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Association between Dietary Pattern, Level of Physical Activity, Obesity and Metabolic Syndrome in Adolescents: A Cross-Sectional Study

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Obese adolescents is a worldwide public health issue that increases the risk of illnesses. It is critical for treatments to understand context-specific hazards. Evaluate the impact of dietary pattern on risk of metabolic syndrome (MS) and dyslipidemia in apparently healthy adolescents. Cross-sectional study was conducted on 600 subjects (250 males and 350 females), aged between 13 and 17 years. They were 300 obese and 300 with normal weight. Dietary consumption was divided into quintiles. Dyslipidemia was found in 60% of cases and MS in 40%. Adolescents in the highest quintiles (Q5) showed significantly higher consumption of carbohydrates, sugar, fats, sweat snakes, high intake of saturated fatty acid (SFA) and body fat %. Odd ratios showed that risk factors for metabolic syndrome components were unhealthy dietary habit, sedentary life, the presence of obesity and dyslipidemia. Inadequate dietary habits, sedentary behavior are important risk factors related to MS and dyslipidemia and obesity among Egyptian adolescents.

Keywords: Adolescents; Body Composition; Dietary Pattern; Dyslipidemia; Obesity; Metabolic Syndrome.

Prevalence of Overweight and obesity have reached epidemic degree worldwide, impacting children and adolescents [1]. According to estimations 254 million children aged 5–19 years will be obese by 2030[2]. The health and nutrition transition in Egypt has been evident previously[3]. Obesity is linked to a number of serious health risks and comorbidities, including cardiovascular disease, hypertension, hyperlipidemia, type 2 diabetes, and metabolic disturbance[4].

The number of stunted children may be decreasing as UNICEF/WHO/World Bank indicate that two-thirds of nations in all regions, with the exception of Africa, are making some progress. In addition, 45.4 million children under the age of five are affected by wasting, with 13.6 million seriously impacted [5]. Nutritional counselling is regarded as a critical intervention in clinical practice for increasing food intake and the quality of food choices in obese patients, which can enhance the regulation of metabolic syndrome parameters and, as a result, cardiovascular risks[6]. Obesity has a complex etiology. Interactions exist between genetic, neuroendocrine, metabolic, psychological, environmental, behavioral, and sociocultural factors[7,8,9]. Treatment for obese adolescents

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focused mostly on encouraging a healthy lifestyle and healthy food intake. However, it is still unclear whether there are particular risk factors of metabolic health linked to lifestyle variables and dietary behavior among Egyptian adolescents.

The aim of our study was to examine dietary factors and the potential risk factors for MS components and dyslipidemia in apparently healthy Egyptian adolescents.

SUBJECTS AND METHODS

The cross-sectional study was carried out on 600 subjects (250 males and 350 females), aged between 13 and 17 years, with no significant sex difference in BMI and age. Subjects were collected from March 2019 to April 2021. They were 300 obese and 300 with normal weight. They grouped according to WHO classification [10]. Metabolic syndrome (MS) components were found in 60% of obese cases. Body fat % was carried out by body composition analyzer TANITA SC - 330. All subjects were volunteers, registering to participate in the study and informed consent was taken. BMI was calculated as weight (kg) divided by height squared (m^2). Serum lipids (total cholesterol, high-density lipoprotein cholesterol (HDL-C) triglycerides (TG) were measured by enzymatic colorimetric. The BMI z-score represents an age- and sex-specific BMI according to the WHO reference and allows for directly comparing of BMI changes between boys and girls of different ages. This study protocol was approved by the ethical committee board of the National Research Centre of Egypt (no. 10/223).

Dietary assessment

The 24- hour dietary recall was used. The subjects were interviewed in person by an experienced dietician; using the multi-pass, 24-h dietary interview method. The respondent was asked to remember all the types and amounts of foods and beverages consumed during the previous 24-h period. Extra emphasis was given to fat type and fat content, added sugars and salt intakes. Due to logistical constraints a repeat dietary recall was not possible. The completed 24 h dietary recall were reviewed, checked for errors and were judged reliable by the interviewer. Unreliability was defined as the inability of the respondent to recall one or more meals or if less than 500 Kcal/day. The data were processed by data entry using the software Nutri survey computer - based database[11]. Moreover, dietary assessment using the 24-h dietary recall data was reported previously [12].

Physical activity (PA) and sedentary behavior

PA was assessed by the validated short version of the International Physical Activity Questionnaire[13,14], a self-reported questionnaire based on the declaration of PA performed in the previous7 days. The results allow for estimating the frequency (number/week) and the duration (minutes/day) for three types of activities: vigorous, moderate and walking. Frequency, type and duration of PA were used to calculate the energy expenditure due to PA by using scoring guidelines (IPAQ scoring protocol - International Physical Activity Questionnaire, n.d.)[15]. Sedentary lifestyle is defined as a moderate practice of physical activity (PA) less than 300 min per week[16]. Therefore, light physical activity (walking) was not considered for the classification of sedentary lifestyle.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation. To compare dietary patterns, participants were categorized into quintiles. ANOVA or chi-square testing was applied as appropriate. Logistic regression was used to obtain adjusted ORs, and to assess assoction between MS and risk factors, odds ratios (ORs) were reported along with their 95% CIs, and a P value of < 0.05 was considered statistically significant. Data were analyzed using the Statistical Package for Social Sciences, version 20. To eliminate skewed data distribution and heteroscedasticity, data are presented as medians with 95% confidence.

RESULTS

Table 1 shows dietary consumption as divided into quintiles in obese adolescents. Participants in the highest quintiles (Q5) of food consumption were being obese while subjects in the lowest quintiles (Q1) have normal weight subjects ($p<0.001$). Adolescents in the highest quintiles (Q5) showed significantly higher values of carbohydrates, sugar, fats, snakes, SFA, body fat % and frequency of MS components than Q1. The age (mean ± standard deviation) of the participants

Table 1. Characteristics of dietary factors and body composition across quintiles of obese adolescents

Nutrient Nutrient	ObeseQuintiles of food intakeNormal weight			
	Q5 (Highest)	Q3	Q1 (Lowest)	P
Age (y) (mean± SD)	9 ±2.9	9±2.5	9 ±2.1	0.07
BMI (kg/m^2) (mean± SD)	27.33±4.6	26.33±3.5	20.92±2.1	0.06
BMI z-score	2.5± 0.98	2.4± 0.18	2.1± 0.23	0.07
Total Food Intake, g	1489.16 (978.89:156.15)	1369.2 (948.71:1486.97)	1274.01 (990.22:1574.8)	0.01
Total Energy, kcal	2691 (1626.07:2605.7)	2351.4(1751.5:27.85)	2027.75 (1597.9:2674.6)	0.01
Food Density, kcal/g	1.9716 (1.5236:1.8204)	1.7798(1.594:2.0141)	1.4436 (1.493:1.8733)	0.01
Protein, g	92.2 (55.175:92.225)	82.5(59.325:109.85)	72.65(53.4:94.3)	0.06
Fat, g	69.8 (47.3:77.725)	62.8(36.9:84.725)	53.7 (36.5:87.6)	0.01
Fat,%kcal	30.0907 (23.6413:29.88)	27.7231(23.4308:29.70)	26.319 (21.3876:30.70)	0.01
Carbohydrate, g	398.7(257.85:425.5)	352.6(248.7:44.875)	332.7(258.4:405.7)	0.01
Carbohydrate, %kcal	72.8515 (59.9634:68.3366)	63.0261(57.9158:68.176)	61.4524 (59.6948:68.443)	0.01
Dietary Fiber, g	22.1(15.875:30.75)	21.5(16.4:31.95)	23.1(13.9:31.6)	0.06
Sugars, g	3.1(1:3.7)	2.5(.9:4.425)	1.15(0:4.32)	0.01
Sugars, %kcal	0.18232 (0:0.88965)	0.05424 (0:0.70778)	0.0274(0:0.92067)	0.01
Cholesterol, mg	168.6 (95.6:211.7)	151.9 (79.15:220.1)	140.65(87.5:213)	0.01
SFA	5.4 (1.8:5.25)	3.5 (1.35:5.65)	3.1(1.8:7.4)	0.01
Components of MS %	70%	25%	5%	0.001
Body fat % (kg) (mean ±SD)	31 ± 7.8	25± 11.89	19 ±9.55	0.01

Data are presented as medians (95% confidence intervals).

Table 2. Multivariate odd ratios (OR) for and 95 % confidence intervals (CI) of MS, adjusted for age, BMI and body fat %

Characteristics	OR*	95.0 % CI	P value
High fat consumption	1.72	1.558-1.948	0.001
High consumption of carbohydrates	1.52	1.658-1.977	0.001
Obesity	1.57	1.362-1.871	0.001
High sweat snakes	1.62	1.711-1.934	0.001
High consumption of SFA	1.56	1.458-1.574	0.002
High consumption of sugar	1.62	1.356-1.781	0.004
Sedentary life	1.42	1.255-1.375	0.005
Dyslipidemia	1.63	1.345-1.670	0.004

was 14 ± 3.4 year, ranging from 13 to 17 years old. The mean BMI was 15.77±2.55 ranging from 14.56± 2.12 to 25.78 ± 3.65.

Table 2 shows odds ratios of risk factors for MS components. High consumption of fats, carbohydrates, sweat snakes, SFA, sugar as well as sedentary life style, obesity and dyslipidemia increased the risk of MS.

DISCUSSION

Overweight and obesity were more prevalent among Egyptian adolescents in 12.1 and 6.2% of cases, respectively [17]. Due to increase of dietary energy availability in Egypt a nutrition shift has been occurred [3]. Overweight and obesity are strongly linked with specific types of diets, including high consumption of fats, animal-based meals and processed foods[18]. Adolescents' lifestyles are characteristically defined by physical inactivity, sedentary behavior, and unhealthy eating habits in general[19]. Obesity is linked with serious health risks and comorbidities, including cardio vascular disease, hypertension, hyperlipidemia, type 2 diabetes, and certain cancers[4]. Previously, it was assumed that levels of nutrient intakes may rise enough to stimulate pathogenic pathway in obese subjects that leading to the activation of immune cells in the different metabolic tissues [20] . Waist-BMI Ratio was independently associated with cardiovascular mortality , offering an enormous potential risk marker for obesity in the clinical setting[21]. Previous study reported week assoction between metabolic health and lifestyle factors in obese adolescents[22]. However, this study was only performed on Czech Caucasian population that might be not comparable with our results or other populations groups. Our findings are consistent with previous research that have found that a reduction in physical activity and a sedentary lifestyle are important risk factors for adolescent's obesity [23]. Obesity and diabetes are on the rise, and a lack of regular physical activity has been highlighted as a key cause [24]. Reduced regular physical activity has been identified as a major contributor to the rise in obesity and diabetes[25]. However, previous study found[26] in this cohort of participants that a healthy dietary pattern resembling the Mediterranean diet was inversely associated with such characteristics of the MS[27] . Together with standard care of lifestyle changes and medication, dietary supplements derived from herbal resources could be an alternative therapeutic strategy that is safe, efficient, culturally acceptable, and has few side effects[28]. A detailed examination of the eating habits and the factors associated with them revealed similar risks that in consistent with our findings[29]. Many studies conducted in high-income countries discovered that adolescents with a higher socioeconomic status was more obese [30–32] and more likely to choice carbohydrate-rich meals that are enjoyable or comforting, which lead to the increase of sedentary activity and influence on sleeping problem [33]. Obese children have a high prevalence of dyslipidemia, with hypertriglyceridemia [34]. Moreover, several previous studies reported that obese adolescents are more likely to be younger and in the early stages of puberty[35].

CONCLUSIONS

The present study provides evidence of causal relationship between obesity, dietary factors, dyslipidemia and risk of MS. Improvement of dietary habits and regular evaluation of blood lipids might prevent developing of MS in Egyptian adolescents. Physical activity less than 300 min per week was found an important risk factor of MS.

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