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ASSESSMENT OF NUTRITIONAL RISK FACTORS ASSOCIATED WITH CARDIO METABOLIC DISEASES IN OBESE ADOLESCENTS

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Abstract

Objective: *To evaluate the nutritional risk factors and lipid profile abnormalities associated with cardiometabolic diseases in obese adolescents aged 11-19 years in Quetta, Pakistan.*

Methodology: *A cross-sectional study was conducted in secondary and higher secondary schools of Quetta. A total of 280 adolescents (122 normal weight, 158 obese) were enrolled. Anthropometric measurements including height, weight, BMI, waist, hip, and neck circumference were recorded. Fasting blood samples were analyzed for total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). Nutritional assessment was performed using 24-hour dietary recall method. Data were analyzed using SPSS-16, employing ANOVA and Student's t-test.*

Results: *Obese males (n=82) had mean BMI of 27.89±0.52, while obese females (n=75) had mean BMI of 26.05±0.50. Baseline anthropometric measures were significantly higher in girls (P<0.05). However, no significant gender difference was observed in baseline lipid profile (P>0.05). Obese adolescents in the 17-19 years age group exhibited comparatively higher BMI. Nutritional assessment revealed that adolescents consuming junk and fast food had elevated blood pressure and increased adiposity. Obese individuals demonstrated significantly higher LDL, triglycerides, and total cholesterol levels compared to normal-weight counterparts.*

Conclusion: *Adolescents consuming junk and fast food have a higher probability of developing cardiovascular disease. Nutritional modification and adoption of healthy eating habits in daily routines can improve quality of life. There is an urgent need for nutritional awareness programs among adolescents in schools and colleges.*

Keywords: *Adolescents, Cardiometabolic diseases, Hyperlipidemia, Lipid profile, Obesity, Triglycerides*

INTRODUCTION

Obesity is widely regarded as one of the most pressing global public health challenges (1). In many European nations, more than 60% of the population is classified as overweight or obese. Excess body weight is a well-established contributor to several cardiovascular (CV) risk factors, including high blood pressure, type 2 diabetes, and abnormal lipid profiles, and is associated with increased rates of cardiovascular disease-related illness and death (2). A large systematic review and meta-analysis involving 95 cohort studies reported that individuals with obesity had approximately 60% greater prevalence of cardiovascular disease compared with those of normal body weight (3).

While CVD mortality rates in the United States have generally decreased over recent decades, the rate of decline has more recently slowed, possibly due to the obesity epidemic reversing much of the progress previously gained in CVD outcomes (4). Several studies have suggested that a particular subgroup of individuals with obesity those with Metabolically Healthy Obesity (MHO) may have a much lower risk than generally estimated for obesity-related CVDs. Compared with individuals who have metabolically unhealthy obesity, those with MHO tend to exhibit less visceral and liver fat, greater subcutaneous fat accumulation in the lower body, higher levels of physical activity and cardiorespiratory fitness, better insulin sensitivity, reduced inflammatory markers, and healthier adipose tissue function (5).

Although BMI is frequently used to define obesity, it is insufficient on its own to accurately evaluate cardiovascular risk linked to accumulated adiposity. It is now well recognized that fat distribution plays a more critical role than BMI alone in determining cardiovascular risk (6). A recent consensus statement recommends that healthcare practitioners routinely measure waist circumference, as this represents an important opportunity to enhance patient care and health outcomes. According to the same consensus, the most critical care endpoint for reducing harmful health risks in both genders is to reduce waist circumference rather than body weight or BMI (7).

In low- and middle-income countries, mortality from cardiovascular disease occurs at younger ages compared to high-income nations. Prevalence of coronary heart disease is at least a decade earlier in South Asians than in other races, with the mean age of stroke occurring much lower than that seen in Western countries (8). The INTERHEART study demonstrated that cardiovascular risk factors present at earlier ages in South Asians, primarily due to higher levels of risk factors at younger ages (9). Age groups together with cardiovascular risk determinants relevant to older persons are equally important for the young South Asian population (10).

Children and adolescents who are obese are more likely to remain obese into adulthood and develop conditions including diabetes, cardiovascular disease, and dyslipidemia. Dyslipidemia refers to abnormal levels of lipids and lipoproteins in the blood and is closely linked to the formation of atherosclerotic plaques. These lipid abnormalities are strongly associated with increased body fat, particularly visceral fat (11). To reduce the burden of cardiovascular disease, prevention must begin early in life, long before clinical symptoms appear (12). Evidence suggests that a higher BMI during childhood, even between the ages of 7 and 13 years, is associated with an increased risk of heart failure later in life (13). Among various risk factors, elevated cholesterol levels and obesity show strong persistence from childhood into adulthood. Obesity-related metabolic syndrome is characterized by increased levels of inflammatory markers, particularly C-reactive protein (14). This chronic or low-grade inflammation observed in uncomplicated obesity contributes to a higher risk of developing diabetes and cardiovascular disease.

Given the rising prevalence of adolescent obesity and its associated cardiometabolic risks in Pakistan, this study was conducted to evaluate the nutritional risk factors and lipid profile abnormalities in obese adolescents in Quetta.

MATERIALS AND METHODS

STUDY DESIGN, SETTING AND PARTICIPANTS

This cross-sectional study was conducted in various educational institutes (secondary and higher secondary schools) of Quetta, Pakistan. A single time point assessment of cardiometabolic risk factors was performed among 280 adolescents aged 11-19 years. A total of 280 adolescents were enrolled and divided into three age groups: 11-13 years, 14-16 years, and 17-19 years. Among them, 122 were normal-weight and 158 were obese.

INCLUSION AND EXCLUSION CRITERIA

Subjects aged 11 to 19 years of both genders with with no previous history of cardiometabolic disorder and obese adolescents identified by BMI according to WHO criteria were included in the study. While subjects aged less than 11 or more than 19 years having previous history of cardiometabolic disorder and subjects with normal BMI were excluded in the study.

CONSENT PROCEDURE

Informed consent and parental permission were obtained from every participant.

DATA COLLECTION

Anthropometric data including height, weight, and waist circumference were gathered in accordance with standard protocols. Height was measured using an inch tape (in cm), and weight was measured using a digital weight scale (JVD). BMI was calculated as weight (kg) divided by height squared (m^2) according to CDC guidelines.

BLOOD PRESSURE MEASUREMENT

Blood pressure was measured using a digital sphygmomanometer following standard protocols. Blood pressure was recorded at the initial visit according to the Center for Disease Control and Prevention (CDC) standards.

LIPID PROFILE TEST

Venous blood samples (3-5 ml) were collected in serum separator tubes. Blood was allowed to clot for 20-30 minutes and centrifuged at 3000 rpm for 10 minutes to obtain serum. Lipid profile analysis (total cholesterol, LDL, HDL, and triglycerides) was performed using an automated analyzer (Cobas c311). Biochemical tests including fasting glucose levels were also conducted.

NUTRITIONAL ASSESSMENT

Nutritional assessment was performed using the 24-hour dietary recall method, which included medical history, dietary lifestyle assessment, and oral interviews with participants. Anthropometric measurements including BMI, waist circumference, hip circumference, and neck circumference were manually recorded for each individual.

STATISTICAL ANALYSIS

Data were analyzed using MS-Excel and SPSS-16 statistics software. ANOVA and Student's t-test were used for statistical analysis. Results were presented as mean ± standard error (SE), and a P-value <0.05 was considered statistically significant.

RESULTS

ANTHROPOMETRIC CHARACTERISTICS

The anthropometric characteristics of the participants are summarized in Table I. Obese males (n=82) had a mean height of 165.68±1.30 cm, weight of 77.67±2.19 kg, and BMI of 27.89±0.52. Obese females (n=75) had a mean height of 156.20±1.95 cm, weight of 68.21±2.10 kg, and BMI of 26.05±0.50. Normal males (n=56) and females (n=66) had significantly lower weights and BMIs, with means of 50.72±1.19 kg and 19.57±0.10, and 48.05±1.20 kg and 19.53±0.11, respectively.

Height differences followed the expected sex pattern, with males taller than females. However, the reported mean heights for normal-weight groups appeared unusually low. BMI values indicated that obese participants had higher body mass relative to height compared with normal-weight participants. Across groups, height ranged from 135.3 to 184.3 cm, weight from 35 to 114 kg, and BMI from 16.19 to 37.37, demonstrating variability within each category. Baseline anthropometric measures were significantly higher in girls (P<0.05). However, there was no difference between boys and girls in baseline lipid profile (P>0.05).

Table I. Comparison of height, weight and BMI of obese and normal adolescents

	Height (cm)				Weight (kg)				Body Mass Index			
	Obese male	Normal male	Obese female	Normal female	Obese male	Normal male	Obese female	Normal female	Obese male	Normal male	Obese female	Normal female
n =	82	56	75	66	82	56	75	66	82	56	75	66
Mean	165.68±1.0[a]	106.39±1.84[b]	106.45±1.57[a]	156.20±1.95[b]	77.67±2.19[a]	50.72±1.186[b]	68.21±2.10[a]	48.05±1.2[b]	27.89±0.52[a]	19.57±0.10[b]	26.05 ±0.50[a]	19.53±0.1[b]
Minimu	135.3	135.3	135.3	135.3	38.3	35	35.9	35	20.01	16.98	19.27	16.19
Maximur	183.9	183.9	184.3	184.3	114	68.7	97	70	37.37	20.97	34.11	22.34

WAIST, HIP, AND NECK CIRCUMFERENCE

Table II shows that obese individuals exhibited higher waist, hip, and neck circumferences compared to normal-weight counterparts in both sexes. Obese males had a mean waist of 86.14 cm versus

69.26 cm in normal males, while obese females averaged 81.46 cm compared to 66.22 cm in normal females. Hip and neck measurements showed similar trends. However, waist-to-hip ratios were comparable between obese and normal groups, indicating that fat distribution proportions were similar despite overall increases in body size.

Table II. Comparison of waist, hip, waist-hip ratio, and neck of obese and normal adolescents

	Waist (cm)				Hip (cm)				Waist-Hip Ratio				Neck (cm)			
	Obese Male	Normal Male	Obese Female	Normal Female	Obese Male	Normal Male	Obese Female	Normal Female	Obese Male	Normal Male	Obese Female	Normal Female	Obese Male	Normal Male	Obese Female	Normal Female
n =	82	56	75	66	82	56	75	66	82	56	75	66	82	56	75	66
Mean	86.14 ±1.65^{a}	69.26± 1.14^{b}	81.46±1.98^{a}	66.22± 0.78^{b}	97.25±2.01^{a}	75.98±1.23^{b}	91.81 ±2.47^{a}	73.14±0.91^{b}	0.89 ±0.64^{a}	0.91 ±0.53^{b}	0.89 ±0.78^{a}	0.90 ±0.46^{b}	33.10± 0.40^{a}	32.42±0.49^{b}	32.54±0.45	31.87±0.51
Minimum	51.8	51.8	55.7	54.6	57.6	57.6	60.7	60.7	0.75	0.85	0.68	0.85	26.3	25.9	25.5	25.3
Maximum	110	88.2	108	85.6	123	93.8	122	95.7	0.99	0.98	0.99	0.98	40	38.9	41.5	41.5

BODY COMPOSITION

Table III presents body composition measures for obese and normal males and females, including fat mass (kg), fat percentage, and lean mass. In terms of absolute fat mass, obese individuals of both sexes showed significantly higher values compared to their normal-weight counterparts. Obese males had a mean fat mass of 18.17±1.16 kg, while normal males averaged 5.27±0.40 kg. Similarly, obese females had a mean fat mass of 21.38±1.83 kg compared to 6.09±0.38 kg in normal females. This pattern was also reflected in fat percentage, where obese males and females had higher fat percentages (21.84±1.11% and 28.36±2.05%, respectively) than normal males and females (10.38±0.74% and 12.75±0.71%, respectively).

Table III. Comparison of fat, fat%, and lean mass in obese and normal adolescents

	Fat (kg)				Fat (%)				Lean Mass			
	Obese male	Normal male	Obese female	Normal female	Obese male	Normal male	Obese female	Normal female	Obese male	Normal male	Obese female	Normal female
n =	82	56	75	66	82	56	75	66	82	56	75	66
Mean	18.17±1.16^{a}	5.27±0.40^{b}	21.38±1.83^{b}	6.09±0.38^{b}	21.84± 1.11^{a}	10.38±0.74^{b}	28.36±2.05^{a}	12.75±0.71^{b}	59.50± 1.38^{a}	45.44±1.11^{b}	46.83± 1.26^{a}	41.96±1.13^{b}
Minimum	1.12	0.09	0.92	0.25	1.98	0.18	1.21	0.65	31.98	29.64	26.1	29.63
Maximum	35.55	12.28	47.13	16.84	39.5	19.69	53.28	25.52	82.74	63.24	75.18	67.18

AGE-WISE ANALYSIS

Table IV shows the year-wise comparison of height, weight, and BMI for males and females aged 11 to 19 years. The investigation of anthropometric measurements across ages revealed an ascending trend in height and weight for both males and females. Males exhibited a distinct increase in height across ages, particularly between ages 13 and 15, where the mean height rose from 159 cm to 169 cm. Females presented an ascending trend in height, peaking between ages 15 and 16 years, with subsequent fluctuations.

BMI values were higher among males than females for all adolescents, with a notable peak in the age group of 17 to 19 years, showing a greater increase in relation to weight against height. Females showed lower BMI than males, with random variability in body composition and developmental structure during puberty.

DISCUSSION

The rising prevalence of diet-related non-communicable diseases (NCDs) among adolescents has become a major global public health concern (15). Over the past decade, dietary patterns have increasingly shifted toward the consumption of energy-dense, nutrient-poor foods collectively recognized as obesogenic diets. These consist of fast food and junk food containing unhealthy fats, sugar, and salt, which are easily available to young persons. These transition foods increase the prevalence of young person's at risk of developing early-life onset of metabolic syndrome (MetS), obesity, and cardiovascular diseases (CVDs) (16).

Table IV. Year-wise comparison of height, weight, and BMI in males and females

Age	Height (cm)		Weight (kg)		Body Mass Index	
	Male	Female	Male	Female	Male	Female
11y Mean	149.56±3.76	153.07±5.26	52.31±3.14	45.86±3.45	23.33±0.95a	19.42±0.28b
12y Mean	153.85±4.78	153.45±8.36	63.52±3.47a	46.00±2.14b	26.70±1.12a	19.55±2.03b
13y Mean	159.31±2.59	165.48±4.74	69.51±3.85	55.94±3.58	27.23±1.11a	20.10±0.32b
14y Mean	169.16±2.38a	163.68±8.57b	78.20±2.29a	53.48±5.81b	27.51±1.24a	19.69±0.29b
15y Mean	169.70±1.01	167.60±4.3	85.11±3.82	55.05±2.95	29.59±1.4a	19.58±0.04b
16y Mean	165.41±4.41	166.69±4.67	79.05±6.4a	55.27±2.6b	28.38±1.42a	19.82±0.17b
17y Mean	174.94±1.54	160.82±3.29	95.70±4.49	48.33±1.64	31.22±1.29a	18.69±0.35b
18y Mean	174.68±1.71a	159.13±5.49b	92.40±6.78	49.37±3.07	30.09±1.86a	19.40±0.26b
19y Mean	167.78±3.25	157.94±6.75	85.11±9.12a	50.31±7.46b	29.43±3.22a	20.09±2.41b

This study highlights the importance of dietary assessment in understanding metabolic status. Our findings revealed differences in gender-based cardiometabolic risk factors among obese youth attending secondary and higher secondary schools in Quetta city. Among our participants (n=280), 122 were normal weight and 158 were obese, with a mean age of 11-19 years. We measured all anthropometric parameters including height, weight, BMI, hip, waist, and neck circumference of all individuals. Laboratory parameters including LDL, HDL, triglycerides, total cholesterol, and glucose levels were also assessed.

Our findings demonstrated that individuals with high BMI also had higher levels of LDL, triglycerides, and total cholesterol. The adolescents consuming more fast food and junk food had higher risk factors for cardiometabolic disorders including adiposity, diabetes, and hypertension. These clusters represent heterogeneous patterns of food consumption and offer valuable insight into the phenotypic characteristics of adolescents' diets (17). Similar clustering approaches have been applied in countries such as the United States, Brazil, South Korea, and China (18).

A key finding from an Indian study is that adolescents following a highly obesogenic dietary pattern exhibited significantly higher prevalence of obesity and diabetes (19). Our study shows similar findings to the national study of India, but we found no significant evidence of diabetes in obese adolescents; our findings showed higher LDL and triglycerides in obese adolescents compared to normal individuals, especially in the age group 17-19 years. This is consistent with global evidence showing that frequent intake of processed foods, fried snacks, and sugary beverages contributes strongly to insulin resistance, adiposity, and dyslipidemia among adolescents (20). Studies from Chile, Mexico, and Brazil similarly report that adolescents consuming ultra-processed foods are at elevated risk for MetS and its components (21).

The cluster characterized as a Western dietary pattern high in animal-based protein and low in fiber—was significantly associated with lipid abnormalities and micronutrient deficiencies. Research from Western countries similarly shows that diets rich in meat and low in plant-based foods increase LDL cholesterol, disturb glucose metabolism, and lead to deficiencies in calcium, folate, and vitamins (6). The similarity of these patterns with global findings suggests that Pakistani adolescents are experiencing dietary transitions comparable to those observed in rapidly urbanizing and industrializing regions worldwide (22).

In addition to changing behaviors, other structural strategies such as regulating the marketing of foods, improving food environments in educational institutions, and monitoring food processing to ensure minimal presence of trans fats are important (23). Successful reductions in trans fats in foods in the United Kingdom emphasize the effectiveness of a regulatory approach, while nutritional technology developments such as rapid pathogen detection methods may improve public health infrastructure and ensure the prevention of food-borne diseases.

The prevalence of MetS among adolescents in Pakistan is a growing concern, with studies reporting that approximately 17% of adolescents in resource-poor areas of Karachi have MetS (24). A substantial proportion of schoolchildren rely on school canteens where energy-dense, nutrient-poor foods are widely available, contributing to increased consumption of ultra-processed foods (25). Mechanistically, these foods promote metabolic dysregulation through glycemic instability, hyperinsulinemia, and ectopic fat accumulation (26).

CONCLUSION

This study highlights important gender-specific differences in cardiometabolic risk factors linked to diverse dietary patterns among adolescents and offers valuable insight into how these eating behaviors relate to metabolic syndrome. The observation that approximately one in four adolescents consumes a highly obesogenic diet underscores the urgent need for focused public health action. Nutritional assessment showed that adolescents consuming junk and fast food have high blood pressure and increased adiposity. We conclude that adolescents consuming junk and fast food have a higher probability of developing CVD. Quality of life can be improved by nutritional modification and adopting healthy eating habits in daily routines. There is a dire need for nutritional awareness among adolescents in schools and colleges.

Limitations of the study:

This study has several limitations. Being a cross-sectional study, it cannot establish causal relationships between dietary patterns and metabolic outcomes. Additionally, the dietary behavior measures used in the analysis were self-reported, which may be influenced by recall bias or social desirability bias. The dataset lacked detailed information on physical activity and familial metabolic history, which are important determinants of MetS. Furthermore, the study was conducted in a specific area with only 280 participants, limiting the generalizability of findings.

Recommendations:

Future research should employ longitudinal or intervention study designs to examine whether adolescents with different dietary patterns respond differently to interventions. Including additional variables such as levels of physical activity and parental metabolic syndrome could provide a more comprehensive understanding of MetS risk. Furthermore, considering psychological and environmental factors may offer important insights into how and why adolescents' food habits change over time. School-based health promotion, public awareness campaigns, and policy measures such as warning labels on processed foods can collectively help reduce the burden of early-onset cardiometabolic illnesses.

Conflict of interest:

Authors declared no conflict of interest.

Authors' contribution:

RA Study design and data collection; ZT Dietary assessment and statistical support; RA & DKH Biochemical and laboratory analysis; GN Fieldwork and participant management; IUK Critical analysis; MR Supervision and review

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