RESEARCH ARTICLE

Nutritional value of the Middle Eastern diet: analysis of total sugar, salt, and iron in Lebanese traditional dishes [version 1; peer review: 2 approved]

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Abstract

Background: The expanding burden of diet-related non-communicable diseases in the Eastern Mediterranean Countries requires urgent public health vigilance and actions. This study aimed at establishing a database analysis of total sugar, salt and iron content in Lebanese foods, focusing on traditional dishes.

Methods: The collection of food samples was done using stratified sampling techniques. These samples were classified into five strata, taking into account variation by geographical area (Mount Lebanon, Bekaa, Beirut, Tripoli, and Saida). The number of samples per governorate was estimated to be 30 according to the variability in the dishes' composition. Food samples were chemically analyzed for total sugar, salt, and iron.

Results: Among all the governorates, all the tested traditional Lebanese dishes contained little total sugar. More than 60% of the samples tested were rich in sodium. The sodium content ranges were 120-720 mg/100 g in Mount Lebanon, 240-960 mg/100 g in Bekaa, 80-520 mg/100g in Beirut, 252-1952 mg/100g in Tripoli and 40-680 mg/100 g in Saida. The highest mean amount of sodium was observed in the dishes *Fatayer Sabanikh* and *Malfouf Mehche* ($\geq$ 600 mg/100 g). Furthermore, more than 80% of the samples had poor amounts of iron in all governorates.

Conclusion: This study emphasizes the need for multi-cultural education and awareness on food sources of salt and iron, and the health effects regarding high intake of salt and low intake of iron. This study is a stepping stone for further research exploring total sugar, salt and iron content of traditional dishes, as well as potential intake by individuals in the Lebanese population.

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Keywords
Total sugar, salt, iron, Lebanese traditional dishes, governorates

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Introduction

In light of global spread of non-communicable diseases (NCDs), accounting for 70% of the 41 million deaths each year, the probability of premature death, in 2018, caused by NCDs is 91% of all deaths in Lebanon[1]. The global rise in the prevalence of NCDs is a consequence of shifting dietary patterns specified by a high intake of meals rich in fat, sugar, salt, and low in fiber and micronutrients[2]. Home cooking and at-home eating have become scarce, while processed foods and prepared meals are increasing and have become a major part of the population's lives[2]. Furthermore, it is widely believed that urbanization has played a role in producing side effects for NCDs-related health outcomes[3]. Cardiovascular diseases (CVDs) constitute the primary cause of death in the Middle Eastern Region[4]. According to the World Health Organization (WHO), based on 2017 data, 17.9 million people die each year from CVDs, representing 31% of all deaths worldwide[5]. Furthermore, around 23.6 million people are expected to die from many forms of CVDs by 2030[6].

High blood pressure is a dominant factor for CVDs[7]. A higher intake of dietary salt (equivalent to 5 g salt/day) is associated with high levels of blood pressure, cardiovascular diseases and strokes[5]. In May 2013, the WHO Member States decided to target a reduction in the global intake of salt by 30% by 2025[8]. A systematic review, published in 2020, on 133 randomized control trials showed a reduction of 1.10 mmHg in systolic blood pressure and 0.33 mmHg reductions in diastolic blood pressure with every 50 mmol reduction in 24-hour sodium excretion. This can lead to a protection against vascular complications and decrease CVD risk[9]. In addition, there is considerable evidence of the advantages of Mediterranean diet on health[10]. An umbrella review and meta-analyses of observational and randomized controlled trials showed a strong relation between the adherence to Mediterranean diet and the 50% reduction in mortality from NCDs[10].

Today, the major target of nutrition interventions is the energy dense "added sugars". The WHO definition for added sugars is "all monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook, or consumer, and sugars naturally present in honey, fruit juices, and fruit concentrates"[11]. In this definition the "total sugar" term that is "naturally occurring or intrinsic sugars, which are stored within the cells of intact fruits, vegetables, or involve lactose in milk or unsweetened dairy products" was not included[11]. In 2015, the WHO recommended the reduction of the daily intake of added sugars to less than 10% of the total energy intake[12]. Additional suggestion of reducing the daily intake of added sugars to less than 5% of total energy intake may promote additional health benefits[12]. Until today, total sugar has no recommendation for the daily intake[13]. However, for the aim of achieving the goals set by the *Global Action Plan for NCDs 2013–2020*, a guideline on total sugar was developed to help in the reduction of the prevalence of diabetes and obesity, and decrease the incidence of premature deaths caused by NCDs by 25% by 2025[14].

Furthermore, deficiencies in iron lead to the development of anemia, which is one of the most common nutrition problems. As per the WHO, more than 2 billion people are anemic and iron deficiency is one of the main causes[15]. In addition, there is a high prevalence of 42% of children less than 5 years of age and more than 40% of pregnant women who are anemic[15]. In 2012, specific dietary guidelines for Arab countries were developed by the WHO and the Arab Center for Nutrition. Only seven countries that represent 29% of the Eastern Mediterranean Region population (namely Afghanistan, KSA, Oman, Lebanon, Qatar and Iran) designated their national food based dietary guidelines[16,17].

The main purpose of this study is to initiate a database analysis of total sugar, salt and iron content in Lebanese foods, focusing on traditional dishes.

Methods

Dish selection

The definition of 'composite dishes' is "dishes consumed at main meals (i.e. lunch or dinner), whose preparation involves culinary skills and contains ingredients from at least three of five main food groups: meat/poultry/fish and eggs; dairy products; fruits and vegetables; starchy foods including legumes; added sweets and fats"[18]. The list of Lebanese composite dishes frequently consumed by Lebanese citizens was retrieved from a study done in 2005 on a representative sample of 799 Lebanese adults[18], and in line with a study conducted in 2009 where the objective was to compare the consumption of traditional dishes between Lebanon and France[19]. The Lebanese diet includes a range of foods with often complex recipes, and it is rarely possible to analyze all the types of dishes. In such cases, a laboratory analysis of the traditional dishes and a calculation of some nutrients should be achieved. The names of the dishes most eaten by Lebanese citizens and chosen for this study are shown in Table 1.

Data collection

Samples of cooked composite dishes were collected (see below). The food samples were bought from five different governorates (Mount Lebanon, Bekaa, Beirut, Tripoli and Saida), taking into account geographical and cultural variations.

A total of 500 g of each dish was collected and used for analysis. According to Greenfield and Southgate, this size is a convenient sample to avoid errors during analysis[20].

Our research group collected 500 g of 30 types of traditional dishes from five different central kitchens in the following governorates: Mount Lebanon, Beirut, Bekaa, Tripoli, and Saida to show wide representation. Thus, 150 samples were collected. A list of kitchens that served tradition meals, found on internet, was prepared for each of the governorates. The central kitchens were randomly chosen from the results of the internet search, based on the following criteria: 1) their specialty in cooking home-made dishes; 2) their popularity; and 3) their involvement in supporting women as part of the

Table 1. Local names and main ingredients of selected traditional dishes frequently consumed in Lebanon.

Appetizer/Dish	Ingredients
Baba Ghanouj	Aubergines, garlic cloves, lemon juice, tahini, pomegranate seeds, salt
Batata mihchi	Lamb ground, onions, butter, salt, pepper, pine nuts, potato, tomato juice
Bulgur b banadoura	Coarse bulgur wheat, small pearl onions, chickpeas, cinnamon stick, caraway seed, vegetable oil, mild white pepper, salt
Chichbarak	Chichbarak Dough: multi-purpose flour, salt, water warm to form a paste, yeast, sugar. Meat Stuffing: ground beef, salt to taste, black pepper to taste, cinnamon powder to taste, onion finely chopped, pine nuts, olive oil, bushel of parsley chopped Chich Barak Stew: yogurt, water, starch, garlic cloves crushed (optional), rice, dried mint, salt to taste
Falafel	Dry peeled fava beans dried chickpeas (aka Garbanzo beans), Italian parsley (chop away the stems), green cilantro (chop away the stems), freshly peeled crushed garlic cloves, red or yellow onion, green onions, salt, black pepper, flour, baking soda, red chili pepper (optional, if spicy falafel is desired), cumin, coriander. Falafel Tahini Sauce: Tahini paste, freshly squeezed lemon juice, garlic cloves, crushed, salt
Fatayer Sabanikh	Fresh spinach, onions, pine nuts, lemon juice, olive oil, sumac, salt, plain white flour, caster sugar, baker yeast, olive oil, salt
Fatteh	Chickpeas, tomatoes, onion, basil leaves, garlic cloves, pitta bread, pine nuts, yogurt, tahini and vinegar, vegetable oil, salt and pepper
Fattoush	Lettuces or romaine lettuce, cherry tomatoes, cucumbers, radishes, spring onions, flat-leaf parsley mint, pitta bread, olive oil, vinegar, sumac, salt
Foul moudamas	Broad beans, baking soda, water, water, salt, garlic cloves minced, lemon juice, olive oil
Hindbe b zet	Chicory greens, water, olive oil, onions, salt, lemon juice
Hummus bi tahini	Chickpeas, garlic cloves, lemon juice, Tahini, olive oil, salt
Kafta w batata	Minced lamb, flat-leaf parsley, onions, salt and pepper, onions, red pepper, tomato juice, debs roman, olive oil, salt and pepper, potatoes, ripe tomatoes, vegetable oil
Kibbeh b sayniye	Finely ground beef (or lamb, lean), bulgur cracked wheat, salt, all spice,cumin, onions (finely chopped)
Koussa Mihchi	Minced lamb, small zucchini, short grain rice, olive oil, salt and black pepper
Lahm bi ajeen	Plain white flour, caster sugar, baker's yeast, salt, olive oil, minced lamb, tomatoes, few drops of pomegranate molasses, salt and pepper
Loubieh b zet	Vegetable oil, white onions, sliced, frozen bag green beans, garlic cloves, peeled, Cans of chopped tomatoes, salt and sweet pepper to taste, 7 spices, extra-virgin olive oil
Malfouf mehche	Cabbage leaves, basic vegetables stuffing, tomato, lemon juice, water, cinnamon, garlic cloves, dry mint
Moujadara	Green or coral lentils, short-grain rice, onions, olive oil, salt
Moghrabieh	Dry dough, chickpeas, pearl onions, vegetable oil, caraway butter, ground cinnamon, ground cumin, salt, black pepper
Mousaka batinjen	Aubergine,yellow or white onion, diced, garlic cloves, minced, low-salt chickpeas, extra virgin olive oil, low-salt diced tomatoes, tomato paste, piquant post spicy mint blend, Pita chips or crusty bread for dipping, salt and pepper to taste
Riz a djeij	Chicken breast, basmati rice, carrot, onions, tomato juice, whole black peppercorns, whole green cardamoms, cinnamon, cloves, cumin, vegetable oil, salt
Riz b lahme	Medium fat meat, basmati rice, carrot, onions, tomato juice, whole black peppercorns, whole green cardamoms, cinnamon, cloves, cumin, vegetable oils, salt
Sayadieh	Sea bass, scaled and gutted or in fillets, basmati rice, onions, caraway seeds, ground cumin, pines nuts, olive oil, fish stock, vegetable oil, salt, flour, butter, lemon juice
Shawarma Djeij	Chicken, olive oil, onions, red vinegar, lemon juice, pepper, cinnamon, nutmeg, salt, cloves of garlic
Shawarma Lahme	Meat, olive oil, onions, red vinegar, lemon juice, pepper, cinnamon, nutmeg, salt, cloves of garlic
Tabboule	Tomatoes, spring onions, flat leaf parsley, mint, bulgur wheat, lemon juice, olive oil, salt
Warak enab	Vine leaves, tomatoes, onion, flat-leaf parsley, mint, lemon juice, short-grain rice, meat, olive oil, salt
Yakhnet Bemieh	Lamb cubed, onions, garlic cloves minced, green coriander, okra, lemon juice, salt, pepper, water and tomatoes
Yakhnet Fassoulia	Shoulder of lamb, fresh white haricot beans, coriander, onions, garlic cloves, tomato juice, olive oils, water or chicken stock, salt and black pepper
Yakhnet Mloukhie	Free-range chicken, basmati rice, coriander, garlic cloves, onion, shallots, pitta bread, vinegar, lemon juice, vegetable oil and salt

social entrepreneurship initiatives that are aimed at empowering women.

Chemical analysis

After the receipt of food samples, 500 g of each composite dish was mashed, and then analyzed in the laboratory. The remaining samples were kept frozen at -18°C in tight containers for further analysis.

Total sugar. An amount ranging between 2 and 10g (depending on expected value of sugar content) of the sample was put in a 250 ml volumetric flask. 125 ml of 50% alcohol solution was placed in steam bath overnight. The volume was made up to 125 ml with 95 % ethanol followed by filtration with filter paper. 100 ml of the filtrate was pipetted into a beaker and evaporated to reduce the volume to 20 – 30 ml. After that, the solution was placed in 100 ml volumetric flask and rinsed thoroughly with water and then added to the flask. Then the solution was made up to volume of 100 ml and mixed thoroughly. Later on, 50 ml of the obtained solution was placed in 100 ml volumetric flask,then a piece of Lithmus paper was added and the total was neutralized with hydrochloric acid (HCL). An addition of 5 ml of HCl was added and the inversion of sucrose was done at room temperature. When the inversion of sucrose was complete, the solution was transferred to a beaker and neutralized with Na_2CO_3 until a pink color appeared. Later, the solution was returned to 100 ml flask, diluted to volume of 100 ml with water. Filtration was done when necessary, and the determination of reducing sugars in 50 ml of the solution was done by adding 25 ml each of Fehling A and Fehling B solutions and boiling for 4 min. After a red precipitate formed, the solution was cooled and filtered with a Gooch crucible. The mixture was dried in oven and the calculation of the precipitate was achieved (AOAC 906.03, 930.36 and 975.15)[21].

The content of reducing sugars was red from the table, and calculated as % sugars using the formula

$$\% \text{ sugar} = \frac{\text{Reading from table} \times \text{dilution factors} \times 100}{1000 \times \text{wt sample}}$$

Salt. To measure the salt content, 2–3 g of the food sample was weighteded into a pre-weighed furnace-proof crucible. It was baked until ash in a 600° C furnace overnight.

When the sampled had cooled, the ash was dissolved in water and was transferred quantitatively in a 50 ml volumetric flask. After making up to volume of 50 ml, the solution obtained was transferred into an Erlenmeyer flask. Later on, 1 ml of potassium chromate indicator solution was added and the solutions was titrated drop wise with the addition of 0.1 N silver nitrate solutions until the color of the solution changed to a reddish brown. A blank test was carried out in parallel using 50 ml of distilled water instead of the sample solution. The blank value did not exceed 0.2 ml of silver nitrate (AOAC 937.09 & ISO 9297)[21].

The chloride content in the sample was calculated using the formula.

$$\text{Chloride content} = \frac{Vs \times N \times 58.5 \times 100}{Wt \times 1000}$$

Where Vs = volume in ml of silver nitrate

N = normality of silver nitrate

Wt = weight of sample used

Finally, the chloride content was used to calculate NaCl. The molecular weight of NaCl is 58.44 and the molecular weight of Chloride is 35.453 g. Thus, to calculate the NaCl in the solution, the Cl should be multiplied by 1.65 (58.44 divided by 35.453).

Iron. An amount of 15 g of the edible portions was dried in an air oven at 105°C for more than 2 hours then charred until smoke disappearance. A muffle furnace was used to bake the charred sample at 550°C until a grey-colored ash yielded. 25–30 ml of 3.7% HCl was used to treat the ash, and then the mixture was conveyed to a container and done up to a volume of 50 ml with HCl. For each tested food, two solutions of ash were made ready to be analyzed twice. Each fraction of the ash sample was used for iron measurement using a Varian Atomic Absorption Spectrophotometer model 175 with an air-acetylene flame. Ferric nitrate solution was used as a standard. For each ash solution, at least three readings were obtained, and the average was calculated based on AOAC 975.03, 985.35 &965.09[21].

All the above chemical analyses were conducted at the Industrial Research Institute (Beirut, Lebanon), which is an accredited laboratory for chemical analyses. After food samples were analyzed, stamped laboratory results were received and data was entered on Excel 2019. The data validation process was conducted, and cross checked by two research assistants.

Recipes

The recipes of the dishes in this study were selected from those mostly consumed in Lebanon. The dishes were bought and analyzed as they are consumed by customers. The description (ingredients) of the selected recipes is presented in Table 1.

Results and discussion

The composition of 100 g of the Lebanese traditional dishes in the five Lebanese governorates is shown in Table 2.

Total sugar

Among all the governorates, all the tested traditional Lebanese dishes contained little total sugar. The highest total sugar (≥3 g/100 g) was observed in the dishes *Hindbe b bzet* and *Falafel* from Mount Lebanon, in *Yakhnet Bemieh* and *Lahm bi ajeen* from Bekaa, in *Lahm bi ajeen* and *Foul Moudamas* from Beirut, *Lahm bi ajeen* and *Fattoush* from Tripoli, and in

Table 2. Analysis of total sugar, salt and iron in 100 g of traditional dishes from five governorates in Lebanon. Units: Total sugar (Tot S.) in gram, salt (NaCl) in gram, sodium (Na) in milligram, and iron in milligram.

Appetizer/Dish	Amounts in 100 g of edible portions																			
	Mount Lebanon				Bekaa				Beirut				Tripoli				Saida			
	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron
Baba Ghanouj	2.8	0.7	280	0.6	1.8	1.2	480	0.7	2.1	0.9	360	0.9	3	0.6	252	0.6	1.5	0.9	360	0.7
Batata mihchi	2.5	1.1	440	1.1	0.4	0.8	320	1.1	1.5	0.7	280	0.7	1.5	1.1	476	1.1	0.8	1.3	520	1.2
Bulgur b banadoura	1.5	1.4	560	1.5	1.6	0.8	320	1.6	1.3	1.3	520	1	1.4	1.2	500	1.2	1.8	1.1	440	1.3
Chichbarak	2.3	0.7	280	2.8	2.7	1.1	440	2.7	2.5	0.7	280	0.7	6	1.1	456	1.1	2.6	1	400	2.5
Falafel	3.6	1.4	560	1.8	3.2	1.9	760	1.7	2	1.3	520	3.2	3	1.7	700	1.7	4.3	1.4	560	1.9
Fatayer Sabanikh	1.6	0.9	360	5	2.4	1.5	600	5.1	1.4	0.7	280	4.7	2.3	4.8	1952	4.8	2.2	0.9	360	4.5
Fatteh	3	0.6	240	0.9	2.2	0.6	240	1.7	3.2	0.6	240	1.2	3.4	1.3	528	1.3	0.6	0.1	40	1
Fattoush	1.6	0.3	120	0.6	1.3	1.3	520	0.8	1.8	0.4	160	2.2	5.2	0.9	380	0.9	2	0.7	280	0.4
Foul moudamas	1	1	400	0.6	1	2.4	960	0.9	3.3	0.7	280	0.7	1.1	0.6	272	0.6	2.3	1.4	560	0.7
Hindbeb zet	4.2	0.7	280	1.6	1.3	0.9	360	2	2.3	0.8	320	2.6	4.6	1.7	688	1.7	0.7	0.9	360	1.7
Hummus bi tahini	1.6	0.8	320	0.8	2.7	0.6	240	1.2	2.4	0.8	320	1.2	3	1	400	1	1.8	0.9	360	0.9
Kafta w batata	1.1	1.2	480	4.1	0.9	0.9	360	1.3	2	0.8	320	1.4	1.9	1.2	500	1.2	1.3	1.2	480	3.9
Kibbeh b sayniye	2.5	1.2	480	2	2	1	400	2	3.3	0.8	320	1.3	2.5	1.8	748	1.8	1.3	1.1	440	1.9
KoussaMihchi	0.4	1.2	480	1.3	0.8	0.9	360	1.1	1.1	0.7	280	1.7	1.9	1.7	704	1.7	0.8	1.2	480	1.2
Lahm bi ajeen	1.5	0.5	200	1.9	4.7	0.7	280	3.1	3.4	0.7	280	1.7	4.1	1.3	528	1.3	3.2	0.7	280	2
Loubieh b zet	1.8	0.6	240	0.8	0.6	0.8	320	1.1	1.8	0.9	360	0.9	0.9	2	820	2	0.9	0.6	240	0.7
Malfouf mehche	2.1	1.8	720	1	1.6	0.7	280	1	2.1	0.9	360	1.1	2.6	2.7	1088	2.7	1.6	1.7	680	1.1
Moujadara	1.5	0.4	160	1.2	1	0.9	360	1.1	2	0.5	200	1.4	1.1	1.6	664	1.6	1.6	0.6	240	1.3
Moghrabieh	1.2	0.4	160	0.9	1.5	1	400	1.2	1.2	0.2	80	1	1.7	0.9	364	0.9	1.8	0.6	240	0.8
Mousaka batinjen	2	0.6	240	1	1.5	1.9	760	2.4	0.5	1.3	520	0.9	1.9	1.1	456	1.1	1.9	0.7	280	0.9

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Appetizer/Dish	Amounts in 100 g of edible portions																			
	Mount Lebanon				Bekaa				Beirut				Tripoli				Saida			
	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron	Tot S.	NaCl	Na	Iron
Riz a djeij	1.2	0.7	280	1	0.7	0.7	280	3.8	0.4	1	400	1	0.2	1.2	500	1.2	1.3	0.4	160	0.9
Riz b lahme	1	0.4	160	1.3	0.6	0.9	360	1.7	1.2	0.9	360	1	2	1	436	1	0.9	1	400	1.2
Sayadieh	0.4	0.8	320	1.3	0.8	1.5	600	1.4	0.2	0.8	320	0.7	0.6	1.2	500	1.2	0.7	1.4	560	1.1
Shawarma Djeij	2.2	1.4	560	1.6	2	1.2	480	1.5	1.8	0.8	320	1.5	1.9	1.3	544	1.3	0.1	0.8	320	1.5
Shawarma Lahme	0.9	0.7	280	1.5	0.9	1.4	560	1.4	1.1	0.4	160	1.3	1.1	1.7	700	1.7	1	0.9	360	1.3
Tabboule	0.6	1.1	440	1	1.3	1.9	760	1.2	1.4	0.6	240	2.3	1.3	1.5	600	1.5	0.8	0.7	280	0.9
Warak enab	1.1	1.3	520	1.3	1	0.9	360	1.7	2.5	0.7	280	1	0.8	1	400	1	0.3	1.3	520	1.4
Yakhnet Bemieh	1.4	1.1	440	1.5	5.5	0.8	320	1	1.7	0.9	360	1.3	2.2	1.5	600	1.5	1.6	0.7	280	1.4
Yakhnet Fassoulia	1	1	400	0.9	0.9	0.7	280	1.1	1	0.6	240	1.8	1.1	1.6	668	1.6	0.9	0.9	360	0.8
Yakhnet Mloukhie	0.9	0.9	360	1	0.8	0.9	360	1.1	0.2	0.7	280	1	0.9	1.6	668	1.6	0.8	0.9	360	1.1

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Lahm bi ajeen and *Falafel* from Saida (Table 2). As per Table 3, *Lahm bi ajeen* and *Falafel* ranked first in the highest mean total sugar.

Table 3. The mean values from the five governorates of total sugar, salt and iron in the traditional dishes. Units: Total sugar in gram, salt in gram, sodium in milligram and iron in milligram.

Appetizer/Dish	Mean values in 100 g			
	Total sugar	Salt	Sodium	Iron
Baba Ghanouj	2.2	0.8	346.4	0.7
Batata mihchi	1.3	1	407.2	1
Bulgur b banadoura	1.5	1.1	468	1.3
Chichbarak	3.2	0.9	371.2	2
Falafel	3.2	1.5	620	2.1
Fatayer Sabanikh	1.9	1.7	710.4	4.8
Fatteh	2.4	0.6	257.6	1.2
Fattoush	2.3	0.7	292	1
Foul moudamas	1.7	1.2	494.4	0.7
Hindbe b zet	2.6	1	401.6	1.9
Hummus bi tahini	2.3	0.8	328	1
Kafta w batata	1.4	1	428	2.4
Kibbeh b sayniye	2.3	1.1	477.6	1.8
Koussa Mihchi	1	1.1	460.8	1.4
Lahm bi ajeen	3.3	0.7	313.6	2
Loubieh b zet	1.2	0.9	396	1.1
Malfouf mehche	2	1.5	625.6	1.4
Moujadara	1.4	0.8	324.8	1.3
Moghrabieh	1.4	0.6	248.8	1
Mousaka batinjen	1.5	1.1	451.2	1.3
Riz a djeij	0.7	0.8	324	1.6
Riz b lahme	1.1	0.8	343.2	1.3
Sayadieh	0.5	1.1	460	1.1
Shawarma Djeij	1.6	1.1	444.8	1.5
Shawarma Lahme	1	1	412	1.4
Tabboule	1	1.1	464	1.4
Warak enab	1.1	1	416	1.3
Yakhnet Bemieh	2.4	1	400	1.4
Yakhnet Fassoulia	0.9	0.9	389.6	1.2
Yakhnet Mloukhie	0.7	1.0	405.6	1.2

Salt

The sodium (Na) level was high in most dishes (Table 2). The highest mean amount of Na was observed in *Fatayer Sabanikh* and *Malfouf Mehche* (≥ 600 mg/100 g) (Table 3). The Na content ranges are 120–720 mg/100 g in Mount Lebanon, 240–960 mg/100 g in Bekaa, 80–520 mg/100g in Beirut, 252–1952 mg/100g in Tripoli, and 40–680 mg/100g in Saida.

One of the main factors of the richness of these Lebanese dishes in salt is mainly the high amount of salt added to the ingredients. Additional factors could be the use of spices rich in Na, like coriander leaf, cumin, cloves and cinnamon, during cooking, which are commonly used in the Lebanese cuisine[22]. The Bahraini plates *Shawarma Lahme* and *Shawarma Djeij* contained 100 mg of Na[23], less than the Lebanese plates (Table 3). Unfortunately, we could not compare the Lebanese traditional dishes to the traditional dishes in other Arab and Middle Eastern countries because few dishes are common between them.

Iron

In general, meat-based dishes contained the highest levels of iron compared with other dishes. This was observed in Mount Lebanon particularly in *Chichbarak* and *Batata w kafta* (≥2.5 mg/100 g) (Table 2). However, in all other governorates, the highest level of iron was shown in *Fatayer Sabanikh* (≥4.5 mg/100g) (Table 2). As for the highest mean level of iron, Table 3 shows that *Fatayer Sabanikh and Kafta w Batata* ranked first. The Bahraini plates, *Shawarma Lahme* and *Shawarma Djeij*, contained the triple amount of iron (>3 mg) compared to the Lebanese plates (around 1 mg of iron)[23].

Given the available evidence about the influence of culture on health and health behaviors, reducing total sugar or salt and improving iron intake cannot be separated from cultural factors influencing nutrition-related-attitudes towards the health benefits of iron intake or the use of salt when cooking foods. Cultural influences play a critical role in framing how people perceive food preparation patterns, dietary habits, and coping with variability in agricultural conditions[24].

Contributions to daily values

The nutrient goal represents the average intake that is compatible with maintaining of good health in individuals[25]. According to the US Food and Drug Administration (FDA) definition, the daily value (DV) is "reference values for reporting nutrients on the nutrition labels". The percentage (%) DV assists the consumer in recognizing how the serving of food and its content in nutrients, fit into their daily diet[25]. As per FDA regulations, the expression "high," "rich in," or "excellent source of" nutrients are used if the food has≥20% of the daily value per reference amount. The terms "good source," "contains," or "provides" are used if the food yields 10–19% of the Recommended Dietary Intake (RDI) per reference amount of the nutrient. Foods that carry <10% of the RDI from the nutrient per reference amount are considered as having low amounts[25–27].

In our study, the contribution of each dish to the overall amount of iron, salt and total sugar needed per day was calculated. The calculations are presented in Table 4 and Table 5. The term "total carbohydrate" (CHO) includes dietary fiber, total sugar, added sugars and sugar alcohols. As per the updated FDA regulations, the DV of total CHO is 275 g/day (55% of energy intake in a 2000 kcal-diet) and the DV of added sugar is 50 g/day (10% of energy intake in a 2000 kcal-diet)[26,27]. As

Table 4. The percentage contribution to a 2000 Kcal diet of 100 g of traditional dishes for the amount of total sugar (Tot.S), salt (NaCl) and iron based on daily recommend amounts. The daily recommended amount of total sugar is 147 g; NaCl is <5 g;iron is18 mg.

Appetizer/Dish	Mount Lebanon			Bekaa			Beirut			Tripoli			Saida		
	Tot S.	NaCl	Iron	Tot S.	NaCl	Iron	Tot S.	NaCl	Iron	Tot S.	NaCl	Iron	Tot S.	NaCl	Iron
Baba Ghanouj	1.9	14	3.3	1.2	24	4.1	1.4	18	5.3	2	12.6	3.5	1.	18	4.1
Batata mihchi	1.7	22	6.3	0.2	16	6.2	1	14	3.9	1	23.8	6.6	0.5	26	7
Bulgur b banadoura	1	28	8.5	1	16	9.1	0.8	26	5.5	0.9	25	6.9	1.2	22	7.3
Chichbarak	1.5	14	15.7	1.8	22	15.2	1.7	14	4.3	4	22.8	6.3	1.7	20	14.3
Falafel	2.4	28	10.2	2.1	38	9.7	1.3	26	17.9	2.0	35	9.7	2.9	28	10.7
Fatayer Sabanikh	1	18	27.7	1.6	30	28.5	0.9	14	26.2	1.5	97.6	27.1	1.5	18	25.3
Fatteh	2	12	5.2	1.5	12	9.9	2.1	12	6.6	2.3	26.4	7.3	0.4	2	5.8
Fattoush	1	6	3.3	0.8	26	4.8	1.2	8	12.5	3.5	19	5.2	1.3	14	2.6
Foul moudamas	0.6	20	3.3	0.6	48	5.2	2.2	14	4.1	0.7	13.6	3.7	1.5	28	3.9
Hindbe b zet	2.8	14	9	0.8	18	11.1	1.5	16	14.6	3.1	34.4	9.5	0.4	18	9.9
Hummus bi tahini	1.0	16	4.7	1.8	12	6.6	1.6	16	6.6	2	20	5.5	1.2	18	5.2
Kafta w batata	0.7	24	22.9	0.6	18	7.2	1.3	16	7.9	1.2	25	6.9	0.8	24	22
Kibbeh b sayniye	1.7	24	11.3	1.3	20	11.6	2.2	16	7.5	1.7	37.4	10.3	0.8	22	10.8
Koussa Mihchi	0.2	24	7.3	0.5	18	6.5	0.7	14	9.8	1.2	35.2	9.7	0.5	24	6.7
Lahm bi ajeen	1	10	11	3.2	14	17.5	2.3	14	9.7	2.7	26.4	7.3	2.1	14	11.2
Loubieh b zet	1.2	12	4.8	0.4	16	6.5	1.2	18	5.1	0.6	41	11.3	0.6	12	4.3
Malfouf mehche	1.4	36	6	1	14	6	1.4	18	6.2	1.7	54.4	15.1	1	34	6.3
Moujadara	1	8	6.9	0.6	18	6.3	1.3	10	7.8	0.7	33.2	9.2	1	12	7.6
Moghrabieh	0.8	8	5.2	1	20	6.7	0.8	4	5.9	1.1	18.2	5	1.2	12	4.9
Mousaka batinjen	1.3	12	5.7	1	38	13.5	0.3	26	5.1	1.2	22.8	6.3	1.2	14	5.4
Riz a djeij	0.8	14	5.9	0.4	14	21.3	0.2	20	6	0.1	25	6.9	0.8	8	5.4
Riz b lahme	0.6	8	7.3	0.4	18	9.9	0.8	18	5.9	1.3	21.8	6	0.6	20	7.1
Sayadieh	0.2	16	7.3	0.5	30	7.8	0.1	16	3.9	0.4	25	6.9	0.4	28	6.6
Shawarma Djeij	1.5	28	9.2	1.3	24	8.8	1.2	16	8.7	1.2	27.2	7.5	0	16	8.8
Shawarma Lahme	0.6	14	8.3	0.6	28	7.9	0.7	8	7.6	0.7	35	9.7	0.6	18	7.6
Tabboule	0.4	22	6	0.8	38	6.7	0.9	12	13.2	0.8	30	8.3	0.5	14	5.4
Warak enab	0.7	26	7.3	0.6	18	9.7	1.7	14	5.9	0.5	20	5.5	0.2	26	7.8
Yakhnet Bemieh	0.9	22	8.6	3.7	16	5.9	1.1	18	7.7	1.5	30	8.3	1	14	8.2
Yakhnet Fassoulia	0.6	20	5.2	0.6	14	6.1	0.6	12	10.2	0.7	33.4	9.2	0.6	18	4.9
Yakhnet Mloukhie	0.6	18	5.8	0.5	18	6.5	0.1	14	5.7	0.6	33.4	9.2	0.5	18	6.5

Table 5. The percentage contribution to a 2000 Kcaldiet of mean values of traditional dishes from five governorates for the amount of total sugar, salt and iron based on daily recommend amounts. The daily recommended amount of total sugar is 147 g; NaCl is >5 g; iron is 18 mg.

Appetizer/Dish	Percentage of daily contribution to 2000 Kcal-diet		
	Total sugar	Salt	Iron
Baba Ghanouj	1.5	17.3	4.1
Batata mihchi	0.9	20.3	6
Bulgur b banadoura	1	23.4	7.5
Chichbarak	2.1	18.5	11.2
Falafel	2.1	31	11.6
Fatayer Sabanikh	1.3	35.5	27
Fatteh	1.6	12.8	7
Fattoush	1.6	14.6	5.7
Foul moudamas	1.1	24.7	4
Hindbe b zet	1.7	20	10.8
Hummus bi tahini	1.5	16.4	5.7
Kafta w batata	0.9	21.4	13.4
Kibbeh b sayniye	1.5	23.8	10.3
Koussa Mihchi	0.6	23	8
Lahm bi ajeen	2.3	15.6	11.3
Loubieh b zet	0.8	19.8	6.4
Malfouf mehche	1.3	31.2	7.9
Moujadara	0.9	16.2	7.6
Moghrabieh	1	12.4	5.5
Mousaka batinjen	1	22.5	7.2
Riz a djeij	0.5	16.2	9.1
Riz b lahme	0.7	17.1	7.3
Sayadieh	0.3	23	6.5
Shawarma Djeij	1	22.2	8.6
Shawarma Lahme	0.6	20.6	8.2
Tabboule	0.7	23.2	7.9
Warakenab	0.7	20.8	7.3
Yakhnet Bemieh	1.6	20	7.7
Yakhnet Fassoulia	0.6	19.4	7.1
Yakhnet Mloukhie	0.4	20.2	6.7

per Rapaille *et al*, and because of the low digestibility of polyols or sugar alcohols, the intake level is restricted to 40–50 g per day in adults[28]. We hypothesized that based on the above recommendations; the daily total sugar consumption should not exceed 147 g per day. This number was obtained by subtracting 50g (recommendation of total sugar) and 50 g (recommendation of polyols) and 28 g (recommendation of fiber) from 275 g (recommendation of total carbohydrate). As per WHO, the iron intake should be limited to 18 mg/day[15] and the salt intake should not exceed 5g/day (1 tsp)[29].

We determined the percent contribution of 100 g of each traditional dish to the mean daily need of total sugar, salt, and iron in a 2000 Kcal-diet. The percentage of contribution of nutrients and minerals in a 2000 kcal-diet tested in 100 g of the dishes is shown in Table 4. Our data showed that all the traditional dishes in the five governorates contain low amount of total sugar (<10% of the DV). As for the salt, the majority (67%) of the dishes contains a high amount of salt; however this differed between governorates. A total of 43% of the dishes from Mount Lebanon and Bekaa, 13% of dishes from Beirut, 86% of the dishes from Tripoli, and 40% of dishes from Saida contained a high amount of salt (>20% of the DV). High sodium intake is associated with hypertension, a modifiable risk factor for CVDs[5]. In 2013, Powles *et al*. estimated that 3.13 g per person per day was the daily sodium intake in the Lebanese population[30]. In addition, a representative survey on 2,543 Lebanese adults showed that the average sodium intake was 2.9 g/day, with high intake in men (3.4 g/day) compared to women (2.4 g/day)[31]. Around 60% of the adults in Lebanon are considered as exceeding the WHO limit level of Na intake of 2 g/day[31]. Parallel to these alarming results, another study was conducted to investigate the knowledge, attitudes, and salt-related behaviors in Lebanese consumers. It showed that the majority of Lebanese participants developed discernible behaviors that increase the intake of salt and had limited knowledge of the food sources of salt[22]. Thus, the adoption of long-term strategies by healthcare providers is required to control adding salt to reduce its negative effects, in Lebanon and elsewhere.

As for the iron content in the Lebanese traditional dishes, more than 60% of the recipes are deficient in iron (<10% of the DV of iron). Only 6% of the dishes from Mount Lebanon and Bekaa, and 3% of the dishes from Beirut, Tripoli, and Saida contain a high amount of iron in 100 g from each dish. Furthermore, in Table 5, the range of the percentage of DC of iron fluctuates between 4% and 27% indicating low content of iron in these dishes. Pellet and Shadarevian tested some of the same traditional dishes in 1970; their data also showed that all the dishes were also deficient in iron[32]. More than one third of the region's population suffers from anemia especially preschool children, pregnant women and women of childbearing age[15]. Iron deficiency and iron-deficiency anemia have numerous adverse health consequences that affect the health of high-risk groups (women and children)[15,33]. Iron

deficiency and iron deficiency anemia can be caused by numerous factors such as low iron intake, decreased iron absorption, chronic blood loss, and chronic inflammation[15,33]. There is a high worldwide prevalence range of iron deficiency anemia among pregnant women (14–75%)[33]. This type of anemia can lead to maternal complications and increased the risk of obstetric hemorrhage in pregnant women[34]. Furthermore, more than 50% of Lebanese hospitalized children aged between 1 month and 12 years, were anemic moderately or severely[35]. Taking into consideration that anemia is prevalent in children and women, preventive measures related to good nutritional patterns and supplementation of iron-rich food are recommended. Strategies to tackle iron deficiency involve nutrition education and food fortification as well as targeted interventions for high risk groups, when needed. Wheat and maize flour fortification is a simple, inexpensive and effective strategy for supplying vitamins and minerals[36].

There have been widespread priority actions that were implemented by the WHO Regional Office for the Eastern Mediterranean Region in response to unhealthy eating patterns among this population and the high prevalence of obesity. In 2016, taking into account the recommendations made by the WHO's Commission on Ending Childhood Obesity, the WHO Regional Office for the Eastern Mediterranean Region prioritized the importance of dietary patterns modification at a regional level to halt the rise of NCDs in all age categories[37]. These priority targets and interventions have sufficiently strong evidence based expert analysis[38]. Furthermore, the WHO Regional Committee for the Eastern Mediterranean Region translated the United Nations political declarations and recommendations into a regional framework for action targeting the endorsement of population and individual measures by WHO Member States[39].

Conclusions

At the national government level, all the related-health sectors should develop a comprehensive range of policy actions that provide support of healthy diet adherence to ensure that agriculture and food policies meet health recommendations. They should also assess the effects of the agri-food systems on NCDs. At the research level, academia should be engaged proactively in building evidence based, and communicating this data to policymakers, handling and supporting the development of data systems with research donors to enable countries to monitor the implementation of effective policies in conjunction with international health agencies.

The main limitation of this study is the analysis of nutrients and minerals in limited numbers of Lebanese traditional dishes. Furthermore, since the food samples were purchased from central kitchens, the proportions of ingredients were not described. The ingredients were retrieved from the literature (Table 1). In addition, variations in ingredients and preparation methods among traditional dishes from various governorates in Lebanon were inevitable.

In conclusion, this study is a stepping stone for studies exploring the total sugar, salt and iron content of traditional dishes, as well as potential intake in the Lebanese population. It emphasizes the need for multi-cultural education and awareness on salt and iron and their impact on health because nutrition education has the power to productively modify behaviors, attitudes and consumption. Healthy choices result from empowering and motivating people by increasing their knowledge. In general, food composition data are essential for taking action to educate and inform the public about nutrition. There remains a need to expand implementation of rules on nutrition labeling and to scale up introduction of simplified front-of-pack nutrition labeling. Widespread adoption of nutrition policies and/or strategies, along with implementation of multisectoral coordination mechanisms, is indicative of strengthened political commitment to improve nutrition in the countries of the Eastern Mediterranean Region.

Data availability

All data underlying the results are available as part of the article and no additional source data are required.

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✔ **Haleama Al Sabbah**
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Thanks to the journal and authors for giving me this opportunity to review this excellent work.

The main objective of this study is to establish a database analysis of total sugar, salt and iron content in Lebanese foods, focusing on traditional dishes. To achieve this objective, the researchers collected the data by using a stratified sampling methodology. The number of samples per governorate was estimated to be 30 according to the variability in the dishes' composition. The presented results are mapped with the objective and assess the total sugar, sodium (Salt) and iron.

In order to improve the work of this paper I have the following comments for the authors:

General
There is a need for language editing and proof reading for the consistency in writing and phrasing some of the Arabic food names.

The list of References at the end of the paper needs to be checked, delete the repeated references and be consistent in the style of referencing. The majority the references are links to websites and when trying to open some of these links it says that the page is not found (e.g. https://www.fda.gov/regulatory-information/search-fda-guidance-documents/industry-resources-changes-nutrition-facts-label/ accessed on June 10, 2020).

Detailed comments:
Abstract:
" ...*food samples was done using stratified sampling techniques. These samples were classified into five strata, taking into account variation by geographical area (Mount Lebanon, Bekaa, Beirut, Tripoli, and Saida)".*
The above statement needs rephrasing as by reading further in the methodology and sampling, it's clear that the sampling methodology is convenience sampling technique from five regions/ governorate and not a stratified method.

It is also not clear in the abstract if the analysis of the samples had been done theoretically or in the lab? You need to add the software used to analyse the data at the end of the methods section. Also, the study design and setting should be added to the methods of the abstract. The total sample size?

The following statement needs re-phrasing "... little total sugar" how you define little?" - What is the number/percentage?

Main Manuscript:
Methods:
Need to be consistent with the methods presented under the abstract and in the main body of the manuscript (e.g. sampling methodology*?) "Our research group collected 500 g of 30 types of traditional dishes from five different central kitchens in the following governorates"*
How many kitchen from each region they used? What are the selection criteria for the kitchen where you take the sample from? Do they know that you are analyzing their food contents for sugar, iron and salt? If they knew that do you think they did changes in the recipe/ ingredients for each dish of food?

It's not clear enough how did you do the analysis in the lab for each nutrient.
"All the above chemical analyses were conducted at the Industrial Research Institute (Beirut, Lebanon), which is an accredited laboratory for chemical analyses. After food samples were analyzed, stamped laboratory results were received and data was entered on Excel 2019. The data validation process was conducted, and cross checked by two research assistants."
The above paragraph should be revised and integrated with more information about the study design, settings and sampling methodology.

It's better to move Table 1 to the annex with more specific and quantifiable ingredients of the recipes for each kitchen you have selected and have samples from.

Results
Total Sugar
"Among all the governorates, all the tested traditional Lebanese dishes contained little total sugar."
What is the definition for 'little total sugar'? How did you judge that it is little and according to what? You need a reference to compare and say that it is little.

Table 3, the mean values in 100g of food is not clear if it's in gram, milligram or microgram? The unit should be written under each item.

Salt
In the statements under salt "*The sodium (Na) level was high in most dishes (Table 2)*." and "*One of the main factors of the richness of these Lebanese dishes in salt is mainly the high amount of salt added to the ingredients."*
How did you judge that the level is high and not low or medium? What is your reference for that and compared to what? You need to have a reference in order to compare and say that it's high otherwise it should be descriptive only without analytical statement that its high.

The titles of Table 4 & 5 are too long and some of the information can be inserted in the tables

heading or adding them under the table as key information.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Public Health and Nutrition

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 02 November 2020

https://doi.org/10.5256/f1000research.29005.r73294

Reema Fayez Tayyem
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It is a well-written and informative manuscript. This study is targeted to establish and initiate a database analysis of total sugar, salt, and iron content in Lebanese foods, focusing on traditional dishes.

A few suggestions and corrections have been addressed to improve the quality of the paper. All these corrections are presented in the pdf file attached.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Not applicable

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Human Nutrition and policy planning.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.