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Original Article

Exploring the Metabolic Syndrome Trend in Young Adults in COVID-19 Era

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ABSTRACT

COVID-19 pandemic imposed sudden changes in lifestyle with consequent altered metabolic status. Metabolic Syndrome is described as an altered metabolic profile of insulin resistance, dyslipidemia, hypertension, and central obesity which raises type 2 Diabetes Mellitus and cardiovascular disease danger at an early age. **Objective:** To analyze COVID-19 era status of obesity, hypertension, impaired glucose tolerance, dyslipidemia and metabolic syndrome in young adults. **Methods:** This was a cross-sectional study. 245 university students of either gender with ages 19-25 years were included. The lipid profile, fasting blood sugar and serum insulin was performed by kit method. The insulin resistance was determined by calculating the ratio of fasting glucose to insulin. SPSS version number 24.0 was used to analyze the data. **Results:** Metabolic syndrome's prevalence in overweight and obese subjects was found to be 36%. The most prevalent risk factor of Metabolic syndrome was raised blood pressure (60%) followed by insulin resistance (57%) and dyslipidemia (40%). The positive coefficient correlations were found for all Metabolic syndrome risk factors in general except HDL. The multivariate regression analysis evidenced that the BMI and WHR were the significant predictors of Metabolic syndrome risk factors. **Conclusion:** The COVID-19 restrictions consequences call for an urgency to effectively address the metabolic syndrome and related problems, especially among young individuals.

INTRODUCTION

The metabolic disorders have been reported to account for death in a greater than half of the population suffering from COVID-19 [1]. Metabolic syndrome (MetS) is associated with obesity, deranged lipid metabolism, elevated blood pressure, hyperglycemia and insulin resistance. A study reported a greater than 35% increase in MetS in US adult population during covid era [2]. Metabolic syndrome is more prevalent in adults as compared to young adults. In the US, in adults of age 18 years and above, metabolic syndrome prevalence was found to rise from 25.3% to 34.2% during the year 1999 to 2012. This metabolic syndrome prevalence almost doubled in the United States as declared in NHANES data [3]. The criteria of the International Diabetes Federation for Metabolic Syndrome were fulfilled by 6.1% of the undergraduate students in urban areas of Pakistan [4]. Obesity and overweight among young adults in developing countries are alarmingly high ranging from 2.3 to 12 %, and 28.8 % respectively [5]. World obesity foundation has published a report on childhood obesity that ranked Pakistan at position number 9 and predicted that by the end of 2030, more than one million school-aged children and youth will suffer from obesity. Obesity has more severe adverse effects on the younger population than the older ones [6]. Youth aged between 15 and 33 years contributes around 63% of the population of Pakistan [7]. The implications of COVID-19 constraints

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might step up the pre-existing prevalence of overweight or obesity in young adults. The pathologies associated with metabolic syndrome are correlated with obesity and high-calorie intake. The risk of developing metabolic syndrome is already on the rise in university students as its components are being reported at an early age [8]. The COVID-19 lockdown has negatively affected physical activity and diet quality, and a greater frequency of overeating specifically among university students. This could further predispose university students to obesity and other metabolic risk factors [9]. Few basic lifestyle changes and an early diagnosis and treatment are key to stop the symptoms from progressing in metabolic syndrome. These interventions will decrease the global load of type II diabetes, cardiovascular diseases and mortality linked with MetS [10]. There is a lack of data assessing the burden of MetS in general as well as in the overweight and obese young adult individuals in Pakistan. There is an urgent need to update data and information on the frequency and prevalence of metabolic disorder related to health impacts of COVID-19 and to assess the post-pandemic MetS among young adults as they remain a scarcely studied group in Pakistan. The study objectives are to evaluate the metabolic syndrome, its components, frequency and association with BMI in young adults (19-25 years).

METHODS

This study was conducted at Dow University of Health Sciences after approval from IRB-2364/DUHS/Approval/2022/739. It was a cross-sectional study. Sample size of 245 was calculated by Open Epi software for public health, (version 3.01). The following assumptions were made while calculating the sample size. MetS prevalence of 6.1% among young adults with 3% margin of error and 95% confidence level [11]. The students of either gender of ages between 19 to 25 years with BMI >23 kg/m2 as per the Asian criteria consented for the study were included through non-probability consecutive sampling [12]. A structured questionnaire was administered to extract the demographic details of the participants including age, gender, socioeconomic and family history. The physical measurements were taken and recorded by a trained nurse. The height was recorded on Seca Rod 220 stadiometer in centimeters at the exact point to the nearest mm. The weight was measured by a TANITA weighing scale with one foot of the participant on each side of the scale. The waist was measured by Gulick tape measure at the end of exhalation over light clothing; with relaxed arms at both sides; at the top of the iliac crest (hip bone) and midpoint between the lower margin of the last palpable rib. The maximum circumference over the buttocks was taken to measure the hip circumference. Blood pressure was recorded using an automated blood pressure monitor Benemed (Hong Kong) Industry Co., Limited Model NO.: BP-05). While measuring B.P, it was made sure that cuffs level was same as the level of heart. The systolic and diastolic blood pressure readings were noted after switching it on. The next day participants were called after a minimum 12-h fast, 5 cc blood samples were drawn by a phlebotomist after taking all aseptic measures. The blood samples were collected in the gel-barrier tube and transported for biochemical analysis within 4 hours. The samples were centrifuged. An enzymatic colorimetric (GOD-PAP) method was used to determine the serum glucose levels. The standard enzymatic colorimetric method determined the serum triglycerides, serum LDL-cholesterol, serum HDL-cholesterol, and serum total cholesterol. The serum insulin was evaluated by using ELISA according to the given directions by (R & D Systems, Inc., USA). Insulin sensitivity was computed as a glucose-to-insulin ratio. New International Diabetes Federation criteria were used to define MetS in this study [13]. SPSS version 24.0 (by IBM Corp, Armonk, NY) was used to assess the data. The quantitative variables were evaluated for normality and reported as mean ± SD. One-factor ANOVA and the Bonferroni post hoc test were used for comparing means of continuous variables by categories of BMI according to Asian criteria. The Pearson correlation coefficients used between BMI and WHR for each metabolic component were calculated. The multivariate linear regression analyses were performed to find out the influence of BMI and WHR on each metabolic component in all participants.

RESULTS

The mean values of physical, clinical, and biochemical variables of young adults are presented in Table 1. The BMI and waist-hip ratio was 28.15 kg/m2 and 0.84 respectively. The systolic BP was 120.4 mmHg and diastolic BP was 81.3 mmHg. The serum concentrations of fasting glucose (FBG), insulin, cholesterol and triacylglycerol (TGs) were 89.3 g/dL, 21.70 mU/L, 174.6 mg/dL and 80.8 mg/dL respectively. The LDL and HDL level was 98.43 mg/dL and 45.05 mg/dL.

Variables	Mean ± SD
Physical variables	
Height (meters)	1.61 ± 0.14
Weight (kg)	75.36 ± 22.14
BMI (kg/m2)	28.15 ± 4.94
Hip (cm)	100.01 ± 12.18
Waist (cm)	84.95 ± 12.32
Waist hip ratio	0.84 ± 0.06

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Clinical variables	
Systolic blood pressure (mmHg)	120.42 ± 9.68
Diastolic blood pressure (mmHg)	81.36 ± 11.14
Biochemical variables	
Fasting blood glucose (mg/dL)	89.31 ± 2.52
Triacylglycerol (mg/dL)	80.79 ± 23.78
LDL (mg/dL)	98.43 ± 9.13
HDL (mg/dL)	45.05 ± 9.24
Total cholesterol (mg/dL)	174.68 ± 37.73
Insulin (mU/L)	21.70 ± 13.13

Table 1: Descriptive analysis of physical, clinical and biochemical variables of young adults (n=245)

Table 2 presents the mean BMI of overweight patients was higher than the participants with normal weight ($p \le 0.05$). The obese subjects reported higher BMI than the normal as well as overweight subjects ($p \le 0.05$). However, the waist-hip ratio was only notably high in obese than the normal weight subjects. The overweight subjects had higher average systolic and diastolic blood pressure when compared to normal ($p \le 0.05$) while the obese subjects showed higher values than normal and overweight subjects as well ($p \le 0.05$) The serum FBG and insulin concentrations were increased in the overweight ($p \le 0.05$) but the obese subjects showed higher concentrations than the overweight in comparison to normal-weight subjects ($p \le 0.001$). Accordingly, the serum total cholesterol, LDL, and HDL concentrations were raised in the overweight and obese than in the normal weight subjects ($p \le 0.05$). The Serum TGs conc was more in the overweight than the normal ($p \le 0.05$) while in the obese it was higher than the overweight subjects as well ($p \le 0.05$).

Variables	Normal weight (BMI 18.5-22.9 kg/m2) n=85	Overweight (BMI 23–24.9 kg/m2) n=80	Pre-obese/Obese (BMI≥25 kg/m2) n=80
Physical variables			
Height (meters)	1.55 ± 0.02	1.60 ± 0.02	1.67**¥ ± 0.02
Weight (kg)	57.5 ± 2.1	72.9* ± 0.02	95.6* ± 3.5
BMI (kg/m2)	22.98 ± 0.28	28.1** ± 0.22	33.43£ ± 0.61
Waist hip ratio	0.8 ± 0.009	0.81 ± 0.008	0.9* ± 0.006
Clinical variables			
Systolic blood pressure (mm of Hg)	114.0 ± 1.7	122.0**§ ± 1.18	125**¥ ± 1.35
Diastolic blood pressure (mm of Hg)	77.5 ± 1.6	2.8* ± 1.2	85.0§ ± 1.1
Biochemical variables			
Fasting blood glucose (mg/dL)	87.94 ± 0.44	89.22* ± 0.39	90.77**¥ ± 0.29
Triacylglycerol (mg/dL)	48.14 ± 0.60	94.62** ± 0.97	99.60£ ± 0.85
LDL (mg/dL)	88.94 ± 0.40	98.48** ± 0.40	100.88** ± 0.48
HDL (mg/dL)	56.31 ± 1.00	40.00** ± 0.23	198.74** ± 3.03
Total cholesterol (mg/dL)	128.82 ± 3.84	196.48** ± 2.76	198.74** ± 3.03
Insulin (mU/L)	10.07 ± 0.13	15.76** ± 0.39	39.28£ ± 0.89

Table 2: Comparison of physical, clinical and biochemical variables of young adults by BMI category (n245)

Values are given in mean ± S.E.M; *p<0.05; ** p<0.001 when compared with normal weight subjects; ¥ p<0.05 when compared with overweight subjects; §p<0.05, £ p<0.001 when compared with overweight and normal weight subjects

Correlations between BMI and waist-to-hip ratio & MetS risk factors in young adults are shown in Table 3. Notable (except HDL) correlations were found in all MetS risk factors in general. Significant and positive correlations for serum FBG, TGs, and insulin with BMI and WHR were observed in obese subjects in comparison to normal-weight subjects. The serum FBG and TGs showed higher correlation coefficients with WHR than BMI in overweight/obese subjects.

Metabolic syndrome risk factors		Pearson's correlation (r)		
		All subjects (n245)	Normal weight (n80)	Overweight/ pre-obese/Obese (n160)
Systolic blood pressure (mmHg)	BMI(kg/m2)	0.46**	0.31	0.11
	WHR	0.18	-0.12	0.11
Diastolic blood pressure (mmHg)	BMI(kg/m2)	0.25**	-0.09	0.20
	WHR	0.34**	0.36*	0.26*
Fasting blood glucose (mg/dL)	BMI(kg/m2)	0.42**	0.08	0.26*
	WHR	0.39**	0.21	0.36**
Triacylglycerol (mg/dL)	BMI(kg/m2)	0.77**	0.21	0.34*
	WHR	0.37**	-0.16	0.42**
HDL (mg/dL)	BMI(kg/m2)	-0.67**	-0.002	-0.23
	WHR	-0.29**	0.03	-0.07
Insulin (mU/L)	BMI(kg/m2)	0.80**	0.02	0.67**
	WHR	0.57**	-0.02	0.60**

Table 3: Correlations between BMI, waist hip ratio (WHR) and metabolic syndrome risk factors in young adults (n245)

*p<0.05; ** p<0.001; WHR= Waist hip ratio

Figure 1 shows a 36% metabolic syndrome (MetS) prevalence in the overweight and obese subjects. The most marked risk factor of MetS was raised blood pressure (60%) followed by insulin resistance (57%) and dyslipidemia (40%).

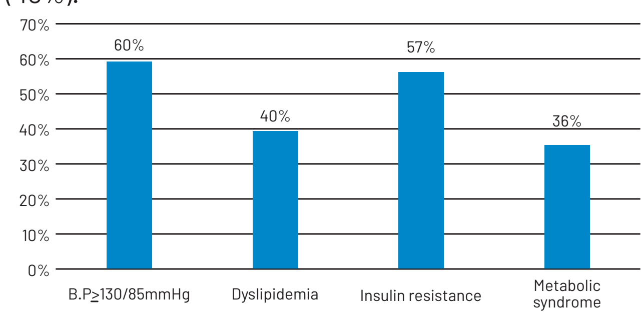

Figure 1: Prevalence of metabolic syndrome and its risk factors in overweight/obese young adults

Multivariate regression analysis showed that the BMI and WHR were the significant predictors of MetS risk factors (Table 4). The main effect model including BMI and WHR explained a high percentage of the variability of insulin 67.9%; TGs 59.3%; HDL 45.2 %; followed by FBG 22.2 %; systolic BP 21.7 % and diastolic BP 12.6 %. In this model, BMI

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was associated with systolic BP and WHR with diastolic BP (p<0.001), while serum insulin and FBG were associated with BMI and WHR (p<0.05). In addition, BMI was positively linked with TGs (p<0.001), and inversely linked with HDL (p<0.001).

Independent variable	Metabolic syndrome risk factors					
	Systolic BP (mmHg) β (95% CI)	Diastolic BP (mmHg) β (95% CI)	Fasting blood glucose (mg/dL) β (95% CI)	Triacylglycerol (mg/dL) β (95% CI)	HDL (mg/dL) β (95% CI)	Insulin (mU/L) β (95% CI)
Intercept	101.9** (78.20-125.65)	29.75* (0.90-58.59)	76.25** (70.08-82.42)	-22.20 (-64.23-19.82)	75.27** (56.32-94.22)	-71.35** (-91.97-50.74)
BMI (kg/m2)	0.97** (0.57-1.36)	0.25 (-0.22-0.73)	0.15** (0.05-0.25)	3.71** (3.02-4.40)	-1.30** (-1.61 - -0.98)	1.82** (1.48-2.16)
Waist hip ratio	-10.43 (-42.6-21.80)	52.89** (13.62-92.01)	10.47* (2.08-18.86)	-1.81 (-58.93-55.30)	7.59 (-18.16-33.34)	49.54** (21.52-77.55)
Adjusted R2	0.217	0.126	0.222	0.593	0.452	0.679

Table 4: Association of BMI, Waist hip ratio and metabolic syndrome risk factors in multivariate analysis in young adults (n245)

*p<0.05; ** p<0.001; All values are expressed as regression coefficient β(95% confidence interval)

DISCUSSION

The metabolic syndrome frequency in the present cross-sectional study conducted in young adults in the COVID-19 era is 36%. The most frequent MetS component is blood pressure ≥130/85 mmHg being 60% followed by 57% insulin resistance and 40% dyslipidemia. The metabolic syndrome components are found to be notably high in obese/overweight participants when compared to normal-weight subjects. This study shows BMI and WHR are significantly correlated with each MetS component in all young adults but the correlations are changed in overweight/obese participants for plasma concentrations of fasting blood sugar, triglycerides, and insulin. The plasma FBS, TGs, and insulin levels were better correlated with BMI and WHR in overweight or obese whereas this correlation was not present in normal-weight students. These results suggest that the risk of metabolic syndrome increases with increasing BMI in young adults which was in agreement with Liu *et al.*, 2021 in a study conducted on young adults in China [14]. The COVID-19 pandemic restrictions have further reduced physical activity and overeating in young adults with pre-existing overweight and obesity [15]. In addition, a stronger correlation between WHR and the MetS components was observed than BMI which was in line with many studies [16,17]. High visceral adipose tissue in obese young adults lowers insulin sensitivity than in those with lower amount [18]. Therefore, waist circumference is an independent predictor of blood pressure, lipid levels and insulin resistance. The multivariate regression analysis of the present study shows that the BMI and WHR were positively associated with increased blood pressure, insulin levels, and hyperglycemia. The researchers at Johns Hopkins documented that obesity in young adults might increase the COVID-19 complications in this age group [19]. The metabolic dysfunction and obesity are characterized by upregulation of IL-6 and TNF-alpha that led to a pro-inflammatory state resulting in insulin signaling dysfunction and may progress to insulin resistance. The SARS-CoV-2 infection further deteriorates insulin resistance which can lead to new-onset diabetes thus adding to the burden [20]. Furthermore, BMI is also associated with increased levels of fasting triglycerides and reduced HDL in the present study. Azizi *et al.*, study have linked the modified plasma fasting TGs and HDL and reduced physical activity in overweight and obese [21]. The COVID-19 restrictions have severely reduced physical activity for all age groups which tends to accelerate BMI gain [22, 23].

CONCLUSIONS

COVID-19 restrictions consequences call for an urgency to combat the problem and complications of metabolic syndrome, especially in young adults. Alleviation strategies may utilize ways to promote physical activity in young adults along with healthy dietary habits and interventions to modify those with Metabolic Syndrome. The reason is even before the onset of a pandemic of COVID-19, the metabolic syndrome and its components were common worldwide, especially among under-resourced and disorganized healthcare systems.

Conflicts of Interest

The authors declare no conflict of interest

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