AMERICAN UNIVERSITY OF BEIRUT

REPEATED 24 HOUR DIETARY RECALLS FOR THE ASSESSMENT OF ENERGY AND ADDED SUGAR INTAKES: METHODOLOGICAL CONSIDERATIONS

by
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ABSTRACT
OF THE THESIS OF

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Non-communicable diseases (NCDs) pose a growing global health challenge, with Lebanon experiencing a high NCD-related mortality rate of 83%. The pivotal role of diet, such as excessive intakes of energy, fats, salt, and added sugar (AS), has been established by several studies as a major contributor to this public health crisis. It is therefore imperative to have proper ways of assessing dietary intakes at the population level. The limited availability of food composition databases (such as for AS) and the challenges associated with certain dietary assessment methods further complicate dietary assessment strategies.

This study uses four repeated 24-hour dietary recalls (24 HRs), with the aim of assessing dietary energy intakes (EI) in a sample of Lebanese adults, comparing EI estimates to total energy expenditure (TEE) based on indirect calorimetry and physical activity (PA) assessment, and determining AS intake. Another objective is to evaluate the consistency of the four 24 HRs in terms of energy, macronutrients, and AS intakes, and to compare energy estimates generated by four vs. two 24 HRs. This will allow us to evaluate whether four 24 HRs are needed, or if two non-consecutive 24 HRs would be sufficient to assess the participants' dietary intakes.

Conducted as an observational study on a convenience sample of 77 participants from AUB, the research spanned over a 4-week timeframe for each participant. Assessments included four repeated 24 HRs (including one weekend day), completion of forms and questionnaires, PA assessment using the IPAQ, as well as BMR and anthropometric measurements. Analysis of the four 24 HRs was done using the Nutritionist Pro (NutriPro) software (version 7.1.0, 2019, Nutritionist Pro, Axxya Systems, USA) to estimate energy and macronutrients' intakes, while AS intake was determined using the 10-step approach published by Louie et al (given that comprehensive information on AS content is not available in the food composition database). Subsequent data analysis was conducted using SPSS.

Results showed that average EI was 2260.91 ± 875.073 kcal/day for the total population, 2690.026 ± 831.94 kcal/day for males, and 1670.88 ± 521.404 kcal/day for females. As for TEE, it was estimated at 2560.26 ± 676.61 kcal/day for the total population, 2926.73 ± 1100.98 kcal/day for males, and 2198.4 ± 427.26 kcal/day for females. AS sugar intake was estimated at 43.9 ± 27.32 g/day for the total population, 49.066 ± 29.093 g/day for males, and 36.8 ± 23.28 g/day for females, representing 7.83% of EI in the total population, 7.14%

in men and 8.79% in women.
Data showed that when comparing the four different 24HRs, there was no significant difference in EI, AS or macronutrient intakes between the days. Similarly, no significant difference was observed when comparing two vs. four 24 HRs in terms of energy, macronutrients and AS intakes. Although there was a significant moderate correlation between EI and TEE (spearman correlation = 0.37), there was a significant mean difference between EI and TEE in women (-527.52 ± 641.52 kcal/day), individuals who have completed high school level education nor higher (-402.2 ± 1094.83 kcal/day), and individuals with a higher BMI (-707.94 ± 1208.78 kcal/day). Multiple linear regression was conducted to examine the predictors of the mean difference (EI-TEE). Results showed that only BMI remained significantly associated with the difference between EI and TEE [beta (95% CI): -869.18 (-1476.35; -262.02)] after the adjustment for other confounders, with 71.9% of people with high BMI having EI<TEE.

These study findings showed a consistency in the reporting of dietary recalls across four different days distributed along a month period, and suggest that two repeated recalls may be sufficient for the assessment of dietary intake in Lebanese adults. This was observed for total EI, macronutrient intakes as well as AS intake. Only BMI was identified as a significant predictor of the mean difference between EI and TEE in the study sample - a finding that has been reported by several previous studies conducted in other parts of the world. Larger and longer studies are needed to further confirm the results of this study.

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ABBREVIATIONS

%: percent

= Equal

< Less than

> Greater than

≤ Less than or equal

≥ Greater than or equal

24 HR: 24 Hour Recall

AS: Added Sugar

AUB: American University of Beirut

BIA: Bioelectrical Impedance Analysis

BMI: Body Mass Index

BMR: Basal Metabolic Rate

CAD: Coronary Artery Disease

CHF: congestive heart failure

COPD: Chronic Obstructive Pulmonary Disease

CRP: C-Reactive Protein

CVD: Cardiovascular Disease

DGA: Dietary Guidelines for Americans

DLW: Doubly Labeled Water

DNL: de novo lipogenesis

EE: Energy Expenditure

EI: Energy Intake

FAFS: Faculty of Agricultural and Food Sciences

FFQ: Food Frequency Questionnaire

g: grams

G3P: glyceraldehyde-3-phosphate

Glc: Glucose

HFCS: High Fructose Corn Syrup

HIP: Health Insurance Plan

HTN: Hypertension

IGF: Insulin-Like Growth Factor

IPAQ: International Physical Activity Questionnaire

IRB: Institutional Review Board

kcal: kilocalories

kg: kilogram

LDL: Low-Density Lipoprotein

MetS: Metabolic Syndrome

MET: Metabolic Equivalent of Task

mTOR: Mammalian Target of Rapamycin

MUFA: Monounsaturated Fatty Acid

Na: Sodium

NAFLD: Non-Alcoholic Fatty Liver Disease

NCD: Non-Communicable Disease

NHANES: National Health and Nutrition Examination Survey

PA: Physical Activity

PAL: Physical Activity Level

PUFA: Polyunsaturated Fatty Acid

RCT: Randomized Controlled Trial

SACN: Scientific Advisory Committee on Nutrition

SFA: Saturated Fatty Acid

T2D: Type 2 Diabetes

TBW: Total Body Water

TEE: Total Energy Expenditure

TFA: Trans Fatty Acid

TG: triglyceride

US: United States

USDA: United States Department of Agriculture

VLDL: very low-density lipoprotein

WHO: World Health Organization

CHAPTER I

INTRODUCTION

Non-communicable diseases (NCDs), also known as chronic diseases, have emerged as a global health challenge, significantly impacting morbidity and mortality rates worldwide (WHO, 2023a). Unlike infectious diseases, NCDs are primarily attributed to unhealthy behaviors rather than communicable agents. The major categories of NCDs include diabetes, cardiovascular diseases (CVDs) (such as stroke and heart attacks), cancers, and chronic respiratory diseases like asthma and chronic obstructive pulmonary disease (COPD). These conditions collectively account for a staggering 74% of global deaths (WHO, 2023a). Despite global efforts to address NCDs, their prevalence continues to escalate. The World Health organization (WHO) projects that if current trends persist, NCDs will contribute to 86% of annual deaths, signifying a 90% increase since 2019 (UNnews, 2023). This alarming trajectory highlights the importance of comprehensive research and interventions to understand and mitigate the risk factors contributing to NCDs.

Among the various risk factors for NCDs, behavioral factors play a pivotal role, including smoking, inadequate physical activity (PA), excessive alcohol consumption, and notably, unhealthy diets (Karger, 2016), specifically diets low in fiber (fruits, vegetables, and whole grains), and high in sodium, fat, and added sugar (AS) (Reeve et al., 2022). The intake of AS, i.e. the sugar added to food by manufacturers or during food preparations (Vos et al., 2017) has been linked to several chronic diseases, including obesity, CVDs, diabetes, non-alcoholic fatty liver disease (NAFLD), some cancers, and cognitive decline (Rippe & Angelopoulos, 2016).

Because of the well-recognized impact of diet on NCD risk and outcomes, proper means of dietary assessment are necessary. Dietary assessment plays a pivotal role in comprehending individuals' or populations' nutritional habits, helping identify potential deficiencies, toxicities, or nutrition-related diseases (Bailey, 2021). Several methods are used in dietary assessment studies, each possessing its own set of strengths and limitations. These methods include retrospective approaches (dietary recalls, food frequency questionnaires) which are generally administered to assess dietary habits in periods preceding the interview, and prospective ones (food records, food checklists) which account for foods and beverages consumed prospectively in a defined period of time (Smiciklas-Wright, Mitchell, & Ledikwe, 2007). Dietary records have been proposed as the gold standard in dietary assessment with seven day records historically being the most accurate, but other research suggests that the quality of the record decreases in relation to the number of days recorded (University of Houston, 2015). Moreover, the mere fact that people are recording their intakes potentially leads to conscious or unconscious alterations of food consumption patterns which is referred to as recording bias (University of Houston, 2015). Therefore, repeated 24-hour dietary recalls (24 HRs) over non-consecutive days have been proposed as a more practical and equally accurate alternative, with the recalls generally being administered over 2-8 days (Ralph, Von Ah, Scheett, Hoverson, & Anderson, 2011). The higher the number of days included, the higher the reported accuracy of the data but also the higher the risk of recall bias, training bias, misreporting, and boredom of participants (Ralph et al., 2011). This may result in under or overestimation of dietary energy intakes as well as other nutrients of concern such as AS. In fact, AS intake may vary significantly from one day to the other (Peralta et al., 2021), but there is no clear guidance on the needed number of days for its accurate estimation. The limited availability of databases and the challenges associated with dietary assessment methods further compound this issue. It is in this context that this study was undertaken with the aim of assessing energy and AS intake using the repeated 24 HR approach, and to determine the effectiveness of this approach as elaborated in the specific objectives stated below.

A. Thesis objectives

- To assess dietary energy intake (EI) in a sample of Lebanese adults using four repeated 24-hour dietary recalls (24-HR)
- To compare EI estimates generated by four vs. two 24 HRs in the study sample
- To assess total energy expenditure (TEE) in the study sample based on indirect calorimetry and physical activity (PA) assessment
- To identify mismatching between dietary EI and TEE in the study sample
- To assess added sugar (AS) intake using the method of Louie et al
- To evaluate the consistency of the four repeated 24 HRs in terms of intakes of energy, macronutrients and AS
- To investigate whether four 24 HRs are needed, or if two non-consecutive 24 HRs would be enough to assess the participants' dietary intakes

CHAPTER II

LITERATURE REVIEW

A. NCD burden

Non-communicable diseases (NCDs), or chronic diseases, are diseases that are usually caused by unhealthy behaviors, rather than spread through infection or other people (IFRC, 2023). They are a combination of behavioral, physiological, genetic, and environmental factors, and these diseases tend to be of long duration (WHO, 2023a). The main types of NCDs are diabetes, cardiovascular diseases (e.g. stroke, heart attacks), cancers, and chronic respiratory diseases (e.g. asthma, COPD) (WHO, 2023a). They are the leading cause of death worldwide, contributing to 74% of global deaths (WHO, 2023a). In fact, CVDs account for 17.9 million annual deaths, then come cancers with 9.3 million deaths, followed by chronic respiratory diseases at 4.1 million, and diabetes at 2 million (including kidney disease deaths caused by diabetes) (WHO, 2023a). Even though these diseases are associated with older age groups, 17 million of these deaths occur before the age of 70, and 86% occur in low-income and middle-income countries (WHO, 2023a). This shows that anyone of any age or region can be affected by NCDs.

There has been some progress when it comes to NCDs globally, but the toll of NCDs is still increasing, and according to the WHO, if that trend continues, NCDs will account for 86% of yearly deaths – a 90% increase since 2019 (UNnews, 2023). The bar graph below shows the projected deaths till 2030, with NCDs, cancers, and CVDs being among the top reasons.

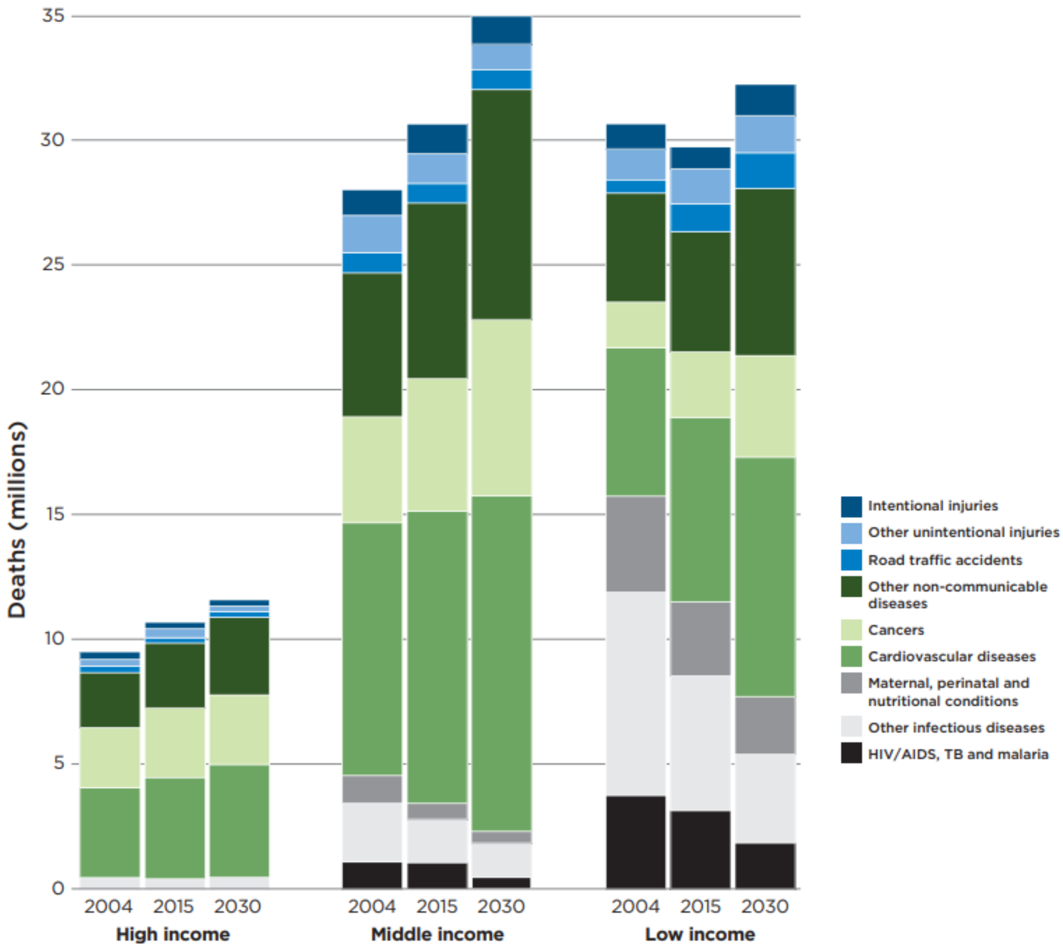

Figure 1 Projected deaths by cause in high-, middle, and low-income countries, 2004 to 2030

(Karger, 2016)

B. Diet as a Modifiable Risk factor for NCDs

Other than genetics, the major risk factors for NCDs are behavioral, and they include smoking, inadequate PA, excessive alcohol drinking, and most notably of all, an unhealthy diet (Karger, 2016). More specifically, the diet-related risk factors include being overweight or obese, hypertension (HTN), high blood lipids, and hyperglycemia. The figure below shows the different factors contributing to the various NCDs.

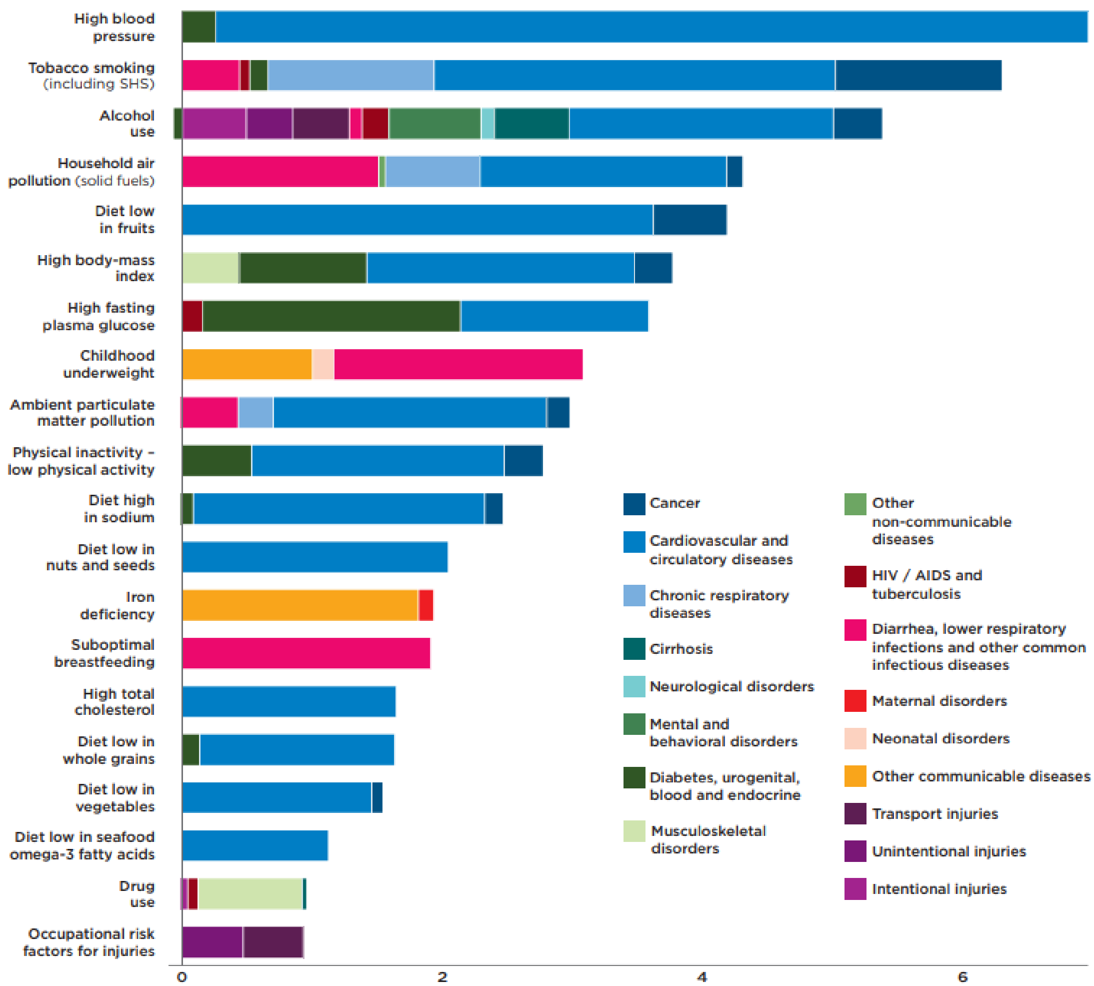

Figure 2 Burden of disease attributable to 20 leading risk factors in 2010, expressed as a percentage of global disability-adjusted life years (DALYs).

(Karger, 2016)

The elements in our diet which have the strongest correlation to NCDs and mortality include a diet low in fruits, vegetables, and whole grains (i.e. low in fibers), and high in sodium, fat, and sugar (Reeve et al., 2022).

The primary sources of dietary fibers are fruits, vegetables, and whole grains. These have favorable effects on blood pressure, serum cholesterol, chronic inflammation, insulin sensitivity, satiety, and body weight, and thus decrease risk for NCDs (Ramezani et al., 2024). On the long term, they even play a role in preventing mortality (Veronese et al., 2018).

As for salt, the WHO has deemed it as one of the factors that lead to increasing NCDs, noting that the scientific evidence linking an increased salt intake to an increase in blood pressure is conclusive. In fact, when salt intake was decreased by 1g per person per day in certain countries, there was more than 7% reduction in deaths from heart attacks and strokes (WHO, 2023b). That is why the WHO recommends reducing salt intake to less that 5g per person per day (2g sodium per day) (WHO, 2023c).

When discussing fats, it is important to note that not all fats are associated with NCDs. Systematic reviews of prospective observational studies showed that there is no or little association between total fat, SFA, MUFA, and PUFA with the risk of NCDs. However, they showed a positive association between higher intake of total trans-fats and an increased risk for CVDs. Also, current studies recommend replacing SFAs with MUFA and PUFA, and avoiding trans-fats (Schwingshackl, Heseker, Kiesswetter, & Koletzko, 2022).

The various effects of sugars, specifically added sugars (AS), on NCDs will be discussed in details later in the paper (in part E of the Literature Review).

Because of the well-established link between diet and NCD risk, it has been deemed important to have proper ways of dietary assessment.

C. Importance of Dietary Assessment

Dietary assessments help professionals understand what individuals or a population consume from macro- and micro-nutrients to assess the likelihood for deficiencies, toxicities, or nutrition-related diseases (TuftsUniversity, 2023).

Several methods are used in dietary assessment studies, each possessing its own set of strengths and limitations. The various methods include retrospective methods (such as dietary recalls, food frequency questionnaires [FFQs]) which are administered over a period of time, generally to cover the 24-hours preceding the interview, and prospective ones (such as food records) which account for foods and beverages consumed in a short-term, defined period of time (Smiciklas-Wright et al., 2007). More methods are detailed in Table 1, but ultimately the choice of assessment depends on the research question, study design, sample characteristics, the size of the sample, and many other factors (Bailey, 2021).

Table 1 Different methods of dietary assessment and their uses

(TuftsUniversity, 2023)

Name of Measurement:	Determine by Research Population:	Determine by Investigative Goal:	Determine by who administers the measurement:	Determine by length of administration:
24 Hour Recall	Individual	Caloric and nutrient intake	Administered by Nutritional Investigator	15 Minutes
Detailed Food Record (72 hours)	Individual	Caloric and nutrient intake	Self-Administered	72 Hours
Healthy Eating Index	Individual	Nutrient intake quality	Administered by Nutritional Investigator	Two 24 Hour recalls administered 1 week apart
Dietary Diversity Score	Household/Individual	Diet pattern and access	Self-Administered	10 Minutes
Food Frequency Questionnaire	Population	Diet pattern and population diet quality	Self-Administered	45 Minutes

Dietary records have been suggested as the benchmark for evaluating dietary intake, historically favoring seven-day records for their perceived accuracy. However, subsequent research has indicated that the quality of these records diminishes with an increasing number of days recorded (University of Houston, 2015). Additionally, the act of recording itself can prompt individuals to modify their eating habits, and eventually there will be a loss of motivation. Recording bias is also a concern, as individuals may not accurately document their typical daily food intake (University of Houston, 2015). As an alternative, repeated 24 HRs have been proposed as a more convenient and practical option, typically involving recording over a span of 2 to 8 days.

In this study, we will be using repeated 24 HRs to assess dietary patterns.

D. 24-hour dietary recalls

A 24 HR assesses a person's dietary intake over the previous 24 hours. To best assess the individual's intake, it is recommended to collect multiple, non-consecutive recalls on random days. This will account for the large day-to-day variations in intake (Bailey, 2021).

This type of recall is administered by a trained interviewer who asks probing questions related to time of food intake, food preparation methods, additions after preparation, and many more (Bailey, 2021).

However, there is a discrepancy in the literature as to how many recalls are best. A study conducted on 595 subjects who completed a total of 28 recalls (7 each season) showed that two non-consecutive recalls is enough for large-scale nutritional surveys, with one recall being a weekday and another being a weekend (Huang, Zhao, Fang, et al., 2022). A study conducted on 79 middle-aged women who completed seven 24 HRs over 14 days showed that three 24HRs are optimal to estimate EI (Ma et al., 2009). Another study conducted on Chinese adults concluded that two non-consecutive 24 HRs or 3 consecutive 24 HRs yielded accurate results (Huang, Zhao, Guo, et al., 2022). The results of a study conducted on African American youth indicated that 8-32 recalls are necessary to get ≥ 80% reliability for intake (St George, Van Horn, Lawman, & Wilson, 2016). NHANES (National Health and Nutrition Examination Survey) includes one 24 HR for participants of all ages in the nutrition component of the studies (CDC-NHANES, 2015). There are many other studies conducted, each recommending a different ideal number of 24 HRs.

Increased number of days included in dietary data collection improves data accuracy but also raises the likelihood of recall bias, misreporting, and participant boredom (Ralph et al., 2011). This can lead to potential underestimation or overestimation of dietary EI and other critical nutrients like AS.

E. Dietary Sugars

Sugars can be found naturally in foods such as dairy products and fruits, or they can be added to foods. That is why it is important to differentiate between the different terms for sugars which we can find.

1. Different sugar terms

Total Sugars: this refers to all monosaccharides: glucose, fructose, and galactose; as well as disaccharides: sucrose, lactose, and maltose, that exist in food (Erickson & Slavin, 2015).

Free sugars: these are monosaccharides and disaccharides which are added to foods and beverages by the cook, consumer, or manufacturer, as well as sugars naturally present in syrups, honey, fruit juices, and fruit juice concentrates (WHO, 2015). The WHO recommends reducing these to less than 10% of total daily EI, and SACN recommends that free sugars should not exceed 5% of daily EI (Pyne & Macdonald, 2016).

Added sugars: these are sugars and syrups which are added to food during preparation and processing, and this includes types of sugar like white sugar, brown sugar, sucrose, and high fructose corn syrup (HFCS) (Vos et al., 2017).

2. Added Sugars

AS is a major target for nutrition intervention since it provides “empty calories”, i.e. calories that have little or no associated nutrients. Studies have shown that AS intake of more than 20% of EI can increase the total EI (Drewnowski, 2007), resulting in weight gain (Te Morenga, Mallard, & Mann, 2012) and a dilution of nutrient content of the diet (Joyce & Gibney, 2008).

The dietary intake of AS is difficult to accurately assess since there are not any analytical methods which differentiate between AS and sugar that is naturally occurring like sugar in milk, fruits, and vegetables. That is why it is not mandatory to have AS content of a food on nutrition labels (Louie et al., 2015). The recommended AS consumption for Americans is broad and has decreased year after year, as shown in Table 2. The rationale for establishing these recommendations aims at decreasing food types high in sugar which contribute to empty calories with low nutrient density. That would prevent nutrient deficiencies or calorie overconsumption (Hess, Latulippe, Ayoob, & Slavin, 2012).

Table 2 Current and proposed recommendations for added sugar intake for Americans (WHO, 2015) (Hess et al., 2012) (USDA, 2020)

Institution	**Recommendation**
Institute of Medicine (2002)	<25% total energy intake from added sugars
WHO current recommendation (2003)	<10% total energy intake from free sugars
American Heart Association (2009)	No more than half of discretionary calorie intake from added sugars. 100 calories for females, 150 calories for males.
USDA Dietary Guidelines for Americans (2010)	5%-15% total energy from solid fats and added sugars
WHO conditional recommendations (2015)	Aim for <5% total energy intake from free sugars

USDA Dietary Guidelines for Americans (2020-2025)	Limit added sugar to <10% total energy intake per day

However, it is very important to know the AS content of food and to know how much AS one consumes so that we can put those recommendations to use, because AS has been associated with various health outcomes.

Some results regarding AS have been analyzed from NHANES, which is a program of studies that assess the nutritional status and health of adults and children in the US (CDC-NHANES, 2023). For instance, a time-trend analysis of AS intake from 2001 to 2018 was done using nine consecutive 2-year cycles of NHANES. The results showed that, with the increased emphasis for a decreased AS intake in the Dietary Guidelines for Americans (DGA), the intake of AS actually significantly decreased from 15.6% to 12.6% kcal among children (2–8 years) and from 18.4% to 14.3% kcal among adolescents and teens (9–18 years). Decrease in intake was observed regardless of physical activity level (PAL), sociodemographic factors, body weight, or food assistance. This decrease was attributed to the decreased amounts of AS from sweetened beverages, even though they remained the top source of AS (Ricciuto, Fulgoni, Gaine, Scott, & DiFrancesco, 2022). Although there was a decrease in the consumption of AS, intake remained above the most recent aforementioned recommendation of less than 5% of total EI (WHO, 2015).

3. *Scarcity of Food Composition Data*

There is a scarcity in studies that examine the intake of added and free sugars in Lebanon. This is due to the scarcity of databases and the limitations of traditional dietary assessment methods in estimating added and free sugars.

A national study was conducted on Lebanese children and adolescents in 2018. It showed that free sugars compromised of 12.6 to 12.9% of EI and that 60% of children exceeded the WHO upper limit for free sugar intake, which is 10%. The sources of these free sugars were 15.1 to 22.2% from sweetened juices, 13.8 to 25.2% from regular soft drinks, and 10.6 to 14% from biscuits, wafers, and chocolate (Hamamji, 2018).

This study, however, was based on only one 24 HR, which allows for recall bias and under-reporting of sugar intake. This proves the need for further studies and methods to verify these 24 HRs, and to determine AS intake.

4. *Health Outcomes of Excessive Added Sugar Consumption on NCDs*

Even though there is no chemical difference between AS and naturally occurring sugars, foods and beverages which are major sources of AS have lower micronutrient densities than ones with naturally occurring sugars (Erickson & Slavin, 2015). This can lead to several NCDs, or chronic diseases, which include obesity, CVDs, diabetes, and some cancers (Rippe & Angelopoulos, 2016).

a. Obesity

The WHO reports that in 2016, 1.9 billion adults were overweight, and 650 million were obese (WHO, 2021). As a consequence, chronic illnesses associated with obesity are among the leading causes of death in the US, and these include diabetes and CVDs (Institute of Medicine Committee on Examination of Front-of-Package Nutrition Rating & Symbols, 2010). Other obesity or overweight-related chronic illnesses are HTN, hyperlipidemia, sleep apnea, and cancer (Rakhra, Galappaththy, Bulchandani, & Cabandugama, 2020).

Understanding how these AS are converted to fats in our body is essential in understanding how AS contribute to the obesity epidemic.

AS being sucrose is mainly digested in the small intestine. There is only partial digestion in the stomach via mechanical forces and low pH (hydrochloric acid). In the small intestine, the majority of sugars are digested and absorbed. Sucrose specifically is hydrolyzed to glucose and fructose by sucrase. These monosaccharides are then transported across the small intestine's epithelium and into the circulation. Glucose does that via a Na-glc symporter, which pumps the glucose and Na out of the epithelium. Fructose does that via GLUT-5 transporter. (Faruque et al., 2019)

Glucose and fructose then enter hepatic or non-hepatic tissues. Fructose only enters hepatic tissues because of the high affinity of fructokinase (fructose capturing enzyme) for fructose, but glucose enters both types of tissues, so the liver takes up most of the fructose and most of the glucose mainly provides energy for other cells like brain cells and muscle cells (myocites). (Faruque et al., 2019)

In non-hepatic tissue, glucose is either used for glycolysis i.e. broken down for energy, or it is stored as fat – depending on the energy state. (Faruque et al., 2019)

In the liver, both monosaccharides are converted to G3P: glyceraldehyde-3-phosphate (Figure 3-B). G3P then undergoes de novo lipogenesis (DNL), which is the conversion of fructose or excess glucose into fatty acids and ultimately their storage as triglycerides (TGs) (Ameer, Scandiuzzi, Hasnain, Kalbacher, & Zaidi, 2014). It is important to note that fructokinase is not regulated by energy status of the cells like phosphofructokinase, which metabolizes glucose. Meaning that energy status does not regulate the uptake of fructose by the liver and subsequent DNL, so high levels of consumed fructose (or AS which is converted to fructose) enter the liver and are converted to fat and TGs, rather than being used for energy (Stanhope, Schwarz, & Havel, 2013). Also, increased fructose consumption leads to a decrease in the secretion of insulin and leptin which are both hormones that regulate energy homeostasis by decreasing the intake of food and increasing energy expenditure (Elliott, Keim, Stern, Teff, & Havel, 2002).

The TGs formed are then transported out of the liver by VLDL and travel through the blood stream. They then bind to adipocytes through VLDL receptors and are endocytosed, releasing the TGs and other components (such as cholesterol). Excess TGs are incorporated into existing lipid droplets in adipocytes, increasing the size of the droplets (Berg, Tymoczko, Gatto, & Stryer, 2015).

For adipose distribution, glucose promotes lipid distribution in subcutaneous adipose tissue, while fructose favors visceral adipose tissue deposition (Stanhope et al., 2009).

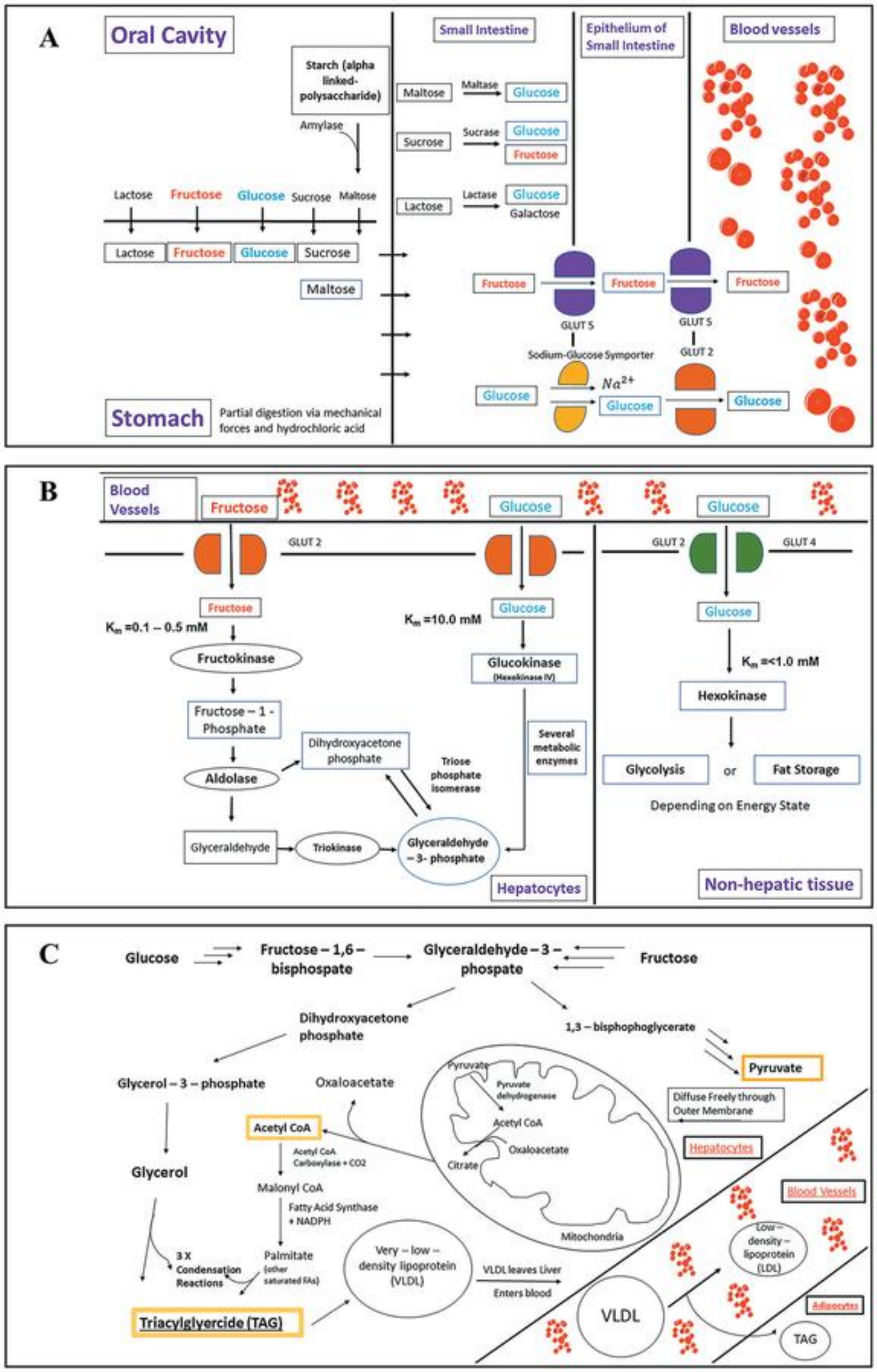

Figure 3 Absorption of sugar and its conversion to fat

(Faruque et al., 2019)

b. CVDs

As explained above, a diet high in AS (glucose and fructose) stimulates the liver to pump more fats into the bloodstream in the form of TGs and cholesterol. TGs combine with cholesterol to form VLDL, which can be converted to LDL. These fatty substances build up in the arteries, thickening their walls and building plaque, which narrows the arteries (NIH, 2022a). The way this happens is as follows: HTN and chemical irritants (tobacco, oxidized LDL, glycated substances, and others) cause damage to the endothelial lining of the arterial wall that results in an inflammatory process. This attracts monocytes and fibroblasts, which deposit collagen and facilitate the healing process. Monocytes convert into macrophages that express receptors for oxidized LDL; they engulf the LDL and are transformed into foam cells. Foam cells are filled with cholesterol, and thin layers of foam cells that develop on artery walls are fatty streaks. These thicken and form plaque as they accumulate additional lipids. The plaque is stable as long as it has a thick fibrous cap. (Jebari-Benslaiman et al., 2022) (Figure 4)

This eventually causes atherosclerosis, which can affect any arteries including those in the heart, brain, legs and arms, kidneys, and intestines. Atherosclerosis reduces the supply of oxygen-rich blood to tissues (ischemia), which can lead to angina (chest pain) and infarcts (cellular necrosis). Blood clots may form (thrombosis) if a plaque bursts, which may block the artery or travel to other parts of the body. These clots can cause heart attacks (myocardial infarctions), strokes (cerebrovascular accidents), peripheral vascular diseases (gangrene), and other complications. (NIH, 2022a)

Coronary artery disease (CAD) is a general term for all causes of heart disease characterized by the narrowing of vessels that supply blood to the heart (coronary arteries). The first sign on CAD can be a heart attack. CAD may impair cardiac function to the point that congestive heart failure (CHF) occurs, which is the inability of the ventricles' capacity to eject blood or to fill with blood. (CDC, 2021)

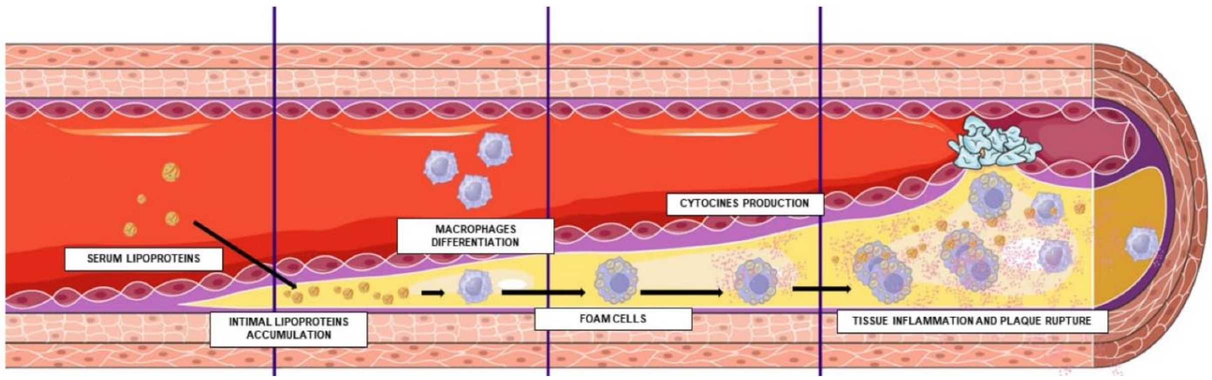

Figure 4 Pathophysiology of atherosclerosis
(Figueiredo et al., 2023)

c. Diabetes

The link between AS and diabetes is not direct. In fact, the question of whether or not AS is a unique cause for diabetes has not been addressed in randomized controlled trials (RCTs) (Rippe & Angelopoulos, 2016). However, AS, converted to TGs and leading to obesity, is a major risk factor for type 2 diabetes (T2D). In fact, the incidence of diabetes increases as the prevalence of obesity rises (Mokdad et al., 2001). Obesity, particularly abdominal obesity, leads to a range of metabolic diseases and abnormalities, such as insulin resistance, atherogenic dyslipidemia (elevated TG and reduced HDL-cholesterol levels), β-cell dysfunction, and ultimately prediabetes and T2D (Klein, Gastaldelli, Yki-Järvinen, & Scherer, 2022).

The function of pancreatic β-cells is a major determinant of whether obese individuals develop T2D. β-cells secrete insulin into the portal vein to be delivered to the body and liver, where it is eventually cleared. The concentration of plasma insulin and the rate of insulin secretion is usually greater in obese individuals than in lean individuals (during basal conditions and after meals) (van Vliet et al., 2020). Ultimately, this higher insulin demand exhausts the pancreas, leading to β-cell dysfunction and a decline in glycemic control, leading to prediabetes and T2D (Gastaldelli, Ferrannini, Miyazaki, Matsuda, & DeFronzo, 2004).

Subcutaneous adipose tissue in people with obesity induces several abnormalities, such as decreased oxygen to cells, increased pro-inflammatory macrophage and T-cell content, production of exosomes that may induce insulin resistance, and others. In fact, adipose inflammation has been proven as a major driver of insulin resistance in obese people, and increased pro-inflammatory immune cells manifest chronic, low-grade inflammation (Klein et al., 2022).

As discussed, diabetes is associated with a chronic, low-grade inflammation, specifically in adipose tissue. In obesity, inflammatory signals are known to disrupt insulin action and mediate insulin resistance. That is why inflammatory biomarkers are important indicators for diabetes risk. Some biomarkers that have been associated with diabetes are circulating adiponectin, plasma high-sensitivity C-reactive protein (CRP), and interleukins. Weight loss has been strongly associated with a decrease of CRP levels. Of course, dietary components can modulate the inflammatory and oxidative process, possibly leading to insulin resistance and diabetes if a person is genetically susceptible. Figure 5 illustrates some of the dietary components that may lead to T2D. (Salas-Salvadó, Martinez-González, Bulló, & Ros, 2011)

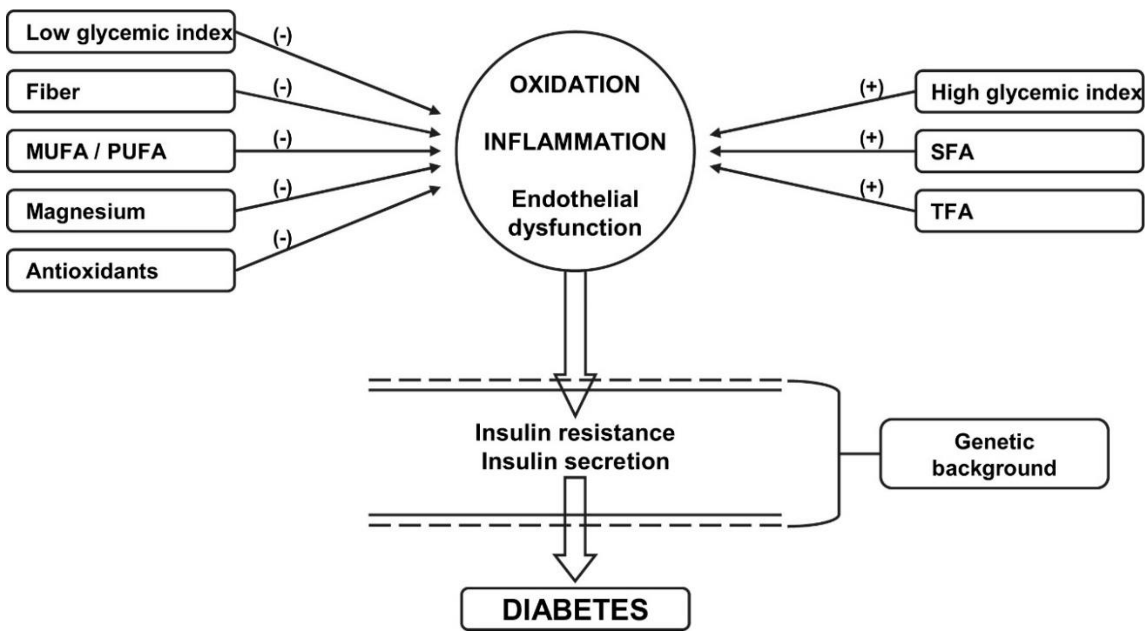

Figure 5 Effects of nutrients on the risk of developing diabetes
(Salas-Salvadó et al., 2011)

It is also important to note the effect of AS on dietary Advanced Glycosylated End Products (AGE), and the effect of AGEs on diabetes. AGEs are proteins or lipids that become glycated after they are exposed to sugars. In hyperglycemic environments, AGEs alter cell structure and function, contributing to the micro- and macrovascular complications of diabetes such as diabetic retinopathy, neuropathy, and nephropathy. (Goldin, Beckman, Schmidt, & Creager, 2006) AGEs are also causes for the inflammation that contributes to diabetes, and are thought of as oxidative derivatives resulting from diabetic hyperglycemia. They are seen as potential risks for β-cell injury, peripheral insulin resistance, and ultimately diabetes (Vlassara & Uribarri, 2014). There have been associations between elevated AGE intakes and serum biomarkers of oxidative stress, inflammation, endothelial dysfunction, hyperglycemia, and hyperlipidemia. They are also implicated in the death and dysfunction of β-cells. (Kellow & Savige, 2013)

The effect of dietary AGEs on diabetes is shown in Figure 6. Though AGEs can be formed endogenously, they are also found in foods. Dietary AGEs are formed in much higher extent, and they are mostly formed as a result of the Maillard reaction (thermal processing leading to non-enzymatic browning). AGEs are also found in foods high in fats and proteins. (Nowotny, Schröter, Schreiner, & Grune, 2018)

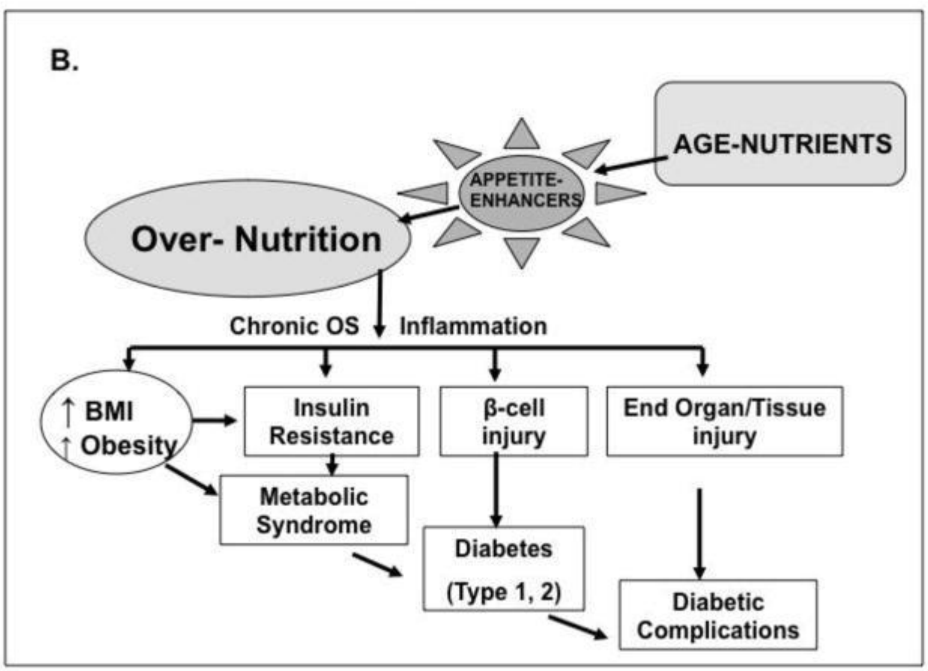

Figure 6 The effect of dietary AGEs on Diabetes
(Vlassara & Uribarri, 2014)

d. Cancer

There is a common misconception that consuming sugar, especially AS, can cause cancer or make cancer cells grow faster, but sugar is not a carcinogenic substance. Most cancer cells grow at a faster rate than other cells, thus requiring more energy. To meet the higher demand for glucose, glucose metabolism is often altered in cancer cells. This does not mean that eating more sugar will cause cancer or make cancer cells grow faster – all foods are broken down into glucose and used for energy for all cells. The way AS is a risk factor for cancer is the same way it is a risk factor for CVDs or T2D – through obesity. (CancerCouncil, 2023)

However, experimental data shows that sugars may play a role in the etiology of cancer through inflammation, oxidation, and insulin resistance, even in the absence of obesity. Total sugars were associated with a higher cancer risk, and there were significant associations between cancer risk and AS, free sugar, and sucrose intake. (Debras et al., 2020) Epidemiologic and preclinical studies also show that excess sugar intake may lead to cancer development and progression independent of the association between sugar and obesity – there is in fact a causal link between excess sugar and cancer. High sucrose or fructose diets activate multiple pathways, including inflammation. Moreover, there is a causal link between AS and metabolic syndrome (MetS): a risk factor for cancer. (Epner, Yang, Wagner, & Cohen, 2022)

Being overweight or obese is linked to 13 kinds of cancer: adenocarcinoma of the esophagus, breast (for women after menopause), ovaries, pancreas, rectum and colon, uterus, gallbladder, upper stomach, kidneys, liver, thyroid, meningioma, and multiple myeloma. (CDC, 2023)

There are several possible mechanisms that explain how obesity might increase the risk of some cancers. Adipose tissue produces an excess amount of estrogen. High levels of this hormone have been associated with a higher risk of breast, ovarian, endometrial, and other cancers. (NIH, 2022b) Moreover, the higher levels of insulin and insulin-like growth factor-1 (IGF-1) in obese individuals may contribute to the development of T2D – another risk factor for cancer. Hyperinsulinemia and IGF-1 may promote the development of endometrial, prostate, kidney, and colon cancer. (Gallagher & LeRoith, 2015) In addition, obese people often have chronic inflammatory conditions like NAFLD or gallstones, which cause oxidative stress, leading to DNA damage. This increases the risk of biliary tract and other cancers. (Roberts, Dive, & Renehan, 2010) Another way that obesity can increase the risk of cancer is that fat cells produce adipokines: hormones that can inhibit or stimulate the growth of cells. Leptin for instance (an adipokine) is directly proportional to body fat level, and high leptin levels can promote abnormal proliferation of cells. Adiponectin (another adipokine) decreases in obese individuals, and this adiponectin may have anti-proliferative effects that protect against the growth of tumors. (NIH, 2022b) Adipose tissues may also have effects on other regulators of cell growth and metabolic regulators, such as mammalian target of rapamycin (mTOR) and AMP-activated protein kinase. (NIH, 2022b)

In addition to the biological effects, obesity may lead to difficulties in management and screening of cancer. (Clarke et al., 2018)

There are also several studies showing that obesity may worsen certain aspects of cancer survivorship. These include quality of live, recurrence of cancer, cancer progression, prognosis, and risk of certain second primary cancer. (NIH, 2022b)

CHAPTER III

MATERIALS AND METHODS

A. Study Design

This is an observational study conducted on a convenience sample, based on the parent study titled "*Quantitative Estimation of Dietary Energy and Added Sugar Intakes: A Validation Study amongst Lebanese Adults*" that aims at assessing the utility and specificity of specific stable isotope biomarkers to assess AS intake in Lebanese adults. The parent study is a multi-country project that is funded by the International Atomic Energy Agency (IAEA).

B. Study Population and Sampling

The study was conducted on a convenience sample of Lebanese adults from the AUB community (staff, faculty, or students). Inclusion criteria were as follows: from AUB with valid insurance (HIP), age above 18 years old, Lebanese nationality, having a stable body weight (less than 5% weight loss or weight gain during the past month), and stable dietary habits during the past month (i.e. not on a temporary weight-loss, ketogenic, or vegan diet for example).

Subjects were excluded if they were suffering from chronic diseases that may alter body composition, metabolism, or dietary habits, taking medication that affect eating habits, don't have HIP, or were following a therapeutic or unusual diet (for this purpose, a screening tool was developed: Appendix A).

C. sample size

Sample size calculation was based on an SD of EI of 478 kilocalories (kcal) and a correlation coefficient between EI and TEE of 0.5. Using a paired t-test, an 80% power and a 5% significance level, 32 individuals were needed to detect a mean difference between EI and TEE of 240 kcal. (Andersen, Pollestad, Jacobs, Løvø, & Hustvedt, 2006)

D. Recruitment

The recruitment of participants was conducted via 1) advertisements that were posted in and around the Faculty of Agricultural and Food Sciences (FAFS) and other locations in AUB, and through 2) a snowballing approach.

Recruitment of participants was done in two stages:

Stage 1 involved the pre-assessment of habitual sugar dietary intake using a sugar consumption screening tool (Appendix B). This questionnaire asked about the frequency of consumption of certain categories of food known to have AS, and allowed for an approximation of the amount of AS that the participant consumes in grams. Using a scoring system, tertiles of sugar intake were constructed.

In stage 2, and in order to ensure a sufficiently wide range of sugar intake, the selection of subjects was based on a stratified sampling (by tertiles of sugar intake determined via the scoring of the screening tool). The tertiles were set at 0 to 20g of AS consumed, 20 to 60g, and more than 60g. Screening (stage 1) and recruitment (stage 2) were planned to continue until a minimum of 11 subjects fell in each tertile of sugar intake.

E. Data Collection

Subjects who were interested to participate in the study were invited to visit the department of Nutrition and Food Sciences at the American University of Beirut (AUB). Subjects were briefed about the study, its objectives and methodology. Eligibility of the participant was confirmed based on age, nationality, health status, stability of diet over the past month, and weight stability (using the screening tool, Appendix A). The sugar screening questionnaire was also administered to assess eligibility of the participants.

1. Timeline

The study was conducted during a 4-week time frame for each participant.

During week 1, the subject provided signed informed consent, and a multicomponent questionnaire (including the IPAQ, medical, socioeconomic) was administered (Appendix A, C, D). The questionnaires included information such as household income, crowding index, education level, and occupation. Anthropometrics were also measured (weight and height), and the first 24 HR was conducted.

During week 2 and week 3, the second and third 24 HRs were administered to the participant, respectively.

During week 4, the fourth 24HR was taken and Basal Metabolic rate (BMR) was measured. A body composition analysis was also done using the InBody 770 machine. The InBody is a Bioelectrical Impedance Analysis (BIA) device, which means that it measures body composition by sending alternating low-and high-frequency electrical currents through the body's water via contact with electrodes to measure impedance (opposition of electrical flow, or resistance). Then, the impedance is used to measure Total Body Water (TBW), which is then used to derive the fat-free (e.g. muscles) mass and the body fat. (InBody, 2023)

2. *Anthropometrics*

Anthropometric measurements are noninvasive quantitative body measurements. They include weight, height, BMI, head circumference, body circumferences, and skinfold thickness (Casadei & Kiel, 2022). In our study, we measured weight, height, and we calculated BMI. Weight was measured using the Seca 876 scale, height using the Seca 274 stadiometer, and BMI was calculated as follows:

$$BMI = \frac{weight}{height^2}$$

Weight and height were measured twice for accuracy, and if there was a difference, it was averaged.

3. *Dietary Assessment*

In study participants, dietary intake was measured through repeated 24-hour dietary recalls (24 HRs). Four non-consecutive 24 HRs, including at least one weekend day, were conducted to measure dietary intakes. The 24 HRs were administered in-person by trained nutritionists.

The 24 HRs were carried using the USDA Multiple-Pass Method, which is a five-step multiple pass food recall approach (USDA, 2021). This approach has consistently showed attenuation in the 24 HRs' limitations (Steinfeldt, Anand, & Murayi, 2013). The steps that were 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) a final probe review of the foods consumed. For each 24 HR, the interviewer obtained information regarding dietary intake during the past 24 hours, related to the time of each meal's intake, the food consumed by the subject, its portion size, preparation methods, and the brand of the food and beverages consumed, if applicable. (USDA, 2021) For the estimation of portion size, the 2D Food Portion Visual by Posner and Morgan (Millen & Morgan, 1996) was used.

Analysis of the four 24 HRs was done using the Nutritionist Pro (NutriPro) software (version 7.1.0, 2019, Nutritionist Pro, Axxya Systems, USA) to estimate energy and macronutrients' intakes. For the analysis of Lebanese composite and mixed dishes, standardized recipes were added to the NutriPro software using single food items. Within the NutriPro, the USDA database will be selected for analysis.

The NutriPro Software allows for the estimation of energy and macronutrient intakes, but not AS. The software estimates the intakes of "Total Sugars", which correspond to dietary monosaccharides, i.e. glucose, fructose, and galactose, and disaccharides, i.e. sucrose and lactose, and encompass naturally occurring sugars as well as sugar added during food reparations. The intake of "added sugars", which correspond to sugars added to foods by the manufacturer, cook, or consumer, was therefore calculated using the method of Louie et al, as explained in part E: Data Collection, section v: Determining Added Sugar Intake.

4. Physical Activity Assessment

The short form of the International Physical Activity Questionnaire (IPAQ) (Appendix D) was used, to assess PA amongst the study participants. The IPAQ's short form has been previously validated in English and in Arabic for the assessment of PA among Lebanese adults (Helou et al., 2017).

In brief, the IPAQ asks participants about their activity levels to determine whether a person is sedentary, moderately active, or highly active. This is done by converting the time spent doing certain activities into Metabolic Equivalents of Task (METs). METs are calculated by multiplying number of times the activity was performed by the duration and by a constant: 3.3 for low activity, 4.0 for moderate, and 8.0 for high (certain types of activities are categorized as low, moderate, and high). If the total METs of a person are below 600, then their activity level is low and they are assigned an activity factor of 1.25. If the METs are between 600 and 3000, then they are moderately active and the activity factor is 1.5. If the METs are above 3000, then the person is highly active and the activity factor is 1.75 (Ohkawara, Ishikawa-Takata, Park, Tabata, & Tanaka, 2011).

5. Assessment of Basal Metabolic Rate (BMR)

BMR was assessed via indirect calorimetry using the COSMED machine (COSMED, 2023) at the Department of Nutrition and Food Sciences. With indirect calorimetry, respiratory gas exchange (oxygen consumption V_{O2}, and carbon dioxide production V_{CO2}) is measured to estimate basal metabolic rate when participants are in a fasting state. We used a ventilated canopy hood, which is used for spontaneously breathing subjects. As shown in Figure 7, a clear rigid hood with a plastic drape surround the head to avoid air leakage, as well as a pump that pulls air through the canopy at a constant rate. Then, the indirect calorimeter analyzes respiratory gases and calculates BMR through Weir's equation:

$$BMR\ (kcal/day) = \ [(VO_2\ x\ 3.941) + (VCO_2\ x\ 1.11)]\ x\ 1440]$$

(Delsoglio, Achamrah, Berger, & Pichard, 2019)

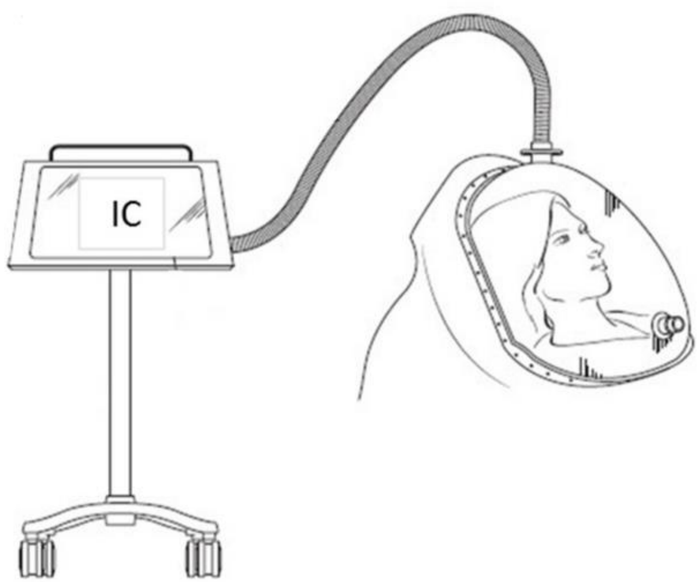

Figure 7 Indirect calorimetry on spontaneous breathing subject in canopy mode (Delsoglio et al., 2019)

The BMR was then multiplied by the activity factor derived for each participant using the IPAQ to get the TEE of each person (Kreymann, Adolph, & Mueller, 2009).

6. Determining Added Sugar Intake

For the assessment of AS intake, we first consulted the published USDA database to "borrow" AS content of food items (if included in the database). For culture-specific food items and those not found in the USDA database, the Louie et al method, as described below, was used to determine the AS component of the foods. Louie et al proposes a 10-step protocol to determine AS intake. Steps 1 to 6 are objective and they measure AS based on the content of foods. Steps 7 to 10 are subjective and they rely on estimations. The 10 steps are included below:

Step 1: For foods with 0 g total sugars, 0 g AS is assigned.

Step 2: 0 g AS is assigned to these food groups:

(a) 100% fruit or vegetable juice, and juice or cordial base sweetened only with artificial sweeteners.

(b) All herbs and spices

(c) All oils and fats

(d) All pastas, flours, rice, and cereal grains

(e) Eggs and egg products (except desserts which are egg-based)

(f) Fresh fruits and fresh vegetables (including salads without dressing), fresh meat, seafood, and tofu.

(g) Fruits canned in 100% fruit juiceor liquid sweetened only with artificial sweeteners.

(h) Intensely sweetened jam and beverage base (without AS).

(i) Legumes (dried, fresh, and/or processed, except varieties which are sweetened)

(j) Mixed meat dished without AS (decided based on ingredients; e.g. recipe).

(k) Non-sweetened alcoholic drinks.

(l) Non-sweetened teas and coffees.

(m) Non-sugar-sweetened milk, breast milk, and buttermilk.

(n) Non-sugar-sweetened dairy products (including yoghurts sweetened only with artificial sweeteners).

(o) Nuts (except sweetened varieties and nut bars), coconut (all products except the sweetened varieties), and seeds.

(p) Oats (and porridge) without AS (decided based on ingredients; e.g. ingredient list).

(q) Plain pastries without fillings (like chocolate, nuts, and/or dried fruits.

(r) Plain breads (except gluten-free), bagels, English muffins, naan, pizza bases.

(s) Unsweetened dried fruits.

Step 3: 100% of total sugars are assigned as AS for these food groups:

(a) All confectionaries except the ones that contain dairy products like chocolate and fudge.

(b) Breakfast cereals and cereal bars with no dried fruits, dairy, milk solids, or chocolate.

(c) Coffee and beverage base with no milk solids, dry, or made up with water,

(d) Crumbed or battered seafood and meat.

(e) Processed meats.

(f) Sports drinks, regular soft drinks, non-fruit-based energy drinks, and flavored water.

(g) Sweet biscuits, savory biscuits, donuts, cakes, buns, batter-based products that do not contain fruit, dairy products, or chocolate.

(h) Soy yoghurt and soy beverages without added fruits.

(i) Stock powder.

(j) Sugar and syrups.

Step 4: calculation of AS based on standard recipes used in food composition database, where AS content of all ingredients is available.

Added sugar per 100 g ($AS_{100\ g}$) is given by this formula:

$$AS_{100\ g} = \frac{\sum_{i=1}^{j} W_i\ x\ AS_i}{(\sum_{i=1}^{j} W_i)\ x\ (100\% + \%W)}$$

Where W_i is the weight of the i-th ingredient in the recipe, AS_i is the added sugar content per 100 g of the i-th ingredient, and $\%W_{\Delta}$ is the percentage change in weight when cooking.

Step 5: calculation based on comparison with values from the unsweetened variety.

Added sugar per 100 g ($AS_{100\ g}$) is given by this formula:

$$AS_{100\ g} = \frac{100\ x\ (S_{us} - S_{total})}{S_{us} - 100}$$

Where S_{us} is the total sugar content per 100 g of the unsweetened variety of the food and S_{total} is the final listed sugar content.

Step 6: decision based on analytical data. If there is analytical data for lactose, and there are no fruits or malted cereals in the ingredients, then:

added sugar = total sugar – lactose

If there are malted cereals, lactose, and maltose, then AS is as follows:

added sugar = total sugar – lactose – maltose

Step 7: use borrowed values from products that are similar to the ones in steps 1 to 6 or from overseas databases. Such databases include the USDA database that is used in this project.

Step 8: subjective estimation of AS based on common recipes or ingredients. If the recipes do not include AS, then AS content is 0 g. If they do contain AS or ingredients with AS, then the proportion of sugary ingredient is used for the estimation. If there is not any information on proportion, the common recipes as well as the order of appearance of the sugary ingredients is used for the decision. If the food is not packaged, then estimation is based on common recipes.

Step 9: calculation based on the standard recipe that includes ingredients with AS values assigned at steps 5 to 8 using the proportioning method.

Step 10: assign 50% of total sugars as AS if estimation of AS is impossible in any way suggested in steps 1 to 9.

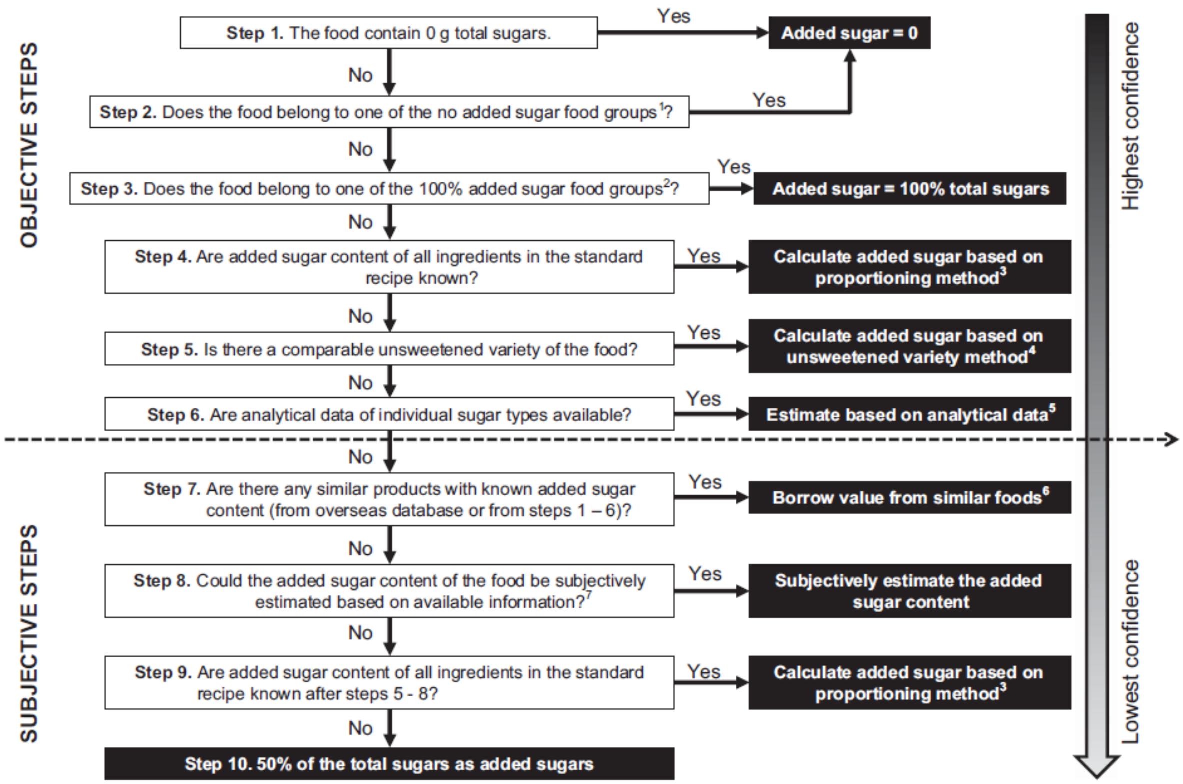

Figure 8 Louie et al's decision algorithm as published (Louie et al., 2015)

7. Data Management and Statistical Analysis

The NutriPro software (version 5.1.0, 2014, First Data Bank,Nutritionist Pro, Axxya Systems, San Bruno, CA, USA) was used to analyze food consumption of each participant from the 24 HRs. In this software, the USDA database was selected, and for specific Lebanese composite foods that are not included in the software, AUB food lists were selected.

AS content of the foods was obtained from the published USDA database (not the software's database since it was incomplete) or, if not available, they were calculated using the Louie et al method.

Data analysis was carried out using Statistical Package for Social Sciences 25.0 (SPSS for Windows, 2013, Chicago: SPSS Inc.). Frequency and descriptive statistics were performed on all variables, presented as means and standard deviations (SD), medians and interquartile ranges (IQR) for continuous variables, and counts and percentages for categorical variables. Anthropometric characteristics of the study sample were stratified between men and women. To compare EI between the four days, the Friedman test was used after confirming the non-normal distribution of the data. Mean and median of EI, AS, CHO, proteins, and fats between each day were compared. This analysis was also stratified by gender. Additionally, the Wilcoxon Signed Ranks test was used to compare taking two 24 HRs versus taking four 24 HRs for the assessment of EI, stratified by gender. Spearman correlation analysis was used to assess the correlation between EI and TEE.

The Wilcoxon Signed Ranks test was employed to compare means between EI and TEE by gender, level of education, BMI, crowding index level, PA category, and occupation. Crude analysis involved using simple linear regression to assess the association between the EI-TEE difference (dependent variable), and gender, education, BMI, age, crowding index, PA, and occupation. Beta coefficients and 95% confidence intervals (CIs) were generated. Adjusted analysis was then carried out using multiple linear regression where Beta coefficients and 95% CIs were also generated as adjusted measures of association. A p-value less than 0.05 was considered statistically significant.

8. Ethical Considerations

This study was approved by the Institutional Review Board (IRB) of the American University of Beirut (AUB). For the data collection and analysis of this study, each subject was assigned an ID number to ensure their confidentiality. The link between the subject name and ID number was placed in a locked cabinet to which only the researchers involved in the study had access. Moreover, all participants provided written informed consent to the study and all its steps, and they were given the freedom to quit the study at any point.

CHAPTER IV

RESULTS

A. Descriptive Data

1. Socio-Demographic Characteristics

The study was conducted on 77 participants, and their demographic and socioeconomic characteristics are shown in Table 3. The study sample comprised 45 males (58.4%) and 32 females (41.6%). Mean age was 30.04 ± 12.38 years. The majority of the participants had secondary school or university level education (36.4% and 46.8%, respectively). Almost 40% of the sample were AUB employees (faculty or staff) and close to 60% were students. The participants' crowding index is also shown in the Table. Crowding occurs when there is more than 1 person per room (excluding bathrooms, balconies, hallways, porches, half-rooms, foyers) (WHO, 2018), and in our study 45.5% of the participants' households were crowded.

Table 3 Socio-demographic characteristics of the study population

	n=77
	Mean ± SD
Age (years)	30.04 ± 12.38
Household income (USD)	3184.99 ± 4554.24
	n (%)
Crowding index	
< 1 person/ room	42 (54.5)
≥ 1 person/ room	35 (45.5)
Gender	
Male	45 (58.4)
Female	32 (41.6)
Education level	
Primary school or less	9 (11.7)
Secondary school	28 (36.4)

University or equivalent Higher degree (masters or PhD)	36 (46.8) 4 (5.2)
Occupation Professionals Technicians & Associated Professional Workers Machine Operators & Clerical/Service/Craft Workers Student --- Faculty or Staff Student	 7 (9.1) 6 (7.8) 18 (23.4) 46 (59.7) ----------------------- 31 (40.3) 46 59.7)

2. Anthropometric Characteristics of the Study Sample

The table below shows the anthropometric measurements of the study sample. The mean weight of the population was 74.04 ± 18.85 kg, with a statistically significant difference between men (82.84 ± 17.25 kg) and women (61.97 ± 13.46 kg). The mean height was 169.32 ± 9.68 cm, and, as expected, there was also a statistically significant difference between men (174.5 ± 8.16 cm) and women (161.79 ± 6.14). Mean BMI was 25.74 ± 5.35 kg/m^2, being significantly higher in men (27.2 ± 5.39 kg/m^2) compared to women (23.61 ± 4.59 kg/m^2). Of the study sample, 23.4% were obese and 22.1% were overweight, and there was a statistically significant difference in BMI classification between genders.

Table 4 Anthropometric measurements and nutritional status of the study population

	Total (n=77)	**Men (n=45)**	**Women (n=32)**	**P-value**
Mean ± SD				
Weight (kg)	74.04 ± 18.85	82.84 ± 17.25	61.97 ± 13.46	**<0.001**
Height (cm)	169.32 ± 9.68	174.5 ± 8.16	161.79 ± 6.14	**<0.001**
BMI (kg/m^2)	25.74 ± 5.35	27.2 ± 5.39	23.61 ± 4.59	**0.003**
n (%)				
BMI				**0.019**
Underweight	1 (1.3)	1 (2.2)	0	
Normal	40 (51.9)	17 (37.8)	23 (74.2)	
Overweight	17 (22.1)	13 (28.9)	4 (12.9)	
Obese	18 (23.4)	14 (31.1)	4 (12.9)	

3. Energy Expenditure and Dietary Energy Intake in the Study Sample

The assessment of total energy expenditure was based on the assessment of PAL amongst the study participants in addition to the measurement of BMR. Based on PA assessment, almost half of the study sample was classified as moderately active (55.5%) according to the MET categorical scores, and only 3.9% had low PALs. When stratified according to gender, 51.1% of men were moderately active, and 62.5% of women were moderately active, and the difference in PAL between males and females is not significant.

Table 5 Physical activity level in the study population.

Physical activity level	**n (%)**	**Males (%)**	**Females (%)**	**P-value***
High	31 (40.3)	21 (46.7)	10 (31.3)	0.28
Moderate	43 (55.5)	23 (51.1)	20 (62.5)	
Low	3 (3.9)	1 (2.2)	2 (6.3)	

METs were calculated by multiplying number of times the activity was performed by the duration and by a constant: 3.3 for low activity, 4.0 for moderate, and 8.0 for high.
If total METs of a person < 600: low activity level and activity factor (AF) 1.25.
If total METs 600-3000: moderately active and AF 1.5.
If total METs > 3000: highly active and AF 1.75.
*Fisher Exact Test to compare PAL between males and females

The average BMR of the study population was estimated at 1706.57 ± 468.18 kcal/day (median (IQR): 1640.66 (628.85) kcal/day). By multiplying the BMR value with the assigned activity factor for each participant, TEE was computed, and the average TEE was estimated at 2560.26 ± 676.61 kcal/day (median (IQR): 2531.52 (1239.75) kcal/day).

Table 6 shows that the average EI for the whole sample was 2260.91 ± 875.073 kcal/day (median (IQR): 2091.031 (998.63) kcal/day). As for the macronutrients, mean CHO intake was estimated at 261.67 ± 113.503 g/day (241.77 (101.69) g/day), protein at 82.93 ± 34.22 g/day (74.74 (46.054) g/day), and fats at 100.32 ± 43.084 g/day (92.23 (57.083) g/day). These were all derived from the 24 HRs and analyzed using NutriPro software. As for the AS intake, foods from the 24 HRs were analyzed using the USDA database and the Louie et all method, and was estimated at 43.9 ± 27.32 g/day (41.17 (34.205) g/day). Appendix E shows the AS content of all the foods consumed by the participants in their four 24 HRs. These results were then stratified by gender. As expected and justified by significant p-values, EI of males was greater than that of females [2690.026 ± 831.94 (2471.14 (1157.13)) kcal/day > 1670.88 ± 521.404 (1632.43 (741.47)) kcal/day], and so were all macronutrients and AS intakes.

Table 7 shows the same results of macronutrients and AS, but in calorie and percent contribution to energy intakes. For the total population, CHOs contributed to 46.22% to EI on average, protein 15.019%, fats 39.61%, and AS 7.83%. When comparing males and females, carbohydrates took up a larger percentage of women's diets vs. men's (47.57% > 45.24%), and so did AS (8.79% > 7.14%). Proteins were almost the same for men (15.011%) and women (15.03%), so even though the amounts eaten (in grams or calories) were statistically significant, their contribution to the diet is almost the same. Fats contributed a larger portion of men's diets than women (40.48% > 38.42%).

Table 6 BMR, TEE, EI, macronutrient, and AS intake of the study sample in grams/day

	Total (Mean ± SD)	Total (Median, (IQR))	Males (Mean ± SD)	Males (Median, (IQR))	Females (Mean ± SD)	Females (Median, (IQR))	P-value*
BMR (kcal/day)	1706.57 ± 468.18	1640.66 (628.85)	1934.38 ± 473.68	1964.16 (550.8)	1407.57 ± 238.36	1369.8 (254.84)	<0.001
TEE (kcal/day)	2560.26 ± 676.61	2531.52 (1239.75)	2926.73 ± 1100.98	3106.08 (1074.87)	2198.4 ± 427.26	2083.68 (525.33)	<0.001
E intake (kcal)	2260.91 ± 875.073	2091.031 (998.63)	2690.026 ± 831.94	2471.14 (1157.13)	1670.88 ± 521.404	1632.43 (741.47)	<0.001
CHO intake (g)	261.67 ± 113.503	241.77 (101.69)	307.59 ± 119.09	281.64 (168.76)	198.54 ± 66.25	196.12 (76.79)	<0.001
Prot intake (g)	82.93 ± 34.22	74.74 (46.054)	98.81 ± 33.7	94.97 (43.14)	61.1 ± 20.19	59.9 (23.34)	<0.001
Fat intake (g)	100.32 ± 43.084	92.23 (57.083)	120.69 ± 41.18	112.056 (48.36)	72.31 ± 27.2	68.88 (34.64)	<0.001
AS intake (g)	43.9 ± 27.32	41.17 (34.205)	49.066 ± 29.093	47.102 (38.29)	36.8 ± 23.28	32.19 (23.84)	0.042

TEE was based on BMR and IPAQ. Dietary EI based on 24 HRs with analysis using NutriPro for EI and macronutrients, and Louie et al method for AS.

TEE was calculated by multiplying BMR per day with assigned AF.

*Mann-Whitney test to compare between males and females

Table 7 Macronutrient, and AS intake of the study sample in kilocalories/day, with percent contribution to EI.

	Total (Mean ± SD)	**Total (Median, (IQR))**	**% EI Total**	**Males (Mean ± SD)**	**Males (Median, (IQR))**	**%EI Males**	**Females (Mean ± SD)**	**Females (Median, (IQR))**	**%EI Females**	**P-value***
CHO intake (kcal)	1046.7 ± 454.011	967.067 (406.76)	46.22	1230.37 ± 476.36	1126.55 (675.05)	45.24	794.15 ± 264.99	784.48 (307.15)	47.57	**<0.001**
Prot intake (kcal)	331.73 ± 136.88	298.96 (184.22)	15.019	395.26 ± 134.79	379.86 (172.57)	15.011	244.39 ± 80.77	239.58 (93.35)	15.03	**<0.001**
Fat intake (kcal)	902.87 ± 387.75	830.104 (513.74)	39.61	1086.2 ± 370.64	1008.504 (435.21)	40.48	650.806 ± 244.79	619.93 (311.76)	38.42	**<0.001**
AS intake (kcal)	175.606 ± 109.29	164.67 (136.82)	7.83	196.26 ± 116.37	188.407 (153.16)	7.14	147.203 ± 93.13	128.75 (95.36)	8.79	**0.042**

Dietary EI based on 24 HRs with analysis using NutriPro for EI and macronutrients, and Louie et al method for AS.
*Mann-Whitney test to compare between males and females

B. Comparisons of Energy and Macronutrient Intakes as Determined by the 4 Days Of 24 HRs

1. Comparisons of Energy and Nutrient Intakes Generated by Each of the 24 HRs

When comparing the four days in which the 24 HRs were taken, Friedman test was used since the data is not normally distributed. Mean EI ranged between 2240.89 ± 1092.66 kcal/day and 2403.95 ± 1175.21 kcal/day in the total sample, but there was no statistically significant difference between the 4-day estimates. The same was observed for analysis based on gender. The intake of AS per day ranged between 41.86 ± 40.91 g/day and 46.95 ± 41.22, without observing significant differences between the various days in the total sample and by gender. Similarly, there was no significant difference in the intakes of CHO, protein, or fat between the various 24 HR days.

Table 9 shows the same results, but in calories with the percent contribution of the macronutrients and AS to the participants' EI. Contribution of AS to daily EI ranged between 7.81% and 8.27% for the total sample, between 6.53% and 9.71% for males, and between 6.84% and 9.58% for females, with none of these differences being significant. Percent contribution of proteins to EI was also not significant for the total sample, males, or females. P-value showed that percent contribution of CHO to EI of the total sample was significantly different across days, but when stratified by gender, there was no significant difference across days. As for fats, there was a significant difference in percent contribution to EI for females; for the total sample and for males, the difference was not significant.

Table 8 Comparisons of different parameters from the collected 24 HRs by day in grams

grams	**Total Sample**			**Males**			**Females**		
	Mean ± SD	**(Median, (IQR))**	**P-value***	**Mean ± SD**	**(Median, (IQR))**	**P-value***	**Mean ± SD**	**(Median, (IQR))**	**P-value***
Energy Intake									
Day 1	2240.89 ± 1092.66	2046.95 (1606.58)	0.65	2649.054 ± 1178.8	2569.91 (1527.53)	0.59	1672.37 ± 622.054	1481.33 (994.80)	0.9
Day 2	2307.75 ± 1154.64	2133 (1415.80)		2792.76 ± 1163.65	2762.81 (1361.34)		1632.2 ± 734.92	1661.65 (1196.22)	
Day 3	2403.95 ± 1175.21	2104.06 (1555.68)		2846.27 ± 1159.32	2915.38 (1558.86)		1787.87 ± 899.04	1681.86 (630.09)	
Day 4	2296.89 ± 1189.88	2064.82 (1540.63)		2797.4 ± 1200.33	2634.10 (1337.90)		1599.74 ± 753.14	1459.57 (1089.90)	
Added Sugar									
Day 1	41.86 ± 40.91	31.19 (44.65)	0.88	46.67 ± 45.28	34.97 (42.83)	0.43	35.17 ± 33.55	24.40 (36.09)	0.73
Day 2	43.45 ± 34.96	31.45 (51.01)		48.052 ± 37.15	37.59 (56.22)		37.037 ± 31.17	30.10 (31.51)	
Day 3	46.95 ± 41.22	34.28 (48.21)		58.71 ± 47.72	45.22 (56.76)		30.55 ± 21.69	470.65 (31.64)	
Day 4	43.021 ± 37.019	36.21 (49.49)		47.49 ± 38.26	40.26 (47.34)		36.8 ± 34.93	25.89 (45.71)	
CHO									
Day 1	269.89 ± 145.17	240.45 (209.63)	0.67	316.36 ± 159.76	310.73 (231.11)	0.73	205.16 ± 90.15	194.24 (116.68)	0.52
Day 2	265.94 ± 146.11	252.00 (189.89)		327.96 ± 150.69	286.65 (138.82)		179.56 ± 83.27	158.47 (144.59)	
Day 3	282.36 ± 145.73	248.61 (187.49)		337.73 ± 144.56	335.56 (199.17)		205.23 ± 109.12	201.34 (92.81)	
Day 4	257.99 ± 134.99	246.34 (187.56)		299.65 ± 146.52	306.79 (176.56)		199.96 ± 91.26	192.50 (144.56)	
Proteins									
Day 1	82.93 ± 47.58	70.80 (56.36)	0.81	96.06 ± 53.34	84.50 (69.87)	0.57	64.66 ± 30.59	59.33 (50.49)	0.49
Day 2	85.89 ± 46.67	82.24 (70.00)		104.99 ± 47.33	98.24 (67.63)		59.28 ± 30.18	43.33 (52.67)	

Day 3	88.66 ± 54.908	79.92 (51.75)		103.15 ± 60.28	93.74 (51.92)		68.47 ± 39.12	60.64 (40.80)	
Day 4	83.49 ± 50.706	80.13 (68.50)		104.94 ± 53.74	96.54 (69.19)		53.61 ± 25.104	53.14 (45.76)	
Fats									
Day 1	94.84 ± 54.41	85.68 (67.18)	0.53	113.66 ± 61.67	106.58 (85.84)	0.43	68.63 ± 34.68	64.24 (64.45)	0.73
Day 2	103.06 ± 66.81	98.97 (67.43)		121.26 ± 75.68	114.16 (74.52)		77.71 ± 41.303	72.14 (58.69)	
Day 3	104.36 ± 58.76	95.68 (80.22)		122.85 ± 60.33	121.03 (88.76)		78.605 ± 46.21	71.64 (52.21)	
Day 4	106.307 ± 71.78	97.94 (86.54)		134.12 ± 74.67	114.48 (84.02)		67.57 ± 45.56	51.14 (58.14)	

* Friedman test to compare difference across days

kcals	**Total Sample**					**Males**					**Females**				
	Mean ± SD	**(Median, (IQR))**	**P-value***	**%EI Total**	**P-value* of %EI Total**	**Mean ± SD**	**(Median, (IQR))**	**P-value***	**%EI Males**	**P-value* of %EI Males**	**Mean ± SD**	**(Median, (IQR))**	**P-value***	**%EI Female**	**P-value* of %EI Female**
Added Sugar															
Day 1	173.61 ± 163.95	139.03 (184.17)	0.88	8.27	0.61	191.96 ± 183.41	141.033 (200.12)	0.43	8.11	0.48	153.73 ± 135.07	123.59 (199.14)	0.73	8.43	0.22
Day 2	179.95 ± 143.46	130.87 (202.45)		7.81		190.57 ± 143.013	141.14 (211.79)		6.53		165.34 ± 145.068	123.074 (146.46)		9.58	
Day 3	194.905 ± 162.65	139.28 (220.61)		8.602		234.15 ± 183.23	188.63 (224.42)		8.5		140.95 ± 110.67	106.82 (139.89)		8.74	
Day 4	172.086 ± 148.077	144.83 (197.96)		7.85		176.29 ± 148.27	142.078 (177.47)		9.71		178.3 ± 140.94	158.0 (216.75)		6.84	
CHO															
Day 1	1100.87 ± 576.85	1034.12 (809.56)	0.67	50.91	< **0.001**	1268.58 ± 629.32	1244.49 (928.41)	0.73	53.22	0.13	870.26 ± 368.75	789.25 (526.05)	0.52	47.63	0.26
Day 2	1070.3 ± 570.1	1009.304 (782.66)		46.27		1292.23 ± 596.88	1207.32 (638.19)		46.96		765.14 ± 355.12	678.34 (592.08)		45.32	
Day 3	1105.87 ± 555.88	995.62 (710.19)		46.96		1298.26 ± 568.64	1230.05 (849.39)		47.038		841.33 ± 417.49	824.88 (431.78)		46.85	
Day 4	1031.96 ± 539.97	985.37 (750.26)		46.401		968.69 ± 531.26	985.37 (705.69)		49.57		1110.92 ± 551.051	1025.59 (718.45)		44.97	
Proteins															
Day 1	346.0 ± 194.83	298.18 (221.36)	0.81	16.06	0.53	399.68 ± 216.86	361.68 (278.72)	0.57	17.041	0.33	272.19 ± 129.96	257.092 (197.53)	0.49	14.67	0.9
Day 2	340.69 ± 180.96	327.66 (275.83)		15.067		410.92 ± 185.41	390.25 (274.01)		15.32		244.11 ± 122.097	176.48 (207.33)		14.72	
Day 3	345.84 ± 211.909	299.42 (202.64)		14.87		398.36 ± 235.59	359.49 (233.71)		14.33		273.63 ± 149.53	242.56 (162.12)		15.62	
Day 4	333.97 ± 202.82	320.54 (274.01)		14.99		294.54 ± 236.103	235.22 (198.54)		14.32		349.63 ± 162.8	349.008 (258.36)		14.44	
Fats															

Day 1	895.4 ± 513.81	835.66 (609.3)	0.53	40.057	0.25	1069.55 ± 562.37	961.93 (823.97)	0.43	44.46	0.74	655.94 ± 312.72	629.48 (608.88)	0.73	33.81	**0.006**
Day 2	937.89 ± 583.98	904.94 (603.23)		39.42		1097.95 ± 662.65	1025.73 (739.62)		38.18		717.79 ± 360.026	673.83 (511.45)		41.12	
Day 3	934.75 ± 504.91	877.73 (644.61)		38.81		1107.36 ± 512.62	1084.35 (602.96)		39.49		697.402 ± 389.67	637.051 (377.39)		37.88	
Day 4	956.76 ± 646.052	881.48 (778.88)		39.69		818.025 ± 632.37	639.18 (807.57)		37.33		1109.52 ± 744.71	973.71 (889.54)		41.73	

Table 9 Comparisons of macronutrient intakes from the four collected 24 HRs by day in kilocalories and %EI

* Friedman test to compare difference across days

2. *Comparison between the first two 24 HRs and the four 24 HRs*

To compare two versus four 24 HRs, the Wilcoxon Signed Ranks test was used because the data is not normally distributed. The results showed that there was no statistically significant difference between the means of EI, AS, CHO, protein, and fat intake in the total sample and by gender.

The results were also shown by calories with percent contribution of macronutrients and AS to the participants' total daily food intake. For example, AS made up 7.77% of participants' intake when two 24 HRs were conducted, and 7.83% when four 24 HRs were conducted. The results are shown in Table 11.

Table 10 Comparison of parameters between two 24 HRs and the four 24 HRs in grams

grams	**Total**			**Males**			**Females**		
	Mean ± SD	**Median (IQR)**	**P-value***	**Mean ± SD**	**Median (IQR)**	**P-value***	**Mean ± SD**	**Median (IQR)**	**P-value***
Energy Intake									
2 days 24 HR	2324.97 ± 946.49	2212.029 (1384.87)	0.35	2749.23 ± 922.2	2703.088 (1143.61)	0.57	1741.62 ± 617.23	1649.99 (887.38)	0.42
4 days 24 HR	2260.91 ± 875.073	2091.031 (998.63)		2690.026 ± 831.94	2471.14 (1157.13)		1670.88 ± 521.405	1632.43 (741.47)	
Added Sugar									
2 days 24 HR	44.48 ± 30.24	38.27 (41.65)	0.88	47.82 ± 29.68	47.34 (39.903)	0.67	39.88 ± 30.87	30.89 (34.63)	0.43
4 days 24 HR	43.9 ± 27.32	41.17 (34.205)		47.98 ± 29.68	47.102 (38.29)		36.8 ± 23.28	32.19 (23.84)	
CHO									
2 days 24 HR	271.4 ± 127.15	248.72 (169.77)	0.26	320.102 ± 133.41	300.74 (173.31)	0.26	204.43 ± 80.2	185.48 (119.16)	0.76
4 days 24 HR	261.67 ± 113.503	241.77 (101.69)		300.76 ± 126.34	281.64 (168.76)		198.54 ± 66.25	196.12 (76.79)	
Proteins									
2 days 24 HR	85.84 ± 37.52	78.24 (55.83)	0.17	101.33 ± 38.29	92.43 (57.99)	0.41	64.54 ± 23.73	62.33 (33.22)	0.25
4 days 24 HR	82.93 ± 34.22	74.74 (46.054)		96.62 ± 36.42	94.97 (43.14)		61.1 ± 20.19	59.9 (23.34)	
Fats									
2 days 24 HR	101.85 ± 47.78	95.22 (57.98)	0.45	120.42 ± 49.84	120.97 (49.84)	>0.99	76.32 ± 30.26	79.7 (36.77)	0.21
4 days 24 HR	100.32 ± 43.084	92.23 (57.083)		118.006 ± 44.51	112.056 (48.36)		72.31 ± 27.2	68.88 (34.64)	

* Wilcoxon Signed Ranks test

Table 11 Comparison of macronutrient intakes between two 24 HRs and four 24 HRs in kcals and %EI

kcals	**Total**				**Males**				**Females**			
	Mean ± SD	**Median (IQR)**	**P-value***	**%EI**	**Mean ± SD**	**Median (IQR)**	**P-value***	**%EI**	**Mean ± SD**	**Median (IQR)**	**P-value***	**%EI**
Added Sugar												
2 days 24 HR	177.906 ± 120.96	153.084 (166.62)	0.88	7.77	180.023 ± 122.75	155.062 (175.73)	0.67	6.82	172.29 ± 121.34	152.16 (140.83)	0.43	9.15
4 days 24 HR	175.606 ± 109.29	164.67 (136.82)		7.83	196.26 ± 116.37	188.407 (153.16)		7.14	147.203 ± 93.13	128.75 (95.36)		8.79
CHO												
2 days 24 HR	1085.58 ± 508.62	994.88 (679.08)	0.26	46.88	1220.56 ± 540.67	1091.15 (694.08)	0.26	47.28	881.46 ± 391.039	822.99 (601.11)	0.76	46.55
4 days 24 HR	1046.7 ± 454.011	967.067 (406.76)		46.22	1230.37 ± 476.36	1126.55 (675.05)		45.24	794.15 ± 264.99	784.48 (307.15)		47.57
Proteins												
2 days 24 HR	343.34 ± 150.074	312.97 (150.074)	0.17	15.22	375.11 ± 155.52	333.89 (243.23)	0.41	14.82	290.38 ± 123.602	266.66 (152.08)	0.25	15.77
4 days 24 HR	331.73 ± 136.88	298.96 (184.22)		15.019	395.26 ± 134.79	379.86 (172.57)		15.011	244.39 ± 80.77	239.58 (93.35)		15.03
Fats												
2 days 24 HR	916.64 ± 430.038	856.99 (521.81)	0.45	38.88	1011.46 ± 440.34	944.96 (507.08)	>0.99	38.86	756.32 ± 351.34	760.62 (408.66)	0.21	38.69
4 days 24 HR	902.87 ± 387.75	830.104 (513.74)		39.61	1086.2 ± 370.64	1008.504 (435.21)		40.48	650.806 ± 244.79	619.93 (311.76)		38.42

* Wilcoxon Signed Ranks test

C. Relation between EI and TEE

1. Correlation between EI and TEE

The correlation between EI and TEE was examined using Spearman correlation analysis. A significant positive correlation coefficient of 0.37 was obtained (p-value = 0.001), indicating a moderate positive relationship between EI and TEE. The positive correlation implies that individuals who consume more calories also tend to burn more calories through EE.

2. Mean Difference Between EI and TEE in the Total Sample and its Association with Socioeconomic Characteristics

The Wilcoxon Signed Ranks test was used to compare EI vs. TEE in the study sample. When comparing intake vs. expenditure among genders, 75% of women had EI statistically significantly lower than their TEE (p-value <0.001). EI was also statistically significantly lower than TEE for 67.2% of people who have completed high school (p-value 0.002) and 71.9% of people with a high BMI (p-value 0.002). This suggests that females, people with a high school (HS) level education, and people with high BMI are potentially expending more energy than they are consuming. There was also a statistically significant difference between EI and TEE for people with high or low/ moderate PALs, for CI lower or greater than 1, and for students or faculty/ staff.

Table 12 Mean difference between EI and TEE in the total sample and by socioeconomic characteristics

kcals	**Mean ± SD**				
	EI	**TEE**	**EI - TEE**	**% EI < TEE**	**P-value***
Males	2690.026 ± 831.94	2993.25 ± 153.49	-303.22 ± 1350.13	59.1%	0.11
Females	1670.88 ± 521.404	2198.4 ± 427.26	-527.52 ± 641.52	75.0%	**< 0.001**
High-school level or higher education	2244.87 ± 898.79	2608.14 ± 923.36	-402.2 ± 1094.83	67.2%	**0.002**
Lower than High school level education	2380.34 ± 704.42	2744.24 ± 1206.41	-363.89 ± 1272.28	55.6%	0.37
Normal BMI	2282.64 ± 962.86	2404.43 ± 693.82	-121.79 ± 973.606	58.5%	0.19
High BMI**	2297.14 ± 743.34	3005.084 ± 1061.36	-707.94 ± 1208.78	71.9%	**0.002**
High PA	2429.87 ± 902.82	3006.68 ± 904.407	-576.805 ± 1179.027	61.3%	**0.01**
Low/ Moderate PA	2144.52 ± 845.903	2418.77 ± 840.12	-274.26 ± 1051.94	68.9%	**0.02**
< 1 CI	2162.74 ± 851.09	2577.89 ± 965.045	-415.14 ± 1072.32	73.8%	**0.007**
≥ 1 CI	2382.18 ± 901.65	2758.25 ± 837.44	-376.07 ± 1166.43	55.9%	**0.045**
Student	2150.064 ± 923.906	2489.1 ± 837.85	-339.036 ± 1096.34	71.1%	**0.012**
Faculty/ Staff	2421.82 ± 785.65	2904.59 ± 964.046	-482.77 ± 1137.35	58.1%	**0.023**

* Wilcoxon Signed Ranks test
** high BMI: overweight & obese

3. Multiple Linear Regression

The multiple linear regression showed a significant association between BMI and the difference between EI and TEE (p-value 0.006 with CI excluding 0: -1408.53; -245.75). Other factors such as gender, education, age, CI, PA, and occupation, did not show a significant difference with the mean difference (EI – TEE) after adjustment for confounders.

Table 13 Multiple linear regression showing the association between (EI-TEE) and different factors.

	Beta (95% CI)	**P-value**
Gender	-428.65 (-1066.5; 69.19)	0.84
Education	-287.093 (-1211.305; 637.12)	0.54
BMI	-869.18 (-1476.35; -262.02)	**0.006**
Age	7.61 (-20.23; 35.46)	0.59
CI	-82.73 (-646.25; 480.79)	0.77
PA	-423.309 (-984.57; 137.95)	0.14
Occupation (student or employee)	16.106 (-693.45; 725.66)	0.96

* Dependent variable: difference between EI and TEE (EI-TEE)

Find simple linear regression of these characteristics in Appendix F.

CHAPTER V

DISCUSSION

This study examined total energy expenditure (TEE) and dietary energy intake (EI) based on four repeated 24 HRs in a sample of Lebanese adults. The study showed that average TEE was estimated at 2560.26 ± 676.61 kcal/day based on the measurement of BMR and the assessment of physical activity (PA) in the study participants, while average EI was estimated at 2260.91 ± 875.073 kcal/day. Dietary EI was found to be consistent over the four-day recalls administered during a month period. Although a significantly positive correlation was observed between TEE and EI (spearman correlation = 0.37), there was a statistically significant difference between them in the study sample. Mean difference was the largest in women, subjects with higher education levels, high BMI, high PA and low CI. After adjustment for confounders, the factor that remained significantly associated with mismatching between EI and TEE was high BMI.

The observed TEE amongst Lebanese adults (2560.26 ± 676.61 kcal/day) is similar to estimates reported in previous studies on adults which showed TEE to be between 2372 ± 560 kcal/day and 2428 ± 285 kcal/day (Willis et al., 2022) in the US, while being relatively higher than estimates reported from other studies (between 2169.4 ± 411.625 kcal/day and 2248.8 ± 273.534 kcal/day in Nigeria) (Ayogu, Oshomegie, & Udenta, 2022). In our study, TEE was estimated based on a measurement of BMR using indirect calorimetry and self-reported PA. Indirect calorimetry is known to be one of the most accurate, sensitive, and non-invasive measurements of BMR (Delsoglio et al., 2019). It is well acknowledged that indirect calorimetry results may vary under certain conditions such as metabolic acidosis, excess post-exercise VO_2, prolonged exercise, and hyperventilation, all of which were excluded in our current study. Other factors which may increase BMR (cold exposure, high altitude, exercise, pregnancy and lactation, thyroid and glucagon hormones, stress and illness), or decrease it (prolonged fasting, drugs such as sedatives or beta-blockers) have also been controlled for in our study (Gupta et al., 2017). In healthy people, a steady state as short as 3 minutes reflects a clinically acceptable BMR. This state can be achieved within 30 minutes (Reeves, Davies, Bauer, & Battistutta, 2004), which is the time our participants underwent the BMR test. In addition to BMR measurement, PA was assessed among our study participants using the IPAQ, which has been previously validated in English and in Arabic for the assessment of PA among Lebanese adults (Helou et al., 2017). Our study categorized PAL as low (3.9%), moderate (55.5%), and high (40.3%). Another study conducted on Lebanese adults of the same age group (n=300), showed that 43% were inactive, 36.7% were moderately active, and 20.3% were active (Hourani, Hamadeh, Al-Iskandarani, Daouk, & Hoteit, 2017), which suggests that PA levels were higher or over-estimated in our study sample compared to the general population, and hence TEE may have been also over-estimated.

Using four repeated 24 HRs, the mean dietary EI of the study sample was estimated at 2260.91 ± 875.073, a value that falls within estimates reported by previous studies in Lebanon (2259.96 ± 72.59 in 1997 and 2343.40 ± 39.11 in 2008/2009) (Nasreddine et al., 2019). The observed macronutrient intakes and particularly the high fat intake (39.61% EI for total population) is also similar to that reported from previous studies in Lebanon (Nasreddine et al., 2019).

One of the main objectives of the present study was the assessment of AS intakes. These were estimated at 7.83% EI (43.9 ± 27.32 g/day) in the total sample, 7.14% EI (49.066 ± 29.093 g/day) in men, and 8.79% EI (36.8 ± 23.28 g/day) in women. There are no previous studies examining AS intake amongst adults in Lebanon or the region. A previous Lebanese study was conducted on a national sample of children and adolescents, and reported free sugar intake (which includes AS), at a range of 12.6 to 12.9% of EI (Hamamji, 2018). Studies conducted in other parts of the world reported similar or higher levels of AS intake. For instance, a study conducted in the US showed that adults consumed 17 tsp (68 g) of AS per day (Lee, Park, & Blanck, 2023). A review from 2021 examined global AS consumption, demonstrating that AS ranged from 6.3% EI in Norway to 14% EI in Brazil (Bell, Nugent, Re, & Walton, 2023), and our estimate of 7.8% EI falls within this range. It is important to mention that in our study we used the Louie et al method (Louie et al., 2015) to estimate AS intake given the lack of data on AS content in our food composition software. This method, however, comes with some limitations. First, data for individual types of sugars are sometimes not available. Second, the consistency of AS content of food groups were assumed for steps 2 and 3 (0 or 100% sugars as AS). Third, food composition database should provide data for lactose at least to produce reliable estimations using this method for step 6 (decision based on analytical data. If there is analytical data for lactose, and there are no fruits or malted cereals in the ingredients, then: added sugar = total sugar - lactose). Fourth, the ingredients list should provide accurate proportions of ingredients for step 8 to work (subjective estimation of AS based on common recipes or ingredients). Finally, some steps in this method are subjective (steps 8 aforementioned and 10: assign 50% of total sugars as AS if estimation of AS is impossible in any way suggested in steps 1 to 9), which is why Louie et al suggest that two people conduct the estimations independently using their method (Louie et al., 2015).

In our study, four repeated 24 HRs were used to assess dietary intake. The repeated 24 HR approach is a method that is widely used in clinical and epidemiological studies (TuftsUniversity, 2023). Our results showed that the estimates of energy (kcal/day), macronutrients, and AS intakes (kcal/day and g/day) were similar on each of the four recall days. The same was true when the data was separated by gender. This suggests that the subjects' consumption patterns were consistent throughout the four days, and that regardless of the recalls' accuracy, the consistent results throughout the four days shows a consistency in reporting. Some studies show similar consistencies across several taken dietary recalls. For instance, a study conducted on 595 Chinese adults showed that the mean of twenty-three 24 HRs yielded estimates close to the true intakes of the individuals, stating that enough repeated 24 HRs can reduce within-person variation and estimate usual intake more accurately (Huang, Zhao, Guo, et al., 2022). Another study conducted on 388 adults with obesity compared a 24 HR taken during a weekday and another during a weekend, and it found no statistically significant difference (i.e. there was consistency) between the two for the total population, males, or females (Serban et al., 2022). Other studies, however, do not show similar consistencies across several recalls. A study found that the initial 24 HR showed significant under-reporting of EI, three recalls were best to minimize the mean difference between intakes, and additional recalls did not improve estimation of EI, which means that recalls became consistent at three and above (Ma et al., 2009). The same study aforementioned by Serban et al showed that there was a significant difference between the first recall and the rest of the three, a finding that may be explained by the fact that the first recall was the only one performed face-to-face. The authors also argued that the decreased reporting of dietary intake in their study could also be explained by participants becoming more aware of their food intake in the process of reporting these intakes (Serban et al., 2022). This is also known as training bias, or the "big brother" effect. The difference in the consistency of recalls between our findings and the literature may be attributed to cultural and behavioral factors. Cultural attitudes towards dietary disclosure may differ between populations and individuals, and may evolve as participants engage in the research process. In fact, a qualitative study revealed that factors which influenced reporting on diet records are honesty vs. social acceptability, and simplifying food reporting (Vuckovic, Ritenbaugh, Taren, & Tobar, 2000). This means that participants worried that their normal dietary intake may be judged as "bad" or "weird". They actually expressed their intentions to alter recording and reporting their food intake for the sake of impression management. Also, participants reported "simplifying" reporting their food if the dish that they ate or prepared is too complex (Vuckovic et al., 2000). In addition, participants may experience fatigue or boredom during a prolonged dietary recall study, potentially impacting the quality of responses. The first recall may be less affected by response fatigue compared to subsequent ones. A behavioral science study explored the effect of long studies on participants (Meier, Martarelli, & Wolff, 2023). It showed that participants tend to get bored when participating in studies, that the degree of boredom differs and its effect on engagement in the study differs, and that boredom can impair their attention, can make participation more effortful, and can increase the urge to disengage from the study. Also, some participants may adjust their behavior because of their boredom, which might bias the outcomes of the study. In fact, 71% of students and 48% of workers reported that they think boredom affects findings of studies.

When examining macronutrients and AS intakes in terms of their contribution to EI (% EI), we observed that there was a variation in percentage for CHO of the total population. However, when stratified by gender, this significance was lost. As for fats, percent contribution to EI was significantly different for females between the various recall days, which suggests that they may be misreporting food items that are high in fat, a fact that falls in line with the presumed under-reporting of females shown and explained in later results.

After examining the consistency of the four repeated 24 HRs, our next objective was to investigate whether four 24 HRs are actually needed, or if two non-consecutive 24 hour recalls would be enough to assess the participants' dietary intakes. We took the first two recalls vs. all the four for our analysis. The results showed no statistically significant difference between the means for two versus four recalls in the total population, as well as amongst men and women separately. This suggests that two 24 HRs were enough for capturing EI, AS, and macronutrients' intakes in the study population. This finding is important from a methodological perspective because administering less recalls while getting similar results will make dietary data collection much easier, especially for larger populations and when working in the field. Even though our study showed that two recalls were enough to capture the participants' dietary intakes, some studies reported similar findings while others did not. The study conducted by Huang, Zhao, Fang, et al. agreed in that two non-consecutive recalls were enough to assess dietary intakes in large-scale nutritional surveys (Huang, Zhao, Fang, et al., 2022). However, another study concluded that three 24 HRs were the best (Ma et al., 2009), and one study even suggested that 8-32 recalls should be done for ≥ 80% reliability, with 8 recalls being suggested for accurate EI, 13 for fat intake, 21-25 for vegetable intake, and 21-32 for fruit intake (St George et al., 2016).

In our study, there was a significant positive correlation between EI and TEE, which means that individuals with higher caloric intake tend to have a higher TEE, and vice versa. This finding aligns with the basic principles of energy balance, where EI should generally match or be in balance with TEE for the weight maintenance recorded in our study (Hill, Wyatt, & Peters, 2013). However, it is important to note that while the correlation is statistically significant, it was only moderate in magnitude (0.37). Studies examining the correlation between EI and TEE show varying results. A study comparing recording of four 24 HRs across four days vs. seven showed that the four days had a correlation of 0.47 (moderate), and the seven a correlation of 0.74 (high correlation) (Andersen et al., 2006). Another study showed the correlation between TEE – EI to be 0.45 in a 7-day study of food recalls (Johansen, Myhre, Hjartåker, & Andersen, 2019). Despite our observed positive correlation, a statistically significant difference between EI and TEE was found in our study in several subgroups, especially females (-527.52 ± 641.52), individuals with a higher education (-402.2 ± 1094.83) and individuals with a higher BMI (-707.94 ± 1208.78), all indicating a negative energy balance. A study conducted on 240 random individuals showed that there was a positive energy balance among adults above 30 years old (220.5 ± 787.271), females (304.4 ± 921.041), and obese individuals (302.0 ± 1300.19) (Ayogu et al., 2022).

We investigated the factors that might be associated with the mismatch between EI and TEE in our study. Our results showed that there was a statistically significant difference between EI and TEE among individuals with high PA or low/ moderate PA, when CI was below or above 1, and among students or faculty/ staff. This shows that in our study population, PAL, CI, and occupation are not characteristics that explain this difference. In other words, regardless of the PAL, CI, or occupation, EI is going to be less than TEE when singling out these characteristics.

Our results importantly showed that EI was statistically significantly lower than TEE among 75.0% of women, 67.2% of individuals who have completed high school, and 71.9% of those with a high BMI. This suggests that these groups are expending more energy than they are consuming. However, at the beginning and the end of the study, all participants were weight-stable, meaning that if they actually were burning more calories than they were eating, they would be losing weight. The findings therefore suggest that there was under-reporting of food consumption among these groups when the 24 HRs were taken. Under-reporting of EI is actually a common problem in nutritional studies (Mirmiran, Esmaillzadeh, & Azizi, 2006). In fact, in large nutritional surveys, under-reporting occurs substantially, with prevalence rates varying between 18% and 54% for the overall sample, and in specific subgroups such as the ones represented in our study, the prevalence can even reach as high as 70% (Macdiarmid & Blundell, 1998). To elaborate, a cross-sectional study showed that 31% of subjects under-reported, with 40% being female versus 19% being male (Mirmiran et al., 2006). A study conducted on 58 women showed that less than 40% of the 24 HRs were ± 10% of the taken weighed food record, proving that women under-reported their EI (Alemayehu, Abebe, & Gibson, 2011). Women more than men tend to report their food intake in a way that they consider “socially desirable” by reporting foods that are considered fattening or unhealthy less frequently or in smaller quantities (such as fried foods or sweets) (Scagliusi, Polacow, Artioli, Benatti, & Lancha, 2003). While most studies showed that under-reporting is more common among people with lower educational level (Kye et al., 2014), (Zainuddin et al., 2019), others reported that subjects with a higher educational levels tend to under-report EI. A study evaluating under-reporting among Finnish adults showed that a high education level, along with high BMI and female gender, was a factor leading to under-reporting (Hirvonen, Männistö, Roos, & Pietinen, 1997). These findings are in line with our study’s results. This is most likely due to the fact that individuals who know what is less healthy also do not want to reflect a negative health image of themselves (Hirvonen et al., 1997). Another study showed that there was significant under-reporting among obese individuals, specifically those who expressed a desire to lose weight (Johansson, Solvoll, Bjorneboe, & Drevon, 1998).

In fact, our study showed that, after adjustment for confounders, the only factor that remained significantly associated with a mismatch between EI and TEE was high BMI, with 71.9% of people with high BMI under-reporting. In agreement with our results, self-reported EI was proven to be significantly lower than TEE measured by double labeled water (DLW) among obese individuals in a study conducted on 221 adults (Waterworth, Kerr, McManus, Costello, & Sandercock, 2022).

A. Limitations

The study's findings should be interpreted in light of the following limitations. The study was conducted over a period of four weeks. This may not be enough to show the variation of 24 HRs through seasons (many foods are seasonal), and a longer study period might reveal more nuanced insights into dietary habits. Also, 24 HRs require sufficient memory skills, and participants might have missed reporting something they ate the previous day, leading to recall bias (Ralph et al., 2011). Recall bias is when participants omit certain foods they consumed, or do not remember having eaten certain foods (Spencer, Brassey, & Mahtani, 2017). In our study, we used the multiple pass approach that includes five different steps and several probes to improve the quality of the recalls and help them remember all details of their previous day. Moreover, there may be errors in portion estimation. To facilitate portion estimation for participants, we used a 2D poster with visual representation of the actual portion sizes (Millen & Morgan, 1996). There also might have been some misreporting of PA. To assess for participants' PAL, the short form of the IPAQ was used. This questionnaire asks participants how long they sit, walk, and exercise a day (moderate or high-intensity exercise).

CHAPTER VI

CONCLUSION AND RECOMMENDATIONS

This study assessed EI among participants and uncovered a consistency in reporting across four 24 HRs. We observed that two 24 HRs were likely sufficient to estimate EI rather than four 24 HRs. Despite the significant positive correlation between EI and TEE, there was a significant difference between EI and TEE in the study sample, with BMI being the only factor that was significantly associated with the mismatch between EI and TEE after the adjustment for potential confounders.

To further develop these findings and to deal with them, a number of recommendations are put forward:

- Conduct a similar study but with a longer duration to further highlight the variations in dietary habits that might occur throughout different months/ periods/ seasons. For instance, there may be different eating habits during the month of Ramadan, or Lent season, or during summer vs. winter…
- Conduct studies with larger sample size
- Conduct a similar study on a more varied Lebanese population, not just AUB students or faculty/ staff to encompass the entire Lebanese population.
- Develop and update databases to include AS of foods to better analyze its intake. Having accurate numbers on the intake of AS will further highlight the alarming consumption numbers and thus highlight the importance of intervention.

APPENDIX A
SCREENING TOOL

Quantitative Estimation of Dietary Energy and Added Sugar Intakes: A Validation Study amongst Lebanese Adults:

Date:

Surname, first name:	ID:
Date of birth:	Gender:
Home address:	City / State:
e-mail address:	Phone:

	YES	NO
1. Are you pregnant or think you might be pregnant?	☐	☐
2. Are you currently breastfeeding?	☐	☐
3. Have you ever been diagnosed with a liver disease? If yes, please specify:	☐	☐
4. Have you ever been diagnosed with a kidney disease? If yes, please specify:	☐	☐
5. Have you ever been diagnosed with any form of cancer? If yes, please specify:	☐	☐

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YES NO

6. Are you taking any chronic disease medication? (For example, Insulin shot)

If yes, please specify:

YES NO

YES NO

7. In the past one month, have you lost or gained more than 5 kg?

YES NO

8. In the past one month, have you deliberately tried tolose or gain weight?

YES NO

9. Are you currently on a weight-loss diet?

10. In the past three months, have you made any changes to your food intake or food choices?

If yes, please specify:

APPENDIX B
SUGAR CONSUMPTION SCREENING TOOL

ID _ _ _ _ _ _ _

Sugar Intake Questionnaire

	How often did you eat or drink these food items in the past week? Mark one in each row.						
	Never or less than 1 per week	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4+ per day
Jams, jellies, sweet spreads							
Fruit drinks or flavoured teas							
Sports or energy drinks (such as Gatorade)							
Regular soft drinks (includes all kinds such as Coca Cola, Pepsi, 7UP, Fanta..)							
Added sugar to tea or coffee							
Sweets, including chocolates, candy bars, gummies, hard sweets (does not include cookies/biscuits)							
Doughnuts, pastries							
Cookies, brownies, pies and cakes							
Ice cream, sorbet, frozen yogurt							

Total Score: ……………………………

Confirmed Eligibility (Yes/NO): ……………………………

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APPENDIX C
DEMOGRAPHICS & HEALTH STATUS QUESTIONNAIRE

Quantitative Estimation of Dietary Energy and Added Sugar Intake: A Validation

Name: **Date of Birth:** **Gender:** **Area of Residence:**	**ID Number:**
Date:	

<u>Socioeconomic Characteristics:</u>

What is your highest achieved level of education?	□ No schooling □ Primary school □ Intermediate school □ Secondary school □ Technical diploma □ University degree □ I prefer not to answer
What is your current occupation?	
What is your income per family?	□ < 1,000,000 L.L. □ 1,000,000 - < 2,000,000 L.L. □ 2,000,000 - < 3,000,000 L.L. □ > 3,000,000 L.L. □ Other, specify: □ I don't know/Not sure □ I prefer not to answer
What is the total number of individuals living in your house? (Including relatives, family members, and housekeepers that live with you)	
How many rooms are there in your house? (Excluding kitchens, bathrooms, hallways, balconies, and garage)	
Crowding index (calculated as the ratio of the total number of individuals living in the house over the number of rooms in the house)	

 1

Health Status:

Do you have any specific health condition?	□ Yes; please specify: _______________________________ □ No
Are you taking any medication? (vitamins, minerals…)	□ Yes; please specify: _______________________________ □ No

Lifestyle:

Smoking history			
Cigarette	Do you currently smoke cigarettes?	□ Yes □ No	If yes, how many cigarettes/day? _______________ Since when? _______________
	If no, are you a previous cigarette smoker?	□ Yes □ No	If yes, how many cigarettes/day did you use to smoke? _______________ If yes, when did you stop? _______________
Narghileh	Do you currently smoke narghileh?	□ Yes □ No	If yes, how many narghileh/day? _______________ Since when? _______________
	If no, are you a previous narghileh smoker?	□ Yes □ No	If yes, when did you stop? _______________
Alcohol			
Did you drink any alcohol in the past year?		□ Yes □ No	
If yes, do you currently drink alcohol?		□ Yes □ No	
		If yes, Since when? _______	

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	How many bottle/can of beer per week? ______________ How many glass of wine per week? __________________ How many drink of hard liquor (whiskey, Arak, vodka…) per week? _____________ In the past month, what is the largest number of drinks you had in one occasion?____________ drinks	
If no, are you a previous drinker?	□ Yes □ No	If yes, when did you stop? ______________
Coffee		
Do you currently drink coffee?	□ Yes □ No If yes how many cups/day?______________	

 3

APPENDIX D
IPAQ SHORT FORM

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

SHORT LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised August 2002.

APPENDIX E
ADDED SUGAR CONTENT OF FOODS

Food Name	Added Sugar (100g)	Source/Explanation
7 UP Soda, Diet	0	USDA
A-cup coffee and cream	3.58	Nutrition Label
Alcoholic Beverage, Distilled, 80 Proof (Gin, Rum, Vodka, Whiskey)	0	USDA
Almonds, Dry Roasted, Salted	0	USDA
Almonds, Whole	0	USDA
AMORETTI FLAVORS Premium Syrups, Mojito Mint	66.848	USDA
Apple, Custard (Bullock's Heart or Cherimoya)	0	Nutrition Label https://www.fooducate.com/product/Custard-apple-bullock-s-heart-raw/02958B78-1FA1-11E3-A74D-1E047F0525AB
Apple, Medium	0	USDA
Apricots	0	USDA
Apricots, Dried, Halves, Sulfured	0	Louie et al: dried fruit, 0g added sugar (Step 2, 5)
ARBY'S USA Dessert, Molten Lava Cake, Chocolate	20	USDA
Arugula	0	USDA
Asparagus, Canned	0	USDA
ATLANTA BREAD Croissant, Almond	10	USDA
AUB akras kebbeh mekliyeh - with corn oil	0	USDA
AUB akras kebbeh mekliyeh - with sunflower oil	0	USDA
AUB arak alcoholic beverage	0	USDA
AUB Atr / Ater (sugar syrup)	67.02	USDA
AUB Baklawa	40.99	USDA
AUB Bamieh Bi Lahmeh (okra with meat) - with palm oil	0	USDA
AUB Bamieh Bi Lahmeh (okra without meat) - olive oil	0	USDA
AUB Barazek - Sesame Cookies	0	USDA
AUB Batata bil saniyeh, with beef (souflee) - corn oil	0	USDA

AUB Batata bil saniyeh, with beef (souflee) - olive oil	0	USDA
AUB Batata bil saniyeh, with lamb (souflee) - sunflower oil	0	USDA
AUB batata harra bel kezbara - with corn oil	0	USDA
AUB batata harra bel kezbara - with olive oil	0	USDA
AUB batata harra bel kezbara - with sunflower oil	0	USDA
AUB batinjan bi tehini (baba ghannouj)	0	USDA
AUB Batinjan mehshi with meat - with olive oil	0	USDA
AUB Batinjan Moutabbal - Raheb (eggplant without tahini)	0	USDA
AUB Biscuit au chocolat (lazy cake)	15.75	USDA
AUB Bourghoul bi banadoura - with corn oil	0	USDA
AUB Bourghoul bi banadoura - with olive oil	0	USDA
AUB Bourghoul bi banadoura - with sunflower oil	0	USDA
AUB Bread, baladeh, markouk	1.43	USDA
AUB Bread, Pita, fried	0.85	USDA
AUB Bread, Tannour	0	USDA
AUB Brioche	1.05	USDA
AUB Cauliflower, batter-dipped, fried	0	USDA
AUB Cheese - Double Creme	0	USDA
AUB Cheese manaeesh (mankouche)	0	USDA
AUB Cheese manaeesh (mankouche) - homemade with sunflower oil	0	USDA
AUB Cheese man'ouche saj	0	USDA
AUB Cheese, Akkawi	0	USDA
AUB Cheese, Baladi	0	USDA
AUB Cheese, Halloumi	0	USDA
AUB Cheese, Kashkawen	0	USDA
AUB Cheese, Picon	0	USDA

AUB Cheese, Smeds	0	USDA
AUB chicken curry (with creme fraiche, carrots, green peas, and mushroom) - olive oil	0	USDA
AUB chicken curry (without creme fraiche, with herbs)	0	USDA
AUB chicken fahita	0	USDA
AUB chicken strogonoff - with sunflower oil	0	USDA
AUB Coffee, Turkish, Black unsweetened	0	USDA
AUB cooked yogurt (laban matboukh)	0	USDA
AUB Djej w batata bel saniyeh (chicken and potato)	0	USDA
AUB Eggplant, batter-dipped, fried	0	USDA
AUB Falafel	0	USDA
AUB Falafel - with corn oil	0	USDA
AUB Falafel - with sunflower oil	0	USDA
AUB Fassoulia 3arida moutabbal	0	USDA
AUB Fassoulia bayda moutabbal - with sunflower oil	0	USDA
AUB Fassoulia with Meat (kidney beans) - (lamb meat) sunflower oil	0	USDA
AUB Fassoulia with Meat (kidney beans) - canola oil	0	USDA
AUB Fassoulia with Meat (kidney beans) - corn oil	0	USDA
AUB Fassoulia with Meat (kidney beans) - sunflower oil	0	USDA
AUB Fassoulia with Meat (kidney beans) - without oil	0	USDA
AUB fassoulia without meat (kidney beans) - corn oil	0	USDA
AUB fassoulia without meat (kidney beans) - sunflower oil	0	USDA
AUB Fatayer Bi Sbanegh	1.12	USDA
AUB Fatayer Bi Sbanegh - olive oil only	0	USDA
AUB fatayer koussa	1.12	USDA
AUB fatayer potato	0.23	USDA

AUB Fattet Hommos Bil Laban (no bread) - with olive oil	0	USDA
AUB Fattet Hommos Bil Laban (with bread) - sunflower oil	0	USDA
AUB Fattet Hommos Bil Laban with meat (no bread) - with corn oil	0	USDA
AUB Fattoush	0	USDA
AUB Fattoush - with corn oil	0	USDA
AUB Fattoush - with olive oil	0	USDA
AUB Fattoush without bread - olive oil	0	USDA
AUB Fish, Herring, grilled	0	USDA
AUB Foul Moudammas (no oil)	0	USDA
AUB Foul Moudammas (with olive oil)	0	USDA
AUB Foul Moudammas (with sunflower oil)	0	USDA
aub freekeh without meat - with corn oil	0	USDA
aub freekeh without meat - with sunflower oil	0	USDA
AUB fruit salad (without juice)	0	USDA
AUB Garlic sauce	0	USDA
AUB gratin (pasta with bechamel sauce - without chicken)	0	USDA
AUB gratin (pasta with bechamel sauce and chicken)	0	USDA
AUB gratin (pasta with bechamel sauce and chicken) - with olive oil, no butter	0	USDA
AUB grilled Kabab	0	USDA
AUB guacamole sauce (avocado sauce)	0	Louie et al
AUB Halawah Tehineh	19.84	USDA
AUB Halawit el jibn	19.84	USDA
AUB Hindbeh mkala - chicory in corn oil	0	USDA
AUB Hindbeh mkala - chicory in olive oil	0	USDA
AUB Hindbeh mkala - chicory in sunflower oil	0	USDA
AUB hommos baleela	0	USDA

AUB Hommos Bi Tehini	0	USDA
AUB Hreese with beef	0	Louie et al
AUB Hreese with chicken	0	Louie et al
AUB Jallab (without Pine nuts)	13	Website https://www.mynetdiary.com/food/calories-in-jallab-drink-by-x-tra-ml-24867724-0.html
AUB Jordina Chocolate cake	20	USDA
AUB kaak (finger or round)	1.03	USDA
AUB kaak abou arab - knefe	0	USDA
AUB kaak abou arab/ knefe	0	USDA
AUB kaak bi debs wih sesame (grape molasses sticks)	1.03	USDA
AUB kaak bi zaatar - thyme	0	USDA
AUB kaak mdawar	0	USDA
AUB kaak mehshi tamer / fingers with dates	1.03	USDA
AUB Kafta cow	0	USDA
AUB Kafta lamb	0	USDA
AUB kafta with potato bil sayniyyeh - with canola oil	0	USDA
AUB Kashta	4.67	USDA
AUB katayef bel joz (walnuts)	35.11	USDA
AUB katayef bi kashta	39.18	NutriPro: total sugar - lactose = 13.321 - 0
AUB Kebbeh bi laban	0	USDA
AUB Kebbeh Bi Sanieh	0	USDA
AUB Kebbeh Bi Sanieh - with corn oil	0	USDA
AUB Kebbeh Bi Sanieh - with olive oil	0	USDA
AUB Kebbeh Bi Sanieh - with sunflower oil	0	USDA
AUB Kebbi nayyeh	0	USDA
AUB Keshk / Kishk	0	USDA
AUB Keshk / kishk manaeesh (mankouche)	0	USDA
AUB knefeh bil jibn (without atr)	0	USDA
AUB Koussa Mehchi with meat and tomato - with olive oil	0	USDA
AUB Koussa Mehchi with meat and tomato - with sunflower oil	0	USDA
AUB koussa mehshi with laban	0	USDA

AUB laban ayran - yogurt (full fat)	0	USDA
AUB Labneh (cow)	0	USDA
AUB Lahem bi 3ajine	0	USDA
AUB Lasagna with meat	0	USDA
AUB lasagna without meat	0	USDA
AUB Layali Lebnan	35.69	USDA
AUB Loubieh Bil Lahme - lamb meat and sunflower oil	0	USDA
AUB Loubieh Bil Lahme - sunflower oil	0	USDA
AUB Loubieh bil Zeit - with olive oil	0	USDA
AUB Loubieh bil Zeit - with sunflower oil	0	USDA
AUB Maamoul bel festok (with pistachios)	14.81	USDA
AUB Maamoul bil tamer (dates)	8.8355	USDA
AUB macaroni gratin (without chicken)	0	USDA
AUB Macaroons	29.5	USDA
AUB mafroukeh bi kashta	0	USDA
AUB Makdous - eggplant pickles	0	USDA
AUB Makdous - eggplant pickles - with olive oil	0	USDA
AUB makloubet batenjen (with lamb) - sunflower oil	0	USDA
AUB meat fahita	0	Louie et al: mixed meat dish with no added sugar (Step 2, j)
AUB minced meat / lahme mafroumi mkaleye	0	USDA
AUB minced meat / lahme mafroumi mkaleye - with olive oil	0	USDA
AUB minced meat / lahme mafroumi mkaleye - with sunflower oil	0	USDA
AUB mjadara (with bulgur) - with corn oil	0	USDA
AUB mjadara (with bulgur) - with sunflower oil	0	USDA
AUB Mjadara Sawda - with corn oil	0	USDA

AUB Mjadara Sawda - with olive oil	0	USDA
AUB Mjadara Sawda - with sunflower oil	0	USDA
AUB mjaddara safra - with olive oil	0	USDA
AUB Mloukhiye (Jew's mallow with chicken and beef) - with corn oil	0	USDA
AUB Mloukhiye (Jew's mallow with chicken and beef) - with margarine	0	USDA
AUB Mloukhiye (Jew's mallow with chicken and beef) - with sunflower oil	0	USDA
AUB Mloukhiye bel zeit (jew's mallow without chicken and beef) - with olive oil	0	USDA
AUB Moghrabiyeh (chicken) - corn oil	0	USDA
AUB Moghrabiyeh (chicken) - olive oil	0	USDA
AUB Moghrabiyeh (chicken) - sunflower oil	0	USDA
AUB Mousakaa - olive oil only	0	USDA
AUB Nammoura	22.6	USDA
AUB Nescafe (2 in 1)	0	USDA
AUB Nescafe (3 in 1)	8.5	USDA
AUB Nescafe (cappuccino)	1.21	USDA
AUB pasta with yogurt and garlic sauce	0	USDA
AUB Pizza - Margherita	1.54	USDA
AUB Pizza (Regular)	1.54	USDA
AUB Pizza Pepperoni	0.94	USDA
AUB Pizza Pepperoni - olive oil	0.94	USDA
AUB Pizza Pepperoni - sunflower oil	1.11	USDA
AUB pizza vegetarian	1.11	USDA
AUB pizza vegetarian - sunflower oil	1.11	USDA
AUB Rice pudding (riz bi halib)	4.46	USDA
AUB rice with chicken - with corn oil	0	USDA

AUB rice with chicken - with olive oil	0	USDA
AUB rice with chicken - with sunflower oil	0	USDA
AUB rice with meat with nuts - (lamb meat) with sunflower oil	0	USDA
AUB rice with meat without nuts - with corn oil	0	USDA
AUB rice with meat without nuts - with sunflower oil	0	USDA
AUB Rice with vermicelli - with margarine	0	USDA
AUB Rice with vermicelli - with palm oil	0	USDA
AUB Rice with vermicelli (with canola oil)	0	USDA
AUB Rice with vermicelli (with corn oil)	0	USDA
AUB Rice with vermicelli (with olive oil)	0	USDA
AUB Rice with vermicelli (with sunflower oil)	0	USDA
AUB Rice with vermicelli (without oil)	0	USDA
AUB riz bel curry (rice with curry) - sunflower oil	0	USDA
AUB rkakat cheese	0.21	USDA
AUB Salad (cucumber + tomatoes)	0	USDA
AUB Salad cabbage (garlic + lemon juice)	0	USDA
AUB Salad Coleslaw (with mayonnaise)	3.77	USDA
AUB Salad Coleslaw (with mayonnaise) - corn oil	3.77	USDA
AUB Salad Coleslaw (with mayonnaise) - olive oil	3.77	USDA
AUB Salad Coleslaw (with mayonnaise) - without oil	3.77	USDA
AUB Salad lettuce	0	USDA
AUB salad rocket and green thyme	0	USDA
AUB Salad season (Lettuce, tomatoes) - with olive oil	0	USDA

AUB Salad season (Lettuce, tomatoes) - with vinegar and mustard	0	USDA
AUB Salad season (Lettuce, tomatoes, cucumber) - with olive oil	0	USDA
AUB Salad season (Lettuce, tomatoes, cucumber) - with sunflower oil	0	USDA
AUB Salad season (Tomatoes, cucumber) - with olive oil	0	USDA
AUB Sambousek Bil Jibn (cheese) - sunflower oil	0.999	USDA
AUB Sambousik bi lahme (meat)	0.47	USDA
AUB sandwich falafel	0.73	USDA
AUB Sandwish Chicken shawarma	0.6585	USDA
AUB sayniyyet khodra (vegetable stew) no meat - olive oil	0	USDA
AUB Sfiha Bi lahem and Snoubar	0.78	USDA
AUB Sfiha Bi lahem and Snoubar - sunflower oil	0	USDA
AUB Sfouf	23.57	USDA
AUB Shawarma Chicken	0.211	USDA
AUB Shawarma meat	0	USDA
AUB Shawarma meat (homemade)	0	USDA
AUB Sheikh al mehshi (batinjan) - lamb meat and olive oil	0	USDA
AUB shish barak (with cooked yogurt, no rice) - with olive oil	0	USDA
AUB shish barak (without cooked yogurt, no rice) - with olive oil	0	USDA
AUB shish taouk (chicken)	0	USDA
AUB soup adas aswad - with corn oil	0	USDA
AUB soup adas aswad - with sunflower oil	0	USDA
AUB Soup Adas bi hamod	0	USDA
AUB Soup Adas bi hamod - with sunflower oil	0	USDA
AUB Soup Vegetables - olive oil	0	USDA
AUB Spaghetti whole wheat with tomato sauce - with sunflower oil	0.4	USDA

AUB Spaghetti with tomato sauce (with olive oil)	0.4	USDA
AUB Spaghetti with tomato sauce (with sunflower oil)	0.4	USDA
AUB Spaghetti with tomato sauce and ground beef - with canola oil	0.8	USDA
AUB Spaghetti with tomato sauce and ground beef - with corn oil	0.8	USDA
AUB Spaghetti with tomato sauce and ground beef - with sunflower oil	0.8	USDA
AUB Stuffed Chard beet leaves (warak selek with lamb meat)	0	USDA
AUB Tabbouleh	0	USDA
AUB Tabbouleh (no bulgur)	0	USDA
AUB Tabbouleh (without tomatoes)	0	USDA
AUB Tarator	0	USDA
AUB tarte aux fraises	14.52	USDA
AUB Vine leaves, stuffed with meat (warak enab) - corn oil	0	USDA
AUB Vine leaves, stuffed with meat (warak enab) - olive oil	0	USDA
AUB Vine leaves, stuffed with meat (warak enab) - sunflower oil	0	USDA
AUB Warak Enab (Bi Zeit) - corn oil	0	USDA
AUB Warak Enab (Bi Zeit) - olive oil	0	USDA
AUB Warak Enab (Bi Zeit) - sunflower oil	0	USDA
AUB Warak malfouf mehshi bil lahem (cabbage mehshi with meat) - with canola oil	0	USDA
AUB Warak malfouf mehshi bil lahem (cabbage mehshi with meat) - with corn oil	0	USDA
AUB Warak malfouf mehshi bil lahem (cabbage mehshi with meat) - with sunflower oil	0	USDA
AUB yakhnet batata with lamb (potato) - with olive oil	0	USDA
AUB yakhnet batata with meat (potato) - with sunflower oil	0	USDA
AUB yakhnet batata without meat (potato) - composite vegetable oil	0	USDA

AUB yakhnet batata without meat (potato) - olive oil	0	USDA
AUB yakhnet sabanekh with meat (spinach)	0	USDA
AUB yakhnet sabanekh with meat (spinach) - with sunflower oil	0	USDA
AUB Zaatar manaeesh (mankouche)	0.376	USDA
AUB Zaatar man'ouche saj	1.94	USDA
AUB zaatar w zeit mix	0	USDA
AUB Zlabye	75	Website https://www.myfitnesspal.com/food/calories/zalabia-2281130957
AUB Zucchini, fried	0	USDA
AUB_Beef strogonoff	0	USDA
AUB_Beef strogonoff - with olive oil	0	USDA
AUB_Bread, Pita	0.65	USDA
AUB_Bread, Pita, Wholewheat	0.41	USDA
AUB_digestive biscuit (original)	16.024	USDA
AUB_Foret Noire	22.6	USDA
AUB_fruit salad/cocktail (with juice)	0	USDA
AUB_green almond	0	USDA
AUB_kinder chocolate	53	USDA
AUB_lotus biscuit	38.1	USDA
AUB_loubieh bel zeit	0	USDA
AUB_Makdous, pickled eggplant with walnut	0	USDA
AUB_makloubet batenjen (with chicken) - with sunflower oil	0	USDA
AUB_mdardara (with bulgur) - canola oil	0	USDA
AUB_mdardara (with rice)	0	USDA
AUB_mdardara (with rice) - with canola oil	0	USDA
AUB_mdardara (with rice) - with corn oil	0	USDA
AUB_mughli (meghli) without nuts	14.73	USDA
AUB_Osmallyeh	35.69	USDA
AUB_rashta - sunflower oil	0	USDA

Avocado	0	USDA
Avocado, California	0	USDA
Avocado, Pureed	0	USDA
Banana	0	USDA
Beans, Chickpeas, Garbanzo or Bengal Gram, Boiled	0	USDA
Beans, Kidney, Boiled	0	USDA
Beef, Chuck For Stew, All Grades, Separable Lean and Fat, Braised	0	USDA
Beef, Ground, 80% Lean Meat / 20% Fat, Patty, Broiled	0	USDA
Beef, Ground, 80% Lean Meat / 20% Fat, Patty, Pan-Broiled	0	USDA
Beef, Liver, Raw	0	USDA
Beef, Loin, Top Sirloin Filet, Boneless, Separable Lean Only, Trimmed to 0" Fat, All Grades, Grilled	0	USDA
Beef, Shoulder Pot Roast, Boneless, All Grades, Separable Lean and Fat, 0" Fat, Cooked, Braised	0	USDA
Beef, Top Loin, Separable Lean and Fat, 1/4" Fat, Raw	0	USDA
Beef, Top Sirloin, Choice, Separable Lean, 1/4" Fat, Pan Fried	0	USDA
Beer	0	USDA
Beetroot, Boiled In Salted Water	0	Louie et al: veggie (Step 2, f)
Berries, Goji, dried	0	Louie et al: fruit (Step 2, f)
Beverage, Alcoholic, Wine, Rose	0	USDA
Beverages, Juice Drink, Kiwi Strawberry	10.24	USDA
Beverages, Protein Powder, Whey Based	0	Louie et al: 0g added sugar (Step 1)
Biscuit, Plain, Ready to Eat	2.48	USDA
BN Chocolate Biscuits	29.6	Nutrition Label https://www.sainsburys.co.uk/gol-ui/product/mcvities-/mcvities-bn-chocolate-flavour-biscuits-285g
BOCA BURGER Burger Patty, Savory Mushroom Mozzarella, Meatless	0	USDA
Bread, French	4.62	USDA

Bread, French or Vienna, whole wheat	4.62	USDA
Bread, French, Whole Wheat	3.84	USDA
Bread, Oat Bran	7.7	USDA
Bread, Sourdough	1	https://www.fooducate.com/product/Sourdough-Bread/1962F06C-1FA0-11E3-A74D-1E047F0525AB
Bread, Wheat, Toasted	6.42	USDA
Bread, White	5.67	USDA
Bread, White, Made with 2% Milk	3.6	USDA
Bread, White, Toasted	6.2	USDA
Bread, Whole Wheat	3.84	USDA
Breakfast Sandwich, Croissant with Cheese and Ham	10	USDA
BREYERS Ice Cream, Chocolate Caramel, No Sugar Added	25.36	USDA
Broccoli, Chopped, Boiled, Drained	0	USDA
Broth Cube, Beef	0	Louie et al: 0g added sugar
Broth Cube, Chicken	0	Louie et al: 0g added sugar
Brownie, Fast Food	36.61	USDA
BRUSTERS Sorbet, Strawberry	49.5	USDA
Bubble Milk Tea	30	NutriPro: 50% AS --> 60/2=30
BURGER KING French Fries, Small, Salted	0	Louie et al
BURGER KING Hamburger	2.98	USDA
BURGER KING OREO Milkshake, 12 fl oz	12.75	NutriPro: 50% AS --> 25.5/2=12.75
Butter, Salted	0.06	USDA
Cabbage, Boiled, Drained, without Salt Added	0	USDA
Cabbage, Shredded	0	USDA
Cake Roll, Chocolate with Chocolate Ice Cream	28.5	USDA
Cake, Almond Slice (Mr Kipling And Other Brands)	30	Nutrition Label https://www.mrkipling.co.uk/our-ranges/favourites/almond-slices
Cake, Cheesecake, Ready to Eat	10.9	NutriPro: 50% AS --> 21.8/2=10.9
Cake, Chocolate with Frosting, Ready to Eat	39.5	USDA
Cake, Coffeecake with Crumb Topping, Cinnamon, Ready to Eat	32.09	USDA

Cake, Fruitcake, Ready to Eat	27.42	USDA
Cake, Sponge, Ready to Eat	36.07	USDA
Cake, Yellow with Vanilla Frosting, Ready to Eat	38.63	USDA
Candy Bar, Milk Chocolate, with Almonds	43.9	USDA
Candy Bar, Milk Chocolate, with Rice Cereal	44.61	USDA
Candy or Candies, Butterscotch	63.47	USDA
Candy or Candies, Dark Chocolate	44.64	USDA
Candy or Candies, Hard	62.9	USDA
Candy or Candies, Milk Chocolate	51.5	USDA
Cantaloupe	0	USDA
CARAMELLO Candy Bar	56.43	USDA
Carrot Cake (With Topping)	27.42	USDA
Carrots	0	USDA
Carrots, Canned	0	USDA
Carrots, Sliced, Boiled, Drained	0	USDA
Cashews, Dry Roasted	0	USDA
Cashews, Dry Roasted, with Salt Added	0	USDA
Cashews, Raw	0	USDA
Cassava or Manioc	0	USDA
Cauliflower, Boiled, Drained	0	USDA
Cereal, Corn Flakes	6.5	USDA
Cereal, Puffed Corn, Chocolate Flavored, Frosted	43.7	USDA
Cereal, Puffed Rice, Presweetened, Fruit Flavored	44	Website https://www.fatsecret.com/calories-nutrition/usda/puffed-rice-cereal-fruit-flavored-(presweetened)?portionid=58085&portionamount=50.000
Cereal, Wheat and Bran, Presweetened with Nuts and Fruits	14	USDA
Cereal, Whole Wheat, Rolled Oats Presweetened with Nuts and Fruit	24.6	Nutrition Label https://www.fatsecret.com.au/calories-nutrition/generic/whole-wheat-and-rolled-oats-with-nuts-and-fruit-cereal-(presweetened)?portionid=63372&portionamount=100.000
Cheese, American, Processed	0	USDA
Cheese, American, Spread, Processed	0	USDA
Cheese, Blue	0	Louie et al: non-sweetened dairy (Step 2, n)

Cheese, Brie	0	Louie et al: non-sweetened dairy (Step 2, n)
Cheese, Cheddar, Diced	0	USDA
Cheese, Edam	0	Louie et al: non-sweetened dairy (Step 2, n)
Cheese, Feta	0	USDA
Cheese, Gouda	0	Louie et al: non-sweetened dairy (Step 2, n)
Cheese, Mozzarella, Whole Milk	0	USDA
Cheese, Parmesan, Grated	0	USDA
Cherries, Sweet	0	USDA
CHESTER'S Popcorn, Cheddar	0	Louie et al: seeds (Step 2, o)
Chewing Gum Sugar Free	0	USDA
Chewing Gum, Stick	66.08	USDA
Chicken Burger, Takeaway	0	USDA
Chicken Patty, Fillet or Tenders, Breaded, Cooked	0	USDA
Chicken Patty, Frozen, Cooked	0	USDA
Chicken, Breast, Meat and Skin, Boneless, Roasted	0	USDA
Chicken, Breast, Meat Only, Boneless, Skinless, Roasted	0	USDA
Chicken, Drumstick, Meat Only, Roasted	0	USDA
Chicken, Light Meat and Skin, Breaded, Fried	0	USDA
Chicken, Light Meat, Meat and Skin, Roasted	0	USDA
Chicken, Liver, Pan-Fried	0	USDA
Chicken, Liver, Raw	0	USDA
Chicken, Thigh, Meat and Skin, Roasted	0	USDA
Chicken, Thigh, Meat Only, Fried	0	USDA
Chicken, Thigh, Meat Only, Roasted	0	USDA
Chicken, Wing, Meat and Skin, Batter Coated, Fried	0	USDA
Chicken, Wing, Meat Only, Fried	0	USDA
Chicken, Wing, Meat Only, Roasted	0	USDA
Chips, Potato, Barbecue	5.141	USDA
Chips, Potato, Cheese Flavored	5.14	USDA

Chips, Potato, Salted	0	USDA
Chocolate, Drinking (Cadbury's Highlights Instant Hot Chocolate/Options)	25	Nutrition Label https://groceries.asda.com/product/hot-chocolate/cadbury-highlights-instant-hot-chocolate-sachet/910000906302
Cocoa, Unsweetened, Mix	1.75	USDA
Coconut, Shredded	0	USDA
Coffee, Espresso, Restaurant Prepared	0	USDA
Coffee, Instant, Decaffeinated, Powder	0	USDA
Coffee, Instant, Powder	0	USDA
Coffee, Instant, Prepared	0	USDA
Coffee, Latte, Prepared with Whole Milk	0	USDA
COFFEEMATE Non Dairy Creamer, French Vanilla, Sugar Free, Liquid	0	Nutrition Label https://www.fooducate.com/product/Nestle-Original-Coffeemate/50032E26-4568-11E0-A55F-1231380C180E
COFFEEMATE Non Dairy Creamer, Original, Powder	0	Nutrition Label https://www.fooducate.com/product/Nestle-Original-Coffeemate/50032E26-4568-11E0-A55F-1231380C180E
COLD STONE CREAMERY Ice Cream, Chocolate Hazelnut	25.36	USDA
COLD STONE CREAMERY Ice Cream, OREO Creme	25.36	USDA
COLD STONE CREAMERY Ice Cream, Pistachio	25.36	USDA
COLD STONE CREAMERY Sorbet, Lemon	23.79	USDA
COLD STONE CREAMERY Sorbet, Raspberry	23.79	USDA
COLD STONE CREAMERY Sorbet, Strawberry Mango Banana	23.79	USDA
Coleslaw, Fast Food	4.2	USDA
Composite-Doughnut or Sweet Roll	16.833	USDA
Composite-Juice, Apple/Pineapple/Grape/Cranberry	12.52	USDA
Composite-Juice, Orange/Grapefruit	8.226	USDA
Composite-Muffins	16.5	USDA
Composite-Potato/Corn/Tortilla Chips	0.78	USDA
Composite-Pudding or Custard	11.09	USDA
Composite-Vegetable Oil	0	USDA

Cookie, Chocolate Biscuit (Biskut Coklat)	44.25	USDA
Cookie, Chocolate Chip, Fast Food	23.2	USDA
Cookie, Coconut Biscuit (Biskut Kelapa)	44.25	USDA
Cookie, Sandwich, Chocolate Coated, with Chocolate Crème Filling	49.58	USDA
Cookie, Sandwich, Chocolate, with Creme Filling	40.67	USDA
Cookie, Sandwich, Vanilla, with Crème Filling	40.67	USDA
Cookie, Sugar, Ready to Eat	27.31	USDA
Cookie, Wafer, Chocolate	36.83	USDA
Cookie, Wafer, Vanilla	36.9	USDA
Cookies, Sugar Wafer, Chocolate-Covered	51.121	USDA
Corn, Yellow, Canned, Cooked with Fat	0	USDA
Corn, Yellow, Sweet, Whole Kernel, Canned, Drained	0	USDA
Crab Meat, Imitation	0	USDA
Crackers, Cheese	0.88	USDA
Crackers, Graham, Plain	24.86	USDA
Crackers, Rice Cake	0.88	USDA
Crackers, Saltine	1.29	USDA
Cranberries, Chopped	0	USDA
Cream Cheese	0	USDA
Cream, Whipping, Heavy, Whipped	0	USDA
Creme fraiche 38 % (Cream, Cultured, 38 % Fat)	0	USDA
Croissant, Butter	10	USDA
Croissant, Cheese	10	USDA
Croissant, Chocolate	18	USDA
Cucumber	0	USDA
Cucumber Pickled	0	USDA
Curry Sauce, Canned	0	Louie et al: 0g added sugar (Ste 2, b)
DANNON Activia, Yogurt, Peach, Low Fat	1.89	Nutrition Label https://www.fooducate.com/product/Dannon-Activia-Yogurt-Non-fat-Peach/A9A932E4-A179-11E2-9B11-1231381A4CEA

Dates, Medjool	0	USDA
Doughnut, Cake, Chocolate Coated	31.13	Website https://www.carbmanager.com/food-detail/nl:46fda754c7f090ce2332a68aff45d6b4/doughnut-raised-or-yeast-chocolate-covered
Doughnut, Glazed	16.833	USDA
Doughnut, with Crème Filling	16.833	USDA
Doughnut, with Jelly Filling	21.176	Website https://www.nutritionix.com/food/jelly-doughnut
Dried Mixed Fruit	0	USDA
Drink Mix, Orange Flavor, Prepared with Water	11.8	USDA
Drink, Fruit Flavored, Unsweetened, Dry Mix	0	USDA
Drink, Fruit Flavored, with Aspartame, Low Calorie, Dry Mix	0	USDA
Drink, Lemonade, Aspartame Sweetened, Low Calorie, Mix, Prepared with Water	0	Louie et al (Step 2, g)
Drink, Lemonade, Prepared from Frozen Concentrate	9.98	USDA
Drink, Orange Flavored, Mix	92.3	USDA
Drink, Pineapple and Orange Juice, Canned	11.8	USDA
Drink, Strawberry Flavor, Mix	6	USDA
DUNKIN' DONUTS Donut, Boston Kreme	17	Website https://www.mynetdiary.com/food/calories-in-boston-kreme-donut-by-dunkin-donuts-donut-25015814-0.html
DUNKIN' DONUTS Hot Chocolate, Small	5.04	USDA
Eclair, Custard Filled with Chocolate Glaze, Prepared	6.6	USDA
EDO JAPAN Maki Sushi, Avocado Roll	3.88	Website https://www.myfooddiary.com/foods/7277806/edo-japan-sushi-maki-avocado-roll
EDO JAPAN Maki Sushi, California Roll	2.94	Nutrition Label https://www.fooducate.com/product/Moji-Sushi-Roll-California-Classic/5C8455A0-A0B0-A5D7-4482-AFC0F94F592F
EDO JAPAN Maki Sushi, Salmon Roll	3.57	Website https://www.myfooddiary.com/foods/7277808/edo-japan-sushi-maki-salmon-roll
EDO JAPAN Maki Sushi, Shrimp Roll	2.38	Website https://www.myfooddiary.com/foods/7277809/edo-japan-sushi-maki-shrimp-roll
EDO JAPAN Maki Sushi, Tuna Roll	3.57	Website https://www.myfooddiary.com/foods/7277813/edo-japan-sushi-maki-tuna-roll
Eggplant, Boiled, Drained	0	USDA
Eggs, Fried	0	USDA
Eggs, Hard Boiled	0	USDA
Figs	0	USDA

Figs, Dried	0	USDA
Fish Fillet, Batter Coated or Breaded, Fried	0	USDA
FISHER Peanuts, Honey Roasted	0	USDA
French Fries, Fried in Vegetable Oil, Fast Food	0	USDA
French Macaron	29.5	USDA
Frozen Yogurt	20.35	USDA
Frozen Yogurt, Flavors Other Than Chocolate	20.35	USDA
Garlic Clove	0	USDA
Gelatin Dessert, Mix, Prepared with Water	13.49	USDA
GENERAL MILLS Frosted Corn Flakes Cereal	25	Nutrition Label https://www.generalmillscf.com/products/category/cereal/single-serve/bowlpak/frosted-corn-flakes
Granola Bar, Soft, Chocolate Chip, Milk Chocolate Coated	29.17	Nutrition Label https://www.quakeroats.com/products/oat-snacks/chewy-granola/chocolate-chip
Grapefruit, Pink or Red	0	USDA
Grapes, Red or Green	0	USDA
Green Beans, Boiled, Drained	0	USDA
Guayakí Yerba Mate Tea Drink, Traditional, Organic	0	Louie et al
Gullon Oat Biscuits	0	Nutrition Label https://www.mynetdiary.com/food/calories-in-oaty-biscuits-by-gullon-biscuit-19204525-0.html
Ham, 11% Fat, Sliced	0	USDA
Hazelnuts	0	USDA
HERSHEY'S Syrup, Chocolate	49.65	USDA
Honey	0	USDA
Hot Cereal, Whole Wheat, Cooked with Water	0	USDA
Hot Chocolate, Mix, Powder, Prepared with 2% Milk	25	Nutrition Label https://groceries.asda.com/product/hot-chocolate/cadbury-highlights-instant-hot-chocolate-sachet/910000906302
Hot Chocolate, Powder	0	USDA
Hot Dog Weiner or Frankfurter, Beef	0	USDA
Hot Dog Weiner or Frankfurter, Chicken	0	USDA
Ice Cream Cone, Sugar	25.66	USDA
Ice Cream, Bar or Stick, Chocolate Covered	18.3	USDA
Ice Cream, Chocolate	25.36	USDA

Ice Cream, Vanilla	16.97	USDA
Ice Cream, Vanilla, Rich	17.27	USDA
Jam or Preserves	46.4	USDA
Jam or Preserves, Apricot	46.4	USDA
Jellabi, Homemade	13	Website https://www.mynetdiary.com/food/calories-in-jallab-drink-by-x-tra-ml-24867724-0.html
Juice, Grapefruit, Pink	8.226	USDA
Juice, Lemon	11.33	USDA
Juice, Orange	8.226	USDA
Jujube	0	USDA
KA Sparkling Strawberry Soda	0	USDA
Kale	0	USDA
KELLOGG'S RICE KRISPIES Cereal	14	USDA
KELLOGG'S SPECIAL K Cereal, Multigrain, Oats & Honey	14	USDA
KELLOGG'S UK Cereal, Honey Loops	18.75	USDA
Ketchup or Tomato Catsup	18	USDA
KETTLE Chips, Organic, Potato, Sea Salt & Black Pepper	2	Nutrition label: 3g total - 1g (natural)
KETTLE Chips, Potato, Honey Dijon	1.5	Nutrition Label: 2.5g total - 1g (natural)
KFC Chicken, Crispy Strips	0	Louie et al: chicken (Step 2, j)
Kiwi Fruit, Green or Chinese Gooseberries	0	USDA
Kohlrabi	0	Louie et al: veggie (Step 2, f)
Lamb, Australian, Loin, Separable Lean and Fat, 1/8" Fat, Broiled	0	USDA
Lamb, Ground, Broiled	0	USDA
Lamb, Liver, Raw	0	USDA
Leaves, Arugula	0	USDA
Lentils, Boiled	0	USDA
Lettuce, Iceberg	0	USDA
Lettuce, Romaine, Shredded	0	USDA
LIPTON PURELEAF Iced Tea, Peach	4.5	Nutrition Label https://world.openfoodfacts.org/product/5900497610339/lipton-peach-ice-tea
LIPTON PURELEAF Iced Tea, Raspberry	4.5	Nutrition Label https://world.openfoodfacts.org/product/5900497610339/lipton-peach-ice-tea

LIPTON PURELEAF Iced Tea, Unsweetened	0	Louie et al: unsweetened tea (Step 2, l)
Lollipop	65.845	USDA
Luna coffee, regular	0	Louie et al: coffee (Step 2, l)
M&M MARS MILKY WAY Bar	56.69	USDA
M&M MARS SNICKERS Bar	43.74	USDA
M&M MARS TWIX Caramel Cookie Bars	48.25	USDA
Mango	0	USDA
MARS Candy Bar	56.69	USDA
Mayonnaise, Light	0	USDA
Mayonnaise, Regular	0	USDA
MCDONALD'S COCA COLA Medium	8.97	USDA
MCDONALD'S French Fries, Large	0	USDA
MCDONALD'S French Fries, Medium	0	USDA
MCDONALD'S French Fries, Small	0	USDA
MCDONALD'S Hamburger	1.6	USDA
MCDONALD'S Hamburger, Angus, Mushroom & Swiss	1.6	USDA
MCDONALD'S McCafe Coffee, Caramel Latte, Non Fat, Medium	5.078	Website https://www.mcdonalds.com/us/en-us/about-our-food/nutrition-calculator.html
MCDONALD'S McCafe Coffee, Frappe, Caramel, Small	12.41	Website https://www.mcdonalds.com/us/en-us/about-our-food/nutrition-calculator.html
MCDONALD'S MCCHICKEN Sandwich	1.6	USDA
MCDONALD'S QUARTER POUNDER Hamburger w/ Cheese	2.98	USDA
MCDONALD'S Sauce, Barbecue	128.57	Website https://www.mcdonalds.com/us/en-us/about-our-food/nutrition-calculator.html
MCDONALD'S Sundae, Hot Fudge	20.11	Website https://www.mcdonalds.com/us/en-us/about-our-food/nutrition-calculator.html
Milk, Condensed, Sweetened	42.4	USDA
Milk, Low Fat, 1%	0	USDA
Milk, Non Fat Skim or Fat Free	0	USDA
Milk, Whole 3.3%	0	USDA
Milk, Whole, Dry	0	USDA
Minced Lamb, Stewed	0	USDA

Molasses	0	USDA
Mollusks, Squid (Calamary), Mixed Species, Breaded, Fried	0	USDA
Mortadella, Beef and Pork, Sliced	0	USDA
MOUNTAIN DEW Soda	13.029	Nutrition Label https://www.pepsicoproductfacts.com/Home/product?formula=44316*01*01-10&form=RTD&size=20
Mozzarella, Sticks, Fried, Restaurant, Family Style	1.62	USDA
Mushrooms, Boiled, Drained	0	USDA
Mushrooms, Canned, Drained	0	USDA
Mustard, Yellow	0	USDA
Nachos	1.82	Nutrition Label https://www.nutritionix.com/food/nachos
NATURE VALLEY Bar, Granola, Cinnamon	26.19	Nutrition Label https://www.fooducate.com/product/Nature-Valley-Granola-Bars-Crunchy-Cinnamon/1C667FF8-E106-11DF-A102-FEFD45A4D471
NATURE VALLEY Bar, Granola, Oats 'n Honey	28.57	Nutrition Label https://www.fooducate.com/product/Nature-Valley-Granola-Bars-Crunchy-Oats-N-Honey/D153A782-4A25-11E0-A55F-1231380C180E
Nectar, Mango, Canned	12.45	USDA
Noodles, Egg, Enriched, Cooked	0	USDA
Noodles, Egg, Unenriched, Cooked	0	USDA
Noodles, Instant, Dry (Mee Kering, Segera)	0	USDA
Nuts, Chestnuts, Chinese	0	USDA
Nuts, Filbert or Hazelnut, Whole	0	USDA
Nuts, Mixed, with Peanuts, Dry Roasted, with Salt Added	0	USDA
Nuts, Mixed, with Peanuts, Oil Roasted, with Salt Added	0	USDA
Nuts, Pistachio	0	USDA
Nuts, Pistachio, Dry Roasted, with Salt Added	0	USDA
Nuts, Walnut, English, Halves	0	USDA
Nuts, Walnuts, Dry Roasted with Salt Added	0	USDA
Oat Bran, Dry	0	USDA
Oatmeal, Cooked with Water	0	USDA
Oats, Dry	0	USDA
Oil, Canola	0	USDA
Oil, Corn	0	USDA
Oil, Olive	0	USDA

Oil, Sunflower (< 60% Linoleic)	0	USDA
Olives, Black, Ripe, Canned	0	USDA
Olives, Green, Pickled, Canned or Bottled	0	USDA
Onions, Chopped	0	USDA
Onions, Chopped, Boiled, Drained	0	USDA
Onions, Fried In Olive Oil	0	USDA
Onions, Scallion or Spring Green	0	USDA
Orange	0	USDA
ORANGE JULIUS Drink, Strawberry Banana 16 oz	12.52	USDA
Orange, Clementines	0	USDA
Oregano, Ground	0	USDA
Pain perdu (French Toast)	3.59	USDA
Pancake, Plain, Prepared	6	USDA
Parsley, Chopped	0	USDA
Pasta, Spaghetti, Unenriched, Cooked	0	USDA
Paste, Tomato, Canned	0	USDA
Pastry or Roll, Cinnamon, Miniature, Fast Food	21.59	Nutrition Label https://www.nutritionix.com/food/cinnamon-rolls
Peach	0	USDA
Peanut Butter, Smooth	5.6	USDA
Peanuts, All Types, Dry Roasted, Salted	0	USDA
Peanuts, All Types, Oil Roasted, Salted	0	USDA
Pear	0	USDA
Pear, Prickly (Cactus Figs)	0	USDA
Peas, Green, Boiled, Drained	0	USDA
Peas, Green, Canned, Drained	0	USDA
Pepper, Bell or Sweet, Green	0	USDA
Pepper, Bell or Sweet, Red	0	USDA
Pepper, Hot Chili, Green	0	USDA
Pepper, Hot Chili, Red	0	USDA
Peppermint Leaves	0	USDA
PERRIER Mineral Water	0	USDA

Pickle, Dill	0	USDA
Pineapple	0	USDA
Plum	0	USDA
Pomegranate	0	USDA
Popcorn, Popped in Oil	0	USDA
Poppins Wonderfills - Milk Chocolate	33.33	Nutrition Label https://poppins.com/index.php/product/WF-milk-chocolate
Potato Salad	0	USDA
Potatoes, Baked	0	USDA
Potatoes, Flesh Only, Boiled	0	USDA
Potatoes, Flesh Only, Boiled with Skin	0	USDA
Potatoes, Mashed, Prepared with Whole Milk and Butter	0	USDA
Protein Powder	0	Louie et al: 0g added sugar (Step 1)
Prunes, Dried	0	USDA
Quince	0	USDA
Radishes	0	USDA
Raisins, Seedless	0	USDA
Raspberries	0	USDA
RED BULL Energy Drink	10.22	USDA
RED BULL Energy Drink, Sugar Free	0	USDA
Rice, White, Medium Grain, Unenriched, Cooked	0	USDA
Rice, White, Short Grain, Unenriched, Cooked	0	USDA
Risotto, Plain	0	Louie et al
Roll or Bun, Hamburger, Mixed Grain	5.6	USDA
Roll or Bun, Hamburger, Plain	5.6	USDA
Roll or Bun, Hot Dog, Plain	5.6	USDA
Salad Dressing, Honey Mustard, Regular	9.66	USDA
Salad Dressing, Sweet and Sour	9.66	USDA
Salad, Green	0	USDA
Salami, Beef and Pork, Cooked	0	USDA
Salsa	0	Louie et al: 0g added sugar (Step 1)

Salt, Table	0	USDA
Santiveri Chocolate Biscuits	0	Nutrition Label https://nutritionempire.net/en/product/santiveri-no-sugar-added-cocoa-biscuits-190g
Sardines, Atlantic, with Bones, Canned in Oil	0	USDA
Sardines, Atlantic, with Bones, Canned in Oil, Drained	0	USDA
Sauce au beurre (Sauce, Butter)	0	Louie et al: 0g added sugar (Step 1)
Sauce, Barbecue	0	Louie et al: 0g added sugar (Step 1)
Sauce, Cocktail, Ready-to-Serve	0	Louie et al: 0g added sugar (Step 1)
Sauce, Hot Chili Peppers, Mature Red, Canned	0	Louie et al: 0g added sugar (Step 1)
Sauce, Mushroom, Dehydrated	0	Louie et al: 0g added sugar (Step 1)
Sauce, Pesto, ready-to-serve, refrigerated	0	USDA
Sauce, Soy (Shoyu)	0	Louie et al: 0g added sugar (Step 1)
Sauce, Sweet and Sour, Ready-to-Serve	18.86	Nutrition Label https://www.nutritionix.com/food/sweet-and-sour-sauce
Sausage, Beef, Cooked	0	USDA
Seaweed, Laver (Nori)	0	Louie et al: veggie (Step 2, f)
Seeds, Chia, Dried	0	USDA
Seeds, Flax or Linseed, Ground	0	USDA
Seeds, Sesame Kernels, Toasted	0	USDA
Seeds, Sunflower Kernels, Dry Roasted	0	USDA
Seeds, Sunflower Kernels, Dry Roasted, Salted	0	USDA
Seeds, Watermelon Kernels, Dried	0	USDA
Shrimp, Mixed Species, Boiled or Steamed	0	USDA
Shrimp, Mixed Species, Breaded, Fried	0.8	USDA
Snack Cake, Chocolate, Crème Filled, with Frosting	37.76	USDA
Snack Cake, Sponge, Crème Filled	37.3	USDA
Soda, Cola	8.97	USDA
Soda, Cola, with Aspartame, Low Calorie	0	USDA
Soda, Lemon Lime	0.89	USDA
Soda, Orange	12.29	USDA

Soup, Cream of Chicken, Dehydrated, Prepared with Water	0	USDA
Soup, Pumpkin, Homemade	0	Louie et al: veggie (Step 2, f)
Soup, Vegetable, Low Sodium, Prepared with Water	0	USDA
Spinach, Chopped, Raw	0	USDA
Sponge Cake, Jam Filled	37.3	USDA
Spread, Hazelnut, Chocolate Flavored	44.8	USDA
Squash, Summer, Zucchini, Boiled, Drained	0	USDA
STARBUCKS Espresso, Solo	0	Louie et al: coffee (Step 2, l)
STARBUCKS FRAPPUCCINO Blended Beverage, Caramel, Light, Grande	5.72	Total / 2 from Website https://www.starbucks.com/menu/product/424/iced/nutrition
STARBUCKS Smoothie, Chocolate, 2%, Grande	5.72	Total / 2 from Website https://www.starbucks.com/menu/product/424/iced/nutrition
STARBUCKS White Chocolate Mocha, Nonfat, Tall, No Whip	5.72	Total / 2 from Website https://www.starbucks.com/menu/product/420/hot/nutrition
Strawberries (Strawberry)	0	USDA
Sugar, Brown	97.02	USDA
Sugar, White Granulated	99.8	USDA
Sweet Chili Sauce	36.84	Nutrition Label https://www.webstaurantstore.com/documents/nutrition/418311900franksredhotsweetchilisauce405gal.pdf
Syrup, Chocolate	49.65	USDA
Syrup, Maple	66.848	USDA
Tamarind	0	USDA
Tangerine	0	USDA
Tapenade d'olives (Olive Paste)	0	Louie et al: fats & oils (Step 2, c)
Tea, Herbal, Chamomile, Prepared	0	USDA
Tea, Herbal, Prepared	0	USDA
Tea, Prepared	0	USDA
TOBLERONE, milk chocolate with honey and almond nougat	56	Nutrition Label https://www.nutritionix.com/food/toblerone
Tomatoes, Red	0	USDA
Tomatoes, Red, Ripe, Boiled	0	USDA
Tortilla, Corn	0.833	Nutrition Label https://www.nutritionix.com/food/corn-tortilla
Tuna, Light, Canned in Oil, Drained	0	USDA

Tuna, White, Canned in Oil, Drained	0	USDA
Tuna, White, Canned in Water, Drained	0	USDA
Turkey Ham, Extra Lean, Sliced	0	USDA
Turkish Delight, With Nuts	35	Nutrition Label https://www.nutritionix.com/i/nutritionix/turkish-delight-1-one-inch-piece/5c5c4d8c4f7faf60449ea780
Turkish Delight, Without Nuts	0	USDA
Vanilla Extract	0	Louie et al
Veal, Ground, Broiled	0	Louie et al
Vegetables, Mixed, Frozen, Boiled, Drained, with Salt Added	0	USDA
Vinegar, Balsamic	0	Louie et al
Waffle, Plain, Prepared	5.493	USDA
Wasabi	0	Louie et al
Water, Bottled	0	USDA
Water, Mineral, Naturally Sparkling (Carbonated), Bottled	0	USDA
Watermelon	0	USDA
Wine, Red Table	0	USDA
Yogurt, Greek, strawberry, lowfat	5.2	USDA
Yogurt, Plain, Low Fat (12 grams protein per 8 ounces)	0	USDA
Yogurt, Plain, Made with Whole Milk (8 grams protein per 8 ounces)	0	USDA
YOPLAIT GREEK Yogurt, Strawberry Raspberry	5.2	USDA
YOPLAIT PLENTI Greek Yogurt, Peach	5.2	USDA

APPENDIX F
SIMPLE LINEAR REGRESSION SHOWING THE ASSOCIATION BETWEEN (EI-EE) AND DIFFERENT FACTORS

	Beta (95% CI)	**P-value**
Gender	-224.29 (-738.046; 289.46)	0.39
Education	-38.306 (-827.307; 750.7)	0.92
BMI	-598.3 (-1109.59; -87.0)	**0.022**
Age	-0.38 (-21.043; 20.29)	0.97
CI	39.074 (-473.59’ 551.74)	0.88
PA	-302.55 (-816.57; 211.47)	0.25
Occupation (student or employee)	-113.027 (-623.85; 397.79)	0.66

* Dependent variable: difference between EI and EE (EI-EE)
Simple linear regression showing the association between (EI-EE) and different factors.

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