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Profile of healthy female students in Syria: Investigation on anthropometric, lifestyle, and dietary characteristics, along with hematological and plasma biochemical parameters

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Abstract: In Syria, a Mediterranean country, health risk data on young women are limited. The aim of study: is to evaluate lifestyle factors, along with biomarkers related to cardiovascular risk factors in a group of university female students. Healthy female students (n = 206, 18–25 years old) participated in the study. Participant anthropometric characteristics and blood pressure were measured; alcohol drinking, smoking, and physical activity were assessed; the Mediterranean dietary pattern was evaluated; biomarkers such as glucose, uric acid, total cholesterol, triglycerides, alanine aminotransferase, red blood cell count, hemoglobin, and hematocrit were determined. Results: Among participants, 22.34% were overweight and obese; 10.2% were considered to be at high risk for type 2 diabetes, hypertension, and cardiovascular diseases associated to waist circumference (>88 cm); 47.58% have abdominal obesity; 94.17% were non-alcoholic beverage consumers; 70.87% were non-smokers; and 63% practice sport daily. The average of adherence to the Mediterranean dietary pattern was 49.14 ± 8%. No correlation was found between Mediterranean dietary score and anthropometric or biomarkers' measurements. Non-refined cereal consumption was inversely correlated with uric acid

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Mainly, our research activities are concentrated on linking biochemical measurements with food diet and behaviors. This article is the first step of our research for establishing new (or adopting current) methods to draw general food and behaviors' profile. The final step will be the integration of those methods in preventive health care institutional/governmental strategy. We believe that preventive medicine is important in well-developed societies, yet it is vital in developing countries.

PUBLIC INTEREST STATEMENT

Unfortunately, after decades of highlighting on health benefits of Mediterranean diet and daily physical activities, in Syria and south Mediterranean countries, food diet and lifestyle traditions are increasingly changing. Description and understanding the consequences of this changing lifestyle require the application of established methods on large population. Primarily, the performance of these methods needs to be assessed on a small group. Hence, 206 healthy female students participated in this study; their MedDietScore® score, daily behavior, physical activities, and physical shape were recorded and cardiovascular biomarkers (like glucose and total cholesterol levels) were measured in their blood samples. The results drew a food, lifestyle, and health profile for young females in Syria, as well as showed, almost, a six times increase of hubble-bubble smokers since 2004 and 47.6% of participants have abdominal obesity. Exploration of food diet and lifestyle in public can help governments set a preventive health policy.

measurement. Participants with normal levels of hemoglobin had significant correlation between fruits and vegetables' consumption. Clearly, young women in Syria should consider a healthy diet and lifestyle.

Subjects: Biochemistry; Health Informatics and Statistics; Obesity; Population Health; Preventative Medicine; Quality of Life

Keywords: obesity; Mediterranean diet; lifestyle; biological markers; hematologic tests; metabolic syndrome X

1. Introduction

Although it is now well-established that cardiovascular risk tends to track from childhood into adulthood, most efforts to address overt risk do not begin until early adulthood (Poon, Kuk, & Ardern, 2014). Cardio-metabolic risk cluster comprise elevated fasting glucose, hypertension, elevated triglycerides, reduced high-density lipoprotein cholesterol, and increased waist circumference. All of these components are related to lifestyle factors, especially dietary pattern and physical activity (Huffman, Sun, Thomas, & Bales, 2014). Hence, anthropometric measurements, lifestyle (habits and diet), and biomarkers' levels screening at early adulthood can provide prognostic information on health risks.

To simplify the study of diet habits, Panagiotakos et al. proposed MedDietScore concept (Panagiotakos, Pitsavos, & Stefanadis, 2006), where Mediterranean diet pattern consists of: (a) daily consumption of non-refined cereals and products, vegetables, fruits, olive oil, and non-fat or low-fat dairy products; (b) weekly consumption of: potatoes, fish, olives, beans, nuts, and more rare poultry, eggs, and sweets, and (c) monthly consumption of: red meat and meat products. In addition, although intake of milk is moderate, the consumption of cheese and yogurt is relatively high.

It is worthy to note that the adherence to the Mediterranean diet is recognized for its beneficial effects on rates of coronary heart disease, certain cancers, and a series of other diet-related health problems such as lipid metabolism, hypertension, and obesity (Panagiotakos et al., 2009).

In Syria, a Mediterranean country, health risk data on young women, aged between 15 and 24 years, are limited. Little is known about lifestyle factors and biomarkers related to metabolic syndrome and cardiovascular risk. These young women, of childbearing age, present 1/9th of the Syrian population (Central Bureau of Statistics, 2015).

The aim of the present work was to evaluate lifestyle factors like alcoholic drinking, smoking, physical activity, and dietary pattern, along with biomarkers related to cardiovascular risk factors in a group of university female students aged between 18 and 25 years.

2. Materials and methods

2.1. Participants

Female students in the faculty of pharmacy at Arab International University (AIU) were informed about the aim of the study. Among 900 female students, 206 healthy females agreed to participate in the study providing written informed consent and fully answered the questionnaire of the study. The retrieved data were confidential.

The following inclusion criteria were adopted: volunteer's age should be between 18 and 25 years and volunteer neither should have acute nor chronic medical history. All the 206 participants where accepted in the study.

2.2. Anthropometric, clinical, and lifestyle characteristics
A descriptive cross-sectional design was used to investigate the association between serum biomarkers' levels and anthropometric measurements or lifestyle factors for participants. In the presence of a research team, each participant filled in a questionnaire about their age, gender, alcohol drinking habit, smoking habit, physical activity, diet, and medical and medication histories.

Waist, hip circumferences, and height were measured to the nearest 0.5 cm, and weight was measured with a lever balance to the nearest 100 g. Body mass index (BMI, kg/m^2) was calculated as weight (kg) divided by the square of standing height (m^2). Waist to hip ratio (WHR) was calculated as waist circumference divided by hip circumference.

Blood pressure measurements were done twice on the right arm with a time gap of 15 min, and the mean value was used. Hypertension was defined as a systolic blood pressure ≥ 130 mm Hg and/or a diastolic blood pressure ≥ 90 mm Hg.

Alcohol drinking, current cigarette or hubble-bubble (Water pipes, Shisha, Nargile, and hookah have similar structures in which the smoke passes through water, causing a bubbling sound) smoking, physical activity status, and dietary intake were assessed by frequency questionnaire. Furthermore, overall assessment of dietary habits in terms of adherence to the Mediterranean dietary pattern was evaluated through the MedDietScore concept (range 0–55). Higher values in the score indicate greater adherence to this pattern and, consequently, healthier dietary habits. The validation properties of the MedDietScore have been presented elsewhere in the literature (Panagiotakos et al., 2009).

2.3. Laboratory analyses
Laboratory analyses were performed at the medical laboratory of AIU. Venipuncture was performed for each participant after a 12-h fasting period by applying a latex rubber strap and using a 10-mL syringe. Seven milliliters of blood was immediately transferred to one tube for serum separation and 2.5 ml of blood was transferred to another tube containing the anticoagulant ethylenediaminetetraacetic tri-potassium salt (K_3EDTA).

The following parameters were measured using Medichem-Me clinical chemistry reagents: glucose, uric acid, total cholesterol, and triglycerides (Medichem Middle East, 2015). As for alanine aminotransferase, Randox reagent was used (Randox Laboratories, 2015).

Red blood cell count, hemoglobin, and hematocrit were determined using an automated hematology analyzer (Micros 60 ABX-HORIBA).

2.4. Statistical analysis
To summarize the results of continuous variables like anthropometric, clinical chemistry, and hematological characteristics of participants, the mean and median (P50) were calculated to evaluate the central tendency of variables. To describe the dispersion of those variables, the standard deviation (SD), minimum, maximum, the 25th (P25), and 75th (P75) percentiles were calculated.

The normal distribution for each variable was assessed using Shapiro–Wilk and Kolmogorov–Smirnov tests. Statistical significance was defined at $p < 0.05$.

Results of waist circumference and WHR were classified by theirs risks of disease and cross-tabulated with BMI obesity classification. The results are presented as relative frequencies of each crossed class.

Results of categorical variables of lifestyle such as alcohol drinking, smoking, and sport practice were presented as relative frequency. Sport types were classified into two major groups: sport needs sport club and others with no sport club.

Diet habits were studied using the MedDietScore concept and the adherence of participants to classes of MedDietScore was evaluated by the relative frequency of each class and their odds ratios of having coronary heart disease proposed by Panagiotakos et al. were joined (Panagiotakos, Milias, Pitsavos, & Stefanadis, 2006).

The mean and the SD of MedDietScore score were calculated. To determine diet habits of participants, relative frequency of consumption of each food type category was calculated and presented as percentages.

Moreover, assuming that a score equal to 55 represents 100% adherence to the Mediterranean dietary pattern and the score of MedDietScore is equal to (k), the total adherence to the MedDietScore was evaluated as (k/55) × 100%. Furthermore, assuming that the score of a type of food is equal to (h), the adherence of each food type was estimated as (h/5) × 100%. Hence, detailed pattern of adherence to the MedDietScore was evaluated.

MedDietScore scores and frequencies of different food types' consumption of participants were grouped by low, normal, and high levels of clinical chemistry and hematological reference values of American College of Physicians (2015).

To note any differences between groups in frequencies of different food types' consumption, Wilcoxon rank sum test (non-parametric) and t-test for independent samples were preformed.

To recognize food and other measurement patterns among participants, principle component analysis could not be applied because the validity of all possible correlation matrices and samples sizes' (number of participants into different groups) tests showed too little correlation between variables (calculated Bartlett's test for homogeneity of variance p-values were more than 0.05).

Hence, to observe group differences in the tendency of participants to associate between two food types (diet pattern), pairwise Pearson's correlation coefficients for the various food types were calculated for all groups. One sample hypothesis testing for correlation (t-test) was used to evaluate the importance of correlation coefficient values.

Finally, without the assumption of binormality between two variables or any particular distribution, a non-parametric correlation coefficient was needed. The widely used Kendall's tau-b coefficient is easier to understand, interpret, and explain than other correlation coefficients.

Kendall's tau-b correlation coefficients between all pairs of variables were calculated and hypothesis testing for Kendall's tau-b using normal approximation was used to evaluate the importance of correlation coefficient values. Statistical significance was defined at $p < 0.05$. Excel software 2007 (Microsoft) was used for the statistics calculations.

3. Results

3.1. Anthropometric and clinical descriptive characteristics

Two hundred and six healthy university female students (18–25 years old) participated in this study. 72.8% of the sample was 21–25 years old. Table 1 shows characteristics of the participants which include age (year), height (cm), weight (kg), waist circumference (cm), hip circumference (cm) in addition to systolic and diastolic blood pressure values, pulse, BMI, and WHR.

Waist circumference is an indicator of health risk associated with excess fat around the waist. A waist circumference greater than 88 cm (35 inches) in women is associated with health problems such as type 2 diabetes, heart disease, and high blood pressure (Canadian Diabetes Association, 2015; Health Direct-Australia, 2014; National Heart, Lung, and Blood Institute, 2015). Taken together, waist circumference and BMI, risk levels could be presented as is shown in Table 2.

Table 1. Clinical descriptive characteristics of participants (n = 206), results are presented as mean ± SD, P50 (P25–P75), minimum, and maximum. Damascus, Syria, September 2014

Characteristic, Unit	Mean ± SD	P50 (P25–P75)	Minimum	Maximum
Age, year	21.81 ± 1.84[§]	22 (21–23)	18	25
Weight, kg	60.47 ± 7.76[ʃ]	59.35 (54.6–65.8)	38.1	107
Height, cm	162.61 ± 5.58[*,#]	163 (159–166)	149	180
BMI, kg/cm²	23.04 ± 3.38[#]	22.42 (20.70–24.69)	16.49	35.34
Waist, cm	77.91 ± 6.35[ʃ]	77 (73–82)	61	111
Hip, cm	92.39 ± 6.60[ʃ]	91 (87–97)	63	190
WHR, ratio	0.84 ± 0.04[ʃ]	0.85 (0.82–0.87)	0.4	1.17
Systolic bp[†], mmHg	110.53 ± 12.38[§]	110 (100–120)	90	140
Diastolic bp[†], mmHg	72.04 ± 10.06[§]	70 (70–80)	50	90
Diff bp[‡], mmHg	38.50 ± 10.37[§]	40 (30–40)	20	70
Pulse, b/min	79.56 ± 10.36[ʃ]	80 (70–86)	58	120

Note: SD, P50, P25, and P75 are standard deviation, median, 25th, and 75th percentiles of participants, respectively.

[§]No normal distribution, mean ± SD was cited without any further interpretation.

[ʃ]After the elimination of 9–12 outliers, which were out the range of 2.5th and 97.5th percentiles, the normal distribution was proved using Kolmogorov–Smirnov test ($p < 0.05$). Only mean ± SD were recalculated.

*Normal distribution was proved by Shapiro–Wilk test ($p < 0.05$).

[#]Normal distribution was proved by Kolmogorov–Smirnov test ($p < 0.05$).

[†]bp: Blood pressure.

[‡]Diff bp: Difference between systolic and diastolic blood pressures.

As shown in Table 3, overweight and obesity frequency in our study group was 22.34%; waist circumference levels more than 88 cm were present in 10.2% of the participants.

World Health Organization (WHO) states that abdominal obesity for females is defined as a WHR equal to or above 0.85, or a BMI above 30 (World Health Organization, 2011b). As shown in Table 3, results of WHR showed a high frequency of abdominal obesity, 47.6%.

Table 2. Relative frequencies (%) of disease risk for type 2 diabetes, hypertension, and CVD associated with BMI and waist circumference (National Heart, Lung, and Blood Institute, 2015) among participants (n = 206). Damascus, Syria, September 2014

BMI (kg/m²)	Class	Relative frequency (%)	Waist circumference	
			≤88 (cm)	>88 (cm)
			Relative frequency (Disease risk*)	
			89.80 (%)	10.20 (%)
<18.5	Underweight	2.90	2.90 (Non)	0.00 (§)
18.5–24.9	Normal	74.76	73.79 (Non)	0.97 (§)
25.0–29.9	Overweight	18.94	12.14 (Increased)	6.80 (High)
30.0–34.9	Obese I	2.91	0.97 (High)	1.94 (Very high)
35.0–39.9	Obese II	0.49	0.00 (Very high)	0.49 (Very high)
40 or greater	Extremely Obese III	0.00	0.00 (Extremely high)	0.00 (Extremely high)

*Disease risk relative to normal weight and waist circumference.

[§]Increased waist circumference also can be a marker for increased risk, even in persons of normal weight.

Table 3. Relative frequencies (%) of WHR and BMI along with weight classes (World Health Organization,) among participants (*n* = 206). Damascus, Syria, September 2014

BMI (kg/m²)	Class	Relative frequency (%)	WHR	
			<0.85	≥0.85
			Relative frequency	
			52.42 (%)	47.58 (%)
<18.5	Underweight	2.90	2.90	0.00
18.5–24.9	Normal	74.76	40.29	34.47
25.0–29.9	Overweight	18.94	7.77	11.17
30.0–34.9	Obese I	2.91	0.97	1.94
35.0–39.9	Obese II	0.49	0.49	0.00
40 or greater	Extremely Obese III	0.00	0.00	0.00

3.2. Lifestyle factors

3.2.1. Alcohol drinking, smoking, and physical activity

As shown in Table 4, alcohol drinking was highly avoided in our study group, 94.17% of the participants do not consume alcohol. As for smoking, 70.87% of the participants were non-smokers, 27.67% were hubble-bubble smokers, and 2% were cigarette smokers. Our results also demonstrated that approximately 63% of the participants exercise sport daily.

3.2.2. Adhesion to Mediterranean diet

The overall MedDietScore score was normally distributed with mean and SD equal to 27.03 ± 4.40 which reflects 49.14 ± 8% adherence of participants to the Mediterranean dietary pattern proposed by MedDietScore.

MedDietScore approach distinguished five classes of score values and related them with the risk of having coronary heart disease. As shown in Table 5, 80.1% of participants had score levels between 23 and 34 (3rd class). Participants in this class incur 1.42 times higher risk of developing some cardiovascular disease in the future, than someone with same age and clinical characteristics who however had excellent adherence to Mediterranean dietary pattern (Panagiotakos, Milias, et al., 2006).

Overall relative frequencies of consumption of local diet for food types included in Mediterranean pattern diet are shown in Table 6. In contrast to olive oil consumption, alcoholic beverages were not

Table 4. Relative frequencies (%) of alcohol drinking, smoking, and sport habit characteristics among participants (*n* = 206). Damascus, Syria, September 2014

	Habit				
Characteristic	**Non (%)**	**Rarely (%)**	**Monthly (%)**	**Weekly (%)**	**Daily (%)**
Alcohol drinking	94.17	5.83	0.00	0.00	0.00
Smoking	70.87	14.56	0.00	11.17	3.40
Smoking by tobacco type					
Hubble-bubble* (27.67%)	0.00	14.56	0.00	11.17	1.94
Cigarette (1.46%)	0.00	0.00	0.00	0.00	1.46
Sport	27.67	0.49	0.97	7.77	63.11
Sport practices that need					
No sport club (54.37%)	0.00	0.49	0.00	3.40	50.49
Sport club (17.96%)	0.00	0.00	0.97	4.37	12.62

*Water pipes, Shisha, Nargile, and hookah have similar structures in which the smoke passes through water, causing a bubbling sound.

a daily part of local diet. For the other components, the maximum relative frequencies were between 30 and 53%; hence, it is difficult to determine a specific pattern of consumption.

None of the weekly or daily frequencies of the food types consumed had a normal distribution; hence, the median, 25th, and 75th percentiles of participants were used to evaluate the adherence of dietary pattern adopted by our studied group to the MedDietScore-recommended diet pattern.

As shown in Figure 1, consumption of olive oil at high levels was a point in common between the two patterns. Depicting the group enclosed between 25th and 75th percentiles of participants, red

Table 5. Adherence of participants (*n* = 206) to classes of score of MedDietScore and their odds ratios of having coronary heart disease proposed by Panagiotakos et al. (2006). Damascus, *Syria*, September *2014*

Score of MedDietScore	Frequency (%)	Odds ratio*
0–11	0.00	2.17
12–22	16.02	1.63
23–34	80.10	1.42
35–44	3.88	1.01
45–55 "excellent" adherence	0.00	1

*Assuming the highest class as the one that describes "excellent" adherence to the Mediterranean dietary pattern, the odds ratio of having coronary heart disease for each class was calculated.

Table 6. Relative frequencies (%) of MedDietScore food categories' Panagiotakos et al. (2006) consumption for participants (*n* = 206). Damascus, Syria, September 2014

Non-refined cereals	Never	1–6	7–12	13–18	19–31	>32*
%	23.3	31.07§	11.17	7.77	11.17	15.53
Potatoes	Never	<1	1–2	3	4*	>4
%	0.49	20.39	48.54§	16.02	6.8	7.77
Fruits	Never	1–4	5–8	9–15	16–21	>22*
%	7.28	34.47§	30.58§	17.48	6.8	3.4
Vegetables	Never	1–6	7–12	13–20	21–32	>33*
%	0.97	34.47§	34.95§	14.08	5.83	9.71
Legumes	Never	<1	1–2	3–4	5–6	>6*
%	2.91	28.16	38.35§	21.84	5.34	3.4
Fish	Never	<1	1–2	3–4	5–6	>6*
%	20.87	52.91§	20.87	4.85	0	0.49
Red meat and products	≤1*	2–3	4–5	6–7	8–10	>10
%	28.16	43.69§	13.59	11.17	0.97	2.43
Poultry	≤3*	4–5	5–6	7–8	9–10	>10
%	43.7§	26.21	14.08	12.62	0.97	2.43
Full-fat dairy products	≤10*	11–15	16–20	21–28	29–30	>30
%	37.9§	14.08	13.11	9.71	6.31	18.93
Use of olive oil in cooking (times/week)	Never	Rare	<1	1–3	3–5	Daily*
%	0.49	4.37	2.91	8.74	13.11	70.39§
Alcoholic beverages (mL/day-100 mL = 12 g ethanol)	<300*	300	400	500	600	>700§§ or 0
%	3.4	0.49	0	0	0.49	95.63§

*Recommended consumption by MedDietScore.

§Highest frequency.

§§None of the participants reported a consumption over 700 mL of alcoholic.

meat and poultry adherence values were between 60 and 100%. To less agreement, adherence of potato consumption was between 40 and 60%. More broadly, adherence values of legumes, fruits, and vegetables' consumptions were between 20 and 60%. Non-refined cereals and full-fat dairy products' adherence values spread from 20 to 100%. Fish adherence values varied between 20 and 40%. Finally, understanding that the consumption of alcoholic beverage is not welcomed in the traditional societies, its adherence values were at lowest levels.

3.3. Results of laboratory analyses and relations to diet pattern

Results of several biochemical and hematological parameters, glucose, cholesterol, triglycerides, uric acid, alanine aminotransferase, red blood cell count, hemoglobin, and hematocrit, are reported in Table 7.

In the absence of Syrian reference ranges for the specified parameters, we compared our results with American College of Physicians' reference values (2015). The resulted groups of participants were detailed in Table 8.

Clearly, 42.7, 12.6, and 31.1% of participants had low levels of cholesterol, uric acid, and hemoglobin, respectively.

Wilcoxon rank sum test and *t*-test for independent samples ($p < 0.05$) showed that MedDietScore scores of participants of all groups were similar to overall MedDietScore score, and frequencies of different food types' consumption of groups of participants who had normal levels of measurements were similar to the corresponding overall frequencies, and in contrary, non-refined cereal was the only type of food that was significantly more consumed by participants who had low levels of uric acid. The last remark was reflected in a better adherence to consumption of non-refined cereal recommended by MedDietScore as presented by dashed and doted lines shown in Figure 1.

Figure 1. Median, 25th and 75th percentiles of participant adherence to food types of MedDietScore concept.

Notes: Vertical lines denote the median; horizontal lines represent participant's group enclosed between participants at 25th and 75th percentiles. Dashed line is the adherence of participant who has a normal value of uric acid and dotted line is the adherence of participant who has a low value of uric acid. American College of Physicians' (2011–2015) reference values were used. Damascus, Syria, September 2014.

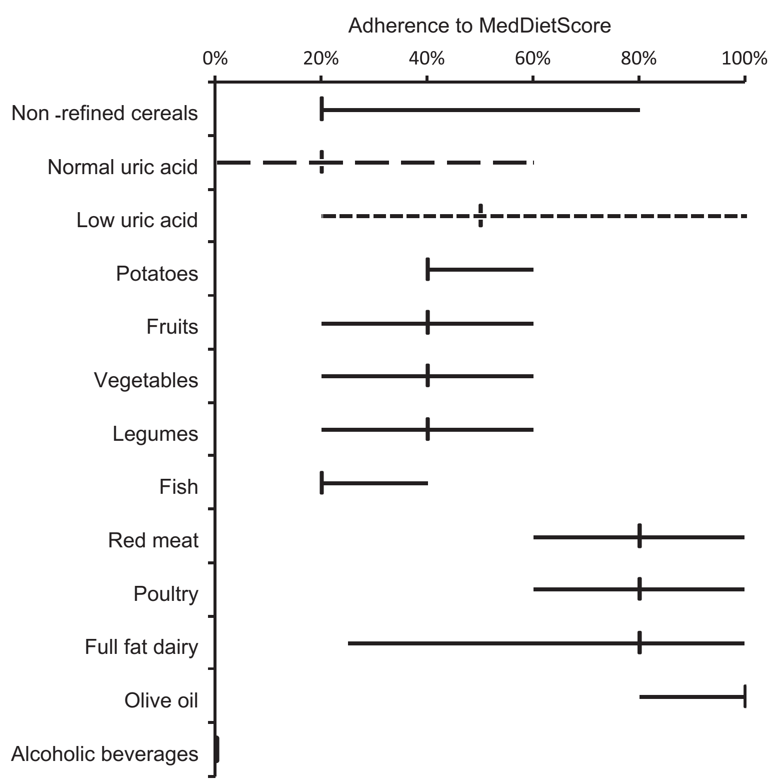

Table 7. Distribution of clinical chemistry and hematological characteristics of participants (*n* = 206), results are presented as mean ± SD or P50 (P25–P75), minimum, and maximum. Damascus, Syria, September 2014

Characteristic, Unit	Mean ± SD	P50 (P25–P75)	Minimum	Maximum
Glucose, mg/dL	85.25 ± 9.95[#]	86 (78.25–93)	56	112
Cholesterol, mg/dL	153.69 ± 29.07[*#]	152.5 (137–173.75)	50	230
Triglycerides, mg/dL	68.90 ± 18.25[ʃ]	66 (54.25–79)	34	220
Uric acid, mg/dL	3.34 ± 0.67[ʃ]	3.25 (2.825–4)	1.5	6
Alanine aminotransferase, IU/L	16.15 ± 4.11[*#]	16 (13–19)	3	28
Red blood cells, million/uL	4.85 ± 0.41[#]	4.81 (4.56–5.07)	3.91	7.13
Hemoglobin, g/dL	12.43 ± 1.36[#]	12.5 (11.72–13.38)	7	16
Hematocrit, %	40.15 ± 3.59[#]	40.8 (38.13–42.20)	27	50.6

Note: SD, P50, P25, and P75 are standard deviation, median, 25th, and 75th percentiles of participants, respectively.

[#]Normal distribution was proved by Kolmogorov–Smirnov test ($p < 0.05$).

*Normal distribution was proved by Shapiro–Wilk test ($p < 0.05$).

[ʃ]After the elimination of 9–12 outliers, which were out the range of 2.5th and 97.5th percentiles, the normal distribution was proved using Kolmogorov–Smirnov test ($p < 0.05$). Only mean ± SD were recalculated.

As previously mentioned (Statistical Analysis section), principle component analysis could not be applied to recognize food and other measurement patterns among participants.

As shown in Table 8, distinguishing in every group the significance and unique pairwise correlation coefficients for the various food types demonstrated that lower levels of cholesterol were found when consuming potatoes combined with legumes, or when fruits were associated with red meat or poultry, or when vegetables coupled with full-fat dairy or olive oil.

Also, uric acid levels were lower when potato consumption was inversely related to full-fat dairy. In addition, decreased levels of hemoglobin were found when non-refined cereals coupled with poultry, or when potatoes combined with legumes, or when full-fat dairy consumption was associated with legumes or poultry. Remarkably, in hemoglobin normal level group, a high significant correlation between fruits and vegetables' consumption was detected.

3.4. Correlation between anthropometric measurements, adherence to MedDietScore food's categories, and serum biomarkers' levels

As shown in Table 9, Kendall's tau-b correlation coefficient values were of weak to moderate strength, although highly significant ($p < 0.05$).

Results of correlation between BMI and each of weight and height, as well as for WHR and each of waist and hip circumferences were not reported due to the use of weight and height to calculate BMI, and the use of waist and hip circumferences in WHR calculation. The same is applied for MedDietScore score calculation dependent on frequency of food type consumption.

The more important correlation coefficient was found between BMI and each of waist and hip circumferences.

A weak and positive correlation was noted between systolic blood pressure and anthropometric measurements.

No correlation was found between adherence to MedDietScore score and any of anthropometric measurements or biomarkers' serum concentrations. As for adherence to food categories' style of consumption recommended by MedDietScore, our results demonstrated that the adherence to potato style of consumption was inversely correlated to anthropometric measurements.

Table 8. Participant numbers, relative frequencies (%), and correlation coefficients* between pairs of food types (diet patterns) were grouped by low, normal, and high levels of clinical chemistry and hematological reference values of ACP (n = 206). Damascus, Syria, September 2014**

	ACP	Low	Normal	High
Characteristic, Unit		**Number of participants (relative frequencies %)**		
Diet pattern		**Food type to pair with: Food type (correlation coefficient)[a, b, c], food type**		
Glucose, mg/dL	[70–100]	11 (5.3)	186 (90.3)	9 (4.4)
Diet pattern		†	§	†
Cholesterol, mg/dL	[150–199]	88 (42.7)	106 (51.5)	12 (5.8)
Diet pattern		Potatoes: Legumes (0.21)[c]	Non-refined cereals: Red meat (0.22)[b] and Poultry (0.24)[b]	†
		Fruits: Red meat (0.24)[b], Poultry (0.28)[b]	Potatoes: Poultry (0.21)[c]	
		Vegetables: Full-fat dairy (0.33)[b] and Olive oil (0.28)[b]	Poultry: Full-fat dairy (0.21)[c]	
Triglycerides, mg/dL	[0–150]	0 (0)	202 (98.1)	4 (1.9)
Diet pattern		†	§	†
Uric acid, mg/dL	[2.5–8]	26 (12.6)	180 (87.4)	0 (0)
Diet pattern		Potatoes: Full-fat dairy (−0.41)[b]	Non-refined cereals: Fruits (0.15)[c], in addition to §	†
ALAT, IU/L	[0–35]	0 (0)	206 (100)	0 (0)
Diet pattern		†	§	†
RBC, million/uL	[4.2–5.9]	4 (1.9)	199 (96.6)	3 (1.5)
Diet pattern		†	§	†
Hemoglobin, g/dL	[12–16]	64 (31.1)	142 (68.9)	0 (0)
Diet pattern		Non-refined cereals: Poultry (0.25)[c]	Potatoes: Poultry (0.21)[b]	†
		Potatoes: Legumes (0.29)[b]	Fruits: Vegetables (0.42)[a] and Legumes (0.17)[c]	
		Legumes: Full-fat dairy (0.27)[c]	Vegetables: Legumes (0.27)[b] and Olive oil (0.27)[b]	
		Poultry: Full-fat dairy (0.28)[b]		
Hematocrit, %	[36–47]	20 (9.7)	182 (88.3)	4 (1.9)
Diet pattern		†	§	†

Notes: ALAT: alanine aminotransferase, RBC: red blood cells.

*That had p-value < 0.05 and were not in common between groups of the same characteristic.

**American College of Physicians (2011–2015).

†Number of participants was not sufficient to identify any correlation.

§Similar to general diet pattern for all participants: Potatoes: Poultry (0.19)[b]. Fruits: Vegetables (0.35)[a] and Legumes (0.15)[c]. Vegetables: Legumes (0.24)[a] and Poultry (0.26)[a]; Full-fat dairy (0.25)[a] and Olive oil (0.19)[b]; and Red meat: Poultry (0.39)[a] and Poultry: Full-fat dairy (0.17)[b].

[a] p-value < 0.001.

[b] p-value < 0.025.

[c] p-value < 0.05.

Glucose levels were influenced by the level of adherence to MedDietScore recommendation for vegetables, poultry, and olive oil consumption. As for uric acid, a negative correlation was found with adherence to recommendation of non-refined cereals consumption. Serum levels of triglycerides were correlated to some anthropometric measurements.

4. Discussion

The present study was conducted on a group of apparently healthy young women in order to evaluate lifestyle factors and biomarkers related to cardio-metabolic risk factors.

Table 9. Notable correlation coefficients* between pairs of variables. Damascus, Syria, September 2014

First variable	Second variable (Kendall's tau-b correlation coefficient, *p*-value)
BMI	Waist circumference (0.61, <0.001)
	Hip circumference (0.60, <0.001)
	W/H ratio (0.14, 0.003)
Systolic blood pressure	Weight (0.26, <0.001)
	BMI (0.26, <0.001)
	Waist circumference (0.17, 0.001)
	Hip circumference (0.18, <0.001)
Potatoes	BMI (−0.17, 0.002)
	Waist circumference (−0.15, 0.006)
	Hip circumference (−0.20, <0.001)
Glucose	Vegetables (0.11, 0.033)
	Poultry (−0.12, 0.028)
	Olive oil (0.15, 0.005)
Uric acid	Non-refined cereals (−0.12, 0.028)
Triglycerides	Weight (0.11, 0.023)
	Waist circumference (0.14, 0.005)
	Hip circumference (0.11, 0.019)

*Only correlation coefficients that have *p*-value < 0.05 are demonstrated.

Our results demonstrated that levels of biomarkers like fasting glucose, triglycerides, alanine aminotransferase, uric acid, and some physiological measurements like blood pressure were all lower than the cut-offs for cardio-metabolic risk reported by several researchers (Bilal et al., 2011; De Oliveira, Moreto, de Arruda Silveira, & Burini, 2013; Ford, Li, Cook, & Choi, 2007; Hanley et al., 2005; Iravani et al., 2010; Paschos & Paletas, 2009; Shen et al., 2005; Yadav et al., 2009).

Alanine aminotransferase levels in our study (16.15 ± 4.11 IU/L) were by far lower from the upper normal value in women (35 IU/L) wildly used. Uric acid levels are gender and age correlated (University of Kentucky Medical Center, 2006). As expected for the group's age and gender, our results demonstrated low levels of uric acid and they were comparable with the results of a study conducted by Das, Borah, Ghose, and Choudhury (2014) in a group of healthy Indian women, aged between 31 and 40 years, where uric acid levels were 2.1–6.5 mg/dL.

In this group of childbearing age females, evaluation of some hematological parameters like red blood cells count, hemoglobin, and hematocrit revealed the presence of non-clinically apparent anemic status (hemoglobin concentrations < 12 g/dL). This is a serious condition since most cases of anemia are related to iron deficiency. Severe anemia among pregnant women resulting from iron deficiency is associated with an increased risk of maternal and fetal mortality and morbidity and of intrauterine growth retardation as mentioned by The Management of Nutrition in Major Emergencies, WHO 2000, and Worldwide Prevalence of Anemia, 1993–2005, WHO global database on anemia (WHO, 2011a, 2011c).

In agreement with our study, hematological indices' values in a study on a group of healthy women in Kenya (n = 83, aged between 18 and 34 years) were lower than those derived from North American population as noted by Zeh et al. (2011).

The increasing prevalence of overweight and obesity is a major public health problem worldwide. Waist circumference is an indicator of health risk associated with excess fat around the waist (central obesity). A waist circumference of 88 cm (35 inches) or more in women is associated with health problems such as type 2 diabetes, heart disease, and high blood pressure (Canadian Diabetes Association, 2015).

In our study group, 18.94% of the participants were overweight (25 ≤ BMI ≤ 29.9) and 3.4% obese (BMI ≥ 30). Similar results were found in a study conducted by El-Qudah, Dababneh, Al-Qudah, and Haddad (2013) where 13.6% were overweight and 11.4% were obese. Ghalaeh, Gholi, Bank, and Azadbakht (2012) reported results for BMI > 25 equal to 9.8%.

Bener et al. (2013) mentioned that while indices of abdominal obesity are waist circumference and/or WHR, studies have different conclusions regarding the superiority of one or the other to diagnose obesity and hence metabolic syndrome.

Abdominal obesity defined as waist circumference > 88 cm in women was present in 10.2% of the participants. If its definition as WHR > 0.85 was considered, a high frequency (47%) was found in our group. Hence, abdominal obesity was the only cardio-metabolic risk factor detected in the study group.

It seems that the level of sport exercising in our study group was not enough to prevent highly frequent abdominal obesity. In addition, because of cultural and local traditional reasons, some sport types like swimming and aerobics could be only practiced in sport clubs, somewhat expensive, where other types of sport like walking could be practiced anywhere. In our study group, only 17.9% of participants go to sport clubs. It was suggested earlier by Przybyłowicz and Wądołowska (2009) that regular aerobic exercise (walking and jogging) has not resulted in significant reductions in metabolic syndrome criteria (fat loss).

For smoking habits, although cigarette smoking is the most common type of tobacco used worldwide, hubble-bubble smoking is spreading globally to affect Arab and Western societies. Several studies have demonstrated a 2 to 38% prevalence of hubble-bubble among female university students in many Arab countries. Unfortunately, as mentioned by Dar-Odeh and Abu-Hammad (2011), the risk of having babies of low birth weight almost triples among those who smoke hubble-bubble in the first trimester. These babies have a higher proportion of other problems, such as pulmonary diseases. The study of Maziak et al. (2004) in a group of Syrian university female students showed a hubble-bubble frequency of 4.9%. In our study, almost 27.7% of participants were hubble-bubble smokers and less than 2% were cigarette smokers. Hence, this habit had spread, wildly, between 2004 and 2014 in Syria.

The diet behavior was documented in our study group in order to assess the association between diet behavior and the cardio-metabolic risk factors.

In comparison with MedDietScore, the daily high frequency of consuming olive oil was a positive sign of good adherence of participants to Mediterranean diet. In contrary, red meat, poultry, and full-fat dairy products were wildly consumed.

Unfortunately, fiber and vitamins sources (fruits, vegetables, legumes, and non-refined cereals), in addition to omega 3 oils' source (fish), were less frequently consumed, which may be the price of modernization and the trend of youth toward fast food. Salameh et al. (2014) conducted a study in Lebanon, on 3,384 university students; three different dietary patterns were identified. These results emphasis the difficulty to determine a specific pattern of consumption that we noted in our study.

Tesfaye et al. (2007) and Ying, Song, Zhao, and Jiang (2010) have demonstrated that overweight and obesity increase the risks of high blood pressure. Similarly, our results have shown a positive correlation between systolic blood pressure and anthropometric measurements like BMI, weight, waist circumference, and hip circumference.

Mediterranean diet is one of the most popular diets for healthy eating in addition to Dietary Approaches to Stop Hypertension (DASH), which was developed to fight high blood pressure, and, Therapeutic Lifestyle Changes (TLC), which is a diet plan created by the National Institutes of Health as a heart-healthy regimen that can reduce the risk of cardiovascular disease (U.S. News & World Report L.P, 2016).

Each diet is classified following its safety, effectiveness, expense, and lifestyle factors. Not being adherent to a diet does not necessarily mean it's an unhealthy diet or vice versa.

In our study, the fact that MedDietScore score did not correlate with any of the anthropometric measurements or biomarkers' serum concentrations could be explained by real differences in dietary patterns among participants. In addition, the absence of correlation between MedDietScore score and other measurements makes us cautious to accept the interpretation of the 3rd class of MedDietScore score as mentioned before in our diet results.

Nevertheless, BMI, waist, and hip circumferences were inversely correlated with adherence to potato consumption. This result is in accordance with results reported by Halkjær, Tjønneland, Thomsen, Overvad, and Sørensen (2006), of a prospective study of the associations between diet and subsequent changes in waist circumference in a large population-based (n = 22,570) cohort of middle-aged women (50–64 years), and followed up for five years that demonstrated a clear and significant positive association between intake of carbohydrates from refined grain and potatoes and changes in waist circumference.

Adherences to some diet components included in MedDietScore were weakly correlated with serum levels of glucose and uric acid.

While Al-Jamal and Ibrahim (2011) reported that the consumption of olive oil significantly lowered the levels of fasting blood glucose in control and diabetic patients with dyslipidemia groups, our results demonstrated that high adherence to olive oil or to vegetables was positively correlated with glucose levels in serum, although still in the normal range. These inconsistent findings may be due in part to that single-nutrient approach which is limited by colinearity among nutrients and by an inability to detect small effects from single nutrients as noted by Newby et al. (2003).

In our study, the negative correlation between adherence to poultry consumption and glucose levels is compatible with Dietary Guidelines for Diabetes published by California Pacific Medical Center (California Pacific Medical Center, 2015).

Our results for triglycerides' levels in serum and their correlation with weight, waist, and hip circumferences are in accordance with a study enrolled by Özkaya, Bavunoglu, and Tunçkale (2014) in Turkey on adult women (n = 2,652), where positive correlation was found between abdominal circumference with triglycerides ($r = 0.24$, $p < 0.05$) and also a positive correlation between BMI with triglycerides ($r = 0.20$, $p < 0.001$).

It is worth to notify that low levels of cholesterol, uric acid, and hemoglobin groups of participants showed unique and significant combinations between two types of foods (diet patterns) and only the low levels of uric acid group demonstrated a significant increase in consumption of non-refined cereals.

More closely, combinations of: fruits with red meat or poultry, potatoes with legumes, or vegetables with full-fat dairy or olive oil could play a role in lowering cholesterol levels. Olive oil had positive effects on lipid profile and blood glucose level in both healthy controls and type 2 diabetic patients as shown by Al-Jamal and Ibrahim (2011). In a cross-sectional study, conducted by Djoussé et al. (2004), it was found that consumption of fruits and vegetables was inversely related to LDL-cholesterol concentrations in men and women. Bazzano, Thompson, Tees, Nguyen, and Winham

(2011) have shown in a meta-analysis of randomized controlled trials that non-soy legume consumption lowers serum total and LDL cholesterol. As for the effect of full-fat dairy on cholesterol levels, Huth and Park (2012) have indicated that a diet higher in saturated fats from whole milk and butter increases LDL; however, they may also increase HDL and therefore might not affect or even lower the total cholesterol:HDL cholesterol ratio. Hence, our results are in accordance with results in literature and the fact of combined consumption of foods lowering cholesterol.

As for uric acid levels, 12.6% of participants had uric acid levels in the range of 2–2.5 mg/dL and revealed a negative correlation between potatoes and full-fat dairy intake. Schmidt, Crowe, Appleby, Key, and Travis (2013) had demonstrated that vegetarians (who eat dairy products and eggs) had low serum uric acid concentrations. Also, our results showed that the adherence of participants to non-refined cereals consumption recommended by MedDietScore was more important in case of low levels of uric acid. These compounds are low in purines as cited by Patient website in its Gout Diet Sheet (Patient Website, 2015).

Finally, decreased hemoglobin levels were associated with non-refined cereals coupled with poultry, or when potatoes combined with legumes, or when full-fat dairy was associated with legumes or poultry. These combinations are not sufficiently rich sources of iron to replace menstrual blood loss. Beck, Conlon, Kruger, and Coad (2014) have indicated that plant-based diets have reduced levels of iron bioavailability (no meat or increased phytic acid from plant foods), and individuals following these diets are likely to have higher iron requirements.

On the other hand, the distinguished high significant correlation between the fruits and vegetables' consumption in hemoglobin normal level group is in accordance with a well-known study of Gillooly et al. (1983) that demonstrated the effect of vitamin C and other organic acids in fruits and vegetables in enhancing the absorption of iron from plant source.

5. Conclusion

The Mediterranean diet has been shown to be a healthy diet in the literature. However, it is not the only healthy diet, and many factors can influence how healthy a diet is. Although the present study showed no correlation between adherence and MedDietScore score and any of anthropometric measurements or biomarkers' levels in serum, it demonstrated how MedDietScore concept by its simple idea of a good traditional diet and its ease of application could be considered as a standard tool for diet studies.

Apparently, frequency of consumption of one type of food could be related with the measurement of one biochemical parameter (such as non-refined cereal consumption was inversely correlated with levels of uric acid). More interestingly, some correlation pairs of consumption of food types could be associated with levels of biochemical or hematological parameters (such as fruits and vegetables' correlation pair of consumption associated with hemoglobin normal level).

Finally, in Syria, young women, in reproductive age, should consider a healthy lifestyle and an equilibrate diet of plant and animal resources in order to avoid obesity outcomes or anemia consequences.

6. Limitations

The most important limitation is the cross-sectional design which prohibited causal interpretations. This design does not allow inference about the temporal relation between diet and differences in abdominal obesity measures, which is needed to build up evidence for prevention.

Another limitation is that the observed findings were based on small group of female students, with a good economical level of live, not suffering from diseases that might have influenced the levels of studied hematological and biochemical markers, in addition to diet miss-reporting that may always exist through dietary evaluation method.

Abbreviations

AIU	Arab International University
BMI	body mass index (kg/m^2)
WHO	World Health Organization
WHR	waist to hip ratio

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References

Al-Jamal, A. R., & Ibrahim, A. (2011). Effects of olive oil on lipid profiles and blood glucose in type 2 diabetic patients. *International Journal of Diabetes & Metabolism, 19*, 19–22.

American College of Physicians. (2011–2015). *Normal lab values reference table*. Retrieved March 21, 2015, from http://im2015.acponline.org/for-meeting-attendees/normal-lab-values-reference-table

Bazzano, L. A., Thompson, A. M., Tees, M. T., Nguyen, C. H., & Winham, D. M. (2011). Non-soy legume consumption lowers cholesterol levels: A meta-analysis of randomized controlled trials. *Nutrition, Metabolism, and Cardiovascular Diseases, 21*, 94–103. http://dx.doi.org/10.1016/j.numecd.2009.08.012

Beck, K., Conlon, C., Kruger, R., & Coad, J. (2014). Dietary determinants of and possible solutions to iron deficiency for young women living in industrialized countries. *Nutrients, 6*, 3747–3776. http://dx.doi.org/10.3390/nu6093747

Bener, A., Yousafzai, M. T., Darwish, S., Al-Hamaq, A. O., Nasralla, E. A., & Abdul-Ghan, M. (2013). Obesity index that better predict metabolic syndrome: Body mass index, waist circumference, waist hip ratio, or waist height ratio. *Journal of Obesity*. Retrieved March 20, 2015, from http://www.hindawi.com/journals/jobe/2013/269038/

Bilal, M., Tariq, A., Quratulain, S. K., Tariq, A., Shahid, M. F., Khan, M. W., … Naveed, A. (2011). Influence of gender, BMI, and ethnicity on serum ALT levels of healthy student of a medical school. *Journal of Ayub Medical College, Abbottabad, 23*, 70–72.

California Pacific Medical Center. (2015). *Dietary guidelines for diabetes*. Retrieved April 2, 2015, from http://www.cpmc.org/learning/documents/diabetes-diet-ws.pdf

Canadian Diabetes Association. (2015). *Weight management, clinical practice guidelines*. Retrieved March 20, 2015, from http://www.diabetes.ca/diabetes-and-you/healthy-living-resources/weight-management

Central Bureau of Statistics. (2015). *Individuals distribution by age groups and gender*. Retrieved March 20, 2015, from http://www.cbssyr.sy/peoplestatistics/popmoh.pdf

Dar-Odeh, N. S., & Abu-Hammad, O. A. (2011). The changing trends in tobacco smoking for young Arab women, narghile, an old habit with a liberal attitude. *Harm Reduction Journal, 8*, 24. http://dx.doi.org/10.1186/1477-7517-8-24

Das, M., Borah, N. C., Ghose, M., & Choudhury, N. (2014). Reference ranges for serum uric acid among healthy assamese. *Biochemistry Research International*. Retrieved March 20, 2015, from http://www.hindawi.com/journals/bri/2014/171053/

De Oliveira, E. P., Moreto, F., de Arruda Silveira, L. V., & Burini, R. C. (2013). Dietary, anthropometric, and biochemical determinants of uric acid in free-living adults. *Nutrition Journal, 12*, 11. http://dx.doi.org/10.1186/1475-2891-12-11

Djoussé, L., Arnett, D. K., Coon, H., Province, M. A., Moore, L. L., & Curtis, E. R. (2004). Fruit and vegetable consumption and LDL cholesterol: The National Heart, Lung, and Blood Institute Family Heart Study. *American Journal of Clinical Nutrition, 79*, 213–217.

El-Qudah, J. M., Dababneh, B. F., Al-Qudah, M. M., & Haddad, M. (2013). Serum Vitamin B12 levels related to weight status among healthy Jordanian students. *Laboratory Medicine, 44*, 34–39. http://dx.doi.org/10.1309/LMG2E7PEDHET5QVI

Ford, E. S., Li, C., Cook, S., & Choi, H. K. (2007). Serum concentrations of uric acid and the metabolic syndrome among US children and adolescents. *Circulation, 115*, 2526–2532. http://dx.doi.org/10.1161/CIRCULATIONAHA.106.657627

Ghalaeh, R. S., Gholi, Z., Bank, S. S., & Azadbakht, L. (2012). Fruit and vegetable intake, body mass index and waist circumference among young female students in Isfahan. *Journal of Health Education and Promotion, 1*, 29. doi:10.4103/2277-9531.99969.

Gillooly, M., Bothwell, T. H., Torrance, J. D., MacPhail, A. P., Derman, D. P., Bezwoda, W. R., … Charlton, R. W. (1983). The effects of organic acids, phytates, and polyphenols on the absorption of iron from vegetables. *British Journal of Nutrition, 49*, 331–342. http://dx.doi.org/10.1079/BJN19830042

Halkjær, J., Tjønneland, A., Thomsen, B. L., Overvad, K., & Sørensen, T. I. (2006). Intake of macronutrients as predictors of 5-years changes in waist circumference. *American Journal of Clinical Nutrition, 84*, 789–797.

Hanley, A. J. G., Williams, K., Festa, A., Wagenknecht, L. E., D'Agostino, R. B., & Haffner, S. M. (2005). Liver markers and development of the metabolic syndrome -the insulin resistance atherosclerosis study. *Diabetes, 54*, 3140–3147. http://dx.doi.org/10.2337/diabetes.54.11.3140

Health Direct-Australia. (2014). *Body mass index (BMI) and waist circumference*. Retrieved March 20, 2015, from http://www.healthdirect.gov.au/body-mass-index-bmi-and-waist-circumference

Huffman, K. M., Sun, J. L., Thomas, L., & Bales, C. W. (2014). Impact of baseline physical activity and diet behavior on metabolic syndrome in a pharmaceutical trial: Results from NAVIGATOR. *Metabolism, 63*, 554–561. http://dx.doi.org/10.1016/j.metabol.2014.01.002

Huth, P. J., & Park, K. M. (2012). Influence of dairy product and milk fat consumption on cardiovascular disease risk: A review of the evidence. *Advances in Nutrition: An International Review Journal, 3*, 266–285. http://dx.doi.org/10.3945/an.112.002030

Iravani, Sh, Sabayan, B., Sedaghat, S., Heydari, S. T., Javad, P., Lankarani, K. B., & Khoshdel, A. R. (2010). The association of elevated serum alanine aminotransferase with metabolic syndrome in a military population in Southern Iran. *Iranian Cardiovascular Research Journal, 4*, 74–80.

Maziak, W., Eissenberg, T., Rastam, S., Hammal, F., Asfar, T., Bachir, M. E., … Ward, K. D. (2004). Beliefs and attitudes related to narghile (waterpipe) smoking among university students in Syria. *Annals of Epidemiology, 14*, 646–654. http://dx.doi.org/10.1016/j.annepidem.2003.11.003

Medichem Middle East-in-vitro Diagnostic Products and Automated Analyzers. (2015). *Medichem-Middle East for clinical chemistry reagents*. Retrieved April 2, 2015, from http://www.medichem-me.com

National Heart, Lung, and Blood Institute. (2015). *Classification of overweight and obesity by BMI, waist circumference, and associated disease risks*. Retrieved March 12, 2015, from http://www.nhlbi.nih.gov/health/educational/lose_wt/BMI/bmi_dis.htm

Newby, P. K., Muller, D., Hallfrisch, J., Qiao, N., Andres, R., & Tucker, K. L. (2003). Dietary patterns and changes in body mass index and waist circumference in adults. *American Journal of Clinical Nutrition, 77*, 1417–1425.

Özkaya, İ., Bavunoglu, I., & Tunçkale, A. (2014). Body mass index and waist circumference affect lipid parameters negatively in Turkish women. *American Journal of Public Health Research, 2*, 226–231.

Panagiotakos, D., Milias, G. A., Pitsavos, C., & Stefanadis, C. (2006). MedDietScore: A computer program that evaluates the adherence to the Mediterranean dietary pattern and its relation to cardiovascular disease risk. *Computer Methods and Programs in Biomedicine, 83*, 73–77. http://dx.doi.org/10.1016/j.cmpb.2006.05.003

Panagiotakos, D., Kalogeropoulos, N., Pitsavos, C., Roussinou, G., Palliou, K., Chrysohoou, C., & Stefanadis, C. (2009). Validation of the MedDietScore via the determination of plasma fatty acids. *International Journal of Food Sciences and Nutrition, 60*, 168–180. http://dx.doi.org/10.1080/09637480902810338

Panagiotakos, D., Pitsavos, C., & Stefanadis, C. (2006). Dietary patterns: A Mediterranean diet score and its relation to clinical and biological markers of cardiovascular disease risk. *Nutrition, Metabolism and Cardiovascular Diseases, 16*, 559–568. http://dx.doi.org/10.1016/j.numecd.2005.08.006

Paschos, P., & Paletas, K. (2009). Non alcoholic fatty liver disease and metabolic syndrome. *Hippokratia, 13*, 9–19.

Patient Website. (2015). *Gout diet sheet*. Retrieved April 2, 2015, from www.patient.co.uk/health/gout-diet-sheet

Poon, V. T. W., Kuk, J. L., & Ardern, C. I. (2014). Trajectories of metabolic syndrome development in young adults. *PLoS ONE, 9*, e111647. http://dx.doi.org/10.1371/journal.pone.0111647

Przybyłowicz, K., & Wądołowska, L. (2009). Biochemical and anthropometrical parameters and physical activity of women–A short report. *Polish Journal of Food and Nutrition Sciences, 59*, 271–273.

Randox Laboratories. (2015). *Diagnostic reagents–Randox Laboratories*. Retrieved April 14, 2015, from http://www.randox.com

Salameh, P., Jomaa, L., Issa, C., Farhat, G., Salamé, J., Zeidan, N., & Baldi, I. (2014). Assessment of dietary intake patterns and their correlates among university students in Lebanon. *Front Public Health, 2*, 185. doi:10.3389/fpubh.2014.00185

Schmidt, J. A., Crowe, F. L., Appleby, P. N., Key, T. J., & Travis, R. C. (2013). Serum uric acid concentrations in meat eaters, fish eaters, vegetarians and vegans: A cross-sectional analysis in the epic-oxford cohort. *PLoS ONE, 8*, e56339. http://dx.doi.org/10.1371/journal.pone.0056339

Shen, Y., Yang, W., Lee, T., Lee, L., Chen, C., & Huang, K. (2005). Bright liver and alanine aminotransferase are associated with metabolic syndrome in adults. *Obesity Research, 13*, 1238–1245. http://dx.doi.org/10.1038/oby.2005.147

Tesfaye, F., Nawi, N. G., Van Minh, H., Byass, P., Berhane, Y., & Bonita, R., Wall, S. (2007). Association between body mass index and blood pressure across three populations in Africa and Asia. *Journal of Human Hypertension, 21*, 28–37. http://dx.doi.org/10.1038/sj.jhh.1002104

University of Kentucky Medical Center. (2006). *Clinical Lab Reference Range Guide*. Retrieved March 21, 2015, from www.hosp.uky.edu/Clinlab/report.pdf

U.S. News & World Report L.P. (2016). *Best diet for healthy eating*. Retrieved March 3, 2016, from http://health.usnews.com/best-diet/best-healthy-eating-diets

World Health Organization. (2011a). *The management of nutrition in major emergencies*. Geneva: Author. Retrieved April 12, 2015, from http://whqlibdoc.who.int/publications/2000/9241545208.pdf

World Health Organization. (2011b, December 8–11). *Waist circumference and waist–hip ratio* (Report of a WHO expert consultation). Geneva. Retrieved March 20, 2015, from http://whqlibdoc.who.int/publications/2011/9789241501491_eng.pdf

World Health Organization. (Eds.). (2011c). *Worldwide Prevalence of Anemia 1993–2005: WHO global database on anemia*. Geneva. Retrieved April 2, 2015, from http://whqlibdoc.who.int/publications/2008/9789241596657_eng.pdf

Yadav, B. K., Chhetri, G. B., Poudel, B., Sigdel, M., Gyawali, P., Regmi, P., & Shrestha, R. (2009). Serum uric acid level in obese and non-obese individuals. *JNAMLS, 10*, 27–30.

Ying, X., Song, Z. Y., Zhao, C. J., & Jiang, Y. (2010). Body mass index, waist circumference, and cardiometabolic risk factors in young and middle-aged Chinese women. n2u*Journal of Zhejiang University Science B, 11*, 639–646. http://dx.doi.org/10.1631/jzus.B1000105

Zeh, C., Amornkul, P. N., Inzaule, S., Ondoa, P., Oyaro, B., Mwaengo, D. M., … Laserson, K. (2011). Population-based biochemistry, immunologic and hematological reference values for adolescents and young adults in a rural population in western Kenya. *PLoS ONE, 6*, e21040. http://dx.doi.org/10.1371/journal.pone.0021040