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Gender Differences in Metabolic Syndrome Risk Factors Based on International Diabetes Federation Criteria

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Abstract. **General Background:** Metabolic syndrome (MetS) represents a cluster of interrelated metabolic and cardiovascular risk factors that substantially increase morbidity and mortality worldwide. **Specific Background:** In Iraq, the rising burden of non-communicable diseases has intensified interest in MetS, yet evidence on gender-specific risk patterns using International Diabetes Federation (IDF) criteria remains limited. **Knowledge Gap:** Few studies have systematically examined gender differences in MetS risk factors among Iraqi adults. **Aims:** This study aimed to identify and compare gender-specific risk factors for MetS among adults in Al-Basra province based on IDF criteria. **Results:** Distinct gender differences were observed in sociodemographic characteristics, anthropometric measures, lipid profiles, blood pressure, smoking status, and family history patterns, while age, residence, body mass index, glycemic status, and physical activity showed no significant gender differences. **Novelty:** The study provides localized, gender-stratified evidence on MetS risk factors in southern Iraq. **Implications:** The findings support the need for gender-sensitive prevention, screening, and management strategies within primary care and public health programs.

Keywords: Metabolic Syndrome, Gender Differences, Risk Factors, International Diabetes Federation Criteria, Waist Circumference

Highlights:

1. Females showed higher LDL, HDL, and familial hypertension, diabetes, and cardiovascular histories.
2. Males exhibited greater waist measurements, smoking prevalence, and familial obesity history.
3. Anthropometric measures differed by sex, while body mass index and physical activity remained comparable.

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Introduction

Metabolic syndrome (MetS) is defined as a collection of interconnected physiological, biochemical, clinical, and metabolic factors that increase the risk of cardiovascular diseases and all causes of mortality in people who would not otherwise be considered at risk. These factors include insulin resistance, central adiposity, dyslipidemia, hyperglycemia, and hypertension. The metabolic syndrome is typically considered a result of environmental and social changes brought on by urbanized living situations, calorie-dense diets, and sedentary lifestyles [1].

Central obesity, defined as the accumulation of abdominal fat around internal organs, is a key factor that leads to MetS in adults because it can contribute to insulin resistance, especially when paired with hyperinsulinemia. Central obesity can be measured using waist circumference, which is more indicative of its profile than the body mass index [2]. The term metabolic syndrome was first introduced by the World Health Organization (WHO) in 1999 [3][4].

Although the idea of MetS has been recognized for decades, no single definition for this syndrome is universally accepted. As a result, multiple attempts have been made by a group of specialists from various organizations to come up with a precise description of MetS based on particular criteria [5]. The World Health Organization (WHO) made the initial attempt. Following that, criteria were defined by the Adult Treatment Panel III of the National Cholesterol Education Program (NCEP: ATP III), the European Group for the Study of Insulin Resistance (EGIR), and the International Diabetes Federation (IDF) [6].

Metabolic syndrome is thought to be the most important predictor of non-communicable diseases. It is a more common abnormality that directly increases the risk of type 2 diabetes mellitus by 3-fold and other cardiovascular problems by 2-fold. Those with MetS had a 2-fold increased risk of death compared to those without it [7].

It is believed that 20 to 25% of the world's adult population has MetS, and they are twice as likely as others to have a stroke or a heart attack. The frequency of MetS has been reported in different Asian nations, ranging from 21.9% throughout Thailand to 49.4% in Malaysia. MetS is expected to affect nearly one-quarter of the adult population in Europe. In comparison to Europe, the US has 23.7%, and it appears to be larger among older people [8].

Iraq is currently experiencing an epidemiological change with an increased incidence of chronic non-communicable diseases. Especially diabetes and hypertension, which are significant risk factors for cardiovascular illnesses, are the main cause of death in people [9].

limited studies have looked into the relationship between the prevalence of MetS components and gender among Iraqi individuals. As a result, the purpose of this study was to find gender-specific factors that increase the risk of MetS in adults based on IDF criteria in the Al-Basra province of the south of Iraq.

Methods

2.1. Population source:

The study population consists of all adults of both genders aged 18 and above who were seen at Al-Fiaha Specialized Diabetes, Endocrine, and Metabolism Center during the study period and who had fasted for eight hours before being enrolled in the study.

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2.2. Sociodemographic information:

General participant information, including age in years, gender, residence (urban or rural), marital status (single, married, divorced, or widow), smoking status (non-smoker, smoker), occupation (employee, student, retired, earner, or housewife), education level (illiterate, primary, secondary, institute, or university/high), and physical activity (according to WHO recommendations, at least 30 min/ day or at least 150 min/week, but considering there should not be two consecutive days of inactivity) as well as family histories of obesity, hypertension, diabetes mellitus, and cardiovascular disease.

2.3. Anthropometric measurements

Each participant's weight and height were both determined using calibrated scales (a Seca stadiometer for height and a weighing scale for weight). Where the person had to stand straight, be lightly dressed, and be barefoot. Height and weight are given to the nearest 0.1 kg and 0.5 cm, respectively. According to the WHO classifications, body mass index (BMI) is determined by taking a person's weight in kilograms and dividing it by the square of their height in meters. The waist circumference was assessed using an inflexible measuring tape at the location midpoint between the highest point of the iliac crest and the lower border of the ribs.

2.4. Blood pressure:

A digital sphygmomanometer was used to measure blood pressure while the patient was at rest for a minimum of 10 minutes in a ventilated setting, utilizing the right arm. The last recorded blood pressure value was an average of two five-minute tests. The International Society of Hypertension (ISH) criteria were used while classifying blood pressure [10].

2.5. Laboratory investigations:

Each participant was instructed to abstain from food for at least 8 to 10 hours the previous night in order to test their lipid profile (TG, very low density lipoprotein (VLDL), HDL, total cholesterol and low density lipoprotein (LDL)) and assess their blood sugar levels. The American Diabetes Association (ADA) standards for diagnosis have been followed, where the FBG level must be between 100 and 125 mg/dl to be diagnosed as having prediabetes.

2.6. Statistical Analyses:

The statistical package of the social science program (version 27) had been used for data entry and analysis. For both categorical and numerical variables, statistical tests such as Student t-test, and Chi-square test were used. The standard deviation, mean, frequencies, and percentages were displayed as descriptive statistics for the data. The P-value of 0.05 or less was used to determine statistical significance.

Results and Discussion

3.1. Sociodemographic characteristics of patients with metabolic syndrome

The results showed no statistically significant differences (p-value >0.05) in the age and residence distributions between males and females. The results show that all the females in the study were non-smokers, but 31 (29.5%) of the males were smokers. However, other socio-demographic characteristics, including occupation, education, and marital status, showed a significant statistical difference between male and female participants (p-value <0.05). The majority of females in the study were housewives 122 (85.9%), and the majority of males were earners 47 (44.8%). In terms of education, MetS is more common among female participants who have completed primary

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education103 (41.7%). Additionally, it is more common among married females 210 (85.0%), Table1.

Table 1. Sociodemographic characteristics of patients with metabolic syndrome

Variables		**Study Sample**			**P-value**
		Male No (%)	**Female No (%)**	**Total No (%)**	
Age (mean ± SD)		53.51 ± 11.21	51.27 ± 12.74	52.22 ± 12.14	0.151
Residence	**Urban**	73 (69.5%)	104 (73.2%)	177 (71.7%)	0.522
	Rural	32 (30.5%)	38 (26.8%)	70 (28.3%)	
Education	**Illiterate**	6 (5.7%)	25 (17.6%)	31 (12.6%)	0.002
	Primary	42 (40.0%)	61 (43.0%)	103 (41.7%)	
	Secondary	19 (18.1%)	32 (22.5%)	51 (20.6%)	
	Institute	9 (8.6%)	6 (4.2%)	15 (6.1%)	
	University/ High	29 (27.6%)	18 (12.7%)	47 (19.0%)	
Occupation	**Housewife**	0 (0.0%)	122 (85.9%)	122 (49.4%)	0.001
	Employee	42 (40.0%)	14 (9.9%)	56 (22.7%)	
	Retired	15 (14.3%)	4 (2.8%)	19 (7.7%)	
	Student	1 (1.0%)	2 (1.4%)	3 (1.2%)	
	Earner	47 (44.8%)	0 (0.0%)	47 (19.0%)	

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Marital status	**Single**	2 (1.9%)	3 (2.1%)	5 (2.0%)	0.010
	Married	98 (93.3%)	112 (78.9%)	210 (85.0%)	
	Divorced	0 (0.0%)	4 (2.8%)	4 (1.6%)	
	Widow	5 (4.8%)	23 (16.2%)	28 (11.3%)	
Smoking	**Yes**	31 (29.5%)	0 (0.0%)	31 (12.6%)	0.0001
	No	74 (70.5%)	142 (100.0%)	216 (87.4%)	

The results of the MetS study for males and females revealed some disparities in the distribution of certain socio-demographic factors between the two groups as in **Table 1**. Furthermore, this study's findings were in line with those of an earlier studies conducted by Lee; Mbugua; Okube; and Rochlani [11][12][13][14], which revealed that the study's social and demographic variables may have an impact on the prevalence of MetS among males and females. In terms of age, the results showed that the mean age of females 51.27 ± 12.74 in the study was very close to the mean age of males 53.51 ± 11.21. The results illustrate that age did not show statistical significance (p-value >0.05) between the two groups. These results came close to the results of a study of Neill & Driscoll, 2015 [15], which showed that the prevalence of MetS among males and females could increase at approximately the same rate with increasing age. While these findings were inconsistent with those of another study by Yi & An [16], which found a statistical difference in age between the two groups. The reason for these results could be because the majority of participants in the study from both groups are of comparable ages.

However, statistically meaningful differences (p-value <0.05) were seen at the occupation level. Housewives 122 (85.9%) make up the majority of females with MetS in this area, followed by employee category 14 (9.9%), while retired and student categories make only 4 (2.8%) and 2 (1.4%), respectively. In comparison to females, the highest proportion of males are earners 47 (44.8%), followed by employees 42 (40.0%), retirees 15 (14.3%), and students1 (1.0%). This study was identical to the conclusions of the following study done by Strauss [17]. These findings could be attributed to the sedentary nature of society or to the existence of occupations with low physical activity requirements. Along with adopting comparable dietary practices and routines.

Regarding their place of residence, this study found no statistically significant disparities (p-value >0.05) between males and females because the majority of participants in both groups were from urban areas 177 (71.7%), while only a small proportion came from rural areas 70 (28.3%). The outcomes of this research contradicted the outcomes of another study done by Nowicki et al., 2021, which found that MetS was more prevalent in rural females and males [18]. According to these findings, the rural population is less likely to develop MetS due to the nature of the rural lifestyle, which requires doing work with great physical effort. Besides, service

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institutions are far away, and this forces them to make more effort to reach them in urban areas. In addition, they follow certain diets, unlike urban residents, who tend to work in stable jobs that require little physical effort and have easy access to service institutions due to the availability of means of transportation, in addition to the diets followed by urban people, which rely heavily on fast food rich in fat. This makes them vulnerable to many chronic diseases, the most important of which is obesity, which is the main component of the MetS.

Nevertheless, the level of education was statistically different (p-value <0.05) between males and females. The highest proportion was among those with primary education 103 (41.7%), followed by secondary education 51 (20.6%), university or high education 47 (19.0%), illiterate education 31 (12.6%), and finally institute education 15 (6.1%). We conclude from these findings that females in our study had lower levels of education than males. Contrary to another study's findings conducted by Guembe [19], which showed that males had lower levels of education than females and this may be because uneducated females are more likely to have chronic illnesses because they are less informed about the dangers, causes, and methods of preventing chronic illnesses, as well as the value of eating a nutritious diet and engaging in regular physical activity.

As for smoking, all of the study's female participants are nonsmokers. This table shows that there are 142 (100.0%) non-smoking females who have MetS. Regarding the males, there were 31(29.5%) smokers and 74 (70.5%) non-smokers. These results are in the same vein as the results of the studies of Chang and Kim [20] [21], which proved that proportion of females smokers less than males. The fact that none of the study's female participant’s smoke indicates that the phenomenon of female smoking is less common in the society in which the study was conducted. Also, these results may be due to the fact that most of the males who quit smoking were considered non-smokers.

Based on marital status, the largest proportion was among married males 98 (93.3%), followed by widows 5 (4.8%), while the lowest proportion was among single 2 (1.9%) and divorced males 0 (0.0%). Regarding the females, married ones made up the highest proportion 112 (78.9%), followed by widows 23 (16.2%), while the lowest proportion was among the divorced 4 (2.8%) and single 3 (2.1%). In our research, MetS was more prevalent among married females with a statistically significant difference (p-value <0.05) than in males. These findings contradict the findings of the study done by Ben-Yacov [22], which indicate the MetS is more prevalent among married males. This is caused by the hormonal and physiological changes that females experience after marriage, such as a change in lifestyle, eating habits, emotional tension, the use of contraceptive pills, the number of births or pregnancies, and other factors that lead to weight gain and many other metabolic abnormalities.

3.2. Distribution of clinical and anthropometric measurements

The results show that males have higher blood pressure readings than females, but only diastolic blood pressure showed a statistically significant difference between them (P -values <0.05). Females recorded higher FBG levels compared to males, but this variable did not show a statistically significant difference between the two groups (p- value >0.05). Regarding anthropometric measurements, weight, height, and waist circumference were higher in males with a significant statistical difference (P -values <0.05), except that BMI was comparable between them with no significant difference. In terms of the lipid profile, female patients showed significantly higher readings of low density lipoprotein (LDL) and HDL than male patients (P -values <0.05). Other markers were not significantly different (p- value >0.05), Table 2

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Table 2. Distribution of clinical and anthropometric measurements

Variables		Study Sample			P-value
		Male Mean ±SD	Female Mean ±SD	Total Mean ±SD	
Blood pressure	Systolic	141.8 ± 17.4	138.1 ± 17.4	139.7 ± 17.5	0.102
	Diastolic	85.5 ± 9.3	81.3 ± 10.4	83.1 ± 10.2	0.001
Glycemic status	Fasting blood glucose	135.9 ± 57.3	140.8 ± 59.8	138.7 ± 58.7	0.520
Lipid profile	Low density lipoprotein	106.7 ± 32.9	117.5 ± 37.9	112.9 ± 36.2	0.019
	High density lipoprotein	36.0 ± 9.8	40.5 ± 12.1	38.6 ± 11.4	0.002
	Total cholesterol	177.9 ± 55.4	190.0 ± 44.2	184.9 ± 49.5	0.058
	Triglyceride	158.9 ± 51.4	163.3 ± 50.1	161.4 ± 50.6	0.502
	Very low density lipoprotein	36.8 ± 17.7	36.9 ± 16.9	36.8 ± 17.2	0.970
Anthropometric measurements	Height	172.2 ± 6.8	157.7 ± 6.5	163.9 ± 9.7	0.0001
	Weight	92.3 ± 15.9	76.2 ± 12.1	83.0 ± 15.9	0.0001
	Waist circumference	106.2 ± 11.1	93.5 ± 11.9	98.9 ± 13.2	0.0001
	Body mass index	31.1 ± 5.3	30.7 ± 4.9	30.9 ± 5.1	0.541

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The anthropometric measurements were higher for males compared to females. The anthropometric measurements for males were as follows: weight (92.3 ± 15.9), height (172.2 ± 6.8), and waist circumference (106.2 ± 11.1). In comparison to the males, the anthropometric measurements for females were as follows: weight (76.2 ± 12.1), height (157.7 ± 6.5), and waist circumference (93.5 ± 11.9). These results were significant between males and females (p-value <0.05). The study's findings were identical to the results of a previous study by Guo [23], which showed that there is a statistical relationship with a significant difference between males and females in weight, height, and waist circumference. The disparity in the results could be explained by the different waist circumference cut-off points used to diagnose MetS in males and females. Males often tend to be taller, heavier, and have higher muscle mass than females in general.

However, the results for BMI showed slight differences between males and females, as the mean ± SD was 31.1 ± 5.3 and 30.7 ± 4.9, respectively. This study did not show any statistical differences (p-value >0.05) in the results between the groups, and this is exactly what was proven by a previous study conducted by Pouragha, where the BMI was 27.6 (4.1) for males and 26.4 (4.4) for females [24]. This may be because MetS participants were heavier in both groups, so the BMI of males and females has the same effect on the occurrence of MetS. These findings do not show a gender difference, which could be attributed to the study participants' weights being convergent. Females have a higher fat content than males. While males have the highest muscle mass, which decreases with age.

As for blood pressure, the results of this current study showed that males have a higher mean ± SD in terms of systolic and diastolic blood pressure compared to females. The mean ± SD of systolic and diastolic blood pressure for males were 141.8 ± 17.4 and 85.5 ± 9.3, respectively. The mean ± SD of systolic and diastolic blood pressure for females were 138.1 ± 17.4 and 81.3 ± 10.4, respectively. The outcomes of the study made clear that the diastolic pressure had a statistical difference (p-value <0.05) between the two groups, in contrast to the systolic pressure, which did not show the same statistical difference (p-value >0.05) between them. The study of Kim [25] is somewhat similar to the results of our study, where it proved that males have higher systolic and diastolic pressures than females, but it showed that both had a statistically significant difference between the two groups. This variation in blood pressure between the sexes may be caused by physiological and hormonal differences, as well as genetic predisposition, advancing age, the nature of occupations, and environmental conditions that can affect both.

Regard to glycemic status, the readings of the FBG test in females were higher than those in males. The mean ± SD of the FBG for males and females were 135.9 ± 57.3 and 140.8 ± 59.8, respectively. There were no significant differences (p-value >0.05) between males and females on this score. The findings did not support the findings of the study of Srinivas [26], which demonstrated that there were statistically significant variations between the two groups. This discrepancy in results could be attributed to a number of variables, such as the hormonal makeup of women, aging, and weight gain, as well as the fact that the majority of the study's female participants had a family history of diabetes and higher lipid levels than males.

Finally, the lipid profile shows some differences in readings between males and females. The mean ± SD of total cholesterol and TG in males were 177.9 ± 55.4 and 158.9 ± 51.4, while in females they were 190.0 ± 44.2 and 163.3 ± 50.1, respectively. Although these readings did not show significant differences (p-value >0.05) between them, the females had higher readings than the males. Subsequently, the readings of

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VLDL were approximately the same between males and females, as they were 36.8 ± 17.7 and 36.9 ± 16.9, respectively. Also, they show no significant difference between males and females. According to the study of Alamgir [27], there was a statistically significant difference between males and females, which is incongruent with the findings of our investigation. This disparity between the two studies could be attributed to changes in the study settings, such as sample size and target group. Furthermore, when it comes to this sort of fat, males and females have the same risk values.

Following that, the readings of HDL and LDL were higher in females than in males, illustrating the significant disparities (p-value <0.05) between the sexes. The mean ± SD of HDL and LDL in males were 36.0 ± 9.8 and 106.7 ± 32.9, while in females they were 40.5 ± 12.1 and 117.5 ± 37.9, respectively. These findings are identical to the finding of the study done by Ou [28]. This could be due to physiological and hormonal changes in females, such as early menopause, thyroid hormone abnormalities, the use of contraceptive pills, genetic factors, obesity, and a lack of physical activity, as well as different HDL cut-off points used to diagnose MetS in males and females.

3.3. Distribution of physical activity according to gender

There was no statistically significant difference in physical activity levels between male and female patients (p- value >0.05), as seen in Figure 1.

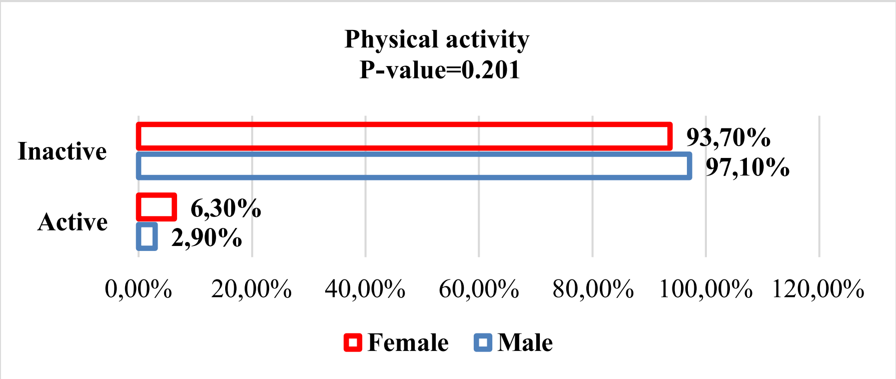

Figure (1). Distribution of physical activity according to gender

Regarding physical activity, no statistical differences in physical activity were found between males and females as seen in Figure 1. The percentage of females that had physical activity was 6.30%, while the percentage of males was 2.90%. This is consistent with the findings of the study done by Kudo [29], which indicated that there is no statistically significant difference in physical activity between genders. There may be differences between the parameters of everyday physical exercise for males and females. Compared to males, females spend more time doing housework, so they engage in light to moderately strenuous physical activity more frequently than males.

3.4. Association between family history and metabolic syndrome

Family histories of hypertension, diabetes mellitus, and cardiovascular disease were more frequently reported from female patients, with a significant statistical difference (P values <0.05), while obesity was more frequent in male patients as seen in Table 3.

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Table (3). Association between family history and metabolic syndrome

Variables		Study sample			P - value
		Male No. (%)	Female No. (%)	Total No. (%)	
Obesity	Yes	44 (41.9%)	30 (21.1%)	74 (30.0%)	0.0001
	No	61 (58.1%)	112 (78.9%)	173 (70.0%)	
Hypertension (HTN)	Yes	33 (31.4%)	76 (53.5%)	109 (44.1%)	0.001
	No	72 (68.6%)	66 (46.5%)	138 (55.9%)	
Diabetes mellitus (DM)	Yes	40 (38.1%)	75 (52.8%)	115 (46.6%)	0.022
	No	65 (61.9%)	67 (47.2%)	132 (53.4%)	
Cardiovascular disease (CVD)	Yes	5 (4.8%)	18 (12.7%)	23 (9.3%)	0.034
	No	100 (95.2%)	124 (87.3%)	224 (90.7%)	

The females recorded high percentage of positive family history of hypertension 76 (53.5%), diabetes mellitus75 (52.8%), and cardiovascular disease 18 (12.7%) compared to males where they recorded 33 (31.4%), 40 (38.1%), and 5 (4.8%) respectively. These results show that family history had a positive effect on the occurrence of MetS in females. These results are consistent with the results of the study conducted by Lee [30] that showed the presence of a family history of diabetes mellitus and cardiovascular disease in females is higher than that in males. Also, these results are consistent with another study done by Okube that showed a family history of hypertension and diabetes mellitus is higher in females.

On the other hand, the percentage of males with a family history of obesity was 44 (41.9%) higher than that of females 30 (21.1%). This result is not consistent with the results of the study by Kim [31], where females had a higher percentage than males. This difference in results between males and females may be due to heritable genetic, lifestyle, and environmental characteristics that are more common in such families than in others.

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Conclusion

In summary, there are apparent and distinct gender-patterns of metabolic syndrome among adults of Al-Basra based on the International Diabetes Federation criteria, where females seemed to bear a heavier burden of risk factors compared to males while adjusting for similarities in age and residence. Males had substantially higher rates of smoking, waist circumference, and a family history of obesity, whereas adverse lipid profiles, a positive family history of hypertension, diabetes mellitus and cardiovascular disease, and sociodemographic vulnerabilities such as lower educational attainment and housewife status were more commonly observed among females. Our results emphasize that the metabolic syndrome is a multifactorial disorder, and warrant the need for gender-sensitive prevention and management strategies, with lifestyle change, health education, and early screening in those at highest risk among women. The findings of this analysis support the promotion of gender-sensitive risk assessment within Iraq's existing primary care and non-communicable disease programs as part of the public health response. Longitudinal studies are needed to disentangle the causal pathways and to investigate the underlying hormonal and sociocultural mechanisms of the observed gender differences to guide the development and evaluation of targeted interventions to prevent and reduce longterm cardiovascular and metabolic consequences of metabolic syndrome.

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