



Effect of various Dietary and Lifestyle Factors on the Prevalence of Metabolic Syndrome (MetS) in a Population in Northwest of Lahore

Tehreem Sajjad¹, Mohammad Perwaiz Iqbal^{1,3,*}, Saleem Perwaiz Iqbal², Muhammad Khurram¹, Mureed Hussain¹

¹ Department of Life Sciences, University of Management & Technology, Lahore, Pakistan

² Department of Community Medicine, Shalamar Medical & Dental College, Lahore Pakistan

³ Department of Biological & Biomedical Sciences, Aga Khan University, Karachi, Pakistan

*** Correspondence E-mail:**

perwaiz.iqbal@aku.edu;

perwaiz.iqbal@umt.edu.pk

DOI: [https://doi.org/10.54692/lgujls.2025.](https://doi.org/10.54692/lgujls.2025.92422)

[92422](https://doi.org/10.54692/lgujls.2025.92422)

Vol 9 Issue 2, July- December 2025

Received: 30-01-2025

Revised: 01-12-2025

Accepted: 01-12-2025

Citation: Sajjad T, Iqbal MP, Iqbal SP, Khurram M, Hussain M (2025). Effect of various Dietary and Lifestyle Factors on the Prevalence of Metabolic Syndrome (MetS) in a Population in Northwest of Lahore.

hypertriglyceridemia, low-HDL cholesterol, hyperglycemia and hypertension were 82.3%, 80.3%, 60.5%, 49.7% and 64.8%, respectively. Regarding gender, compared to men the adjusted odds of developing MetS were 5.72-fold higher in women (AOR = 5.72; 95% CI (3.13 – 10.45)). Fewer consumption of tea/coffee (1-2 times per day) compared to more frequent consumption per day had a protective effect towards having MetS [AOR = 0.44; 95% CI (0.21 – 0.94)]. There is high prevalence of MetS in this population. Reduced consumption of tea/coffee and finishing meals within 10-20 min are protective against odds of having MetS.

Keywords: Metabolic syndrome, Obesity, Low-HDL cholesterol, Dyslipidemia, Lifestyle factors, Dietary factors.

ABSTRACT

The objective of the study was to investigate the effect of various dietary and lifestyle factors on the prevalence of metabolic syndrome (MetS) in an urban population in Lahore.

A cross-sectional study was conducted in which six hundred (n = 600) apparently healthy people who were 18-70 years old were included in the study. Pregnant females and individuals suffering from chronic diseases were excluded from the study. Demographic information was obtained from them using a structured questionnaire. Their waist circumference and blood pressure values were determined using a measuring tape and sphygmomanometer, respectively. Ten ml fasting blood was obtained, and values of serum glucose, triacylglycerols and HDL-cholesterol were estimated using kit methods. The data were analyzed using various statistical tests such as independent sample t test, Chi square test and logistic regression.

The mean \pm SD age of subjects was 40.83 \pm 10.64 years. Prevalence of MetS using Harmonized Criteria was found to be 77.7%, while percentages of abdominal obesity,

INTRODUCTION

Metabolic Syndrome (MetS) is a collection of metabolic conditions, which increase the vulnerability to developing cardiovascular disease and type 2 diabetes mellitus. These include raised levels of fasting serum glucose, abdominal obesity, dyslipidemia, and hypertension (Iqbal et al, 2020). A meta-analysis of global data has shown that nearly a quarter of the adult population of the world suffers from MetS (Noubiap et al., 2022). In Pakistan, the prevalence of MetS ranges from 18% to 46%, similar to other South Asian countries (Basit and Shera, 2008, Misra and Khurana, 2008). Using Asian cut-off values for abdominal obesity (Tham et al, 2022), Asian subjects with MetS have double the chance of death from cardiac disease or strokes in comparison to those individuals without the syndrome (Thomas et al, 2007).

There have been quite a few studies conducted in major cities of Pakistan in Sindh and Punjab on prevalence of MetS and associated complications including both urban and rural populations using mostly International Diabetes Fédération (IDF) or National Cholesterol Education Program Adult Panel III (NCEP-ATP III) criteria (Khalid et al, 2019; Unar et al, 2019; Hussain et al, 2020, Asma et al, 2020, Memon et al 2020, Adil et al, 2023). The reported prevalence ranged from 24.3% - 68.1% with individuals having three or more of these five conditions (obesity, high BP, hypertriglyceridemia, hyperglycemia and low-HDL cholesterol), were referred to as having MetS. However, only a few studies have been conducted in Pakistan for finding out any association of various dietary and lifestyle habits with MetS. The aim of the current study was to find out the relationship of various dietary and lifestyle habits of people in Northwest of Lahore with prevalence of MetS in this population.

METHODOLOGY

Study Design

This was a cross-sectional study for which a questionnaire was developed to find out the influence of demographic and lifestyle factors on prevalence of

MetS. For this purpose, we targeted the general population in the Northwest of Lahore. We conducted this survey from August 7, 2022 to October 25, 2023. All recruited subjects were apparently healthy. Their blood samples were collected. Serum was separated and analyzed for glucose, triacylglycerols and HDL- cholesterol.

Sample size

Considering 68% prevalence of MetS in the province of Punjab (Adil et al., 2023), 5% precision at 95% confidence interval, a sample size of 334 was estimated for this study. However, 600 subjects were recruited for this research study.

Criteria for including subjects: Apparently healthy men and women who were between the age range of 18-70 years.

Criteria for excluding subjects: Pregnant women and subjects with a chronic illness (except type 2 diabetes and blood pressure) such as any malignant disease, hepatic disease, renal disease and malabsorption disorders.

Demographic and clinical information

Demographic and clinical information of all subjects included gender, age, marital status, education, profession, monthly house-hold income, smoking status and history of common chronic diseases. Information was also collected about certain dietary and lifestyle habits. Laboratory results included serum levels (mg/dL) of fasting glucose, triacylglycerols (TG) and HDL-cholesterol. Collection of blood samples was after 8-10 h fasting. The JIS 2009 Harmonized Criteria as put forward by Alberti and co-workers (Alberti et al., 2009) was used for abdominal obesity, hypertension, hypertriglyceridemia, fasting hyperglycemia and low HDL-cholesterol. The cut-off values as described by Alberti et al. (2009), have been mentioned in a recent publication (Iqbal et al., 2025). The presence of any 3 or more of the 5 metabolic abnormalities will diagnose a subject as having MetS.

Serum glucose: Fasting serum glucose was determined using glucose oxidase method following manufacturer's instruction. The kit was obtained from ARENA BioScien, Ismailia, Egypt.

HDL-cholesterol: The HDL-cholesterol test was performed using a kit method following

manufacturer's instructions. The kit was obtained from Bio-active Diagnostic Systems, Voehl, Germany.

Triglycerides: Triglyceride test was performed using a kit method (Bio-active Diagnostic Systems, Voehl Germany) as per manufacturer's guidelines.

Statistical analysis

For statistical analysis, the software SPSS version 23 was used. Percentages were calculated to determine associations among significant variables in different categories using Chi-square test. For continuous variables, independent sample t-test was used to compare means to find out any statistically significant difference. Logistic regression was applied using significant variables while adjusting for confounding variables. $P < 0.05$ was taken as significant.

RESULTS

Regarding demographic characteristics, there were more females compared to males, and 53.5% of subjects were married, 10% were widowed and 7% were divorced, among 600 respondents. Regarding the education level of respondents, 55% had education above intermediate level. Regarding occupation, majority of subjects belonged to farming or working at shops (34%). Regarding monthly income, 40% of the respondents were in the range of Rs. 30,001-50,000, while about quarter of them had

monthly household income in the range of Rs. 50,001-80,000 indicating that most of them belonged to the lower middle class. Only 4% had a monthly income of Rs. 80,000 and above

Regarding lifestyle habits, 87% of participants finished their meals within less than 20 minutes, while only 13% finished their food in more than 20 minutes. A vast majority of the participants took their dinner before 10 pm and only 9% ate their meals every day after 10 pm. Skipping breakfast was less common in the recruited subjects and nearly 33 % skipped breakfast 3 or more times in a week. Dining out was also less common and only 22% dined out 3 or more times in a week. Ninety percent of the subjects were in the habit of taking more than 6 hours of sleep every day. Smoking was less common in this population and only 6% were current smokers. Sixty-three percent of these people watched television for less than 2 hour per day. Sixty-two percent of participants drank soft drinks such as coke and sprite more than 4 times per week. Intake of coffee and tea for 1-2 times per day or less was among 74 % of people.

MetS occurs in people due to the presence of factors like obesity, hypertension, hypertriglyceridemia, low-HDL cholesterol and high levels of fasting serum glucose. The percentages of MetS and its components in this population have been depicted in Figure 1.

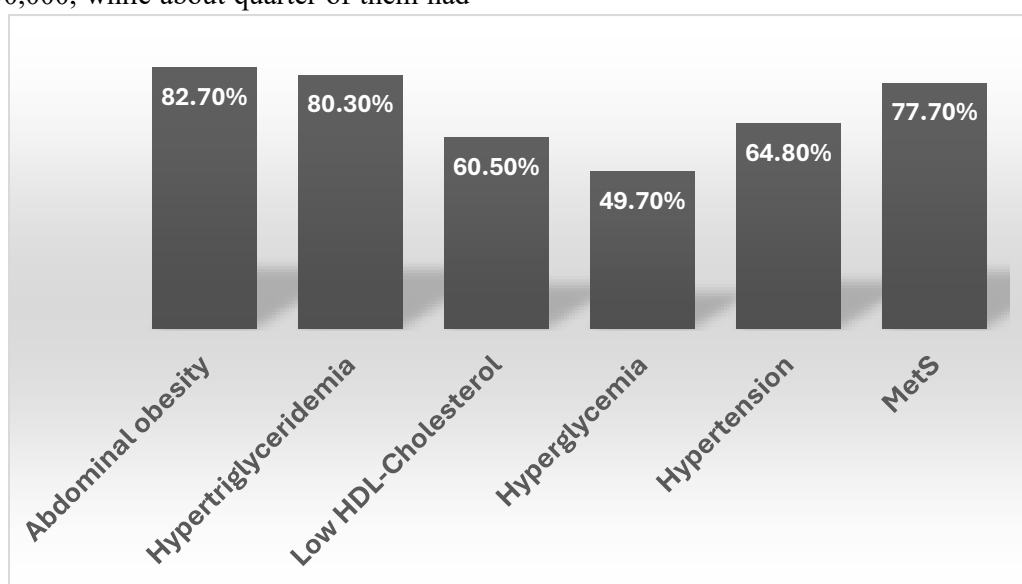


Figure 1: Percentages of MetS and its components identified among the recruited subjects (n=600)

The prevalence of MetS was found to be 77.7% while percentages of those with abdominal obesity, hypertriglyceridemia, low-HDL cholesterol, fasting hyperglycemia and high blood pressure were 82.7%, 80.3%, 60.5%, 49.7%, 64.8%, respectively

The comparison of percentages of sociodemographic characteristics with presence or absence of MetS reveals significantly higher percentage of females with MetS compared to males ($P = 0.01$) (Table 1). Regarding marital status, married, widowed and divorcee had significantly higher percentages of MetS compared to single subjects ($P < 0.01$).

Similarly, those with better education (intermediate and above) also appeared to have greater proportion of MetS compared to those with lower level of education. Regarding employment, the proportions of various categories of subjects were higher in the MetS group compared to those without MetS. Similarly, percentages of subjects in various categories with respect to monthly household income were higher in the MetS group compared to the group with no MetS (76% - 82% vs. 18% - 24%) with no significant association of any category of monthly income with MetS ($P = 0.60$).

Table 1: Comparison of percentages of sociodemographic characteristics with the presence or absence of MetS (n=600) [n (%)]

Sociodemographic characteristics		No MetS (n=134)	MetS (n=466)	P*
<i>Gender</i>	Male	85 (31)	189 (69)	0.01
	Female	49 (15)	277 (85)	
<i>Marriage status</i>	Single	71 (41)	104 (59)	< 0.01
	Married	56 (17)	265 (83)	
	Widowed	7 (11)	56 (89)	
	Divorcee	0 (0)	41 (100)	
<i>Level of education</i>	Nil	1 (14)	6 (86)	< 0.01
	Primary	17 (33)	35 (67)	
	Middle	21 (24)	66 (76)	
	Secondary	37 (33)	75 (67)	
	Intermediate/diploma	33 (18)	151 (82)	
	Graduate	21 (15)	123 (85)	
<i>Employment</i>	Professional degree	4 (29)	10 (71)	
	Unemployed	17 (29)	41 (71)	0.02
	Unskilled worker	31 (29)	76 (71)	
	Skilled worker	43 (23)	145 (77)	
	Clerical/shop/farm	35 (17)	172 (83)	
	Professional job	8 (31)	18 (69)	
<i>Average monthly income</i>	Retired	0 (0)	14 (100)	
	Less than Rs. 30000	49 (24)	151 (76)	0.60
	Rs. 30001-50000	55 (23)	184 (77)	
	Rs. 50001-80000	26 (19)	113 (81)	
>Rs. 80000	4 (18)	18 (82)		

*P was based on comparison of percentages in two groups using Chi-square analysis.

Relationship of various lifestyle habits with MetS is shown in Table 2. Finishing meals in longer time (> 20 min) compared to shorter time (< 20 min) had no significant relationship with MetS ($P = 0.09$). However, those in the habit of skipping breakfast more often (3 or more times per week) compared to those skipping it less frequently (less than 3 times per

week) appeared to have a relationship with MetS ($P < 0.01$). Frequency of dining out per week and sleep duration per day had no influence on the development of MetS in this population. Similarly, time spent on viewing TV and taking soft drinks had no significant relationship with MetS. However, smoking status (both cigarette smoking and use of

Table 2: Relationship of lifestyle habits with the presence or absence of MetS (n=600) [n (%)]

Lifestyle habits		No MetS (n=134)	MetS (n=466)	P*
<i>Meal finishing time</i>	> 20 minutes	14(18)	63 (82)	0.09
	10-20 minutes	67 (27)	184 (73)	
	< 10 minutes	53 (20)	219 (80)	
<i>Taking meals after 10 pm</i>	Daily	21 (39)	33 (61)	< 0.01
	At least 3 times/wk	38 (24)	121 (76)	
	Once or twice/wk	32 (16)	166 (84)	
	< once a week	30 (22)	108 (78)	
	Never	13 (26)	38 (74)	
<i>Skipping breakfast</i>	Daily	10 (48)	11 (52)	< 0.01
	At least 3 times/wk	49 (28)	124 (72)	
	Once or twice/wk	37 (22)	135 (78)	
	< once a week	20 (14)	120 (86)	
	Never	18 (19)	76 (81)	
<i>Dining out frequency</i>	Daily	3 (33)	6 (67)	0.30
	At least 3 times/wk	28 (24)	90 (76)	
	Once or twice/wk	35 (24)	113 (76)	
	< once a week	50 (24)	156 (76)	
	Never	18 (15)	101 (85)	
<i>Duration of sleep</i>	< 6 h/day	13 (22)	47 (78)	0.66
	6-8 h/day	64 (24)	202 (76)	
	> 8 h/day	57 (21)	217 (79)	
<i>Smoking</i>	Never	100 (20)	395 (80)	0.02
	Past smoker	20 (29)	48 (71)	
	Present smoker	14 (38)	23 (62)	
<i>Smokeless tobacco consumption</i>	Never	107 (21)	412 (79)	0.03
	Past consumer	15 (36)	27 (64)	
	Present consumer	12 (31)	27 (69)	
<i>Television viewing time</i>	< 1 h	23 (25)	69 (75)	0.82
	1-2 h	65 (22)	223 (78)	
	2-3 h	28 (23)	95 (77)	
	> 4 h	18 (19)	76 (81)	
<i>Frequency of taking soft drinks (coke, sprite etc.)</i>	Daily	8 (17)	40 (83)	0.32
	At least 3 times/wk	82 (25)	244 (75)	
	Once or twice/wk	27 (19)	115 (81)	
	< once a week	17 (20)	67 (80)	
<i>Frequency of drinking tea/coffee</i>	At least 3 times a day	15 (16)	80 (84)	0.01
	Once or twice a day	96 (26)	268 (74)	
	Rarely	23 (16)	118 (84)	

*P was obtained by comparing the percentages in two groups using Chi-square test.

smokeless tobacco) and frequency of consumption of tea/coffee per day appeared to have a significant relationship with MetS in this population (P < 0.05). Table 3 shows an adjusted odds ratio (AOR) with

95% CI of characteristics associated with MetS. Regarding gender, compared to males the odds of developing MetS was 5.72 times higher in females (AOR = 5.72; 95% CI (3.13 – 10.45). With respect

to marital status, no significant difference was observed among married subjects, widows, divorcees or single. Occupation of subjects appeared to have no influence on MetS. Regarding the time taken to finish the meals, those subjects who were finishing their

meals in less than 20 min had 71% lesser odds of having MetS compared to those who finished their meals in longer time [AOR = 0.29; 95% CI (0.12 - 0.67)]. Regarding late dinner, compared to those who were taking dinner every day after 10 pm, those

Table 3: Logistic regression model depicting association of various characteristics with MetS (n=600)

Character	Sub-Groups	Adjusted Odds Ratio*	95% Confidence Interval	
			Lower	Upper
<i>Age</i>		1.14	1.10	1.18
<i>Gender</i>	Male	1.00		
	Female	5.72	3.13	10.45
<i>Marriage status</i>	Unmarried	1.00		
	Married	1.72	0.98	3.00
	Widow/divorcee	2.21	0.76	6.48
<i>Employment</i>	None	1.00		
	Laborer	0.93	0.37	2.35
	Skilled worker	1.05	0.44	2.53
	Clerical job/shop/farmer	1.32	0.54	3.18
	Professional job	0.93	0.23	3.79
<i>Meal finishing time</i>	> 20 minutes	1.00		
	10-20 minutes	0.29	0.12	0.67
	< 10 minutes	0.31	0.13	0.76
<i>Taking meals after 10 pm</i>	Daily	1.00		
	At least 3 times/wk	2.59	1.07	6.25
	Once or twice/wk	4.31	1.76	10.54
	< once a wk	2.95	1.18	7.32
	Never	1.47	0.48	4.46
<i>Skipping breakfast</i>	Daily	1.00		
	At least 3 times/wk	3.73	1.15	12.08
	Once or twice/wk	4.91	1.48	16.29
	< once a week	8.88	2.53	31.22
	Never	6.87	1.93	24.39
<i>Smoking</i>	Never	1.00		
	Past smoker	1.01	0.42	2.41
	Present smoker	0.78	0.30	2.04
<i>Smokeless tobacco consumption</i>	Never	1.00		
	Past consumer	0.63	0.25	1.57
	Present consumer	1.32	0.45	3.90
<i>Frequency of drinking tea/coffee?</i>	At least 3 times a day	1.00		
	Once or twice a day	0.44	0.21	0.94
	Rarely	1.00	0.41	2.47

*Adjusted for co-variables which were found to be significant in univariate analysis

subjects who were taking late dinner less frequently (1-2 times per week) the odds of having MetS was 4.31 times higher in the later [AOR = 4.31; 95% CI (1.76 – 10.54)]. With respect to skipping breakfast, compared to those subjects who were skipping breakfast every day, those who rarely skipped breakfast the adjusted odds of having MetS was 6.87 times higher [AOR = 6.87; 95%CI (1.93 – 24.39)]. Smoking status and use of smokeless tobacco had no

influence on the odds of MetS. Compared to those who were in the habit of taking tea/coffee more than 3 times a day, those who were consuming tea/coffee less frequently (1-2 times per day) appeared to have 56% protective effect against MetS [AOR = 0.44; 95% CI [0.21 – 0.94]].

DISCUSSION

The aim of this study was to have an insight into the influence of various dietary and lifestyle factors on the prevalence of MetS in a population in Lahore. The findings from our analysis reveal significant public health concern in this region, with an alarmingly high percentage of MetS at 77.7%. This high prevalence of MetS is in line with a very high prevalence (89%) of metabolically unhealthy healthy obesity in Lahore population (Iqbal et al., 2025). This points to the fact that early detection of MetS is crucial, as South Asians are at an elevated risk for diabetes and CVD associated with this syndrome (Basit and Shera, 2008; Misra and Khurana, 2008). For comparison, a previous study conducted in a rural area of Punjab reported a MetS prevalence of 68% (Hussain et al., 2016). However, it is necessary to consider that the authors of that study utilized the IDF criteria to define MetS, whereas our study employed the Harmonized criteria by Joint Interim Societies. The higher prevalence of MetS among Pakistani urban population compared to rural population has also been described by Javaid et al., in a community based comparative study in which the authors have shown that 35.2% prevalence in urban population compared to 24.8% in rural subjects (Javaid et al., 2023). In the present study, logistic regression analysis revealed that the adjusted odds of developing MetS was 5.72 times more common in females, indicating a greater vulnerability of females in this population to MetS. These results are in line with those obtained by Hussain et al., (2016), who have also shown a high percentage of MetS in females compared to males (55.63% vs. 44.36%) in their population. It is particularly noteworthy that in our study percentage of females suffering from MetS was 85%, significantly higher than the 55.63% reported in the study by Hussain et al., (2016). This stark difference may reflect lifestyle variations, particularly between urban and rural populations. Decreased MetS prevalence among rural women in Punjab compared to urban women in Lahore could be linked to variation in physical activity levels. Rural women in Punjab are more likely to engage in physically demanding activities such as working in fields, performing household chores, and walking long distances. In contrast, women in urban Lahore

generally engage in less physical activity. The protective effect of greater engagement in physical activity against MetS has been shown in several earlier studies (Hussain et al., 2016). This difference in lifestyle between rural and urban life may partly explain the significantly higher prevalence of MetS observed among females in our study compared to females in the study by Hussain et al., (2016). Moreover, studies by two groups of scientists, (Tachebele et al., 2014; Yu et al., 2015) indicated that females generally had a greater chance of developing MetS compared to men. This difference could be attributed to factors such as hormonal variations, particularly during menopause. Estrogen is known to influence fat distribution among females.

Another study conducted by Zafar Iqbal and his colleagues on an urban population in Karachi, using the NCEP-ATP III criteria, reported an overall prevalence of 49% (Iqbal et al., 2009). This prevalence was lower compared to our findings in the Northwestern population in Lahore. Although the mean±SD age of the urban population in Karachi was very similar to that in our study (40.8±14.1 vs. 40.83±10.6 years), yet it is well established that the prevalence of MetS increases with advancing age (Iqbal et al., 2009). However, several differences between studies may explain the variation in prevalence rates. Firstly, the sample size in Iqbal's study was relatively smaller than in our study (n = 363 vs. n = 600). Secondly, Iqbal's study was conducted nearly 20 years ago, in 2004, in Lyari Town, Karachi, a population predominantly belonging to lower socioeconomic strata. These factors might have influenced the prevalence rate observed in Karachi study. In another study on a hospital-based population in Karachi, the prevalence of MetS was reported to be 29.7% (Hussain et al., 2024). This low prevalence compared to our study could be because the investigators excluded hypertensive and diabetic patients. Another report about low prevalence of MetS (16.7%) has been published by Sharif et al., among school-going adolescents in Karachi (Sharif et al., 2024).

Additionally, a smaller study (n = 100) conducted on a healthy population in Lahore by Rabia Khalid and her associates (Khalid et al., 2018) described a

prevalence of MetS of 22.53%. However, in that study the mean age of the population was younger (34.1±2.1 years), which could account for the lower prevalence compared to our findings.

Among the noticeable findings of the present study are reduced consumption (1-2 times) of tea/coffee per day and finishing meals within 10-20 min being protective against odds of having MetS.

However, this study has a few limitations as well. The recruitment of subjects was through a non-probability sampling design, and the study was only on a population belonging to the Northwest region of Lahore. Thus, the results do not represent the whole of the population of Lahore. It is suggested that multi-centric large studies covering all the 4 provinces and Northern Areas of Pakistan should be carried out to find out conclusive evidence about relationship of various dietary and lifestyle factors with MetS in Pakistani population.

Conclusions

High prevalence values of MetS and obesity were found in a population in Northwestern region of Lahore. Some dietary habits are important in reducing the prevalence of MetS in this population. Efforts are needed at the community level to combat this menace of MetS in the population of Lahore.

Acknowledgement

Financial support provided by the Pakistan Academy of Sciences and the Life Sciences Department is highly appreciated. Technical help provided by Mr. Koukab Imran is also gratefully acknowledged.

Ethical Approval

Ethical approval of the study was provided by the Biomedical and Biosafety Committee of the Life Sciences Department, University of Management and Technology, Lahore

Conflict of interest

None

REFERENCES

- Adil SO, Islam MA, Musa KI, Shafique K (2023). Prevalence of metabolic syndrome among apparently healthy adult population in Pakistan: A systematic review and meta-analysis. *Healthcare*. 11(4):531.
- Ahmed A, Akhter J, Iqbal R, Jabbar A, Mawani M, Awan S, Samad Z, Shaikh PA, Salik M, Tuomilehto J (2020). Prevalence and associations of metabolic syndrome in urban high diabetes risk population in a low/middle-income country. *Metab Syndr Relat Disord*. 18(5):234-242.
- Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, Fruchart JC, James WP, Loria CM, Smith SC Jr; International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; International Association for the Study of Obesity. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*. 2009 Oct 20;120(16):1640-5.
- Basit A, Shera AS (2008). Prevalence of metabolic syndrome in Pakistan. *Metabolic Syndrome and Related Disorders*. 6(3):171-175.
- Hussain Z, Habib A, Sajjad Z (2024). Prevalence of metabolic syndrome and its association with CT-based central adiposity measures: A cross-sectional study at a tertiary care hospital in Pakistan. *BMJ open*. 14(7):e082095.
- Hussain Z, Mehmood S (2016). Prevalence of metabolic syndrome: Its risk factors and viral hepatitis b & c in underprivileged suburban population of Lahore, Pakistan. *The Professional Medical Journal*. 23(04):434-443.
- Hyderi MZI, Shera AS, Fawwad A, Basit A, Hussain A (2009). Prevalence of metabolic syndrome in urban Pakistan (Karachi): Comparison of newly proposed International Diabetes Federation and Modified Adult Treatment Panel III criteria. *Metabolic Syndrome and Related Disorders*. 7(2):119-124.

- Iqbal MP, Sajjad T, Iqbal SP, Khurram M (2025). Metabolically healthy obesity (mho) and factors influencing its prevalence in a population in north-west Lahore. *Pak J Med Sci.* 41(5):1452.
- Iqbal SP, Ramadas A, Fatt QK, Shin HL, Onn WY, Kadir KA (2020). Relationship of sociodemographic and lifestyle factors and diet habits with metabolic syndrome (mets) among three ethnic groups of the Malaysian population. *PLoS One.* 15(3):e0224054.
- Javaid A, Iram S, Mangrio SAN, Syed U, Ansari MA, Anwer B (2023). Community-based assessment of the prevalence of metabolic syndrome and its association with biochemical markers among rural and urban populations in Pakistan: A comparative study. *Pak J Med Health Sci.* 17(11):210.
- Khalid R, Shams SB, Murtaza BN, Joshua G, Mushtaq S, Al-Talhi H, Al-Amri A (2018). Association of lifestyle and physical activity with the components of metabolic syndrome—A study of bank employees in Lahore. *Pak J Zool.* 51(5).
- Misra A, Khurana L (2008). Obesity and the metabolic syndrome in developing countries. *J Clin Endocrinol Metab.* 93(11 Suppl 1):s9-s30.
- Noubiap JJ, Nanssen JR, Lontchi-Yimagou E, Nkeck JR, Nyago UF, Ngouo AT et al. (2022). Geographic distribution of metabolic syndrome and its components in the general adult population: A meta-analysis of global data from 28 million individuals. *Diabetes Res Clin Pract.* 188:109924.
- Sharif H, Sheikh SS, Seemi T, Naeem H, Khan U, Jan SS (2024). Metabolic syndrome and obesity among marginalised school-going adolescents in Karachi, Pakistan: A cross-sectional study. *Lancet Reg Health Southeast Asia.* 21:100354.
- Tachebele B, Abebe M, Addis Z, Mesfin N (2014). Metabolic syndrome among hypertensive patients at University of Gondar Hospital, Northwest Ethiopia: A cross-sectional study. *BMC Cardiovasc Disord.* 14:177.
- Tham KW, Ghani RA, Cua SC, Deerochanawong C, Fojas M, Hocking M et al. (2023). Obesity in South and Southeast Asia—A new consensus on care and management. *Obes Rev.* 24:e13520.
- Thomas GN, Schooling CM, McGhee SM, Ho S, Cheung BMY, Wat NMS et al. (2007). Metabolic syndrome increases all-cause and vascular mortality: The Hong Kong Cardiovascular Risk Factor Study. *Clin Endocrinol.* 66:666-671.
- Unar K, Laghari ZA, Abbasi AR, Unar AA, Khokhar MA, Channa TA (2019). Prevalence and determinants associated with metabolic syndrome among adults in district Khairpur Mirs Sindh. *Pak J Physiol.* 15(4):59-62.
- Yu S, Guo X, Yang H, Zheng L, Sun Y (2015). Metabolic syndrome in hypertensive adults from rural Northeast China: An update. *BMC Public Health.* 15:247.