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Original Research Article

The difference in antioxidant vitamins consumption between obese and non-obese individuals

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Abstract

Obesity has been associated with a markedly increased oxidative stress: it is characterized by higher levels of reactive oxygen or nitrogen species. Antioxidant vitamins (vitamin A, C and E), among other components, play a big role in the protection against oxidative stress. Literature shows that obese have lower rates of antioxidant defenses than non-obese. In this study, we aimed to measure the dietary antioxidant vitamin intakes and compare them between obese and non-obese. A validated thirty-four items semi-quantitative food frequency questionnaire SQFFQ was used on 500 Lebanese (330 non-obese and 170 obese) aged 18–62 years old, it covers the major sources of dietary antioxidant vitamins in Lebanon. The participants were recruited from the database of dietary clinics in rural and urban regions. Anthropometric parameters were measured according to standardized protocols. Total energy intake, gender and age were adjusted for 250 participants (166 non-obese and 84 obese). The means of daily consumption of vitamin A, C and E were lower for obese individuals compared to non-obese counterparts. The differences between the daily consumption of antioxidant vitamins for non-obese *vs.* obese individuals were highly significant (Student's' *t*-Test, p = 0 <0.01). Nevertheless, according to Pearson correlation, there is no significant correlation between the BMI and the daily vitamin consumption for vitamin A, C and E for non-obese and obese participants. Furthermore, this results were highly significant after caloric adjustment for 250 participants. There is no significant correlation between the age and the daily consumption of antioxidant vitamins for the two groups obese and non-obese; additionally, there is no difference in gender in these two groups regarding the results. Accordingly, maintaining a healthy lifestyle with a balanced diet rich in antioxidants, is associated with reduced oxidative stress. Unfortunately, this protection is less effective in obese with decreased consumption of dietary antioxidants.

Keywords: Obesity, Antioxidant, Vitamins, SQFFQ, Nutrition Assessment

INTRODUCTION

Evidence is mounting that obesity has been associated with a markedly increased oxidative stress that is characterized by an imbalance between tissue oxidants (free radicals, reactive oxygen and/or nitrogen species) and antioxidants and might be a major mechanism underlying obesity-related co-morbidities (Vincent *et al.,* 2007). Antioxidant vitamins (vitamin A, C and E), among other components, play a big physiological role in the

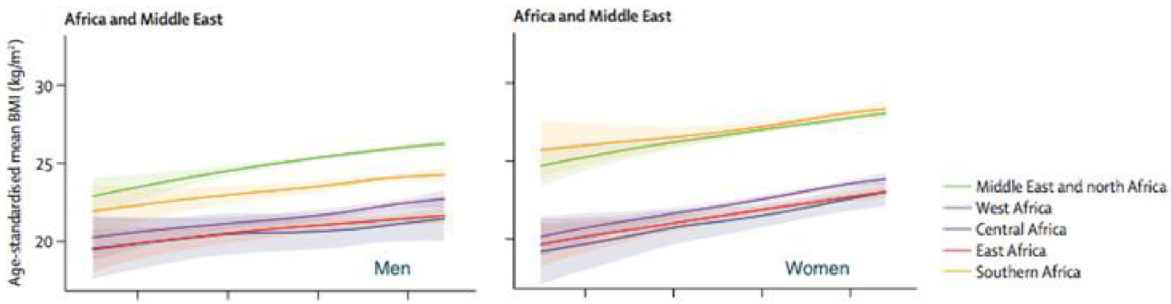

Figure 1. Trends in age-standardized prevalence of BMI categories in men and women by region

Table 1. Characteristics of the participants (*n* = 500)

Characteristics		Mean	SE
Age (years)	Obese (*n* = 170)	33.46	0.751
	Non-Obese (*n* = 330)	33.61	0.579
Male (*n* = 143)	Obese (*n* = 170)	52	36.36
	Non-Obese (*n* = 330)	91	63.63
Female (*n* = 347)	Obese (*n* = 170)	118	34
	Non-Obese (*n* = 330)	229	66

protection against oxidative stress (Young and Woodside, 2001). Literature shows that obese have lower rates of antioxidant defenses (vitamins) than non-obese (Aasheim *et al.,* 2008; Galan *et al,.* 2005; Keaney *et al*., 2003; Sarni *et al*., 2005; Strauss, 1999; Schleicher *et al.,* 2009).

According to WHO estimates, the prevalence of obesity tend to increase in the coming years (WHO, 2017); Obesity is now reaching worldwide unprecedented prevalence in low-income and high-income countries and the Eastern Mediterranean region is no exception (Figure 1) (NCD-RisC, 2016). It has become one of the primary health concerns in many parts of the world because of its increasing contribution to the burden of global morbidity (WHO, 2017). The Middle East, in particular, faces the greatest threat in terms of the growing obesity epidemic (NCD-RisC, 2016). By 2014, about “266 million men and 375 million women were obese worldwide compared to 34 million men and 71 million women in 1975” (NCD-RisC, 2016). For example, in Lebanon, a developing and middle-income country, “the prevalence of overweight and obesity has reached alarming rates among children, adolescents and adults, mostly in urban areas” (Issa *et al.,* 2011). It increased from 17.4% in 1997 to 28.2% in 2009 among adults (20 years and over) (27.4% for men and 28.8% for women in 2009) (Nasreddine *et al.,* 2012). This is due to decreased physical activity and changes in dietary habits characterized by high-calorie, low-fiber diets, low intake of fruits and vegetables, and high intake of fat and sugar (Issa *et al.,* 2011). This alarming increase in the prevalence of obesity in the Lebanese population requires more research. In Lebanon, national studies on obesity are rare, so the aim of this study was to compare the dietary antioxidant vitamin intakes in obese and non-obese Lebanese participants, thereby creating a new registry for the Lebanese obese population.

MATERIALS AND METHODS

Participants

This study was conducted on 500 Lebanese (153 males and 347 females) mean age 33.5+/-1.2 years old, recruited from the database of dietary clinics in rural and urban regions. Participants were examined between May 2016 and September 2016. Recruitment was done by a nutritionist/dietitian who summarized the purpose of this study. The exclusion criteria were pregnancy, less than 18 or above 62 years old and participation in a weight loss program including dietary changes and restrictions. This study was approved by the Ethics Committee of the Department of Human Nutrition and Dietetics of the Faculty of Agronomic and Food Sciences, Holy Spirit University of Kaslik, Lebanon. All participants consented to completing the questionnaires. The demographic characteristics of the participants in the SQFFQ evaluation study were given in table 1.

SQFFQ

A thirty-four items SQFFQ was administered face-to-face, it covers the major sources of dietary antioxidant vitamins

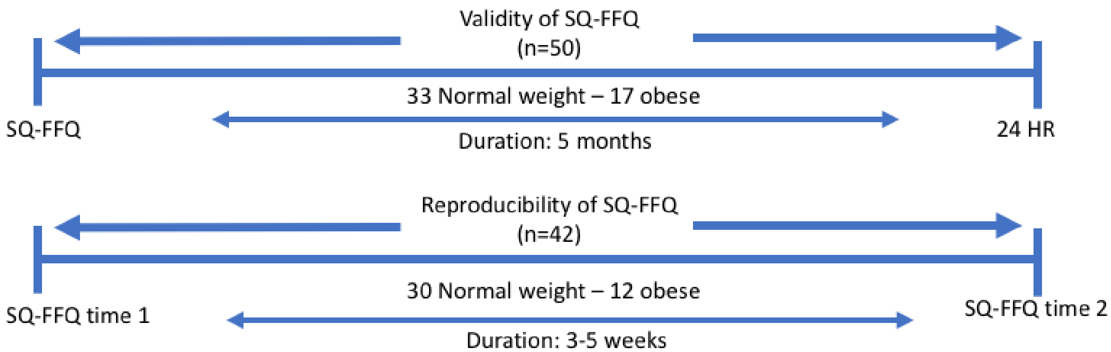

Figure 2. Design of the development, validity and reproducibility study of the SQFFQ among Lebanese adults (obese and non-obese).

Table 2. Classification of Body Mass Index

Classification	Body Mass Index (kg/m^2)
Underweight	<18.50
Normal	18.50-24.99
Overweight	25.00-29.99
Obese	≥30.00
class I	30.00-34.99
class II	35.00-39.99
class III	≥40.00

Source: *WHO (2016)*

in Lebanon. The validity and reproducibility of the questionnaire were studied in previous article (figure 2)

Data were collected in May-September 2016. Each tool in this study was administered by a trained nutritionist at dietary clinics. A sample of 50 participants were recruited in March 2016 to complete 24HR (three week days and one weekend day) in order to build a food list based on the major sources of antioxidant vitamins, that are most frequently reported in the 24HR collected. 500 Lebanese participants aged 18-61 Years (the previous 50 who provided the 24HR, along with 450 new participants) were part of the development study, whereas only 50 and 42 accepted to be enrolled in the validity and reproducibility studies, respectively. To assess validity, the questionnaire was compared to the 24HR performed on a subsample of 50 participants (33 non-obese and 17 obese) who have already completed the Semi Quantitative Food Frequency Questionnaire (SQFFQ). The 42 participants (30 non-obese and 12 obese) in the reproducibility study are also part of the validity study. The reproducibility was assessed by comparing the baseline SQFFQ with a second administration of the SQFFQ three to five weeks later at the same dietetic clinic.

Measuring obesity

According to WHO (2016), body mass index (BMI) is a simple way to measure obesity in the adult population: it is the person's weight (in kilograms) divided by the square of its height (in meter^2) (rounded decimals). A person with a BMI of 29.9 or more is generally considered obese (table 2). BMI is the most useful and common measure of overweight and obesity in a population because, in adults, the scale is the same irrespective of gender or age. However, it gives an approximate indication, since it does not necessarily correspond to the same degree of adiposity from one individual to another and does not differentiate between body lean mass and body fat mass (Ramírez-Vélez *et al.,* 2017). Anthropometric parameters (weight and height) were measured according to standardized protocols during the interview in the dietary clinics. The weight was taken by bioelectrical impedance scale (Bodecoder body composition analyser) and the height by a stadiometer. The weight was recorded to the nearest 0.1 kg. The participants were weighed with light clothing and bare feet or with stockings or socks. Size was measured without footwear and recorded to within 0.5 cm. All measurements were taken twice and the average of the two values was adopted. Although BMI is the most frequently used method to assess the level of obesity, BMI does not differentiate between body lean mass and body fat mass (Ramírez-Vélez *et al.,* 2017). Anthropometric parameters (weight and height) were measured by a nutritionist/dietitian according to standardized protocols during the interview in the dietary clinics. The weight and body fat percentage were measured by bioelectrical impedance scale (Bodecoder body composition analyzer) and the height by a stadiometer. The weight was recorded to the nearest 0.1 kg. The participants were weighed with light clothing and bare feet or with stockings or socks. Size was measured without footwear and recorded to within 0.5 cm. All measurements were taken twice and the average of the two values was adopted and rounded.

Adjustment for energy intake, gender and age

Total daily energy intakes were collected from 24HR from 250 participants (166 non-obese and 84 obese) among the 500 participants after completing the SQFFQ. Gender and age were collected before weighing the participants.

Statistical Methods

Data from the SQFFQ were transformed into daily intake of each food (g/d) and beverage (ml/d). The daily intake was calculated by multiplying the specified portion unit by the frequency of intake, using the following values for reported frequencies: 1-3 times/d = 2 ((1+2+3)/3); 1-3 times/w =0.28 ((1/7+2/7+3/7)/3); 1–3 times/ month =0.06 ((1/30+2/30+3/30)/3); occasionally and never eaten =0.

The validity the SQFFQ was assessed, in a sub-sample of fifty participants (17 obese and 33 non-obese), by comparing the intakes of thirty-four food items from the SQFFQ with the average intakes from the 24HR. For each individual in the validation study, the daily intakes of foods consumed during each of the24HR were computed and used to calculate the mean daily intakes of foods from the 24HR. The mixed dishes from the 24HR were divided into their components and allocated to the appropriate food items of the questionnaire as would routinely be done in the analysis of mixed dishes (Shaikh *et al.,* 2017). Pearson correlation coefficients and Bland-Altman plots were used to measure the strength of the relationship between food intakes estimated by SQFFQ and the 24HR.

The correlation between BMI and the daily antioxidant vitamins consumption was studied with Pearson correlation coefficients.

The means of the three antioxidant vitamins were compared for obese and non-obese and the daily caloric intake, gender and age were adjusted also for obese and non-obese participants.

Estimates were analyzed using the statistical software package SPSS® (Statistical Package for Social Sciences, version 24.0, SPSS Inc., Chicago, Ill, USA). Results with a p <0.05 value will be considered statistically significant.

RESULTS

Difference in antioxidant vitamins intake between obese and non-obese

The means of daily consumption of vitamin A, C and E were lower for obese individuals compared to non-obese. The values were respectively for vitamin A: 18.9 +/- 70.2 *vs.* 155.1 +/- 455.9 micrograms of RAE (figure 3), for vitamin C: 31.7 +/- 30.4 *vs.* 60.1 +/- 41.7 milligrams (figure 4) and for vitamin E: 12.5 +/- 5.7 *vs.* 15.6 +/- 7.3 milligrams (figure 5).

The difference between the daily consumption of antioxidant vitamins for non-obese *vs.* obese individuals were highly significant (Students' *t*-Test, p = 0 <0.01 for vitamin A, C and E).

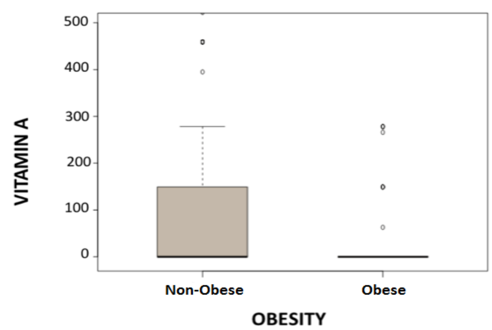

Figure 3. The means of daily consumption of vitamin A

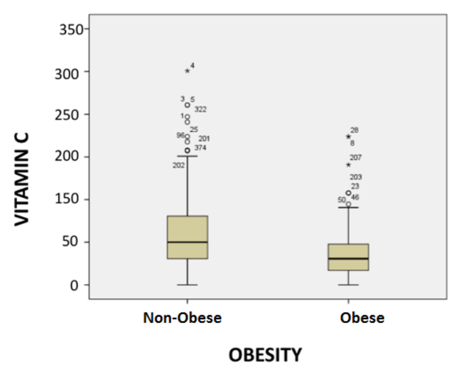

Figure 4. The means of daily consumption of vitamin C

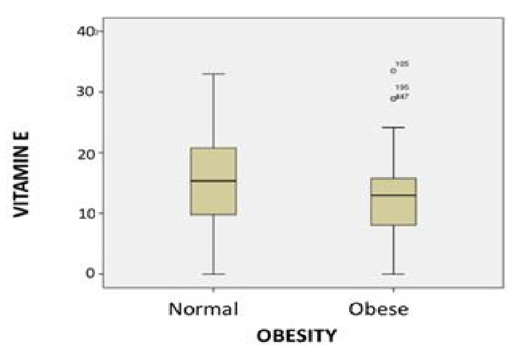

Figure 5. The means of daily consumption of vitamin E

BMI and the daily antioxidant vitamins intake between obese and non-obese

According to Pearson correlation, there was no significant correlation between the BMI and the daily vitamin consumption for vitamin A, C and E respectively for non-obese and obese participants, p (vitamin A) = 0.795, 0.879, p (vitamin C) = 0.642, 0.738 and p (vitamin E) = 0.282, 0.491 >0.05

Adjustment

Daily energy intake

In this study, total daily energy intakes were collected from 24HR from 250 participants (166 non-obese and 84 obese) among the 500 participants after completing the SQFFQ, using database of Mahan *et al.,* 2012. Afterwards the daily calories were adjusted for vitamin A, C and E in the obese and non-obese participants. And then the difference between the daily consumption of antioxidant vitamins for non-obese *vs.* obese individuals was tested via Anova one-way test. The results were highly significant too after caloric adjustment with p-values for vitamin A, C and E respectively, p = 0.014, p = 0 and p = 0 <0.05.

Gender

The difference between the daily consumption of antioxidant vitamins for non-obese *vs.* obese individuals was tested via Anova one-way test. The difference between obese men and obese women is not significant with p-values = 0.443>0.05, additionally the difference between non-obese men and non-obese women was not significant with p-values = 0.09>0.05. Thus, there was no difference between gender and the difference in daily consumption of antioxidant vitamins for obese and non-obese.

Age

Furthermore, using Pearson correlation, there was no significant correlation between the age and the daily consumption of antioxidant vitamins for the 2 groups obese with p-value for vitamin A, C and E respectively 0.217, 0.626 and 0.232 >0.05 and non-obese with p-value for vitamin A, C and E respectively 0.988, 0.08 and 0.06 >0.05 too. Therefore, there was no pattern regarding the age and there was no difference between age and the difference in daily consumption of antioxidant vitamins for obese and non-obese.

DISCUSSION

In this study, dietary antioxidant vitamin intakes were measured and compared for obese and non-obese Lebanese using a SQFFQ developed and validated to evaluate the antioxidant vitamins consumption in Lebanese population. The study provided for the first-time data on the difference of consumption of vitamins with antioxidant properties in Lebanese obese and non-obese population. Not only the difference in the means of the three vitamins was too obvious (figure 3, 4 and 5), but this difference between the daily consumption of antioxidant vitamins for non-obese *vs.* obese individuals were highly significant according to Student's' *t*-Test, p = 0 <0.01. And this result was compatible with different studies abroad that tested the difference in food intake and also the blood and urine biomarkers (Decsi *et al.,* 1997; Singh *et al.,* 1998; Strauss, 1999; Neuhouser *et al.,* 2001; Keaney *et al.,* 2003; Myara *et al.,* 2003; Galan *et al.,* 2005; Sarni *et al.,* 2005; de Souza Valente da Silva *et al.,* 2007; Aasheim *et al.,* 2008; Villaça Chaves *et al.,* 2008). Different food preferences between obese and non-obese individuals can be a cause of different consumption of micronutrients, furthermore, socioeconomic factors can contribute to vitamin deficiencies in obesity as has previously been demonstrated in Southern Italy by Altamirano and Sapienza (2018).

As for the calorie adjustment, intakes of most specific nutrients are correlated with total energy intake, especially when comparing intakes of micronutrients such as vitamins in obese and non-obese people. Therefore, it might result of confounding by total energy intake. For this reason, in this study, total daily energy intakes were collected from 24HR from 250 participants (166 non-obese and 84 obese) among the 500 participants after completing the SQFFQ. Afterwards the daily calories were adjusted for vitamin A, C and E in the obese and non-obese participants. The difference between the daily consumption of antioxidant vitamins for non-obese *vs.* obese individuals was highly significant too after caloric adjustment. Moreover, there is no difference between men and women of all ages (obese and non-obese) regarding the consumption of antioxidant vitamins, similar results of previous study (Wengreen *et al.,* 2007).

As for BMI, there is no significant correlation between the BMI and the daily vitamin consumption for vitamin A, C and E respectively for non-obese and obese participants, the observations on this subject are rare, Beydoun *et al*., 2015, showed that a low intake of vitamin C is inversely correlated with BMI.

To be noted, that the sample of this study was representative of the Lebanese population at large, because the project was concentrated in rural and urban areas. Micronutrient deficiencies (including antioxidants) continue to be a public health problem in several regions of the world, not only in poor communities, but also in populations in developed countries. Obesity disrupts antioxidant defenses in tissues. These insufficient defenses may be due to a low dietary intake of antioxidants since the obese have a lower consumption of foods rich in antioxidants (fruits, vegetables, whole grains, legumes, wine, olive oil, seeds and nuts) which is documented by various studies in a meta-analysis by Vincent *et al.,*2007. This low consumption occurs even when fresh products are available and cheap, so it is common in all countries. Obesity has been associated with a markedly increased oxidative stress that itself is an important etiologic factor of the pathologic process of obesity co-morbidities such as cardiovascular disease (Malinska *et al.,* 2009; Roberts and Sindhu, 2009). Fortunately, several defense processes exist against the reactive oxygen species, the first line of defense is their uptake by non-enzymatic systems such as vitamins A, C and E among others (Lavoie, 2012). Normal tissue concentrations of antioxidants suppress oxidative processes and protect tissues. Therefore, the need of intervention strategies to reduce the oxidative stress associated with obesity. According to the literature, it can be lowered through changes in diet such as introducing more antioxidant vitamins in food (Miller *et al.,* 1998; Dandona *et al.,* Chang *et al.,* 2004; Skrha *et al.,* 2005; Gredilla and Barja, 2005) to control blood sugar, decrease fat mass and consequently decrease blood lipid concentrations, which leads, to the reduction of oxidation of LDL and inflammatory cytokines and, to lower concentrations of leptin. Similarly, the consumption of more antioxidants vitamins help to increase the defenses of tissue antioxidants and decrease the production of endothelial oxidants.

As for limitations, the cut-offs used for the BMI are those applicable to the US / European population (WHO, 2016) and therefore can't be perfectly adapted to the sample of the study. Cut-offs should be used for Arab ethnic groups (Issa *et al.,* 2011). Furthermore, the absence of an assessment of the blood antioxidant activity in the studied cohort.

CONCLUSION

Maintaining a healthy lifestyle with a balanced diet rich in antioxidants such as fruits and vegetables, is associated with reduced oxidative stress. Unfortunately, this protection is less effective in obese with decreased consumption of dietary antioxidants. The data of the present study point to a reflection on the pertinence of including these population segments (obese) in programs against antioxidant deficiencies. This inclusion would contribute to the prevention of diseases in adult age and, hence, to an improvement in the quality of life. To be noted that future analysis should take into consideration more confounding factors to clarify this association between low consumption of antioxidants vitamins and obesity status.

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