	1043.43 ± 25.27	1531.45 ± 23.72	1694.1 ± 40.41	2003.86 ± 38.47	1933.32 ± 56.65
Boys	1048.94 ± 36.33	1573.83 ± 30.81	1791.23 ± 56.7	2156.6 ± 54.62	2315.14 ± 95.13
Girls	1038.13 ± 35.27	1484.02 ± 36.41	1604.17± 56.71	1835.52 ± 51.84	1675.44 ± 63.56
P-value	0.83	0.06	**0.02**	**<0.0001**	**<0.0001**
CHO (%)					
Total	49.98 ± 0.42	49.05 ± 0.4	50.39 ± 0.54	48.82 ± 0.43	48.9 ± 0.58
Boys	49.06 ± 0.6	49.7 ± 0.55	49.26 ± 0.74	48.52 ± 0.57	48.32 ± 0.81
Girls	50.87 ± 0.6	48.32 ± 0.59	51.43 ± 0.76	49.14 ± 0.66	49.29 ± 0.8
P-value	**0.03**	0.09	**0.04**	0.48	0.41
Total Sugars (%)					
Total	27.89 ± 0.47	20.57 ± 0.36	17.43 ± 0.48	16.37 ± 0.36	16.68 ± 0.46
Boys	27.37 ± 0.63	21.2 ± 0.51	16.8 ± 0.65	15.84 ± 0.48	16.65 ± 0.6
Girls	28.38 ± 0.69	19.86 ± 0.51	18.02 ± 0.71	16.96 ± 0.52	16.69 ± 0.65
P-value	0.28	0.07	0.21	0.12	0.96
Free Sugars (%)					
Total	6.26 ± 0.32	11.91 ± 0.33	12.86 ± 0.43	12.58 ± 0.33	12.66 ± 0.43
Boys	5.5 ± 0.41	12.62 ± 0.47	12.5 ± 0.53	12.4 ± 0.44	13.04 ± 0.57
Girls	6.98 ± 0.49	11.11 ± 0.46	13.18 ± 0.64	12.78 ± 0.5	12.41 ± 0.61
P-value	**0.02**	**0.02**	0.42	0.56	0.45
Protein (%)					
Total	10.91 ± 0.16	13.75 ± 0.19	12.09 ± 0.23	12.35 ± 0.21	13.29 ± 0.33
Boys	11.21 ± 0.25	13.84 ± 0.27	11.97 ± 0.34	12.56 ± 0.29	13.73 ± 0.5
Girls	10.62 ± 0.21	13.66 ± 0.27	12.21 ± 0.32	12.12 ± 0.31	12.98 ± 0.44
P-value	0.07	0.64	0.61	0.31	0.27
Total Fat (%)					
Total	40.05 ± 0.38	38.57 ± 0.35	38.88 ± 0.48	40.06 ± 0.42	39.05 ± 0.51
Boys	40.54 ± 0.53	37.85 ± 0.47	40.06 ± 0.67	40.06 ± 0.57	38.98 ± 0.78
Girls	39.58 ± 0.55	39.37 ± 0.52	37.78 ± 0.67	40.06 ± 0.62	39.1 ± 0.68
P-value	0.21	**0.03**	**0.017**	0.99	0.91

Saturated Fat (%) Total Boys Girls *P-value*	12.45 ± 0.22 12.88 ± 0.34 12.04 ± 0.29 0.06	12.65 ± 0.21 12.7 ± 0.3 1.61 ± 0.28 0.83	10.74 ± 0.27 10.76 ± 0.4 10.72 ± 0.38 0.93	10.46 ± 0.21 10.16 ± 0.26 10.8 ± 0.32 0.12	9.89 ± 0.24 10.02 ± 0.37 9.81 ± 0.31 0.67
Sodium (g) Total Boys Girls *P-value*	0.87 ± 0.03 0.9 ± 0.05 0.84 ± 0.05 0.4	1.73 ± 0.04 1.78 ± 0.05 1.67 ± 0.06 0.13	1.95 ± 0.06 2.07 ± 0.1 1.84 ± 0.08 0.08	2.31 ± 0.06 2.45 ± 0.08 2.16 ± 0.08 **0.01**	2.21 ± 0.09 2.75 ± 0.15 1.84 ± 0.1 **<0.0001**

Values in **Bold** are significantly different

b. Macronutrients and Sodium Intakes by BMI Status

As shown in Table 6, obese children aged 3-5 years old had significantly higher sodium intake (2.5 g/d ± 0.37) than overweight (1.46 g/d ± 0.12) and normal weight children (1.68 g/d ± 0.05) in the same age group. Obese children aged 9-13 years had significantly higher protein intake (13.39% EI ± 0.48) than their normal weight counterparts (11.99% EI ± 0.29) in the same age group. Results have also shown that free sugars intake was significantly lower in obese compared to normal weight children aged 6-8 years (11.3% EI ± 0.81 vs. 13.69% EI ± 0.56) and 9-13 years (10.67% EI ± 0.63 vs. 13.35% EI ± 0.46).

Table 6: *Mean intake of energy, sodium (g/d) and macronutrients as percent of total energy intake (EI) among Lebanese children and adolescents by age group and BMI Status.*

Intake/day	**6 months-2 years (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
	Mean ± SE				
Energy (Kcal)					
Normal	986.02 ± 33.79	1513.13 ± 28.67	1651 ± 54.59	2011.7 ± 52.06	1949.96 ± 75.24
At risk of overweight	1126.97 ± 44.44	1581.02 ± 50.25	N/A	N/A	N/A
Overweight	1184.68 ± 81.69	1469.19 ± 79.93	1683.94 ± 87.2	1995.12 ± 74.6	1810.78 ± 119.5
Obese	1016.48 ± 147.32	1727.13 ± 199.11	1849.4 ± 80.49	1992.25 ± 89.58	1948.13 ± 129.2
P-value	**0.03**	0.3	0.16	0.98	0.6
CHO (%)					
Normal	49.93 ± 0.57	49.39 ± 0.51	51.5 ± 0.7	48.81 ± 0.6	49.64 ± 0.77
At risk of overweight	50.28 ± 0.81	49.3 ± 0.73	N/A	N/A	N/A
Overweight	49.18 ± 1.2	46.96 ± 1.54	48.58 ± 1.12	49.65 ± 0.79	46.36 ± 1.16
Obese	52.17 ± 2.7	44.58 ± 2.82	49.03 ± 1.15	47.98 ± 1.04	49.14 ± 1.42
P-value	0.73	0.14	0.052	0.45	0.08
Total Sugars (%)					
Normal	28 ± 0.61	20.84 ± 0.46	18.4 ± 0.62	16.53 ± 0.47	17.6 ± 0.62
At risk of overweight	27.65 ± 0.91	20.53 ± 0.7	N/A	N/A	N/A
Overweight	28.14 ± 1.44	20.45 ± 1.07	16.42 ± 1.19	16.67 ± 0.75	15.22 ± 0.95
Obese	25.06 ± 3.64	16.42 ± 2.52	15.74 ± 1	15.61 ± 0.8	15.61 ± 1.05
P-value	0.75	0.3	0.058	0.55	0.07
Free Sugars (%)					
Normal	6.23 ± 0.43	12.26 ± 0.43	**13.69 ± 0.56**	**13.35 ± 0.46**	13.43 ± 0.58
At risk of overweight	6.62 ± 0.62	11.65 ± 0.61	N/A	N/A	N/A
Overweight	5.78 ± 0.88	10.88 ± 1.19	11.69 ± 1.02	12.44 ± 0.65	11 ± 0.87
Obese	6.19 ± 3.04	11.73 ± 2.11	**11.3 ± 0.81**	**10.67 ± 0.63**	12.03 ± 1.02
P-value	0.91	0.69	**0.04**	**<0.001**	0.07
Protein (%)					
Normal	11.07 ± 0.21	13.75 ± 0.25	11.9 ± 0.31	**11.99 ± 0.29**	13.09 ± 0.4
At risk of overweight	11.12 ± 0.34	13.63 ± 0.34	N/A	N/A	N/A
Overweight	10.17 ± 0.45	14.24 ± 0.63	11.82 ± 0.47	12.38 ± 0.43	14.19 ± 0.85
Obese	10.58 ± 0.75	13.3 ± 0.19	12.85 ± 0.5	**13.39 ± 0.48**	13.3 ± 0.79
P-value	0.36	0.88	0.25	**0.04**	0.43
Total Fat (%)					
Normal	39.93 ± 0.51	38.3 ± 0.44	37.99 ± 0.62	40.38 ± 0.55	38.62 ± 0.67
At risk of overweight	39.54 ± 0.75	38.38 ± 0.66	N/A	N/A	N/A
Overweight	41.53 ± 1.18	40.15 ± 1.28	41.08 ± 1.09	39.23 ± 0.84	40.32 ± 1.13
Obese	38.48 ± 2.57	42.7 ± 2.34	39.31 ± 1.07	39.93 ± 1.04	38.85 ± 1.21
P-value	0.46	0.15	0.054	0.54	0.42
Saturated Fat (%)					
Normal	12.69 ± 0.3	12.44 ± 0.26	10.6 ± 0.36	10.5 ± 0.26	9.98 ± 0.34
At risk of overweight	11.85 ± 0.39	12.81 ± 0.42	N/A	N/A	N/A
Overweight	12.37 ± 0.72	13.06 ± 0.87	11.04 ± 0.57	10.87 ± 0.48	10.15 ± 0.51
Obese	12.37 ± 2.04	14.92 ± 1.72	10.85 ± 0.64	9.86 ± 0.48	9.4 ± 0.47
P-value	0.47	0.25	0.82	0.26	0.56
Sodium (g)					
Normal	0.82 ±0.05	**1.68 ± 0.05**	1.84 ± 0.08	2.33 ± 0.08	2.18 ± 0.11
At risk of overweight	0.92 ± 0.06	1.86 ± 0.08	N/A	N/A	N/A
Overweight	0.96 ± 0.1	**1.46 ± 0.12**	1.99 ± 0.19	2.29 ± 0.12	1.94 ± 0.17
Obese	0.94 ± 0.19	**2.5 ± 0.37***	2.21 ± 0.15	2.3 ± 0.12	2.46 ± 0.22
P-value	0.47	**0.001**	0.08	0.95	0.15

Values in **Bold** are significantly different
* Both normal & overweight values were only statistically significant with obese value

c. Macronutrients and Sodium Intake by socio-demographic status

Dietary intakes of children and adolescents were examined by different socio-demographic characteristics, including maternal education and family income.

i. Dietary intakes & Maternal Education Level

Mean intake of macronutrients as % EI and mean sodium intake (g/d) for all age groups were examined by maternal education level in Table 7. Among children and adolescents aged 3-5 years intake of SFA (% EI) was significantly higher among children whose mothers attained university degree (13.2% EI ± 0.42) compared to children whose mothers' educational level was intermediate or technical (12.92% EI ± 0.28) and primary or less (11.13% EI ± 0.46) in the same age group. Similarly, in 9-13 years old children, a significantly higher SFA (% EI) was observed among children whose mothers' obtained university degree (11.58% EI ± 0.52) compared to those whose mothers' educational level was primary or less (9.64% EI ± 0.4).

Table 7**:** *Mean intake of energy, sodium and macronutrients as (%) of total energy intake (EI) among Lebanese children and adolescents by age group and maternal education level.*

Intake/day	**6 months-2 yea (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14-18 years (n=321)**
	Mean ± SE				
Energy (Kcal)					
Primary or less	941.91 ± 80.27	1599.58 ± 64.39	1712.36 ± 124.3	2144.47 ± 88.32	1992.02 ± 126.53
Intermediate, high school or technical diploma	1077.29 ± 32.99	1523.11 ± 28.77	1727.79 ± 48.32	1960.24 ± 48.56	1879.05 ± 67.64
University degree	985.47 ± 37.78	1495.77 ± 52.46	1587.56 ± 80.38	1984.55 ± 88.22	2041.82 ± 152.07
P-value	0.14	0.37	0.37	0.16	0.51
CHO (%)					
Primary or less	50.98 ± 1.33	48.97 ± 1.08	50.41 ± 1.32	49.57 ± 0.95	50.02 ± 1.18
Intermediate, high school or technical diploma	49.94 ± 0.54	49.66 ± 0.5	50.07 ± 0.69	48.83 ± 0.57	48.85 ± 0.72
University degree	49.66 ± 0.71	47.26 ± 0.85	51.24 ± 1.11	47.98 ± 0.97	47.02 ± 1.57
P-value	0.7	0.07	0.68	0.51	0.28

Total Sugars (%) Primary or less Intermediate, high school or technical diploma University degree *P-value*	 26.67 ± 1.72 27.78 ± 0.57 28.77 ± 0.91 0.48	 20.05 ± 0.96 20.73 ± 0.43 20.57 ± 0.87 0.79	 15.56 ± 1.2 17.49 ± 0.61 18.73 ± 1.02 0.12	 16.62 ± 0.81 16.23 ± 0.45 16.55 ± 0.81 0.88	 16.58 ± 0.91 16.67 ± 0.59 16.86 ± 1.2 0.98
Free Sugars (%) Primary or less Intermediate, high school or technical diploma University degree *P-value*	 6.9 ± 1.23 6.54 ± 0.4 5.08 ± 0.58 0.14	 13.1 ± 0.84 11.78 ± 0.42 11.22 ± 0.7 0.19	 11.46 ± 0.91 13. 4 ± 0.56 12.45 ± 0.87 0.21	 13.27 ± 0.69 12.57 ± 0.43 11.85 ± 0.72 0.39	 12.84 ± 0.82 12.67 ± 0.56 12.33 ± 1.14 0.94
Protein (%) Primary or less Intermediate, high school or technical diploma University degree *P-value*	 10.48 ± 0.53 10.84 ± 0.2 11.29 ± 0.31 0.36	 13.41 ± 0.57 13.56 ± 0.22 14.66 ± 0.39 0.06	 11.43 ± 0.48 11.96 ± 0.3 12.96 ± 0.51 0.1	 12.21 ± 0.52 12.11 ± 0.27 13.23 ± 0.47 0.13	 12.89 ± 0.58 13.24 ± 0.45 14.09 ± 0.88 0.48
Total Fat (%) Primary or less Intermediate, high school or technical diploma University degree *P-value*	 39.37 ± 1.37 40.19 ± 0.48 39.96 ± 0.67 0.81	 39.13 ± 0.95 38.16 ± 0.43 39.34 ± 0.74 0.32	 39.54 ± 1.2 39.26 ± 0.62 37.33 ± 0.93 0.22	 39.54 ± 0.91 40.25 ± 0.57 40.06 ± 0.86 0.8	 38.26 ± 0.99 39.23 ± 0.67 39.8 ± 1.35 0.6
Saturated Fat (%) Primary or less Intermediate, high school or technical diploma University degree *P-value*	 12.67 ± 0.82 12.51 ± 0.27 12.17 ± 0.4 0.78	 **11.13 ± 0.46** **12.92 ± 0.28** **13.2 ± 0.42** **0.003***	 9.75 ± 0.61 10.86 ± 0.36 11.17 ± 0.55 0.23	 **9.64 ± 0.4** 10.4 ± 0.27 **11.58 ± 0.52** **0.01**	 9.67± 0.5 9.82 ± 0.3 10.58 ± 0.64 0.48
Sodium (g) Primary or less Intermediate, high school or technical diploma University degree *P-value*	 0.77 ± 0.11 0.9 ± 0.04 0.79 ± 0.05 0.27	 1.76 ± 0.1 1.74 ± 0.05 1.68 ± 0.09 0.8	 2 ± 0.16 1.92 ± 0.08 1.96 ± 0.17 0.9	 2.58 ± 0.14 2.23 ± 0.07 2.27 ± 0.12 0.47	 2.13 ± 0.17 2.17 ± 0.11 2.5 ± 0.25 0.4

Values in **Bold** are significantly different
* Both values were only statistically significant with university degree value

ii. Dietary intakes &Family Income

Children aged 3-5 years with family income between 1000,000-3000,000 L.L had significantly higher intake of total sugars (21.56% EI ± 0.54) than children of the same age group with family income less than 1000,000 L.L (19.2% EI ± 0.64). Likewise, as shown in Table 8, significantly higher intake of total sugars was observed among children aged 6-8 years with family income more than 3000,000 L.L (20.71% EI

± 2.48) compared to their counterparts with family income between 1000,000-3000,000 L.L (18.4% EI ± 0.84) and to those with family income less than 1000,000 L.L (15.88% EI ± 0.72) in the same age group. However, children and adolescents with different family income level did not show any statistically significant difference in intake of free sugars in all age groups.

Children and adolescents aged 3-5 years, 9-14 years and 14-18 years with family income between 1000,000-3000,000 L.L had significantly higher intake of SFA (% EI) compared to children and adolescents with family income less than 1000,000 L.L of the same age groups. In addition, children aged 6-8 years with family income more than 3000,000 L.L had also significantly higher intake of SFA (12.13% EI ± 1.29) than those of the same age with family income between 1000,000-3000,000 L.L (11.11%EI ± 0.42) and less than 1000,000 L.L (9.77% EI ± 0.46).

Children aged 9-13 years with family income more than 3000,000 L.L had significantly lower sodium intakes (1.89 g/d ± 0.12) and higher protein intakes (14.87% EI ± 0.75) compared to those with family income between 1000,000-3000,000 L.L (2.32 g/d ± 0.09); (12.43% EI ± 0.29) and those with family income less than 1000,000 L.L (2.42 g/d ± 0.09); (11.84% EI ± 0.34) in the same age group (Table 8).

Table 8: *Mean intake of energy, sodium (g/d) and macronutrients as percent of total energy intake (EI) among Lebanese children and adolescents by age group and family income.*

Intake/day	**6 months-2 year (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
	Mean ± SE				
Energy (Kcal)					
<1000,000	983.41 ± 43.32	1569.5 ± 41.28	1713.05 ± 70.77	**2044.79 ± 56.19**	1902.64 ± 81.51
1000,000 – 3000,000	1076.28 ± 43.5	1535.77 ± 34.04	1764.62 ± 67.55	**2048.98 ± 58.02**	2012.36 ± 92.65
>3000,000	946.61 ± 63	1365.15 ± 79.74	1515.53 ± 180.41	**1581.91 ± 117.5**	1724.52 ± 162.37
P-value	0.21	0.08	0.4	**0.003***	0.32
CHO (%)					
<1000,000	50.6 ± 0.73	49.16 ± 0.74	50.36 ± 0.81	49.33 ± 0.68	**50.12 ± 0.87**
1000,000 – 3000,000	49.67 ± 0.73	49.26 ± 0.59	50.85 ± 0.89	48.43 ± 0.61	48.65 ± 0.84
>3000,000	49.34 ± 1.2	48.12 ± 1.39	51.18 ± 2.88	47.3 ± 1.68	**44.23 ± 1.8**
P-value	0.57	0.76	0.9	0.38	**0.01**
Total Sugars (%)					
<1000,000	28.2 ± 0.83	**19.2 ± 0.64**	**15.88 ± 0.72**	16.48 ± 0.56	16.29 ± 0.68
1000,000 – 3000,000	27.91 ± 0.75	**21.56 ± 0.54**	**18.4 ± 0.84**	16.59 ± 0.51	16.93 ± 0.69
>3000,000	28.84 ± 1.58	20.62 ± 1.35	**20.71 ± 2.48**	14.84 ± 1.16	16.36 ± 1.68
P-value	0.87	**0.02**	**0.03***	0.41	0.8
Free Sugars (%)					
<1000,000	6.16 ± 0.53	12.05± 0.57	12.39 ± 0.65	12.91 ± 0.53	11.99 ± 0.58
1000,000 – 3000,000	6.05 ± 0.56	12.23 ± 0.53	13.89 ± 0.73	12.64 ± 0.46	13.33 ± 0.67
>3000,000	4.36 ± 0.81	10.79 ± 0.98	15.14 ± 2.32	10.45 ± 1.01	12.24 ± 1.69
P-value	0.29	0.55	0.2	0.13	0.33
Protein (%)					
<1000,000	10.88 ± 0.3	13.32± 0.38	11.49 ± 0.38	**11.84 ± 0.34**	12.82 ± 0.48
1000,000 – 3000,000	11.08 ± 0.24	14 ± 0.27	11.57 ± 0.33	**12.43 ± 0.29**	13.32 ± 0.51
>3000,000	11.02 ± 0.48	14.59 ± 0.51	13.09 ± 1.03	**14.87 ± 0.75**	15.21 ± 1.15
P-value	0.87	0.14	0.25	**0.001***	0.13
Total Fat (%)					
<1000,000	39.54 ± 0.65	38.95 ± 0.68	39.47 ± 0.79	40.12 ± 0.64	38.32 ± 0.84
1000,000 – 3000,000	40.16 ± 0.68	38.07 ± 0.52	39.06 ± 0.79	40.35 ± 0.6	39.27 ± 0.71
>3000,000	40.51 ± 1.08	38.49 ± 1.08	36.84 ± 2.5	39.02 ± 1.63	41.51 ± 1.56
P-value	0.7	0.57	0.49	0.7	0.2
Saturated Fat (%)					
<1000,000	12.53 ± 0.39	**11.66 ± 0.35**	**9.77 ± 0.46**	**9.83 ± 0.28**	**9.12 ± 0.34**
1000,000 – 3000,000	12.61 ± 0.38	**13.36 ± 0.33**	**11.11 ± 0.42**	**10.96 ± 0.32**	**10.53 ± 0.38**
>3000,000	12.56 ± 0.67	12.37 ± 0.57	**12.13 ± 1.29**	10.58 ± 0.71	10.74 ± 0.75
P-value	0.99	**0.002**	**0.04***	**0.04**	**0.01**
Sodium (g)					
<1000,000	0.8 ± 0.06	1.78± 0.07	1.88 ± 0.09	**2.42 ± 0.09**	2.15 ± 0.14
1000,000 – 3000,000	0.91 ± 0.05	1.73 ± 0.06	1.97 ± 0.1	**2.32 ± 0.09**	2.36 ± 0.13
>3000,000	0.78 ± 0.11	1.44 ± 0.12	1.93 ± 0.33	**1.89 ± 0.12**	1.88 ± 0.19
P-value	0.38	0.09	0.82	**0.047***	0.23

Values in **Bold** are significantly different

* Both values were only statistically significant with family income >3000,000 value

d. <u>Proportion of Children and Adolescents Who Exceeded the WHO Upper Limits of Free Sugars, Total Fat, SFA & Sodium</u>

Among infants and children aged 6 months to 2 years 45% exceeded the latest WHO (conditional) recommendation for free sugars (5% EI) and 24.8% exceeded 10% EI cut-off point for free sugars, while around 77% of these participants had total fat intakes above WHO recommendation. Among children and adolescents aged above 2 years old, 54.2% to 62.2% reported intakes exceeding 10% EI of free sugars and more than 83% exceeded the 5% EI recommendation. Further, more than 68% exceeded the cut-off points for both total fat and SFA, especially among children aged 3-5 years where only 15% of children were within the WHO recommendation for SFA. As shown in Table 9, 30.1% - 56.4% of children and adolescents aged above 2 years had sodium intakes exceeding 2 grams per day.

Table 9: *Percentage of Lebanese children and adolescents exceeding the WHO recommendations for macronutrients and sodium.*

n (%) exceeding WHO Upper Limits	**WHO Upper Limit**	**6 months-2 years (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
	n (%)					
Free Sugar (1)	**10% EI**	93 (24.8)	279 (54.2)	194 (62.2)	275 (58.1)	199 (62.2)
Free Sugar (2)	**5% EI**	168 (45)	430 (83.5)	272 (87.2)	405 (85.6)	272 (85)
Total Fat	**35% EI**	287 (76.9)	354 (68.7)	224 (71.8)	346 (73.2)	218 (68.1)
Saturated Fat	**8% EI***	325 (86.7)	438 (85)	212 (67.9)	323 (68.3)	203 (63.4)
Sodium	**2 g**	26 (7)	155 (30.1)	125 (40.1)	267 (56.4)	138 (43.1)

*Saturated Fat Upper limits (8% EI) for children aged above 2 years old.

B. Anthropometric and Socio-demographic Predictors of High Intakes of Free Sugars, Total Fat, SFA and Sodium

Logistic regression analysis was carried out to identify the anthropometric & socio-demographic predictors of high intakes of free sugars, total fat, SFA and sodium. High intakes of these nutrients were the dependent variables and were defined as exceeding the WHO benchmarks.

1. Predictors of Excessive Free Sugars Intake among Children aged 6 Months – 5 Years

Among infants and children aged 6 months to 5 years, child's age showed significant association with free sugars' intake exceeding 10% EI (OR=3.56; CI=2.66 - 4.77) and 5% EI (OR=6.17; CI=4.53-8.41). As shown in Table 10, higher mothers' educational level was significantly associated with lower odd ratios (OR) of excessive free sugars consumption above 10% EI (OR=0.53; CI= 0.33-0.83) and above 5% (OR=0.56; CI=0.34-0.92). Further, crowding index was also significantly associated with lower odds (OR=0.76; CI=0.44-0.99) of excessive consumption of free sugars above 10% EI. After adjusting for other variables, child's age remained a significant predictor of excessive intake of free sugars above 10% EI (OR=3.47; CI=2.58-4.65) and above 5% EI (OR=6.1; CI=4.47-8.33). Moreover, children whose mothers attained university degree was less likely to exceed the intake of free sugar above 10% EI (OR=0.61; CI=0.38-0.98).

Table 10: *Association of Socio-demographic and Anthropometric Factors with High Free Sugars Intake (Exceeding 5% and 10% of EI) Among Infants and Children Aged 6 months to 5 years*

Survey 1	**Free Sugars Intake > 10%- WHO UL**		**Free Sugars Intake > 5%- WHO UL**	
	OR (95% CI)- Crude	**OR (95% CI) - Adjusted**	**OR (95% CI)- Crude**	**OR (95% CI) - Adjusted**
Child age				
6months -2 years	-	-	-	-
2- 5 years	**3.56** (**2.66 - 4.77**)	**3.47 (2.58-4.65)**	**6.17 (4.53-8.41)**	**6.1 (4.47-8.33)**
Child gender				
Male	-	-	-	-
Female	0.84 (0.64-1.1)	0.86 (0.65-1.14)	1.03 (0.78-1.36)	1.11 (0.82-1.52)
Maternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	**0.64 (0.44-0.94)**	0.75 (0.5-1.12)	**0.62 (0.4-0.96)**	0.8 (0.5-1.28)
University	**0.53 (0.33-0.83)**	**0.61 (0.38-0.98)**	**0.56 (0.34-0.92)**	0.71 (0.41-1.22)
Paternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	0.75 (0.53-1.04)	-	0.78 (0.54-1.12)	-
University	0.65 (0.41-1.03)	-	0.87 (0.54-1.42)	-
Income				
<1,000,000 L.L.	-	-	-	-
1,000,001-3,000,000 L.L.	1.02 (0.75-1.4)	-	1.3 (0.93-1.81)	-
>3,000,000 L.L.	0.66 (0.39-1.13)	-	0.8 (0.47-1.34)	-
Crowding index				
>=1 person/room	-	-	-	-
<1 person/room	**0.76 (0.44-0.99)**	-	0.72 (0.48-1.07)	-
BMI				
Normal	-	-	-	-
At risk of overweight	0.89 (0.65-1.22)	-	1.12 (0.8-1.56)	-
Overweight	0.61 (0.36-1.02)	-	0.76 (0.46-1.26)	-
Obese	1.07 (0.47-2.43)	-	0.55 (0.24-1.25)	-

2. Predictors of Excessive Total Fat & Saturated Fat intakes among Children aged 6 months – 5 years

Among children aged 6 months to 5 years, increasing child's age was significantly associated with lower odds of exceeding the WHO upper limits of total fat intake (35% EI). Further, overweight children had significantly higher odds of excessive total fat intake (OR=2.00; CI=1.07-3.76). Children with higher maternal education (OR=4.86; CI=2.08-11.36), paternal education (OR=4.34; CI=1.59-11.9) and family income (OR=3.75; CI=1.09-12.84) were more likely to exceed the WHO upper limits of SFA intake. After adjusting for other variables, child's age (OR=0.69; CI=0.51-0.95) and overweight (OR=1.91; CI=1.02-3.59) were predictors for excessive total fat intake above 35% EI. For SFA intake, only family income (1,000,000-3,000,000 L.L.) remained as a significant predictor of excessive intake of SFA (OR=2.09; CI=1.1-3.97), Table 11.

3. Predictors of Excessive Sodium intake among Children aged 6 months – 5 years

Among children aged 6 months to 5 years, children aged 2-5 years were 5.75 times more likely (CI=3.7-8.93) to exceed sodium intake above the WHO upper limit of 2 grams, and children whose mothers attained university degree were less likely (OR=0.5; CI=0.29-0.88) to exceed this upper limit. Furthermore, as shown in Table 12, multiple logistic regressions showed that only child's age remained as a predictor of excessive intake of sodium (OR=5.66; CI=3.64-8.81) after adjustment for other variables.

Table 11: *Association of Socio-demographic and Anthropometric Factors with High Total Fat & SFA Intake (Exceeding 35% and 8% of EI) Among Infants and Children Aged 6 months to 5 years*

Survey 1	**Total Fat Intake > 35%- WHO UL**		**Saturated Fat Intake > 8%- WHO UL**	
	OR (95% CI)-Crude	**OR (95% CI) -Adjusted**	**OR (95% CI)-Crude**	**OR (95% CI) -Adjusted**
Child age			***"No UL under 2"***	***"No UL under 2"***
6months -2 years	-	-	-	-
2- 5 years	**0.66 (0.49-0.89)**	**0.69 (0.51-0.95)**	0.84 (0.57-1.24)	0.75 (0.47-1.18)
Child gender				
Male	-	-	-	-
Female	1.03 (0.77-1.39)	1.05 (0.78-1.41)	1.03 (0.71-1.51)	1.02 (0.59-1.76)
Maternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	1.08 (0.71-1.63)	-	**2.7 (1.55-4.69)**	1.47 (0.7-3.1)
University	1.34 (0.81-2.22)	-	**4.86 (2.08-11.36)**	1.72 (0.55-5.37)
Paternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	1.09 (0.5-1.57)	-	**1.81 (1.05-3.11)**	1.14 (0.56-2.33)
University	1.24 (0.75-2.06)	-	**4.34 (1.59-11.9)**	2.14 (0.56-8.16)
Income				
<1,000,000 L.L.	-	-	-	-
1,000,001-3,000,000 L.L.	0.96 (0.68-1.35)	-	**2.68 (1.53-4.72)**	**2.09 (1.1-3.97)**
>3,000,000 L.L.	1.35 (0.74-2.45)	-	**3.75 (1.09-12.84)**	2.07 (0.5-8.5)
Crowding index				
>=1 person/room	-	-	-	-
<1 person/room	0.89 (0.58-1.36)	-	1.19 (0.54-2.61)	-
BMI				
Normal	-	-	-	-
At risk of overweight	1.12 (0.8-1.58)	1.11 (0.79-1.56)	1.34 (0.74-2.4)	-
Overweight	**2 (1.07-3.76)**	**1.91 (1.02-3.59)**	1.47 (0.5-4.34)	-
Obese	1.29 (0.5-3.3)	1.26 (0.49-3.23)	1.08 (0.23-5)	-

Table 12: *Association of Socio-demographic and Anthropometric Factors with High Sodium Intake (Exceeding 2 grams/day) Among Infants and Children Aged 6 months to 5 years*

Survey 1 (sodium >2 g- WHO UL)	OR (95% CI)- Crude	OR (95% CI) -Adjusted
Child age		
6months -2 years	-	-
2- 5 years	**5.75 (3.7-8.93)**	**5.66 (3.64-8.81)**
Child gender		
Male	-	-
Female	0.84 (0.61-1.16)	0.88 (0.62-1.23)
Maternal Education		
Primary or less	-	-
Intermed., H. school, tech D	0.74 (0.48-1.15)	0.91 (0.57-1.44)
University	**0.5 (0.29-0.88)**	0.6 (0.34-1.07)
Paternal Education		
Primary or less	-	-
Intermed., H. school, tech D	0.81 (0.54-1.2)	-
University	0.83 (0.48-1.43)	-
Income		
<1,000,000 L.L.	-	-
1,000,001-3,000,000 L.L.	1.25 (0.85-1.82)	-
>3,000,000 L.L.	0.51 (0.23-1.12)	-
Crowding index		
>=1 person/room	-	-
<1 person/room	0.73 (0.43-1.23)	-
BMI		
Normal	-	-
At risk of overweight	1.09 (0.75-1.6)	-
Overweight	0.54 (0.26-1.11)	-
Obese	2.33 (0.99-5.46)	-

4. Predictors of Excessive Free Sugars intake among Children aged 6 – 18 years

Females were less likely (OR=0.71; CI=0.5-0.99) to exceed the WHO conditional recommendation of 5% EI of free sugars. Moreover, overweight and obesity were significantly associated with lower odds of free sugars intake exceeding 10% EI (OR=0.65; CI=0.48-0.88, OR=0.63; CI=0.46-0.85 respectively) and 5% EI (OR=0.57; CI=0.38-0.86, OR=0.58; CI=0.38-0.88 respectively). Adjusting for other factors showed that each of female gender (OR=0.69; CI=0.49-0.98), overweight (OR=0.57; CI=0.37-0.86) and obesity (OR=0.56; CI=0.37-0.85) remained negative predictors of free sugars exceeding 5% EI, Table 13.

5. Predictors of Excessive Total Fat & Saturated Fat intake among Children aged 6 – 18 years

As shown in Table 14, higher maternal education level (university degree; OR=1.81; CI=1.2-2.71), paternal education level (university degree; OR=1.83; CI=1.19-2.82) and family income (> 3,000,000 L.L.; OR=1.79; CI=1.08-2.96) were significantly associated with exceeding the SFA WHO upper limit of 8% EI. After adjusting for other variables, the association between higher family income ranged between 1,000,000-3,000,000 L.L. and SFA excessive intake was found to be significant (OR= 1.39; CI=1.02-1.87).

Table 13: *Association of Socio-demographic and Anthropometric Factors with High Free Sugars Intake (Exceeding 5% and 10% of EI) among Infants and Children aged 5-18 years*

Survey 2	**Free Sugars Intake > 10% - WHO UL**		**Free Sugars Intake > 5%- WHO UL**	
	OR (95% CI) - Crude	**OR (95% CI) - Adjusted**	**OR (95% CI)- Crude**	**OR (95% CI)- Adjusted**
Child age				
6-8 yrs	-	-	-	-
9- 13 years	0.85 (0.63-1.13)	0.88 (0.65-1.18)	0.88 (0.58-1.33)	0.91 (0.59-1.38)
14-18 yrs	1 (0.73-1.38)	1.01 (0.73-1.4)	0.83 (0.53-1.31)	0.87 (0.55-1.38)
Child gender				
Male	-	-	-	-
Female	0.96 (0.76-1.22)	0.94 (0.73-1.2)	**0.71 (0.5-0.99)**	**0.69 (0.49-0.98)**
Maternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	1.03 (0.76-1.4)	-	0.98 (0.64-1.51)	-
University	0.84 (0.5-1.22)	-	0.91 (0.53-1.54)	-
Paternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	1.07 (0.81-1.41)	-	0.72 (0.48-1.09)	-
University	0.89 (0.6-1.32)	-	0.69 (0.39-1.2)	-
Income				
<1,000,000 L.L.	-	-	-	-
1,000,001-3,000,000 L.L.	1.06 (0.81-1.38)	-	0.92 (0.62-1.35)	-
>3,000,000 L.L.	0.72 (0.46-1.14)	-	0.6 (0.3-1.1)	-
Crowding index				
>=1 person/room	-	-	-	-
<1 person/room	0.98 (0.65-1.46)	-	1.12 (0.65-1.94)	-
BMI				
Normal	-	-	-	-
Overweight	**0.65 (0.48-0.88)**	**0.65 (0.45-0.88)**	**0.57 (0.38-0.86)**	**0.57 (0.37-0.86)**
Obese	**0.63 (0.46-0.85)**	**0.62 (0.46-0.85)**	**0.58 (0.38-0.88)**	**0.56 (0.37-0.85)**

Table 14: *Association of Socio-demographic and Anthropometric Factors with High Total Fat & SFA Intake (Exceeding 35% and 8% of EI) Among Infants and Children Aged 5-18 years*

Survey 2	**Total Fat Intake > 35% - WHO UL**		**Saturated Fat Intake > 8% - WHO UL**	
	OR (95% CI)-Crude	**OR (95% CI) - Adjusted**	**OR (95% CI)-Crude**	**OR (95% CI) - Adjusted**
Child age				
6-8 yrs	-	-	-	-
9- 13 years	1.07 (0.78-1.47)	1.07 (0.77-1.47)	1.02 (0.75-1.38)	1.14 (0.81-1.58)
14-18 yrs	0.84 (0.6-1.18)	0.85 (0.6-1.19)	0.82 (0.59-1.14)	0.86 (0.6-1.23)
Child gender				
Male	-	-	-	-
Female	0.88 (0.68-1.14)	0.9 (0.69-1.17)	1.12 (0.86-1.42)	1.17 (0.9-1.53)
Maternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	1.15 (0.83-1.59)	-	1.22 (0.9-1.66)	1.04 (0.73-1.48)
University	0.92 (0.61-1.37)	-	**1.81 (1.2-2.71)**	1.31 (0.8-2.15)
Paternal Education				
Primary or less	-	-	-	-
Intermed., H. school, tech D	0.97 (0.72-1.31)	-	1.32 (0.99-1.75)	1.11 (0.8-1.54)
University	1.27 (0.81-1.99)	-	**1.83 (1.19-2.82)**	1.34 (0.79-2.27)
Income				
<1,000,000 L.L.	-	-	-	-
1,000,001-3,000,000 L.L.	1.05 (0.79-1.4)	-	**1.54 (1.18-2.03)**	**1.39 (1.02-1.87)**
>3,000,000 L.L.	0.98 (0.6-1.62)	-	**1.79 (1.08-2.96)**	1.39 (0.78-2.47)
Crowding index				
>=1 person/room	-	-	-	-
<1 person/room	0.92 (0.59-1.44)	-	0.73 (0.47-1.14)	-
BMI				
Normal	-	-	-	-
Overweight	0.99 (0.71-1.38)	-	1.19 (0.86-1.65)	-
Obese	0.86 (0.62-1.1)	-	0.92 (0.67-1.26)	-

6. Predictors of Excessive Sodium intake among Children aged 6 – 18 years

Children aged between 9-13 years had significantly higher odds of exceeding the 2 grams upper limit of sodium (OR=1.94; CI=1.45-2.59). Further, female gender was significantly associated with lower odds of excessive sodium intake (OR=0.55; CI=0.43-0.69), (Table 15). After adjusting for other variables, both child's age (OR=1.92; CI=1.43-2.57) and female gender (OR=0.56; CI=0.44-0.72) remained significant predictors of excessive intake of sodium.

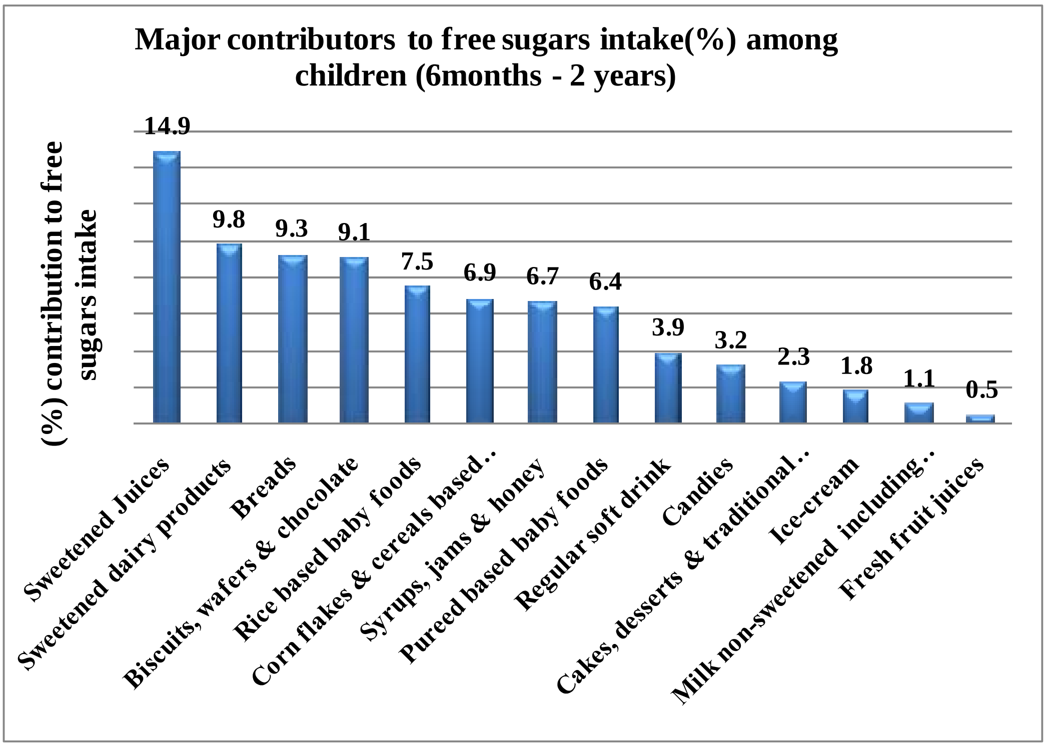
Table 15: *Association of Socio-demographic and Anthropometric Factors with High Sodium Intake (Exceeding 2 grams/day) Among Infants and Children Aged 5 -18 years*

Survey 2 (sodium >2 g- WHO UL)	**OR (95% CI)- Crude**	**OR (95% CI) - Adjusted**
Child age		
6-8 yrs	-	-
9- 13 years	**1.94 (1.45-2.59)**	**1.92 (1.43-2.57)**
14-18 yrs	1.13 (0.83-1.56)	1.19 (0.86-1.64)
Child gender		
Male	-	-
Female	**0.55 (0.43-0.69)**	**0.56 (0.44-0.72)**
Maternal Education		
Primary or less	-	-
Intermed., H. school, tech D	0.95 (0.71-1.28)	-
University	1.19 (0.82-1.72)	-
Paternal Education		
Primary or less	-	-
Intermed., H. school, tech D	0.91 (0.7-1.2)	-
University	0.91 (0.61-1.35)	-
Income		
<1,000,000 L.L.	-	-
1,000,001-3,000,000 L.L.	1.08 (0.84-1.4)	-
>3,000,000 L.L.	0.89 (0.56-1.41)	-
Crowding index		
>=1 person/room	-	-
<1 person/room	1.12 (0.75-1.66)	-
BMI		
Normal	-	-
Overweight	0.95 (0.7-1.28)	-
Obese	1.26 (0.93-1.7)	-

C. Major Food Sources of Free Sugars, Total Fat and Saturated Fat Consumed by Lebanese Children and Adolescents

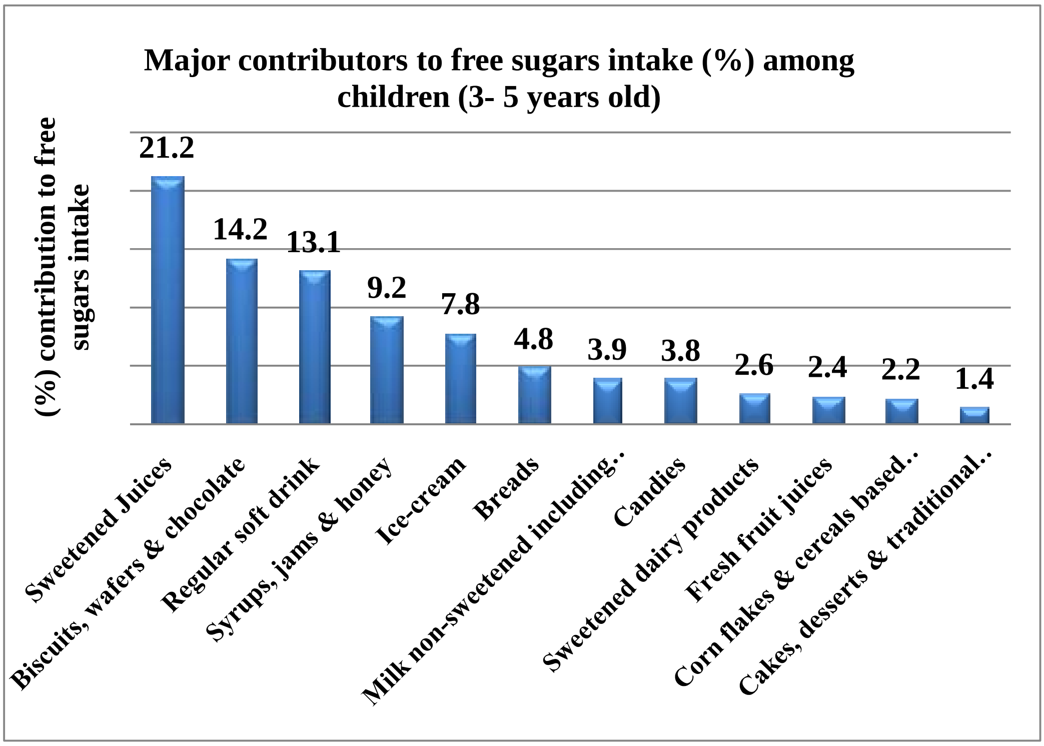
1. Major Food Sources of Free Sugars

Sweetened juices were the first major source of free sugars among infants and children aged 6 months to 2 years old, 3-5 years and 6-8 years, contributing to 14.9%, 21.2% and 22.2% respectively to free sugars intake. These ranked as the second major source of free sugars among children and adolescents above 9 years old as shown in figure 2. Among children and adolescents aged 9-13 years and 14-18 years old, regular soft drinks ranked as the first contributor to free sugars intake with 21.7% and 25.2% of all free sugars intake respectively. As shown in figure 2, sweetened dairy products were the second major source of free sugars (9.8% of free sugars intake) among infants and children aged 6 months to 2 years. On the other hand, the biscuits-wafers & chocolate food group was the second contributor of free sugars intake among children aged 3-8 years and its contribution was around 14-14.2%, while it fell to the third contributing source of free sugars among children and adolescents above 9 years old with 10.6 - 13.2% of free sugars intake. Moreover, “syrups, jams and honey” food group was an important source of free sugars among children and adolescents aged above 2 years, contributing 7 - 9.3% of free sugars intake. In children aged 6-8 years, ice-cream and candies provided 7% of free sugars intake. Among children and adolescents above 9 years old, the food groups “candies”, “ice-cream” and “cake, desserts& traditional sweets” had approximately similar contributions to free sugars intake (5-5.6%, 4.6-5.5% and 4.6% of free sugars intake respectively).



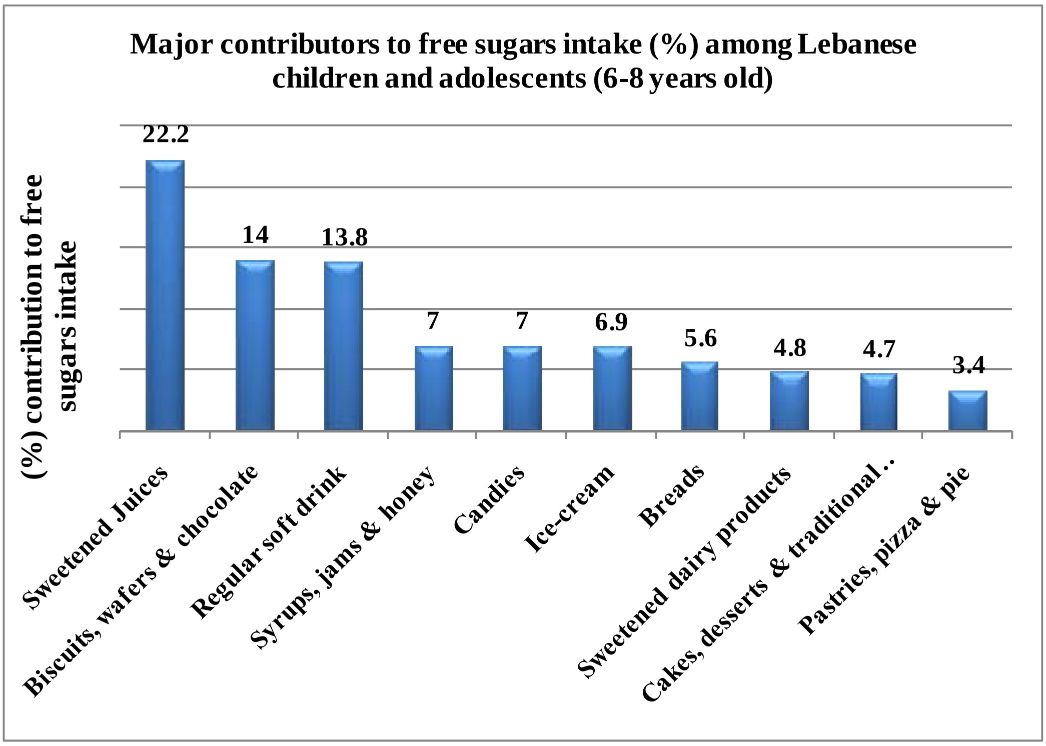
Other foods contributed to 16.6%

Figure 2: Major contributor to free sugars intake (%) among children (6 months - 2 years old) in Lebanon



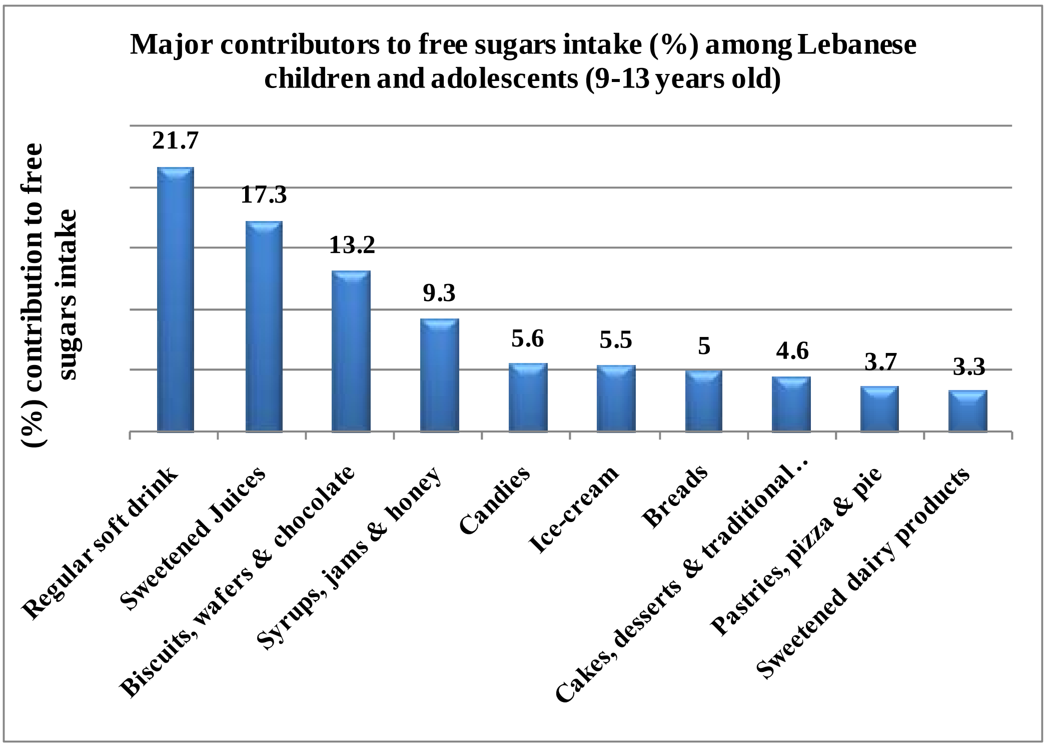
Other foods contributed to 13.4%

Figure 3: Major contributor to free sugar intake (%) among children (3 - 5 years old) in Lebanon



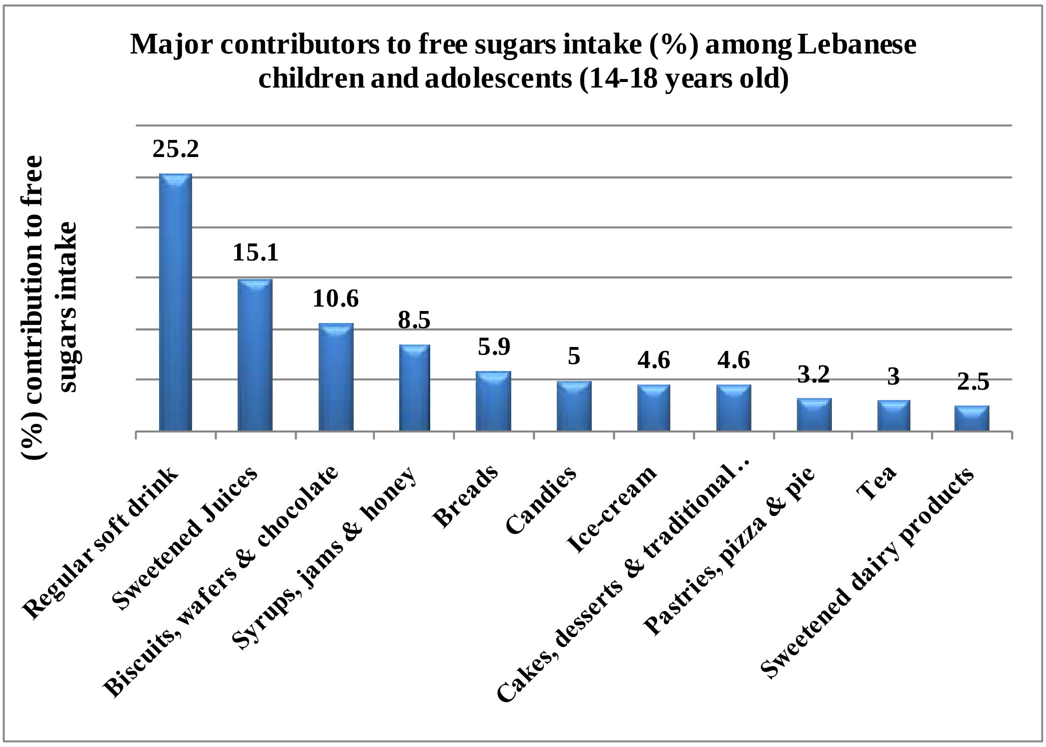
Other foods contributed to 10.6%

Figure 4: Major contributor to free sugar intake (%) among children (6-8 years old) in Lebanon



Other foods contributed to 10.8%

Figure 5: Major contributor to free sugar intake (%) among children and adolescents (9 -13 years old) in Lebanon



Other foods contributed to 11.8%

Figure 6: Major contributor to free sugar intake (%) among children (14 -18 years old) in Lebanon

2. Major Food Sources of Total Fat Intake

Non-sweetened Milk including babies' formulas was the major food source of total fat among infants and children aged 6 months to 2 years contributing to 49.29% of all fat food sources. In addition, it formed the second major source of total fat among children aged 3-5 years old with 13.83% of all fat food sources, Table 16. Desserts that included ice-cream, cakes, traditional sweets, pastries and others were the first major source of total fat among children aged 3-5 years old (14.87% of all food groups) and children and adolescents aged above 5 years old (more than 20% of all fat food sources). Dairy products, especially processed spread cheese, ranked the second major source of total fat among children and adolescents aged 6 months to 2 years, 6-8 years and 9-13 years old (12-15.3% of all fat food sources). Moreover, salty snacks including chips, popcorns and pretzels formed the third major source of total fat among children aged 6-13 years with more than 11% of all fat food sources. Further, fast foods contributed with more than 10% of all fat food sources among children and adolescents above 9 years old and ranked as third major fat food source among children and adolescents above 14 years. However, meats, poultry and eggs including processed meats formed the second major source of total fat intake among children and adolescents above 14 years as shown in Table 13.

Table 16: *Mean % of fat from different food group consumed by infants, children and adolescents according to age.*

Food groups	**6 months-2 years (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
	Mean ± SE				
Desserts[1]	4.97 ± 0.61	14.87 ± 0.83	20.17 ± 1.38	21.38 ± 1.06	20.87 ± 1.39
Dairy Products	12.24 ± 0.73	11.12 ± 0.59	15.3 ± 1.03	12± 0.74	10.4 ± 0.86
Milk non-sweetened[2]	49.29 ± 1.45	13.83 ± 0.72	2.67 ± 0.34	1.7 ± 0.23	0.76 ± 0.18
Salty snacks[3]	3.01 ± 0.4	7.37 ± 0.54	11.07 ± 0.91	11.37 ± 0.72	8.86 ± 0.85
Fast foods	2.12 ± 0.38	6.74 ± 0.52	6.9± 0.82	10.47 ± 0.79	10.44 ± 0.97
Meat, poultry & eggs	4.27 ± 0.56	10.64 ± 0.68	9.30 ± 0.89	10.16 ± 0.71	11.48 ± 1
Biscuits, wafers & chocolate	2.73 ± 0.34	6.01 ± 0.43	6.64 ± 0.64	5.89 ± 0.51	4.76 ± 0.55
Pasta, pasta-based dishes & noodles	2.84 ± 0.56	3.5 ± 0.53	2.12 ± 0.49	2.08 ± 0.45	1.17 ± 0.34
Nuts &legumes	2.88 ± 0.48	5.79 ± 0.59	4.88 ± 0.71	4.94 ± 0.59	5.34 ± 0.76
Main dishes[4]	3.58 ± 0.42	5.2 ± 0.44	6.38 ± 0.63	7.26 ± 0.59	9.9 ± 0.9
Oils & fats	2.78 ± 0.38	5.76 ± 0.47	6.17 ± 0.64	5.22 ± 0.46	5.82 ± 0.72
Rice & rice dishes	3.41 ± 0.48	3.58 ± 0.39	3.6 ± 0.59	2.2 ± 0.38	4.1 ± 0.72
Other food group	4.82 ± 0.4	4.25 ± 0.34	4.43 ± 0.42	4.76 ± 0.42	5.48 ± 0.46

[1]Desserts included: All desserts, ice-cream, cakes, pastries, pies, traditional sweets and candies.
[2] Milk non-sweetened included formula
[3] Salty snacks included chips, popcorns, pretzel & crakers
[4]Main dishes include: All cooked vegetables based on Lebanese traditional dishes, Mahashi, starchy vegetables, salad and raw vegetables.

3. Major Food Sources of Saturated Fat Intake

According to Table 17, non-sweetened milk including babies' formulas was the first contributor to SFA intake among infants and children aged 6 months to 2 years and 2-5 years contributing to more than 57% and 22% of all SFA food sources respectively.

Desserts that included ice-cream, cakes, traditional sweets, pastries and others formed the first major source of SFA among children and adolescents above 5 years with more than 25% of all SFA food sources. Further, dairy products, especially processed spread cheese, ranked between the second and third major SFA food sources for all age groups. Wafers, biscuits and chocolate contributed to more than 10% of all SFA food sources among children and adolescents aged 5-13 years old and ranked the second major SFA food source among children and adolescents above 14 years. Moreover, fast foods were contributed to more than 8% of all SFA food sources among children and adolescents aged 5-13 years old as shown in table 17.

Table 17: *Mean % of saturated fat from different food group consumed by infants, children and adolescents according to age.*

Food groups	6 months-2 years (n=373)	3-5 years (n=515)	6 - 8 years (n=312)	9 - 13 years (n=473)	14 - 18 years (n=321)
	Mean ± SE				
Desserts[1]	5.9 ± 0.73	16.55 ± 0.95	25.79 ± 1.65	27.29 ± 1.28	25.89 ± 1.61
Dairy Products	10.8 ± 0.93	13.76 ± 0.79	14.16 ± 1.29	10.62 ± 0.85	9.9 ± 1.05
Milk non-sweetened[2]	58.17 ± 1.55	22.9 ± 1.04	5.31 ± 0.63	3.64 ± 0.45	1.74 ± 0.4
Salty snacks[3]	2.11 ± 0.29	3.84 ± 0.34	6.14 ± 0.59	6.07 ± 0.47	4.81 ± 0.51
Fast foods	1.34 ±0.29	4.23 ± 0.37	5.81 ± 0.77	8.6 ± 0.73	8.37 ± 0.85
Meat& cured meat	2.19 ± 0.47	5.39 ± 0.56	5.55 ± 0.78	5.7 ± 0.56	6.57 ± 0.82
Poultry & eggs	1.99 ± 0.3	4.82 ± 0.43	4.66 ± 0.64	5.11 ± 0.53	5.38 ± 0.7
Biscuits, wafers & chocolate	2.6 ± 0.42	9.43 ± 0.7	10.82 ± 1.03	10.68 ± 0.88	7.7 ± 0.86
Pasta, pasta-based dishes & noodles	2.59 ± 0.57	2.84 ± 0.47	2.08 ± 0.52	2 ± 0.48	1.3 ± 0.41
Animal fat	0.63 ± 1.79	0.46 ± 0.15	0.26 ± 0.15	0.32 ± 0.09	0.2 ± 0.11
Nuts &legumes	1.65 ± 0.3	3 ± 0.35	3.81 ± 0.64	3.82 ± 0.51	4.13 ± 0.65
Main dishes[4]	2.48 ± 0.31	3.32 ± 0.33	4.86 ± 0.56	5.64 ± 0.52	8.47 ± 0.87
Oils	1.27 ± 0.21	3.12 ± 0.3	3.83 ± 0.45	3.43 ± 0.35	4.22 ± 0.62
Rice & rice dishes	2.34 ± 0.39	2.24 ± 0.27	2.92 ± 0.54	1.83 ± 0.35	3.3 ± 0.6
Other food group	3.24 ± 0.37	2.89 ± 0.31	3.18 ± 0.35	3.96 ± 0.41	6.16 ± 0.62

[1]Desserts included: All desserts, ice-cream, cakes, pastries, pies, traditional sweets and candies.
[2] Milk non-sweetened included formula
[3] Salty snacks included chips, popcorns, pretzel & crackers
[4] Main dishes include: All cooked vegetables based on Lebanese traditional dishes, Mahashi, starchy vegetables, salad and raw vegetables.

CHAPTER V

DISCUSSION

Unhealthy dietary practices especially excessive intake of sugars, fat and sodium are among the most important risk factors for nutrition-related NCDs among children and adolescents (Slining & Popkin, 2013). Hence the importance of assessing dietary intake among this age group. To our knowledge, this is the first study in Lebanon that has estimated the intake of free sugars, total fat, SFA and sodium and documented the proportion of children and adolescents exceeding the WHO upper limits of these nutrients. The present study has also characterized the most important food sources contributing to these intakes and identified the socio-demographic and anthropometric factors that associated with excessive intakes of these nutrients.

The intake of free sugars among Lebanese infants and children aged 6 months to 2 years old was estimated at 6.26% EI, which is below the WHO upper limit of 10% EI, but above the latest WHO conditional recommendation (WHO, 2015) whereby 45% of children in this age group exceeded 5% EI free sugars. However, Lebanese children and adolescents aged above 2 years old had high free sugars intake, with 54.2 - 62.2% exceeding the upper limit of 10% EI, while 83.5 - 87.2% exceeding the 5% WHO conditional recommendation. In comparison with other countries, the intake of free sugars among Lebanese children and adolescent aged 2-18 years was below the intake level of Australian, British and Dutch children of the same age group, while Lebanese children and adolescents aged 9-18 years had higher intakes than their Spanish and

Greek counterparts as shown in Table (1) (Farajian et al., 2016; Gibson et al., 2016; Louie et al., 2016; Ruiz et al., 2017; Sluik et al., 2016).

Among under five Lebanese children, the intake of total fat ranged between 38.57 and 40.05% EI, thus exceeding the WHO recommendations (WHO, 2008b). In particular, SFA intake was high, with 85 % exceeding the WHO upper limit of 8% EI. This intake level was also considerably higher than that observed among American children aged 3-5 years (Kris-Etherton et al., 2012), (Table 2). This could be explained by the high consumption of milk among this age group that contributed to more than 58% of total SFA intake. Among 5-18 year old Lebanese children and adolescents, the intake of total fat was also high exceeding the WHO upper limit of 35% EI and was much higher than levels observed among children from high income countries such as the American, British, Australian, Canadian and Bahraini children and adolescents of the same age group (Table 2). The high intake of SFA (9.89 – 10.74% EI) was in line with estimates reported for American children and adolescents (Kris-Etherton et al., 2012), while being lower than those observed among their British, Australian, Canadian and Bahraini counterparts (Table 2) (Gharib & Rasheed, 2011; Kris-Etherton et al., 2012; McNeill et al., 2010; Mulder et al., 2013; Whitrow et al., 2016). This could be related to the ongoing nutrition transition among Lebanese children and adolescents toward westernized diet that characterized by high intake of SFA and sugar (Rahim et al., 2014).

Lebanese children and adolescents aged 6-8 years old had sodium intake (1.95 grams) close to the WHO upper limit (WHO, 2012), while the intake level among older children aged 9-18 years old (2.21 - 2.31 grams) exceeded the WHO recommendation. In line with these findings, a previous study that was also done in Lebanon indicated that mean daily intake of sodium among Lebanese children aged 6-11 years was high, (2.22 grams), highlighting sodium intake as one of the important risk factors for hypertension and other CVDs in the Lebanese pediatric population (El Mallah et al., 2017). In comparison with other countries, Lebanese children had lower sodium intake than Australian children (2.069 g/d in 4-8 year olds and 2.598 g/d in 9-12 year olds) (Grimes et al., 2017), as well as American children and adolescents whose sodium intake exceeded 3 grams per day (Quader et al., 2017).

The high intake levels of free sugars, total fat and SFA consumption among Lebanese children and adolescents, which were above the WHO recommendations, highlight the need for a better understanding of the major food sources of these nutrients. Regarding free sugars, interestingly, sweetened dairy products were the second major food source among Lebanese children under three years old. This finding is consistent with what has been observed among Australian children of the same age group (Louie et al., 2016). This may be due to the erroneous belief among parents that sweetened dairy products could be a healthy dietary choice for young children. Among children and adolescents aged 3-18 years, sweetened juices and regular soft drinks contributed together around 35% - 40% of total free sugars intake. These findings are in agreement with those reported among children and adolescents in several other countries where soft drinks & fruit juices ranked the most important contributors to free sugars intake. For instance, among British children, these beverages contributed more than 51% of total free sugar intake (Gibson et al., 2016), while among Dutch children and adolescents above 7 years they contributed 38.7- 40% of free sugars intake (Sluik et al., 2016). However, among Australian and Spanish children and adolescents, soft drinks & fruit juices contributed to 16.7-24.1% and 30.2% of free sugars intake respectively, which were lower than the contribution levels observed among Lebanese children and adolescents in the same age group (Louie et al., 2016; Ruiz et al., 2017). These findings are of concern given that current evidence suggests that high consumption of SSBs including soft drink and juices could be a predictor for increased risk of insulin resistance and pre-diabetes even among children and independently of weight gain (Ma et al., 2016). Moreover, biscuits, wafers & chocolate ranked the second major free sugars contributors among Lebanese children and adolescents aged 3-9 years old and the third major contributors among those above 9 years old. This result was also reported for Australian children and adolescents of the same age group where the contribution of biscuits and chocolate to free sugars intake (12.7-15.8%) was very similar to that observed among Lebanese children and adolescents (Louie et al., 2016). In addition, other food sources such as “syrups, jams & honey” , “candies”, “cakes & desserts” accounted for the remaining free sugars intake among Lebanese children and adolescents and also among British children and adolescents (Gibson et al., 2016). Therefore, processed foods that are low-nutrients, energy-dense (LNED) foods were the major sources of free sugars intake among Lebanese children. Discouraging the consumption of these LNED foods could improve child’s food choices and limit excessive consumption of free sugars above WHO recommendation.

The major food sources of total fat and SFA were different between the various age groups. Non-sweetened whole milk, including milk formula, was the highest contributor to total fat and SFA intakes among under-five Lebanese children. This finding was also reported for American children aged 2-3 years and 4-8 years where whole milk was the major food source of SFA (Reedy & Krebs-Smith, 2010). According to WHO, there is not enough data to limit SFA intakes among infants and children aged less than 2 years (WHO, 2008b). However, this does not apply for older children. In this context, the American Academy of Pediatrics (AAP) recommended that children aged above 2 years old consume low-fat and skim milk rather than whole milk in order to decrease their intake of total fat and SFA (Rehm, Drewnowski, & Monsivais, 2015). Desserts, including cakes, pies, traditional sweets, pastries and others, were the second major contributors to SFA intake among children 3-5 years and the top contributors to both total fat and SFA among 5-18 year old Lebanese children and adolescents, In line with our findings, desserts including cakes, cookies, pies and others were the major food source of SFA in American children aged 2-18 years and represented the most important source especially among those aged 9-13 years (Reedy & Krebs-Smith, 2010). Dairy products, particularly spread cheese, was found to be another important contributor to total fat intake and ranked the second major SFA source among Lebanese children aged 6 months to 2 years and children and adolescents aged above 5 years. In agreement with these findings, cheese was the third major source of SFA intake among American children and adolescents aged 2-3 and 9-18 years (Reedy & Krebs-Smith, 2010). Therefore, it is crucial to encourage children and their parents to count more on low-fat milk and dairy products in children's diets to reduce total fat and SFA intakes in this vulnerable population group. Other important sources of total fat comprised salty snacks, including chips, popcorn and pretzels, which contributed to more than 11% of total fat intake, especially among children aged 5-13 years old. Similar contribution level was found among Irish children aged 5-12 years where salty snacks ranked the second major source for total fat intake (Joyce, Wallace, McCarthy, & Gibney, 2009). Biscuits, wafers and chocolate formed alone more than 9% of all SFA food sources among Lebanese children older than 5 years. This percentage level of contribution was also observed among Swedish children aged 9 and 15 years old (Patterson, Wärnberg, Kearney, & Sjöström, 2010). Moreover, fast foods were a considerable source of total fat and SFA among Lebanese children and adolescents aged above 9 years which is possibly because adolescents tend to become more independent and have easier access to unhealthy dietary choices (Majabadi et al., 2016). This high consumption of these energy dense foods was also found among Swedish children aged 9 and 15 years old, where burgers and sausages along with meat dishes formed an important source of total fat and SFA (Patterson et al., 2010).

The high intakes of free sugars, total fat, SFA, and sodium highlight the need for a better understanding of the factors associated with excessive intakes of these nutrients. In the present study, child's age was significantly associated with free sugar intake above 10% EI (OR= 3.47; CI= 2.58-4.65) and 5% EI (OR= 6.1; CI= 4.47-8.33) among under five Lebanese children, whereas this association was weak among older children. Similar findings were reported for Australian children aged 2-3 years, where intake of free sugars was higher among older age (Louie et al., 2016). Interestingly, child's age was associated with high sodium intakes (above 2 g/d) in both under five as well as older Lebanese children and adolescents, (OR= 5.66; CI= 3.64-8.81) and (OR= 1.92; CI= 1.43-2.57), respectively. This association between child's age and higher intake of sodium was also found among American children aged 5-18 years (Quader et al., 2017). Therefore, early intervention to limit sodium intake and hence modulate taste preference for salty foods could be an important priority for public health interventions.

Among children and adolescents above 5 years old, females were less likely to exceed the WHO upper limits of free sugars (above 5% EI) (OR =0.69; CI =0.49-0.98) after adjusting for other variables. In accordance with these findings, Greek boys aged

10-12 years were found to have higher intakes of free sugar compared to girls (Farajian et al., 2016). In the present study, child's gender did not found to be a predictor of high total and saturated fat intake among children and adolescents above 5 years in the present study, and this was also observed among Swedish children (Patterson et al., 2010). In addition, in this study, female gender was associated with lower odd of exceeding the WHO upper limit of sodium intake, a finding that is in agreement with what has been reported among American children (Quader et al., 2017).

Among children aged 6 months to 5 years old, higher maternal education level (university degree) and lower crowding index, which reflects higher socioeconomic status, were significantly associated with lower odds, (OR = 0.61; CI = 0.38-0.98; OR= 0.76; CI= 0.44-0.99 respectively), of exceeding the WHO recommendation (10% EI) for free sugars. These findings are in agreement with those observed among Australian children aged less than 2 years (Ha et al., 2017). The present study also showed that, higher family income was associated with exceeding the WHO benchmarks of SFA among Lebanese children and adolescents aged 6 months to 5 years old (OR= 2.09; CI= 1.1-3.97) and 5-18 years (OR= 1.39; CI= 1.02-1.87). In contrast to our findings, the intakes of fat and SFA were not significantly associated with socioeconomic status in British (McNeill et al., 2010) and other European children (Vyncke et al., 2012). The results of the current study also showed that children, especially aged 9-13 years old, with high family income had significant higher intake of SFA %EI as well as protein. Therefore, this could indicate a higher intake of fatty meat products and full fat dairy products that are rich in both protein and SFA. Further, since it has been found that higher socioeconomic status was associated with lower intake of free sugars among children under 5 years, evidence suggests that lower sugars intake among children encourage the consumption of fat (Gibson et al., 2016). No significant association was found between excessive intakes of Sodium above 2 g/d and maternal, paternal education level and family income among Lebanese children and adolescents in all age groups. This finding was also observed among American children aged 5-18 years with no difference in sodium intake among different household income (Quader et al., 2017).

Regarding BMI status, surprisingly, overweight and obesity among Lebanese children and adolescents aged above 5 years were less likely to have free sugars intake above 10% and 5% EI. In contrast with a previous study conducted in Lebanon in 2014, higher consumption of SSBs, which were the main contributors to free sugars intake among Lebanese children and adolescents in the present study, was positively associated with higher risk of overweight among adolescents (Nasreddine, Naja, Akl, et al., 2014). This is of concern given that the present study showed that 21.1% and 20.5% of Lebanese children and adolescents were overweight and obese. Thus these observations corroborate the fact that under-reporting of energy and dietary intake among overweight and obese children and adolescent is common in dietary assessment (McNeill et al., 2010). Alternatively , we cannot rule out reverse causality; children who are overweight or obese may be less likely to consume unhealthy foods which could be related to the preventable measures that were already taken by these children or their parents, as a result of some dietetic consultations or school based nutrition awareness programs (Habib-Mourad, Moore, Nabhani, Hwalla, & Summerbell, 2014). Other studies did not show any significant association between free sugar intake and BMI, such as those conducted among British and Greek children (Farajian et al., 2016; McNeill et al., 2010). This negative or no association could be explained also by some evidence showing that weight status is affected by the imbalance between energy consumption and expenditure rather than sugar intakes among children and adolescent (Farajian et al., 2016; Song et al., 2012).

Among under five children, overweight was positively associated (OR= 1.91; CI= 1.02-3.59) with exceeding intake of total fat above the WHO recommendation of 35% EI, while this association was not significant among older children and adolescents. In agreement with previous studies conducted among Lebanese preschool children aged 2-5 years old, overweight was positively associated with higher fat intake (Nasreddine et al., 2017). This is of concern given that more than 68 to 77% and 85% of children in this age group exceeded the WHO upper limits for total fat and SFA and given that high fat consumption among children is highly associated with obesity, hypertension and cardio-metabolic risk factors (Setayeshgar et al., 2016). Thus, these findings highlight the need for dietary interventions aimed at reducing fat intake in Lebanese children. This intervention should also focus on the main food sources contributing to these high intakes of total fat and SFA, which included whole milk, processed spread cheese and desserts (ice-cream, cakes, pastries, pies and others).

A. Strengths and Limitations

This study is the first to address the intake of free sugars among Lebanese children and adolescents aged 6 months to 18 years old which is one of the main strength of the current study in addition to the national representation of the studied population. Further, free sugars, total fat and SFA intake of children and adolescents was compared to WHO benchmarks allowing comparison with the intake in other countries.

The results of this study should be interpreted in light of the following limitations. The cross-sectional design of these 2 surveys used in this study did not allow for a cause and effect relation to be drawn, while it only tested the associations of excessive intake of free sugars, total fat, SFA and sodium with socio-demographic and anthropometric factors. In addition, 24-hr recall was used for dietary collection, which misses the day-to-day variation in the diet and relies more on memory and may be associated with recall bias or under-/over-reporting especially among mothers and adolescents (Nasreddine et al., 2017). Relying on maternal report of young children dietary intakes, and noting that some children spend most of their time in care centers or schools, may result in mothers' bias recall and error reporting (Bennett, de Silva-Sanigorski, Nichols, Bell, & Swinburn, 2009). Further, evidence showed that dietary data collection from children and adolescents is difficult with high rate of under-reporting of energy dense food such as those high in sugars (Farajian et al., 2016). In addition, processed food products available on the markets and highly consumed by children and adolescents are continuously changing in ingredients which may affect the estimation of free sugars, total fat, SFA and sodium intake (Ruiz et al., 2017). Estimation of sodium intake among children and adolescents did not include salt added in cooking or at the table thus 24-hour urine sodium excretion remains the gold standard method to assess sodium intake (Quader et al., 2017).

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

This study is the first to evaluate the dietary intakes and the major sources of fat, free sugars and salt among Lebanese children and adolescents aged 6 months to 18 years old. It clearly showed that a high proportion of Lebanese children and adolescents exceed the WHO recommendations for these nutrients, with processed foods such as sugar sweetened beverages (sweetened juices & soft drinks), sweetened dairy products, biscuits, chocolate, desserts, and processed spread cheese being the major sources of these nutrients. This study has also importantly identified specific demographic and socio-economic factors that are associated with high intakes of these atherogenic nutrients. Taken together, these findings corroborate the need for culture-specific interventions targeting the dietary habits and the food environment of Lebanese children and adolescents.

In order to deal with these alarming findings, and improve the diet quality of Lebanese children and adolescents as well as their overall health and wellbeing, a number of recommendations are put forward as follows:

- Develop and implement evidence based educational campaigns targeting, in particular, Lebanese mothers to increase the awareness about the adverse health effects of high sugar, fat and salt consumption among children.
- Encourage parents to limit their children’s consumption of high fat, high sugar and high salt processed foods, and offer healthy choices such as fruits & vegetables in addition to low fat milk and dairy products that are recommended starting from the

second year of age according to American Academy of Pediatrics (AAP) (Rehm et al., 2015).

- Develop and implement school based programs to reduce the intake of unhealthy foods, foremost SSBs, biscuits, chocolate, desserts and processed cheese through:
    - Raising awareness among children and adolescents on the relationship between dietary factors and chronic diseases at an early age.
    - Educating children and adolescents on the hidden contents of sugars and fat in different processed foods by using culture-specific and age-appropriate educational tools.
    - Regulating school food environments by setting mandatory nutrition standards for the foods that can be provided or sold in school and improving access and affordability of nutritious foods (such as fruits, vegetables, lean meat, low fat cheese & dairy products based foods) in and around schools through the cooperation of schools' administration with the relevant Ministries.
- Restricting the marketing of unhealthy food and beverages to children through the development of effective governmental policies that regulate child-targeted marketing in Lebanon.
- Establishing taxation policies to limit consumption of unhealthy food, especially implementing an effective tax on sugar-sweetened beverages, as it is the major contributor of free sugars intake among Lebanese children and adolescents.

APPENDIX I

TABLES

Table 18: *Mean intake of macronutrients as (g/d) among Lebanese children and adolescents by age group and gender.*

Intake/day	**6 months-2 years (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
			Mean ± SE		
CHO (g)					
Total	130.17 ± 3.26	186.45 ± 3.13	212.15 ± 5.49	240.86 ± 4.85	232.97 ± 7.01
Boys	128.53 ± 4.68	194.3 ± 4.2	218.93 ± 7.38	259.66 ± 7.12	277.35 ± 12
Girls	131.75 ± 4.56	177.67 ± 4.62	205.87 ± 8.07	220.15 ± 6.23	202.99 ± 7.8
P-value	0.62	**0.008**	0.24	**<0.0001**	**<0.0001**
Total Sugar (g)					
Total	69.95 ± 1.79	76.51 ± 1.66	72.93 ± 2.81	80.86 ± 2.34	78.93 ± 2.95
Boys	69.31 ± 2.55	81.21 ± 2.36	73.12 ± 3.4	85.01 ± 3.52	94.13 ± 5
Girls	70.57 ± 2.53	71.2 ± 2.28	72.75 ± 4.42	76.28 ± 3	68.66 ± 3.46
P-value	0.73	**0.003**	0.95	0.06	**<0.0001**
Free Sugar (g)					
Total	18.45 ± 1.14	45.95 ± 1.47	54.19 ± 2.47	63.48 ± 2.09	61.28 ± 2.64
Boys	17.21 ± 1.58	49.51 ± 2.07	55.62 ± 3.04	67.68 ± 3.12	75.01 ± 4.44
Girls	19.66 ± 1.65	41.94 ± 2.07	52.86 ± 3.82	58.84 ± 2.7	52 ± 3.09
P-value	0.29	**0.01**	0.58	**0.03**	**<0.0001**
Fiber (g)					
Total	6.22 ± 0.31	11.57 ± 6.92	13.87 ± 0.5	15.61 ± 0.43	15.64 ± 0.58
Boys	6.22 ± 0.52	11.48 ± 0.39	14.05 ± 8.53	16.68 ± 0.64	17.8 ± 0.99
Girls	6.23 ± 0.37	11.66 ± 0.48	13.7 ± 9.16	14.43 ± 0.54	14.19 ± 0.68
P-value	0.98	0.77	0.72	**0.007**	**0.003**
Protein (g)					
Total	29.06 ± 0.9	51.59 ± 0.99	50.04 ± 1.35	60.14 ± 1.42	62.24 ± 2.23
Boys	30.18 ± 1.39	53.35 ± 1.34	52.52 ± 1.95	65.61 ± 2.05	76.55 ± 3.85
Girls	27.98 ± 1.14	49.63 ± 1.45	47.76 ± 1.85	54.11 ± 1.88	52.57 ± 2.46
P-value	0.22	0.06	0.08	**<0.001**	**<0.0001**
Total Fat (g)					
Total	46.22 ± 1.21	66.7 ± 1.3	74.29 ± 2.12	91.6 ± 2.14	86.26 ± 2.97
Boys	46.92 ± 1.71	67.18 ±1.7	80.91 ± 3.16	97.88 ± 2.97	102.75 ± 5.01
Girls	45.55 ± 1.72	66.17 ± 1.99	68.15 ± 2.78	84.68 ± 3.03	75.12 ± 3.44
P-value	0.58	0.7	**0.03**	**0.002**	**<0.0001**
Linoleic Acids n-6 (g)					
Total	9.45 ± 0.32	12.23 ± 0.37	14.4 ± 0.54	19.08 ± 0.59	19.18 ± 0.93
Boys	9.82 ± 0.48	11.87 ± 0.46	15.87 ± 0.8	20.54 ± 13.2	23.12 ± 1.74
Girls	9.09 ± 0.43	12.64 ± 0.58	13.05 ± 9.12	17.47 ± 12.31	16.52 ± 0.99
P-value	0.26	0.3	**0.009**	**0.009**	**0.0001**
Linolenic Acids n-3 (g)					
Total	0.68 ± 0.02	0.72 ± 0.02	0.81 ± 0.03	1.02 ± 0.03	1.02 ± 0.05
Boys	0.7 ± 0.03	0.72 ± 0.03	0.88 ± 0.53	1.08 ± 0.04	1.21 ± 0.09
Girls	0.67 ± 0.03	0.73 ± 0.03	0.76 ± 0.5	0.95 ± 0.04	0.9 ± 0.05
P-value	0.43	0.82	**0.04**	**0.03**	**0.003**
Saturated Fat (g)					
Total	13.99 ± 0.41	21.47 ± 0.49	20.41 ± 0.75	23.76 ± 0.68	21.75 ± 0.85
Boys	14.36 ± 0.57	22.23 ± 0.72	21.85 ± 1.2	24.94 ± 0.99	25.74 ± 1.41
Girls	13.63 ± 0.59	20.62 ± 0.66	19.07 ± 0.92	22.46 ± 0.91	19.05 ± 1.02
P-value	0.73	0.1	0.07	0.07	**<0.001**

Values in **Bold** are significantly different

Table 19: *Mean intake of macronutrients as (g/d) among Lebanese children and adolescents by age group and BMI Status.*

Intake/day	6 months-2 years (n=373)	3-5 years (n=515)	6 - 8 years (n=312)	9 - 13 years (n=473)	14 - 18 years (n=321)
	Mean ± SE				
CHO (g)					
Normal	123.2 ± 4.42	185.37 ± 3.81	211.26 ± 7.52	241 ± 6.57	238.42 ± 9.54
At risk of overweight	140.88 ± 5.64	193.87 ± 6.6	N/A	N/A	N/A
Overweight	146.52 ± 10.73	171.97 ± 10.71	207.02 ± 12.6	264.21 ± 9.7	209.4 ± 14.52
Obese	130.12 ± 17.41	189.27 ± 24.01	222.47 ± 9.96	234.5 ± 10.9	232.67 ± 15.07
P-value	**0.04**	0.4	0.65	0.73	0.26
Total Sugar (g)					
Normal	66.49 ± 2.35	76.68 ± 2.1	75.75 ± 3.93	81.67 ± 3.13	84.66 ± 4.23
At risk of overweight	75.24 ± 3.22	79.06 ± 3.32	N/A	N/A	N/A
Overweight	80.69 ± 6.61	73.28 ± 4.75	68.83 ± 6.79	82.81 ± 4.71	68.02 ± 5.75
Obese	62.51 ± 11.4	65.98 ± 12.25	70.35 ± 4.41	76.1 ± 5.4	72.49 ± 5.79
P-value	**0.03**	0.61	0.55	0.58	0.052
Free Sugar (g)					
Normal	17.79 ± 1.59	46.61 ± 1.84	56.09 ± 3.38	65.91 ± 2.81	65.51 ± 3.75
At risk of overweight	20.39 ± 2.14	46.65 ± 2.94	N/A	N/A	N/A
Overweight	19.12 ± 3.3	41.7 ± 5.44	50.04 ± 6.16	64.05± 4.3	51.16 ± 5.18
Obese	15.05 ± 7.13	45.9 ± 8.89	52.56 ± 4.13	55.89 ± 4.46	57.41 ±5.45
P-value	0.75	0.88	0.63	0.17	0.09
Fiber (g)					
Normal	5.87 ± 0.45	11.53 ± 0.36	13.71 ± 0.68	15.46 ± 0.58	16.08 ± 0.77
At risk of overweight	7.21 ± 0.58	12.15 ± 0.7	N/A	N/A	N/A
Overweight	6.73 ± 0.85	10.38 ± 0.99	14.39 ± 1.09	15.85 ± 0.82	14.25 ± 1.25
Obese	5.26 ± 0.82	10.83 ± 1.73	14.16 ± 1.05	15.84 ±1.02	15.47 ± 1.29
P-value	0.3	0.56	0.15	0.91	0.45
Protein (g)					
Normal	27.99 ± 1.29	50.86 ± 1.23	**47.95 ± 1.78**	59.35 ± 1.92	61.5 ±2.73
At risk of overweight	31.96 ± 1.74	52.93 ± 1.96	N/A	N/A	N/A
Overweight	30 ± 2.21	5.42 ± 3.67	48.61 ± 2.99	59.09 ± 2.71	64.09 ± 5.62
Obese	26.53 ± 3.67	55.89 ± 7.72	**57.77 ± 2.72**	64.17 ± 3.4	62.6 ± 2.27
P-value	0.27	0.71	**0.01**	0.38	0.9
Total Fat (g)					
Normal	**43.34 ± 1.54**	65.57 ± 1.59	70.84 ± 2.78	92.72 ± 2.9	86.33 ± 3.92
At risk of overweight	49.54 ± 2.29	68.3 ± 2.66	N/A	N/A	N/A
Overweight	**54.37 ± 4.18**	65.7 ± 4.09	76.35 ± 4.04	88.71 ± 4.17	81.38 ± 5.82
Obese	44.88 ± 8.27	83.95 ± 11.48	83.32 ± 5.08	91.41 ± 5	87.83 ± 7.25
P-value	**0.02**	0.15	0.07	0.75	0.75
Linoleic Acids n-6 (g)					
Normal	8.71 ± 0.42	12.1 ± 0.44	13.6 ± 0.68	19.43 ± 0.78	19.38 ± 1.29
At risk of overweight	10.41 ± 0.58	12.5 ± 0.75	N/A	N/A	N/A
Overweight	11.43 ± 1.05	11.24 ± 1.08	15.28 ± 1.23	18.67 ± 1.3	17.17 ± 1.42
Obese	8.97 ± 2.66	15.48 ± 4.39	16.14 ± 1.29	18.6 ± 1.3	19.9 ± 2.17
P-value	**0.02**	0.44	0.14	0.78	0.56
Linolenic Acids n-3 (g)					
Normal	**0.63 ± 0.02**	0.71 ± 0.02	0.79 ± 0.04	1.05 ± 0.4	0.97 ± 0.06
At risk of overweight	0.74 ± 0.03	0.76 ± 0.04	N/A	N/A	N/A
Overweight	**0.85 ± 0.07**	0.66 ± 0.07	0.85 ± 0.08	0.99 ± 0.06	0.94 ± 0.08
Obese	0.6 ± 0.13	0.72 ± 0.02	0.86 ± 0.06	0.98 ± 0.06	1.21 ± 0.15
P-value	**0.001**	0.69	0.56	0.58	0.13
Saturated Fat (g)					
Normal	13.42 ± 0.51	20.77 ± 0.58	19.8 ± 1.02	23.81 ± 0.88	22.04 ± 1.17
At risk of overweight	14.77 ± 0.84	22.54 ± 1.1	N/A	N/A	N/A
Overweight	15.7 ± 1.52	21.51 ± 1.88	19.79 ± 1.18	24.49 ± 1.42	20.49 ± 1.63
Obese	12.87 ± 1.87	29.05 ± 4.92	22.93 ± 1.78	22.66 ± 1.6	21.6 ± 1.93
P-value	0.25	**0.04**	0.25	0.66	0.77

Values in **Bold** are significantly different

Table 20: *Mean intake of macronutrients as (g/d) among Lebanese children and adolescents by age group and maternal education level.*

Intake/day	**6 months-2 years (n=373)**	**3-5 years (n=515)**	**6 - 8 years (n=312)**	**9 - 13 years (n=473)**	**14 - 18 years (n=321)**
	Mean ± SE				
CHO (g)					
Primary or less	121.1 ± 11.2	193.27 ± 8.46	211.77 ± 16	**264.25 ± 11.8**	243.82 ± 15.69
Intermediate, high school or technical diploma	134.05 ± 4.2	187.94 ± 3.86	215.49 ± 6.66	**234.42 ± 5.98**	227.08 ± 8.45
University degree	122.37 ± 5	175.69 ± 6.56	203.3 ± 11.41	235.15 ± 10.89	236.54 ± 18.17
P-value	0.22	0.19	0.67	**0.04**	0.58
Total Sugar (g)					
Primary or less	57.69 ± 5.5	78.12 ± 4.34	65.48 ± 6.91	71 ± 4.61	65.44 ± 5.78
Intermediate, high school or technical diploma	71.76 ± 2.27	77.04 ± 2.05	75.01 ± 3.77	61.59 ± 2.64	59.38 ± 3.24
University degree	69.92 ± 3.25	73.36 ± 3.66	73.05 ± 5.1	61.03 ± 4.96	61.2 ± 6.8
P-value	0.07	0.62	0.46	0.17	0.62
Free Sugar (g)					
Primary or less	17.96 ± 3.8	**53.56 ± 3.97**	47.79 ± 4.44	84.18 ± 5.01	79.49 ± 6.55
Intermediate, high school or technical diploma	20.13 ± 1.49	45.13 ± 1.8	58.06 ± 3.56	73.24 ± 2.76	74.07 ± 3.51
University degree	13.58 ± 1.64	**41.51 ± 3.11**	48.6 ± 3.98	77.61 ± 5.97	76.44 ± 7.41
P-value	0.06	**0.03**	0.15	0.16	0.73
Fiber (g)					
Primary or less	5.77 ± 0.82	11.4 ± 0.66	14.02 ± 1.61	16.77 ± 0.98	15.63 ± 1.17
Intermediate, high school or technical diploma	6.3 ± 0.42	11.77 ± 0.42	13.9 ± 0.6	15.14 ± 0.53	15.24 ± 0.71
University degree	6.19 ± 0.47	11.08 ± 0.57	13.52 ± 0.92	15.82 ± 1.02	17.29 ± 1.71
P-value	0.88	0.66	0.91	0.32	0.47
Protein (g)					
Primary or less	25.03 ± 2.3	52.91 ± 2.83	47.73 ± 3.38	63.93 ± 3.25	64.67 ± 5.27
Intermediate, high school or technical diploma	29.91 ± 1.18	50.67 ± 1.16	50.55 ± 1.72	57.69 ± 1.76	59.51 ± 2.64
University degree	28.25 ± 1.44	53.57 ± 2.22	50.48 ± 2.85	63.57 ± 3.47	68.62 ± 5.25
P-value	0.25	0.41	0.73	0.11	0.3
Total Fat (g)					
Primary or less	40.54 ± 3.74	71.1 ± 3.5	77.72 ± 6.87	95.56 ± 4.7	86.44 ± 6.07
Intermediate, high school or technical diploma	47.93 ± 1.59	65.62 ± 1.57	76.2 ± 2.53	90.5 ± 2.73	84.27 ± 3.62
University degree	43.53 ± 1.78	66.4 ± 2.92	66.36 ± 3.87	90.65 ± 5.13	93.83 ± 8.94
P-value	0.99	0.27	0.13	0.63	0.55
Linoleic Acids n-6 (g)					
Primary or less	8.83 ± 1.2	**14.23 ± 0.92**	**16.23 ± 1.69**	21.3 ± 1.39	20.64 ± 2.23
Intermediate, high school or technical diploma	9.75 ± 0.41	**11.76 ± 0.46**	**15 ± 0.65**	18.97 ± 0.77	18.64 ± 1.09
University degree	8.8 ± 0.43	11.92 ± 0.81	**11.032 ± 0.91**	17 ± 1.16	18.65 ± 2.24
P-value	0.39	**0.04**	**0.006***	0.07	0.64
Linolenic Acids n-3 (g)					
Primary or less	0.59 ± 0.07	**0.83 ± 0.05**	0.85 ± 0.08	1.05 ± 0.06	1 ± 0.08
Intermediate, high school or technical diploma	0.69 ± 0.02	**0.7 ± 0.02**	0.84 ± 0.04	1.01 ± 0.04	1 ± 0.07
University degree	0.69 ± 0.03	0.7 ± 0.04	0.72 ± 0.06	1.02 ± 0.07	1.18 ± 0.13
P-value	0.31	**0.03**	0.2	0.86	0.42
Saturated Fat (g)					
Primary or less	11.96 ± 0.96	19.72 ± 1.05	19.24 ± 1.88	23.08 ± 1.26	22.12 ± 1.79
Intermediate, high school or technical diploma	14.53 ± 0.54	21.88 ± 0.65	21.13 ± 1.03	23.26 ± 0.89	20.78 ± 0.97
University degree	13.25 ± 0.66	21.77 ± 1.04	19.35 ± 1.23	26.04 ± 1.67	24.95 ± 2.79
P-value	0.11	0.25	0.5	0.26	0.23

Values in **Bold** are significantly different

* Both values were only statistically significant with university degree value

Table 21: *Mean intake of macronutrients as (g/d) among Lebanese children and adolescents by age group and family income*

Intake/day	6 months-2 years (n=373)	3-5 years (n=515)	6 - 8 years (n=312)	9 - 13 years (n=473)	14 - 18 years (n=321)
	Mean ± SE				
CHO (g)					
<1000,000	124.32 ± 5.6	192.22 ± 5.79	212.12 ± 8.58	**250.27 ± 7.42**	232.92 ± 9.92
1000,000 – 3000,000	133.44 ± 5.72	187.71 ± 4.45	224.42 ± 9.7	**243.68 ± 7.15**	242.95 ± 11.53
>3000,000	115.77 ± 7.95	162.31 ± 10.19	193.68 ± 24.18	**179.26 ± 12.73**	185.95 ± 18.05
P-value	0.28	0.05	0.38	**<0.001***	0.07
Total Sugar (g)					
<1000,000	65.96 ± 3.07	73.95 ± 2.89	66.71 ± 3.75	**82.9 ± 3.56**	75.46 ± 4.09
1000,000 – 3000,000	71.94 ± 2.84	**81.42 ± 2.64**	81.28 ± 5.37	**83.62 ± 3.49**	84.54 ± 4.9
>3000,000	66.98 ± 5.05	**65.62 ± 4.29**	73.24 ± 11.24	**57.09 ± 6.12**	64.83 ± 7.99
P-value	0.35	**0.02**	0.1	**0.007***	0.11
Free Sugar (g)					
<1000,000	17.67 ± 1.84	48.03 ± 2.51	52.31 ± 3.34	**65.63 ± 3.24**	58.03 ± 3.63
1000,000 – 3000,000	7.89 ± 2	46.83 ± 2.31	62.97 ± 4.97	**65.05 ± 3.04**	67.03 ± 4.37
>3000,000	11.57 ± 2.4	36.87 ± 4.04	51.71 ± 9.05	**41.49 ± 5.23**	47.84 ± 7.02
P-value	0.28	0.16	0.2	**0.005***	0.07
Fiber (g)					
<1000,000	6.08 ± 0.65	11.1 ± 0.47	14.16 ± 0.87	15.75 ± 0.66	15.25 ± 0.82
1000,000 – 3000,000	6.31 ± 0.49	12.09 ± 0.52	14.2 ± 0.72	16.11 ± 0.63	16.53 ± 0.96
>3000,000	6.26 ± 0.67	10.46 ± 0.94	10.4 ± 1.53	12.97 ± 1.42	13.68 ± 1.45
P-value	0.96	0.23	0.18	0.15	0.31
Protein (g)					
<1000,000	27.73 ± 1.69	51.53 ± 1.83	48.47 ± 2.22	59.62 ± 2.28	59.72 ± 3.51
1000,000 – 3000,000	30.35 ± 1.43	52.5 ± 1.36	49.74 ±2.14	61.78 ± 2.04	64.14 ± 3.31
>3000,000	27.08 ± 2.64	49.71 ± 3.24	49.02 ± 6.38	56.68 ± 4.64	65.42 ± 7.18
P-value	0.43	0.73	0.92	0.57	0.59
Fat (g)					
<1000,000	42.67 ± 1.97	68.58 ± 2.29	77.05 ± 3.99	**92.4 ± 3.03**	83.75 ± 4.38
1000,000 – 3000,000	47.91 ± 2.14	66.2 ± 1.91	77.07 ± 3.35	**94.66 ± 3.26**	90.14 ± 4.77
>3000,000	42.59 ± 2.94	59.24 ± 3.99	62.23 ± 8.81	**72.82 ± 7.42**	81.71 ± 8.72
P-value	0.16	0.18	0.3	**0.02***	0.53
Linoleic Acids n-6 (g)					
<1000,000	8.39 ± 0.54	12.99 ± 0.68	16.18 ± 1.09	20.81 ± 0.92	19.94 ± 1.4
1000,000 – 3000,000	9.77 ± 0.54	11.59 ± 0.53	14.27 ± 0.77	18.71 ± 0.88	19.02 ± 1.5
>3000,000	9.16 ± 0.79	11.17 ± 1.09	10.85 ± 1.47	13.88 ± 1.55	18.24 ± 2.49
P-value	0.19	0.2	0.06	**0.006**	0.84
Linolenic Acids n-3(g)					
<1000,000	0.62 ± 0.03	0.75 ± 0.03	0.83 ± 0.05	**1.04 ± 0.04**	0.98 ± 0.72
1000,000 – 3000,000	0.72 ± 0.03	0.68 ± 0.03	0.85 ± 0.05	**1.05 ± 0.04**	1.05 ± 0.07
>3000,000	0.7 ± 0.05	0.67 ± 0.06	0.72 ± 0.1	**0.75 ± 0.09**	1.09 ± 0.21
P-value	0.1	0.25	0.63	**0.02***	0.71
Saturated Fat (g)					
<1000,000	12.86 ± 0.61	20.27 ± 0.77	19.02 ± 1.25	**22.37 ± 0.85**	20.09 ± 1.22
1000,000 – 3000,000	14.87 ± 0.78	**22.9 ± 0.77**	22.06 ± 1.25	**25.47 ± 1.09**	23.86 ± 1.4
>3000,000	13.19 ± 1.04	**18.17 ± 1.11**	20.61 ± 3.56	**20.54 ± 2.41**	20.43 ± 2.24
P-value	0.1	**0.007**	0.24	**0.03***	0.1

Values in **Bold** are significantly different

* Both values were only statistically significant with family income >3000,000 value

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