Lifestyle, socioeconomic disparities and intestinal microbiota in a sample of obese Egyptian women

Nayera E. Hassan[a], Salwa M. El Shebini[b], Sahar A. El-Masry[a], Nihad H. Ahmed[b], Nayra Sh. Mehanna[c], Mai M. Badie[a], Ahmed S. Ismail[a], Safinaz Megahed[a], Galal I. Elashry[a], Ayat N. Kamal[a], Mohamed S. Kishta[d], Heba T. Aboud[a]

Departments of [a]Biological Anthropology, [d]Hormones, Medical Research and Clinical Studies Institute, National Research Centre, [b]Department of Nutrition and Food Science, Food industries and Nutrition Institute, National Research Centre, [c]Dairy Department, Probiotics Lab, Central Laboratories Network, National Research Centre, Giza, Egypt

Correspondence to Sahar A. El-Masry, PhD, Department of Biological Anthropology, Medical Research and Clinical Studies Institute, National Research Centre, El-Bohooth Street (El-Tahrir Street previously), Dokki, Giza 12622, Egypt. Tel: 01006606640; e-mail: masrysa@yahoo.com

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Background/Aim

Obesity is caused by genetic and environmental factors, including cultural and societal influences on food intake and a decline in physical activity. This study aimed to assess the relationship between some lifestyle parameters and obesity and investigate the association between gut microbiota and both obesity and socioeconomic status in a sample of obese and normal Egyptian women.

Patients and methods

A cross–sectional study included 112 Egyptian women divided into two groups; 81 obese (BMI $\geq$30 kg/m^2) and 31 normal women (BMI 18–$<$25 kg/m^2) aged from 25 to 60 years. Anthropometric measurements, body composition, microbiota analysis, dietary history, socio-economic class, and lifestyle parameters were assessed. Faecal samples were obtained from all participants to determine gut microbiota and analysis of gene sequence using real-time PCR.

Results

The present result indicated significant differences ($P<0.05$) in both the anthropometric and body composition parameters among the obese and normal women. However, lifestyle parameters; including dietary intake, socioeconomic class, household crowding, sleep duration, internet usage, and physical activity have been shown to affect obesity. The low socioeconomic class participants had the lowest BMI (25.75±2.78 kg/m^2) and the highest Firmicutes/Bacteroidetes ratio (0.83±0.01) with significant differences with the other socioeconomic classes. Obese participants consumed a significant over consumption of energy as a result of the over consumption of carbohydrates, fat and protein. While the mean daily vitamins and minerals intake were low, the highest percentage of the women in both groups were detected in the unsafe and unacceptable categories, especially for vitamins A, D, E, C, B6, B12, and folate, where the most deficient elements were zinc, calcium, and iron.

Conclusion

It was concluded that lifestyle parameters like dietary consumption intake with high caloric and fat contents, household crowding, long sleep duration, and internet usage were associated with obesity. Further data provided evidence that gut microbiota dysbiosis was associated with socioeconomic class rather than high BMI.

Keywords:
dietary consumption intake, gut microbiota, lifestyle, obesity, socioeconomic class

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Introduction

Environmental factors mediated food intake (social and cultural), and reduced outdoor as well as domestic work activities, added to genes, are all involved in the obesity pandemic. The most striking change in lifestyle, coupled with economic growth, was a prolonged sedentary lifestyle more than the Westernized eating habits [1]. Additionally economic status and metabolic syndrome (MetS) both are associated with the gut Microbiome. The term 'Western diet' (WD) refers to one of the lifestyle changes that have taken place in Westernized societies over the past few decades: an increased consumption of fast food (processed foods), snacks, sugary soft drinks, and convenience items while there is a deficiency in fibers, vitamins, and minerals. The WD encourages weight gain due to persistent positive energy balance, as the saturated fatty acids and sugar both dramatically raise energy intake and increase fat mass. As well, the makeup of WD can promote an uncontrolled metabolic environment such as insulin resistance and poor lipid profiles that will maximize diseases associated with adipose tissue [2]. Obesity is caused by a high-calorie diet, which can also alter the gut microbiota functions [3]. At the same time, it has been proposed that obesity may also result from gut Microbiome disruption, which impacts metabolic function and energy homeostasis, in addition to dietary, lifestyle, and hereditary factors [3].

Many empirical studies have been conducted on the relationship between neighborhood socioeconomic status (NSES) and overweight, obesity, and BMI. The studies' findings, however, were inconsistent. Some studies found no or a weak relationship between NSES and overweight/obesity, while others found a strong relationship [4].

Brain-derived Neurotropic Factor (BDNF) levels decrease and oxidative stress increases as a result of consumption of WD and sleep deprivation [5]. More strong proof is required for what was reported by Papathanassoglou *et al.* [6] that BDNF release by physical exercise contributes to inflammatory control. Decrease levels of BDNF were found to be related to hyperphagia and weight gain, while administration of BDNF controlled food intake which was confirmed by the study of Bariohay *et al.* [7], in addition to influencing energy homeostasis and body composition; but, for presently, in spite of the persuading considers, the confirmations are still conflicting [8].

Sleep appears to be a key mediator of the bidirectional link between inflammation and obesity [9]. Studies of rodents as well as humans in the past two decades demonstrated that sleep debt allows a lot of metabolic deregulations [10]. These deregulations are –at least in part- mediated by increased inflammation [11], insulin resistance [12], disturbed lipid profile [13], physical inactivity [14], and increased consumption of food [15].

A large sample of British twins revealed significant correlations between area-based and personal socioeconomic characteristics and the composition of the stool 16S rRNA microbiota. Associations were found in models that controlled for health-related factors known to affect the Microbiome, and it has been hypothesized that individual-level SES attenuates the relationship between the microbiota and health. These results corroborate the theory that the well-documented variations in health outcomes across the socioeconomic spectrum may be caused by changes in the microbiota of social groups [16].

This study aimed to assess the relationship between some lifestyle parameters and obesity, in addition to investigating the association between the gut microbiota and both obesity and socioeconomic status in a sample of obese and normal-weight Egyptian women.

Patients and methods

Patients

This study was a cross-sectional study, including a total of 112 Egyptian women. It was performed at the Medical Research Excellence Center (MERC), National Research Centre, Cairo, Egypt. Any participant with a history of bariatric surgery, or current substance abuse, mental disability, psychosis, neurological problems, dementia, and a history of severe head trauma was excluded from the study. Also, women with conditions that may affect gut microbiota (metabolic, gastrointestinal, autoimmune diseases, and medications, particularly antibiotics) were excluded from the study.

Study design

All participants has been divided into two groups; the first group enrolled 81 obese women with BMI greater than or equal to 30 and their ages ranging from 25 to 60 years with a mean age of 41.62±10.70 years, in addition to 31 healthy women with BMI ranged from 18 to 25 kg/m^2, in the same age range and served as a control group.

Ethical consideration

The present study protocol has been conformity with the Code of Ethics of the World Medical Association, according to the principles expressed in the Declaration of Helsinki 1975. This study has been approved by the local Ethics Committee of National Research Centre, Cairo, Egypt with approval number approval no 19/236. Every participant was handed an informed written consent prior to their inclusion in the study.

Methods

For every participant, anthropometric measurements, body composition, analysis of microbiota, dietetic history, socioeconomic index, and lifestyle parameters were obtained.

Anthropometric measurements

Body weight and body height were measured, according to the 'International Biological Program' recommendations [17]. Body weight (Wt) was rounded to the nearest 0.01 kg using a Seca Scale Balance, with the patient barefooted and wearing minimal clothing. Body height (Ht) was rounded to the nearest 0.1 cm using a Holtain portable anthropometer. BMI was calculated as follows: [BMI: weight (in kilograms) divided by height (in squared meters)]. Participants were classified according to BMI into two groups: 30 women with normal BMI (18–<25 kg/m^2) and 81 women with BMI greater than or equal to 30 kg/m^2.

Body composition

Body composition was evaluated using the TANITA Body Composition Analyzer. As guided by the manufacturer (Tanita Body Composition Analyzer-MC-780 MA III), calibration of the unit was done before testing. Every woman stood on the footboard of the device, holding the 2 handles carefully, each by one hand simultaneously. Entering the subject's age, sex, weight, and height, approximated to the nearest unit, the percentage of body fat (Fat %, an estimate of the fraction of total body mass that is formed of adipose tissue), and visceral fat (fat mass around the internal organs of the abdomen) were calculated.

Microbiota analysis

To determine the effects of the eating plan, probiotic supplement, and physical exercise on the gut microbiota of the study participants, faecal samples were obtained, an analysis of gene sequence was performed, and individual variations of gut microbiota were compared. The proportion of Lactobacillus and Bifidobacteria; as well as Firmicutes/Bacteroidetes ratio strains were assessed using the real-time PCR. Specimen collection and preparation: The stool was collected by defecation in a plain sterilized container and allowed to be frozen. Specimen Storage and Preparation: The stool was frozen at −20°. The primers and probes were used to detect Bifidobacteria spp. and Lactobacillus spp; and Firmicutes spp. and Bacteroidetes spp., were based on 16S rRNA gene sequences retrieved from the National Center for Biotechnology Information databases using the Entrezprogram [18]. Reagents provided by kits: DNA Extraction Kit. Assay procedure: DNA extraction: The QIA amp DNA Stool Mini kit (Qiagen) was used to extract DNA from one gram of frozen or fresh stool sample according to the manufacturer's instructions. Bacterial quantification by real-time PCR was done.

Dietary adequacy

Information about the usual pattern of each woman's food intake was obtained. Data was collected using a dietary interview consisting of 24-hours recall repeated for 3 days, as well as a food frequency questionnaire. Analysis of food items was done using the Computer Aided Nutritional Analysis Program, the food composition Nutri-survey [19]. The dietary adequacy of each woman; as a percentage; was determined as her mean dietary intake in relation to the recommended dietary allowance (RDA). An RDA is the average daily dietary intake level; sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a group. The RDA for energy and macronutrient was determined according to United Nations University/ WHO/ and Food and Agriculture Organization of the United Nations 2004 [20]. The RDA for micronutrients was calculated according to the Food and Agriculture Organization (FAO) (FAO/WHO 2002).

Socio-economic index

The modified Kuppuswamy scale (update for February 2019) depends on education, occupation, and family income/month was used. Education was divided into 5 scores as follows: Illiterate=1 score, Primary school certificate=2, Preparatory school certificate=3, Secondary school certificate=4, and Graduate or postgraduate=5. The occupations were divided into 5 scores as follows: Unemployed Housewife=1, Worker=2, Employed=3, Professional=4, and Private work=5 scores. Average income per month was divided into 5 scores as follows: Up to 1200=1 score, Up to 3000=2, Up to 5000=3, Up to 8000=4, and more than 8000=5. The socioeconomic class was categorized as follows: Upper class (13–15 score), Upper middle class (10–12), Lower middle class (7–9), Upper lower class (4–6), and Lower class (1–3) [21].

Lifestyle parameters

The lifestyle and health attitude towards the consumption of fried foods, fiber (whole meal bread), dairy products and vegetables, physical activity and smoking, were assessed using a questionnaire sheet [22]. It was collected including the marital status (single, married, divorced, or widow), the residential area (luxury residence or popular housing), Socioeconomic class, household crowding index (no. of persons per room: ≤1 uncrowded, >1 crowded, and >1.5 severely crowded), internet usage hours (up to 4 h, up to 8 h and more than 8 h, sleeping hours (4 h daily,5–8 and more than 8 h daily), smoking (not smoking, smoking cigarettes, shisha or cigarettes, and shisha, or passive smoking), and physical exercise (less than 3 times or 3 times and more per week).

Statistical analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS/Windows Version 18, SPSS Inc., Chicago, Illinois, USA). Data normality was tested using the Kolmogorov-–Smirnov test and the Shapiro–Wilk test. The data were normally distributed; so the parametric tests were used. The results of the quantitative data were presented as mean±SE, while the qualitative data were expressed as numbers and percentages. The quantitative variables were analyzed and compared using the Student *t*-test. The qualitative variables were compared using χ^2 test. The mean differences were considered significant at *P* value less than 0.05.

Results

The presented data in Table 1 showed the means±SE of anthropometric and body composition characteristics of all studied participants. The obese women were significantly ($P<0.05$) older than the normal-weight ones. The BMI, visceral fat, and percentage body fat (% BF) were significantly ($P<0.05$) higher among obese women compared with the normal women.

The percentage of the normal and obese women according to their lifestyle parameters revealed significant differences between the two groups when comparing their; marital status, residential area, socio-economic classes, household crowding index, internet usage hours, sleeping hours, and practicing light physical exercise with significant difference at *P* value less than 0.05. Most of the obese women (79%) were single, compared with 52% of normal women, while only 6% of the obese women were widows, compared with 39% of the normal ones. The residential area revealed that 86% of the obese women had luxury residences, while 42% of normal women had popular housing. The highest percentage of obese women (48%) and normal ones (68%) were found in the upper middle socio-economic class, followed by 23% of normal women in the lower class and 19% of obese women in the upper class. Household Crowding index revealed that the greater than 1.5 severely crowded index was high among the obese group (70%) compared with the normal women (61%). Regarding internet usage, 69% of obese women were using the internet more than 8 h compared with 55% of normal ones. While 14% of the obese women sleep more than 8 h/day compared with 10% only of normal women, 32% of obese women were practicing light sport greater than or equal to 3 time/week compared with 13% of normal-weight women. There was an insignificant difference between the 2 groups regarding smoking (Table 2).

Table 1 Participants anthropometric and body composition characteristics

Parameters	Control group (*n*=31) Mean±SE	Obese group (*n*=81) Mean±SE
Age (year)	31.70±1.57	44.90±1.09*
BMI (k/m^2)	19.56±0.26	37.26±0.65*
%BF (kg)	23.52±0.97	44.75±0.58*
Visceral fat	2.60±0.38	10.88±0.40*

%BF, Percentage of body fat; BMI, body mass index. *Significant difference than control group at *P* value less than 0.05, using Student *t*-test.

Table 2 Percentage of the normal and obese women according to the lifestyle parameters

Parameter	Control group (*N*=31) *n* (%)	Obese group (*N*=81) *n* (%)
Social Status		
Single	16 (51.61)	64 (79.01)*
Married	3 (9.68)	8 (9.88)
Divorced	0	4 (4.94)
Widow	12 (38.71)	5 (6.17)*
Residential Area		
Luxury	18 (58.06)	70 (86.42)*
Popular	13 (41.94)	11 (13.58)*
Socio-economic class		
Lower 1–3	7 (22.58)	4 (4.94)*
Upper lower 4–6	0	8 (9.87)
Lower middle 7–9	0	15 (18.52)
Upper middle 10–12	21 (67.74)	39 (48.15)*
Upper 13–15	3 (9.68)	15 (18.52)*
Household Crowding Index		
≤1 uncrowned	8 (25.81)	13 (16.05)*
>1 crowded	4 (12.90)	11 (13.58)
>1.5 severely crowded	19 (61.29)	57 (70.37)*
Internet Usage Hours		
Up to 4 h	2 (6.45)	4 (4.94)
Up to 8 h	12 (38.71)	21 (25.93)*
More	17 (54.84)	56 (69.13)*
Sleeping Hours		
Sleeping 4 h Daily	6 (19.36)	14 (17.28)
Sleeping 5-8 h Daily	22 (70.97)	56 (69.13)
Sleeping more 8 h Daily	3 (9.67)	11 (13.59)*
Smoking		
Not Smoking	30 (96.77)	74 (91.36)
Smoking Cigarettes	1 (3.23)	4 (4.93)
Smoked Shisha	0.00	2 (2.46)
Cigarettes and Shisha	0.00	1 (1.25)
Passive Smoking		
No	11 (35.48)	31 (38.27)
Yes	20 (64.52)	50 (61.73)
Physical Exercise		
Less than 3 times/week	3 (9.68)	37 (45.68)*
3 Times or more/week	4 (12.90)	26 (32.09)*

*Significant difference than control group at *P* value less than 0.05, using Chi-Square-test.

Regarding the different types of gut microbiota among the two groups, the Bacteroidetes was the most prevalent phylum in the two groups, followed by the Firmicutes phylum, in comparison with Lactobacillus and Bifidobacteria phyla, but with insignificant difference between the two studied groups. The Firmicutes/Bacteroidetes ratio was also similar between the two groups with insignificant differences; as presented in our previous study [23].

Table 3 showed the mean±SE of BMI and different gut microbiota phyla in relation to socioeconomic classes in the studied sample. Data revealed that the low socioeconomic class participants had highly significant the lowest BMI (25.75±2.78 kg/m^2) and also had significantly the highest Firmicutes/ Bacteroidetes ratio (0.83±0.01) with a significant difference with the other socioeconomic classes at *P* value less than 0.05. However insignificant differences were found between the different gut microbiota phyla between the different socioeconomic classes.

The highest percentage of obese women was reported in the overconsumption category, especially for carbohydrates (80.25%) and fat (81.48%). Obese participants consumed a significant over consumption of energy (70.37%) as a result of the over consumption of protein (72.84%), carbohydrates (80.25%) and fat (81.48%). While 69.13% of the obese women consumed unsafe amounts of the dietary fibres, which are low when compared with the RDAs. The intake of minerals was low among both groups, with a significant slight increase in values in the normal group. Sodium (66.67 and 53.09%, respectively) and potassium (60 and 49.38%, respectively) in both normal and obese groups were detected in the acceptable category, while calcium (unsafe category: 46.67 and 54.32%, respectively), zinc (unsafe category: 53.33 and 60.49%, respectively) and iron (unacceptable: 50 and 56.79%, respectively), revealed very low consumption in the two groups, especially among the obese participants, with significant differences regarding calcium and iron only (Table 4).

The dietary adequacy of the vitamins was low in both groups, yet it was much lower among obese women. The normal and obese women were suffering from unsafe intake of vitamin C (53.33 and 72.84%, respectively), unacceptable intake of vitamins A (53.34 and 71.60%, respectively) and D (60 and 76.54%, respectively); and unsafe intake of vitamin E in obese women (69.13%) and unacceptable intake in normal ones (46.67%). Regarding vitamin B, both normal and obese groups were consumed an acceptable intake of B1 (50 and 64.2%, respectively), B2 (53.33 and 71.61%, respectively), and Niacin (46.67 and 64.2%, respectively), While they received an unacceptable intake of B6 (56.67 and 72.84%, respectively), and Folate (43.33 and 59.26%, respectively). Moreover, the obese women had unsafe intake (66.67%) and the normal women had unacceptable intake (60%) of B12. Significant differences were found between the groups in vitamin A, D, E, C, and most of the vitamin B (B2, B6, B12, and Niacin), as shown in Table 5. So, the mean daily vitamins and minerals intake were low, and the highest percentage of the women in both groups were detected in the unsafe and unacceptable categories, especially for vitamins A, D, E, C, B6, B12, and folate, where the most deficient elements were zinc, calcium, and iron.

Discussion

The selection of the sample in this study consisted of normal and obese women, in which the anthropometric measurements were recorded, which included weight

Table 3 Body mass index and gut microbiota phyla in relation to socioeconomic classes in all Egyptian women under study

Parameters	Socio-economic class (*n*=112)				
	Lower (1–3) *n*=11 (9.8%)	Upper lower (4–6) *n*=8 (7.1%)	Lower middle (7–9) *n*=15 (13.4%)	Upper middle (10–12) *n*=60 (53.6%)	Upper (13–15) *n*=18 (16.1%)
BMI	25.75±2.78^a	37.02±2.30^b	39.32±1.56^b	31.02±1.29^c	33.09±1.65^c
Log Lactobasillus	5.74±0.13^a	5.70±0.29^a	6.17±0.22^a	6.07±0.08^a	5.90±0.16^a
Log Bifidobacterium	6.19±0.18^a	6.06±0.30^a	6.12±0.16^a	6.10±0.07^a	5.10±0.14^a
Log Bacteroidetes	12.51±0.23^a	12.75±0.58^a	13.63±0.28^a	13.11±0.15^a	13.06±0.35^a
Log Firmicutes	10.35±0.19^a	8.89±0.37^a	8.97±0.36^a	9.17±0.17^a	9.45±0.38^a
F/ B Ratio	0.83±0.01^a	0.71±0.04^b	0.66±0.03^c	0.70±0.15^b	0.73±0.03^b

All data are expressed as Mean±SE. BMI, body mass index. All data with different superscript letter (a, b, c), within each raw are significant at *P* value less than 0.05, using ANOVA test.

Table 4 Percentage of macronutrients and some minerals dietary adequacy within the two different studied groups

	Control group %	Obese group %	*P* value
Macronutrients			
Energy			0.001
Unsafe	16.66	4.94	
Unacceptable	26.67	8.64	
Acceptable	40.00	16.05	
Over consumption	16.67	70.37	
Protein			0.031
Unsafe	10.00	6.17	
Unacceptable	16.66	7.41	
Acceptable	46.67	13.58	
Over consumption	26.67	72.84	
Carbohydrate			0.001
Unsafe	6.67	3.70	
Unacceptable	16.66	8.64	
Acceptable	53.33	7.41	
Over consumption	23.33	80.25	
Fat			0.001
Unsafe	13.33	2.47	
Unacceptable	10.00	6.17	
Acceptable	20.00	9.88	
Over consumption	56.67	81.48	
Dietary fibre			0.001
Unsafe	6.67	69.13	
Unacceptable	53.33	13.58	
Acceptable	26.67	9.88	
Over consumption	13.33	7.40	
Minerals			
Sodium			0.051
Unsafe	6.66	3.70	
Unacceptable	10.00	6.17	
Acceptable	66.67	53.09	
Over consumption	16.67	37.04	
Potassium			0.073
Unsafe	10.00	6.17	
Unacceptable	16.67	11.11	
Acceptable	60.00	49.38	
Over consumption	13.33	33.34	
Calcium			0.030
Unsafe	46.67	54.32	
Unacceptable	6.67	34.57	
Acceptable	10.00	7.41	
Over consumption	6.66	3.70	
Iron			0.048
Unsafe	30.00	35.80	
Unacceptable	50.00	56.79	
Acceptable	13.33	4.94	
Over consumption	6.67	2.47	
Zinc			0.064
Unsafe	53.33	60.49	
Unacceptable	33.33	30.87	
Acceptable	6.67	6.17	
Over consumption	6.67	2.47	

Unsafe Level: less than 50% of recommended dietary allowance, Unacceptable Level: 50% – less than 75% of recommended dietary allowance, Acceptable Level: 75–119% of recommended dietary allowance, Over consumption: greater than or equal to 120% of recommended dietary allowance . *Significant difference than control group at *P* value less than 0.05, using Chi-Square-test.

Table 5 Vitamins dietary adequacy within the two different studied groups

Vitamins	Control group %	Obese group %	*P* value
Vitamin A			0.042
Unsafe	10.00	12.35	
Unacceptable	53.34	71.60	
Acceptable	23.33	9.88	
Over consumption	13.33	6.17	
Vitamin D			0.021
Unsafe	16.67	16.05	
Unacceptable	60.00	76.54	
Acceptable	13.33	4.94	
Over consumption	10.00	2.47	
Vitamin E			0.002
Unsafe	33.33	69.13	
Unacceptable	46.67	16.05	
Acceptable	13.33	9.88	
Over consumption	6.67	4.94	
Vitamin C			0.041
Unsafe	53.33	72.84	
Unacceptable	30.00	18.52	
Acceptable	10.00	4.94	
Over consumption	6.67	3.70	
Thiamin (B1)			0.063
Unsafe	13.33	3.70	
Unacceptable	16.67	8.64	
Acceptable	50.00	64.20	
Over consumption	20.00	23.46	
Riboflavin (B2)			0.020
Unsafe	6.67	3.70	
Unacceptable	16.67	4.94	
Acceptable	53.33	71.61	
Over consumption	23.33	19.75	
Vitamin B6			0.033
Unsafe	26.66	17.28	
Unacceptable	56.67	72.84	
Acceptable	10.00	7.41	
Over consumption	6.67	2.47	
Vitamin B12			0.043
Unsafe	10.00	12.35	
Unacceptable	23.33	14.81	
Acceptable	46.67	64.20	
Over consumption	20.00	8.64	
Niacin			0.003
Unsafe	20.00	66.67	
Unacceptable	60.00	24.69	
Acceptable	13.33	4.94	
Over consumption	6.67	3.70	
Folate			0.050
Unsafe	26.67	23.46	
Unacceptable	43.33	59.26	
Acceptable	23.33	13.58	
Over consumption	6.67	3.70	

Unsafe Level: less than 50% of recommended dietary allowance, Unacceptable Level: 50-less than 75% of recommended dietary allowance, Acceptable Level: 75–119% of RDA, Over consumption: greater than or equal to 120% of recommended dietary allowance. *Significant difference than control group at *P* value less than 0.05, using Chi-Square-test.

and BmI, as well as visceral fat. In addition dietary history and lifestyle parameters were investigated. The outlined results here indicated the significant differences between the obese and the normal-weight participants in most of these parameters. In addition, the results revealed that many lifestyle factors like food intake, dietary habits, social status, residential area, household crowding, internet usage, sleeping hours and physical exercise were associated with obesity. In this context, numerous studies showed that obesity is a complicated health problem rather than a straight forward one, and that it is caused by a confluence of personal variables (genetics and behaviours) and structural causes (unhealthy societal or cultural eating habits [24].

Despite its genetic and epigenetic implications, the majority of researchers concur that obesity is an ‘acquired’ condition that mainly depends on the variables of lifestyle (i.e. individual choices), such as chronic overeating and low rates of physical activity. Asthma, cancer, diabetes, hypercholesterolemia, and cardiovascular illnesses are only a few of the chronic disorders and diseases that have been linked to various forms of obesity, including abdominal obesity [25]. According to Barlow [26], a variety of factors, including genetic (genetic predisposition to obesity), demographic (gender, age, income, and education), and lifestyle factors (physical inactivity, poor dietary habits, and sedentary behaviour) have been linked to the development of obesity.

Social traits play a role in the obesity pandemic and have an impact on body weight through altering food and exercise habits. Social determinants of obesity may identify and target particular subgroups at risk for obesity even though they are not always changeable [27]. The findings of the present study provide evidence that obese women showed an increased intake of all nutrients compared with women of normal group, but on the contrary the proportion of obese participants who exercised was more than the normal group, that may be attributed to their attempts to lose their weight.

According to Mohammed *et al.* [28], in their Systematic review and meta-analysis to synthesize the existing evidence of the association of low NSES with overweight, obesity, and BMI, they concluded that: living in NSES was associated with a higher mean BMI as well as a higher risk of being overweight or obese. In low- and middle-income countries, evidence on the relationship between NSES and weight status is limited. The exact mechanism by which low NSES contributes to unhealthy weight gain as well as whether addressing NSES disparities decreases the risk of obesity are remain greatly unknown. The link between the socioeconomic class and obesity in this study does not agree with what was mentioned in the previous research. The result revealed that people with higher SES were more likely to be obese which would be the result of higher consumption of high-calorie food and avoiding physically tough tasks. Conversely, the obesity rate was low among women in the lower socioeconomic class, it contributing to that family with low monthly having poorer diets and a lack of access to good quality and enough quantity foods which are important factors that contribute to increased obesity rates; additionally, this group had the lowest BMI value compared with the upper group. Zhang and Wang [29] stated that through the previous three decades, obesity prevalence has increased in the low SES class, while significantly has increased among high SES class, thus leading to a reduction in disparities in obesity rates across different SES classes.

From the information obtained in this study, the effect of overcrowded housing on obesity, it was found that crowded houses had the highest rate of obesity, and this is consistent with what Delaroque *et al.* [30] hypothesized that house overcrowding housing might expose to stress, dysbiosis of gut microbiota, inflammation, and consequently, metabolic and chronic disorders.

Marital status (MS) has also been demonstrated to be connected with BMI, and most cross-sectional studies tend to suggest that married people are more likely to be overweight and obese than those living alone [31]. Although intriguing concepts relating these two outcomes have lately been presented, it is still unclear how and under what circumstances marital status is connected with obesity [32]. The results of this research showed that the proportion of obese women was more among unmarried and divorced participants, which can be attributed to that married women have many domestic housework duties in taking care of their family, unlike single and divorced women.

Adverse health effects from improper Internet use can interfere with social interaction and general health [33]. According to Odac and Kalkan [34], this condition could develop into ‘Internet addiction‘ in the sense of shifting away from ‘healthy‘ use. An extensive spectrum of mental health issues, such as stress, anxiety, and attention-deficit/hyperactivity disorder, are connected to the internet [35]. Although neglected and less debated by society in recent years, Internet use has also been linked to some detrimental changes in body weight and body fat distribution [35]. According to this study’s data, obese participants were more likely to use the Internet for an extended period of time (up to 8 h).

Sleep length and quality have also been significantly impacted while being less discussed and neglected by society in recent years [36]. Short sleep duration is linked to changes in metabolism, immunity, and behaviour that damage health status and make people more likely to gain weight [37,38]. Short sleep duration has been linked to obesity, according to systematic reviews and meta-analyses [35]. Sleep may affect obesity risk through both physiological and behavioural mechanisms. For instance, more frequent sleep disturbances lower circulating levels of Leptin, a hormone that controls appetite and regulates fat storage [39]. Results in the current study are not in accordance with the foregoing data, as it was found that only significant difference was found in the case of excessive sleep duration, (more than 8 h/ night) where the percentage was greater in the obese participants compared with the normal women. In this context, extensive epidemiological evidence correlates insufficient (in some studies excessive) sleep duration with obesity. When Li [40] looked at the connection between sleep duration and overweight and obesity, the findings revealed that sleep durations under 7 h are linked to 1.83 times higher rates of overweight and 1.57 times higher obesity rates. Greater than 9 h sleep duration, is likewise linked to higher odds of obesity. Hence, according to our results, we suggested that the association of obesity with long periods of Internet usage and the long sleep duration may be associated with the lack of activity and decreased energy expenditure.

The makeup of the gut microbiota has been linked to numerous symptoms of MetS (e.g. obesity, cardiovascular diseases, type 2 diabetes, and nonalcoholic steatohepatitis). Evidence increasingly points to the possibility that gut microorganisms, through mechanisms linked to gut barrier dysfunctions, play a role in the development of the low-grade inflammation that characterizes these metabolic diseases [41].

It is understood that changes in the diversity and composition of gut microbiota are related to the pathophysiology of obesity (i.e. changes in abundance at the level of phyla, genus, or species). The two dominating phyla of the gut microbiota, Firmicutes and Bacteroidetes, were found to be changing in the first study demonstrating these changes in the gut microbiota in genetically obese mice (ob/ob animals) [42]. Ley *et al.* [43] showed that a diet high in fat is linked to altered mice gut microbiota, i.e., a reduction in numbers of Bacteroides-like mouse intestinal bacteria, bifidobacteria, and one group of Firmicutes-related bacteria (Eubacteriumrectale and Blautiacoccoides). Since these groundbreaking discoveries, numerous reports have described the gut microbiota in obesity-prone animal models, the majority of the findings emphasizing a decrease in Bacteroidetes and an increase in Firmicutes with obesity [44,45]. The results of this study revealed no significant difference between obese and normal-weight women in the studied sample in terms of the type of gut bacteria; it also showed that Bacteroidetes phyla were more numerous than Firmicutes phyla. In humans, the pathology of obesity and type-2 diabetes is also linked to changes in the abundance of the principal bacterial phyla, the increase in the F/B ratio in obese patients raises the question of whether the pathophysiology of type 2 diabetes and obesity in humans also correlated with changes in the abundance of the major bacterial phyla [46,47].

An individual's Microbiome can be influenced by many factors: their routines, diet, social status, education, host genetics, level of medical care, and environment [48]. Data of this study showed that according to the socioeconomic index that includes the education level and occupation of each participant in addition to the per month income of the family, denoted participants found in the lower sector had an abundance of Firmicutes phyla and higher significant value of Firmicutes/Bacteroidetes ratio compared with the other social classes, even though they were the lightest as they had the lowest BMI value.

Conclusion

The current study sample was based on normal and obese Egyptian women characterized by their different anthropometric and biochemical measurements. It was obvious that, the mean daily dietary consumption intake of vitamins and minerals was detected in the unsafe and unacceptable categories among the highest percentage of the women in both studied groups, especially for vitamins A, D, E, C, B6, B12, and the folate, where the most deficient elements were zinc, calcium, and iron. Also, it is possible to suggest that the harmful intestinal microbiota Firmicutes among this sample of Egyptian women is significantly affected by their social and economic status than by their body weight. However, it can be concluded that lifestyle factors, dietary consumption intake with high caloric and fat contents, household crowding, long sleep duration, and internet usage were associated with obesity. Further, data provided evidence that gut microbiota dysbiosis was associated with socioeconomic classes rather than high BMI.

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Conflicts of interest

There are no conflicts of interest.

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