



Prevalence of Metabolic and Endocrine Disorders in Overweight and Obese Individuals: A Cross-sectional Study

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Abstract

Background: Overweight and obesity are major global health concerns that increase the risk of metabolic and endocrine disorders.

Objectives: This study aimed to determine the prevalence of metabolic and endocrine disorders among individuals with overweight or obesity.

Methods: This cross-sectional study included 916 adults with overweight or obesity who attended the obesity clinic at Shariati Hospital between 2014 and 2022. Clinical and laboratory data were evaluated for metabolic syndrome, diabetes, thyroid disorders, hyperlipidemia, vitamin D deficiency, and other endocrine abnormalities. Associations between obesity grades and these conditions were assessed using chi-square and Fisher exact tests.

Results: Metabolic syndrome was present in 30.7% of participants, with prevalence increasing from 18.1% among participants with overweight to 38.7% among those with grade 3 obesity ($P < 0.001$). The prevalence of diabetes increased significantly from 12.7% to 26.7% across these weight categories ($P = 0.001$). Hyperlipidemia affected 51.1% of participants, and vitamin D deficiency was observed in 60%, with a higher prevalence among women. Hypothyroidism was more common in women than in men (29.4% vs 13.6%), whereas hyperthyroidism affected 4.5% of women and 3.5% of men.

Conclusions: This study highlights the high prevalence of metabolic and endocrine disorders among individuals with overweight or obesity, particularly metabolic syndrome, diabetes, hyperlipidemia, and thyroid dysfunction. These findings underscore the need for targeted screening and management in obesity clinics. Further research is needed to investigate the long-term effects of obesity on these disorders.

Keywords: Obesity, Metabolic Syndrome, Diabetes, Cushing Syndrome, Polycystic Ovary Syndrome, Thyroid Disease

1. Background

Overweight and obesity are major public health challenges worldwide, with substantial implications for individuals and governments. Obesity is a chronic, multifactorial disease characterized by an imbalance between energy intake and expenditure, resulting in excessive accumulation of adipose tissue. Although environmental and genetic factors influence obesity,

specific contributors can be identified in some individuals. These include monogenic diseases, genetic syndromes, iatrogenic procedures, physical immobilization, certain medical conditions (e.g., hyperandrogenism in women, hypoandrogenism in men, hypercortisolism, and hypothyroidism), and medications. Overweight and obesity are commonly diagnosed by measuring body mass index (BMI) (1-3).

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The global prevalence of overweight and obesity has increased in recent decades. The proportion of individuals with a BMI of 25 kg/m² or higher increased from 28.8% to 36.9% among men and from 29.8% to 38.0% among women between 1980 and 2013 (4). According to the World Health Organization (WHO), in 2024, 45% of adults had overweight, including 16% of all adults who had obesity. The global prevalence of adult obesity more than doubled between 1990 and 2024 (5). Earlier estimates showed an increase in the prevalence of adult obesity from 6.4% in 1980 to 12% in 2008 (6). In Iran, the reported prevalence of overweight and obesity among adults ranged from 27.0% to 38.5% and from 12.6% to 25.9%, respectively (7).

Overweight and obesity are critical public health concerns because they are associated with an increased risk of several comorbidities, including type 2 diabetes mellitus, hypertension, various cancers, cardiovascular diseases, stroke, gallbladder disease, dyslipidemia, osteoarthritis, chronic back pain, asthma, sleep apnea, and other respiratory disorders (2, 8).

Research has identified several factors involved in the pathophysiology of obesity, including metabolites, cytokines, lipid metabolism, coagulation factors, insulin resistance, and specific neural circuits involving neurochemicals (9, 10). Metabolic disorders are both comorbidities of obesity and contributors to its pathogenesis.

2. Objectives

Given the increasing prevalence of overweight and obesity and their associated morbidities, investigating the pathophysiological mechanisms contributing to elevated BMI may help identify effective therapeutic interventions. The European Guidelines for Obesity Management in Adults and the American Association of Clinical Endocrinologists/American College of Endocrinology Guidelines for Medical Care of Patients with Obesity recommend evaluating metabolic disorders in individuals with overweight or obesity using medical history and biochemical testing (3, 11). Accordingly, this study aimed to determine the prevalence of metabolic and endocrine disorders in individuals with overweight or obesity.

3. Methods

3.1. Study Design

This cross-sectional study included adults with overweight or obesity who attended the obesity clinic at Shariati Hospital between 2014 and 2022. Clinical and laboratory data were recorded in the obesity registry of the Institute of Endocrinology and Metabolism Research

Center at Tehran University of Medical Sciences, which included 1,021 patients. Patients younger than 18 years and those with incomplete data were excluded, leaving 916 participants for analysis.

3.2. Definitions and Diagnostic Criteria

WHO BMI-based definitions were used to classify overweight and obesity grades 1, 2, and 3. Overweight was defined as a BMI of 25 to 29.9 kg/m², and obesity as a BMI $\geq$ 30 kg/m². Obesity grades were classified as follows: grade 1, BMI of 30 to 34.9 kg/m²; grade 2, BMI of 35 to 39.9 kg/m²; and grade 3, BMI $\geq$ 40 kg/m² (5).

Metabolic syndrome was defined using the National Cholesterol Education Program Adult Treatment Panel III criteria, with waist circumference thresholds based on studies of Iranian individuals with overweight or obesity. Metabolic syndrome was defined as the presence of 3 or more of the following risk factors: 1) fasting glucose $\geq$ 100 mg/dL or treatment for elevated blood glucose; 2) high-density lipoprotein (HDL) cholesterol $<$ 40 mg/dL in men or $<$ 50 mg/dL in women, or treatment for low HDL cholesterol; 3) triglycerides $\geq$ 150 mg/dL or treatment for elevated triglycerides; 4) waist circumference $\geq$ 98 cm in men or $\geq$ 84 cm in women; and 5) blood pressure $\geq$ 130/85 mm Hg or treatment for hypertension (12, 13).

Vitamin D status was classified according to 25-hydroxyvitamin D levels: severe deficiency, $<$ 20 ng/mL; mild deficiency, 21 to 29 ng/mL; normal, $\geq$ 30 ng/mL; and risk of vitamin D toxicity, $>$ 100 ng/mL.

The hypothyroidism outcome included overt, treated, and subclinical hypothyroidism. Overt hypothyroidism was defined as a thyroid-stimulating hormone (TSH) level greater than 4 mU/L and a free thyroxine (free T₄) level less than 0.8 ng/dL. Treated hypothyroidism included patients with a history of hypothyroidism who were taking levothyroxine and had normal TSH and free T₄ levels during treatment. Subclinical hypothyroidism was defined as a TSH level greater than 4 mU/L with a free T₄ level between 0.8 and 2.8 ng/dL. Hyperthyroidism was defined as a TSH level less than 0.8 mU/L or a free T₄ level greater than 2.8 ng/dL.

Diabetes was diagnosed based on a fasting blood glucose level of 126 mg/dL or higher or a hemoglobin A_{1c} level of 6.5% or greater.

Hyperlipidemia was diagnosed if any of the following criteria were met: total cholesterol greater than 200 mg/dL; HDL cholesterol less than 40 mg/dL in men or less than 50 mg/dL in women; low-density lipoprotein (LDL) cholesterol greater than 160 mg/dL; or triglycerides greater than 200 mg/dL.

Cushing's syndrome was defined by an overnight dexamethasone suppression test result greater than 50 nmol/L and urinary free cortisol greater than 45 µg/day.

These conditions were also identified in previous medical documentation. Hypogonadism and polycystic ovary syndrome (PCOS) were identified solely from prior clinical records.

3.3. Statistical Analysis

Data were entered into an Excel spreadsheet and cleaned before analysis using SPSS version 26 (USA). Numerical variables were summarized as the mean and standard deviation, and categorical variables as frequencies and percentages. The prevalence of endocrine disorders was reported for each weight category and compared using chi-square or Fisher exact tests, as appropriate. A P value ≤ 0.05 was considered statistically significant.

4. Results

The clinical characteristics of the participants, with a mean age of 39.5 ± 13.24 years, are presented in [Table 1](#). Metabolic syndrome was present in 30.6% of the 718 women and 30.8% of the 198 men. Diabetes was diagnosed in 138 women (19.2%) and 35 men (17.7%) among the 916 participants. Hypothyroidism and hyperthyroidism were diagnosed in 13.6% and 3.5% of men, respectively, and in 29.4% and 4.5% of women, respectively. Hyperlipidemia was present in 51.5% of women and 49.5% of men. Among the 888 participants with complete data on hypogonadism, 1 woman and 1 man had this condition. Cushing's syndrome was diagnosed in 7 of 696 women (1.0%) and 1 of 193 men (0.5%). PCOS was identified in 62 women (8.9%). Among women with vitamin D data, 43.7%, 17.4%, and 3.4% were classified as having severe deficiency, mild deficiency, and toxic levels, respectively. The corresponding proportions among men were 32.6%, 23.2%, and 1.1%. Grade 1, 2, and 3 obesity were present in 26.0%, 23.7%, and 31.9% of women, respectively, and in 27.7%, 19.7%, and 41.0% of men, respectively. Overweight was present in 18.3% of women and 11.7% of men.

The overall prevalence of metabolic and endocrine disorders in the study population is shown in [Figure 1](#). Hyperlipidemia was the most prevalent disorder, with approximately 461 cases per 1,000 participants. Hypogonadism and Cushing's syndrome were the least prevalent disorders, with approximately 2 and 9 cases per 1,000 participants, respectively.

The prevalence of metabolic and endocrine disorders by weight status is shown in [Table 2](#). The prevalence of metabolic syndrome and diabetes increased significantly

from overweight to grade 3 obesity ($P < 0.001$ and $P = 0.001$, respectively). For example, metabolic syndrome was present in 18.1% of participants with overweight and 38.7% of those with grade 3 obesity. The prevalence of hyperthyroidism was 6.7%, 5.1%, 3.4%, and 3.2% in participants with overweight and grade 1, 2, and 3 obesity, respectively ($P = 0.33$). The prevalence of hypothyroidism varied across these categories ($P = 0.49$), and the prevalence of hyperlipidemia was higher in the obesity groups than in the overweight group, although these differences were not statistically significant ($P = 0.06$). The prevalence of hypogonadism and PCOS did not differ significantly across weight categories. Cushing's syndrome was significantly associated with weight status under the stated significance threshold ($P = 0.05$). The prevalence of severe and mild vitamin D deficiency was 43.5% and 13.5% in participants with overweight, 41.9% and 15.2% in those with grade 1 obesity, and 44.3% and 14.1% in those with grade 2 obesity, and 38.6% and 22.6% in those with grade 3 obesity, respectively. Toxic vitamin D levels were found in 5.7%, 4.7%, 1.8%, and 1.2% of participants in these respective weight categories.

A graphical representation of the prevalence of metabolic and endocrine disorders by weight status is shown in [Figure 2](#).

5. Discussion

Hyperlipidemia was present in 51.1% of participants with overweight or obesity. Its prevalence was higher in the obesity groups than in the overweight group; however, the differences across weight categories were not statistically significant. In the general adult population in Iran, the prevalence of hypercholesterolemia, hypertriglyceridemia, elevated LDL cholesterol, and low HDL cholesterol has been reported as 41.6%, 46.0%, 35.5%, and 43.9%, respectively ([14](#)). A study in the United States similarly found that the prevalence of hyperlipidemia among individuals with overweight or obesity was more than twice that among individuals with normal weight ([15](#)). This association may be explained by the contribution of hypertriglyceridemia to other lipid abnormalities through delayed clearance of triglyceride-rich lipoproteins and the formation of small, dense LDL particles. In obesity, lipolysis of triglyceride-rich lipoproteins is impaired ([16](#)).

Vitamin D deficiency affects 56% of Iranian adults, including 64% of women and 44% of men. In the present study, 60% of participants with overweight or obesity had vitamin D deficiency, including 61.1% of women and 55.8% of men. A previous study reported a higher prevalence of vitamin D deficiency among men with obesity than among men with normal weight, a pattern that was not observed in women ([17](#)).

Table 1. Description of Clinical Characteristics of Participants by Sex ^a

Characteristic	Female	Male	P Value
Metabolic syndrome (n = 916)			0.91
Yes	220 (30.6)	61 (30.8)	
No	498 (69.4)	137 (69.2)	
Diabetes (n = 916)			0.62
Yes	138 (19.2)	35 (17.7)	
No	580 (80.8)	163 (82.3)	
Hyperthyroidism (n = 916)			0.57
Yes	32 (4.5)	7 (3.5)	
No	686 (95.5)	191 (96.5)	
Hypothyroidism (n = 916)			< 0.001
Yes	211 (29.4)	27 (13.6)	
No	507 (70.6)	171 (86.4)	
Hyperlipidemia (n = 916)			0.62
Yes	370 (51.5)	98 (49.5)	
No	348 (48.5)	100 (50.5)	
Hypogonadism (n = 888)			0.33
Yes	1 (0.1) ^b	1 (0.5)	
No	694 (99.9)	192 (99.5)	
Cushing's syndrome (n = 889)			0.52
Yes	7 (1.0)	1 (0.5)	
No	689 (99.0)	192 (99.5)	
Polycystic ovary syndrome (n = 888)			< 0.001
Yes	62 (8.9)	0 (0.0)	
No	633 (91.1)	193 (100.0)	
Vitamin D level (n = 452)			0.10
Severe deficiency	156 (43.7)	31 (32.6)	
Mild deficiency	62 (17.4)	22 (23.2)	
Normal	127 (35.6)	41 (43.2)	
Toxic	12 (3.4)	1 (1.1)	
Weight status (n = 883)			0.03
Overweight	127 (18.3)	22 (11.7)	
Obesity grade 1	181 (26.0)	52 (27.7)	
Obesity grade 2	165 (23.7)	37 (19.7)	
Obesity grade 3	222 (31.9)	77 (41.0)	

^a Values are expressed as No. (%). P values are based on the chi-square test. P values ≤ 0.05 are statistically significant. n indicates the number of participants with complete data for each characteristic.

^b Reported by the patient during history taking.

Metabolic syndrome was present in 30.7% of participants, and its prevalence increased significantly across categories from overweight to grade 3 obesity. Meta-analyses of studies conducted up to 2017 have reported a metabolic syndrome prevalence of 26% to 31% among Iranian adults, with a higher prevalence among women (18-20). The relatively small difference between these estimates and our findings does not support the conclusion that metabolic syndrome is substantially more prevalent among individuals with overweight or obesity than in the general population. Although many Iranian studies have

reported a higher prevalence among women, studies in other countries have reported a higher prevalence among men, regardless of weight status, consistent with our findings (21, 22). A Korean study found a higher prevalence of metabolic syndrome among young and middle-aged men than among women, whereas this pattern was reversed among participants aged 60 years (23). The age distribution of participants in the present study may help explain the observed differences between women and men.

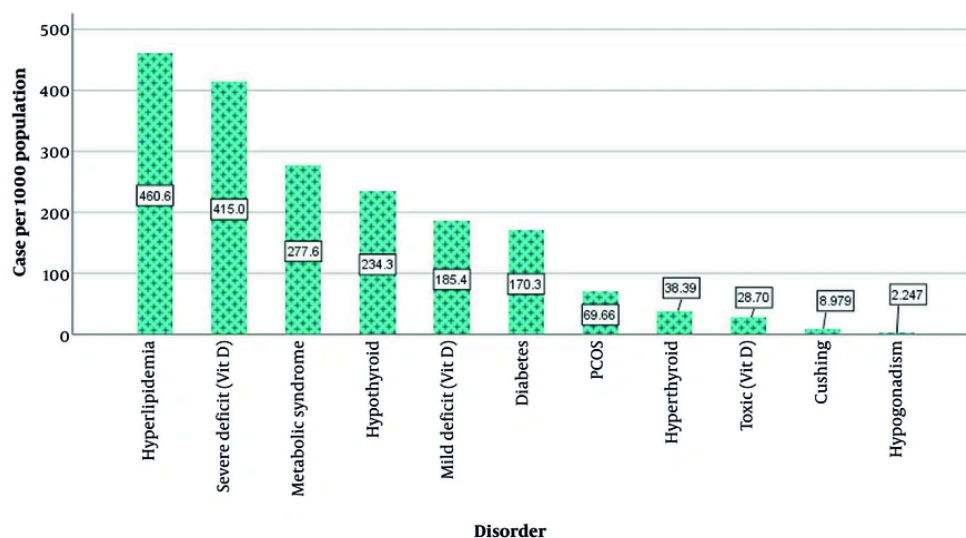


Figure 1. Overall prevalence of metabolic and endocrine disorders in the study population

Table 2. Proportion of Metabolic and Endocrine Disorders by Weight Status^a

Disorder	Overweight	Obesity G1	Obesity G2	Obesity G3	P Value
Metabolic syndrome	18.1	30	33.2	38.7	< 0.001
Diabetes	12.7	16.3	17.2	26.7	0.001
Hyperthyroidism	6.7	5.1	3.4	3.2	0.33
Hypothyroidism	22.8	25.7	30	26.5	0.49
Hyperlipidemia	42.9	53.6	53.2	56.1	0.06
Hypogonadism	0.0	0.5	0.5	0.0	0.55
Cushing's syndrome	0.0	0.0	1	2	0.05
Polycystic ovary syndrome	7.6	4.8	9.5	7.2	0.28
Vitamin D level					0.36
Severe deficiency	43.5	41.9	44.3	38.6	
Mild deficiency	13.5	15.2	14.1	22.6	
Normal	31.8	38.1	39.6	37.5	
Toxic	5.7	4.7	1.8	1.2	

^a Values are expressed as percentage. P values ≤ 0.05 are statistically significant. Abbreviation: G, grade.

Hypothyroidism and hyperthyroidism were present in 26% and 4.2% of participants, respectively, and both were more prevalent among women than among men. The prevalence of hypothyroidism was highest among participants with grade 2 obesity. A similar study in Tehran reported a higher prevalence of hypothyroidism among individuals with overweight or obesity (11.6% vs 8.2%; $P < 0.001$). Obesity was associated with increased odds of overt

hypothyroidism, whereas overweight was not significantly associated with hypothyroidism after adjustment for confounders (24). In the present study, hypothyroidism was not significantly associated with weight status ($P = 0.49$). The prevalence of hyperthyroidism (4.2%) was higher than the reported general population prevalence of 2.43%. A similar study reported a hyperthyroidism prevalence of 4.2% among individuals with obesity and 5.7% among those

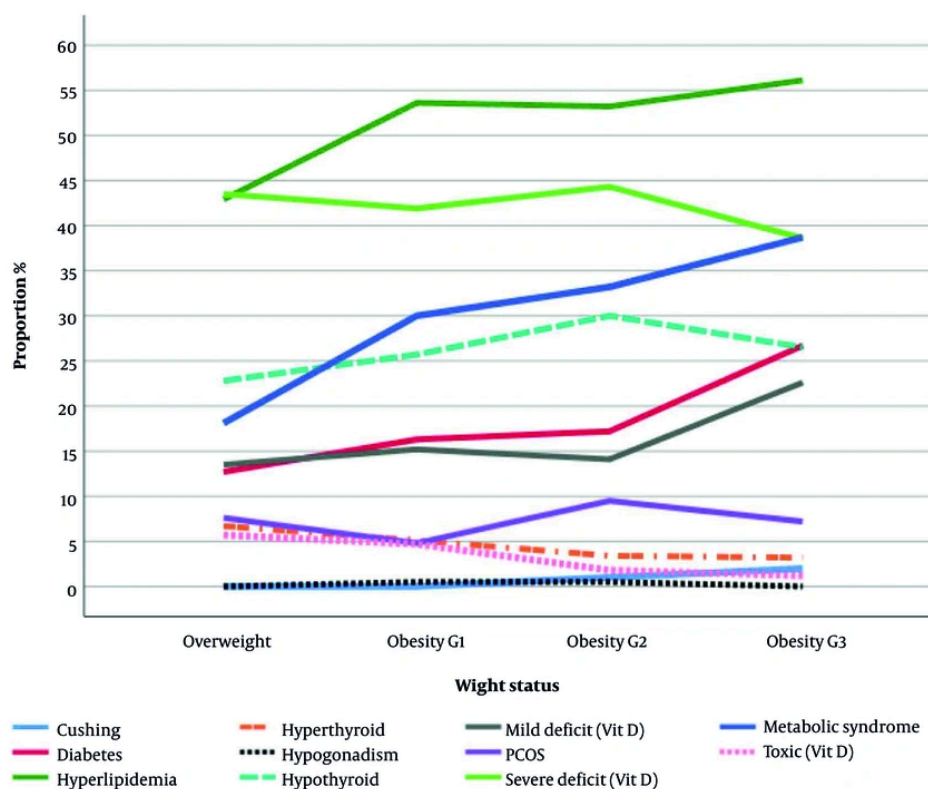


Figure 2. Proportion of metabolic and endocrine disorders by weight status in the study population

with overweight (24). Although hyperthyroidism prevalence decreased across increasing weight categories in our study, the differences were not statistically significant ($P = 0.33$).

Diabetes was present in 18.9% of participants, with a higher prevalence among women. Its prevalence increased significantly across weight categories ($P = 0.001$). The prevalence of diabetes in Iran has increased in recent years from 8.9% to 23.89%, which may reflect a reduction in undiagnosed cases (25). Although the prevalence in our study was lower, the significant association with weight status was consistent with findings from similar studies. Obesity and diabetes share metabolic pathways; for example, obesity increases diabetes risk through insulin resistance. One study reported that overweight and obesity were associated with an increased risk of developing diabetes, with relative risks of 2.17 and 3.4, respectively (25).

PCOS was present in 8.9% of women with overweight or obesity, compared with a reported prevalence of 4.41%

among Iranian women based on ultrasound criteria (26). Other studies have reported that obesity is more prevalent among women with PCOS. The higher prevalence of PCOS among women with overweight or obesity in our study suggests an association between these conditions. Overweight has been reported to affect several aspects of PCOS, including total testosterone, hirsutism scores, and fasting insulin levels, with obesity further exacerbating these outcomes (27).

The small numbers of hypogonadism and Cushing's syndrome cases limited the interpretation of their relationships with weight status. Weight gain and obesity are common manifestations of Cushing's syndrome and may be reversed with appropriate treatment (28). Studies have also reported a bidirectional relationship between obesity and male hypogonadism. Weight loss is associated with increased testosterone levels, and testosterone therapy combined with lifestyle modifications may improve outcomes in men with obesity and hypogonadism (29). The small number of cases in our obesity clinic may

reflect patients seeking care in other clinics, particularly endocrine clinics.

We observed a high prevalence of hyperlipidemia, vitamin D deficiency, metabolic syndrome, PCOS, and thyroid dysfunction, including both hypothyroidism and hyperthyroidism, among individuals with overweight or obesity. This study provides data on metabolic and endocrine disorders among Iranian adults with overweight or obesity, a population underrepresented in existing research, and offers insight into obesity-related health challenges in the Middle East. The lower prevalence of diabetes, hypogonadism, and Cushing's syndrome may reflect patients seeking care in specialized endocrine clinics. The cross-sectional design precludes causal inference, and further cohort studies are needed to better understand these relationships.

5.1. Conclusions

This study assessed the prevalence of metabolic and endocrine disorders among individuals with overweight or obesity. Hyperlipidemia, metabolic syndrome, diabetes, and hypothyroidism were particularly prevalent. The prevalence of metabolic syndrome and diabetes increased significantly across weight categories, whereas hypothyroidism and hyperlipidemia did not show significant differences or a uniformly increasing prevalence across obesity grades. Vitamin D deficiency was also common, particularly among women. These findings support comprehensive management strategies in obesity clinics. Longitudinal studies are needed to explore causal relationships between these conditions and obesity and to evaluate the long-term outcomes of interventions targeting metabolic health.

Footnotes

AI Use Disclosure: The authors declare that no generative AI tools were used in the creation of this article.

Authors' Contribution: Investigation and writing—original draft: D. G. S.; Conceptualization, study design, project administration, supervision, and writing—review and editing: S. H. R. and F. F.; Conceptualization, study design, investigation, and writing—review and editing: Z. H. T., S. G., and H. S. E.; Investigation and writing—original draft: A. N. and A. B. All authors reviewed and approved the final manuscript.

Conflict of Interests Statement: The authors declare that there is no conflict of interest.

Data Availability: The datasets generated and/or analyzed during the current study are not publicly

available but can be obtained from the corresponding author upon reasonable request.

Ethical Approval: This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the Endocrinology and Metabolism Research Institute, Tehran University of Medical Sciences (Approval ID: IR.TUMS.EMRI.REC.1403.113).

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References

1. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—the evidence report. *Obes Res.* 1998;**6**:51S-209S. [PubMed ID: 9813653].
2. Jensen MD, Ryan DH, Apovian CM, Ard JD, Comuzzie AG, Donato KA, et al. 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation.* 2014;**129**(25_suppl_2):S102-S38. [PubMed ID: 24222017]. [PubMed Central ID: PMC5819889]. <https://doi.org/10.1161/01.cir.0000437739.71477.ee>.
3. Yumuk V, Tsigos C, Fried M, Schindler K, Busetto L, Micic D, et al. Obesity Management Task Force of the European Association for the Study of, O. *European Guidelines for Obesity Management in Adults Obes Facts.* 2015;**8**(6):402-24. [PubMed ID: 26641646]. [PubMed Central ID: PMC5644856]. <https://doi.org/10.1159/000442721>.
4. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980 - 2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet.* 2014;**384**(9945):766-81. [PubMed ID: 24880830]. [PubMed Central ID: PMC4624264]. [https://doi.org/10.1016/S0140-6736\(14\)60460-8](https://doi.org/10.1016/S0140-6736(14)60460-8).
5. World Health Organization. *World Health Organization.* Geneva: World Health Organization; 2026, [cited 2026 Oct 10]. Obesity and overweight. Available from: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>.
6. Stevens GA, Singh GM, Lu Y, Danaei G, Lin JK, Finucane MM, et al. National, regional, and global trends in adult overweight and obesity prevalences. *Popul Health Metr.* 2012;**10**(1). 22. [PubMed ID: 23167948]. [PubMed Central ID: PMC3543235]. <https://doi.org/10.1186/1478-7954-10-22>.
7. Jafari-Adli S, Jouyandeh Z, Qorbani M, Soroush A, Larijani B, Hasani-Ranjbar S. Prevalence of obesity and overweight in adults and children in Iran; a systematic review. *J Diabetes Metab Disord.* 2014;**13**(1). 121. [PubMed ID: 25610814]. [PubMed Central ID: PMC4301060]. <https://doi.org/10.1186/s40200-014-0121-2>.
8. Guh DP, Zhang W, Bansback N, Amarsi Z, Birmingham CL, Anis AH. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. *BMC Public Health.* 2009;**9**(1). 88.

- [PubMed ID: 19320986]. [PubMed Central ID: PMC2667420]. <https://doi.org/10.1186/1471-2458-9-88>.
9. Lee EB, Mattson MP. The neuropathology of obesity: insights from human disease. *Acta Neuropathol*. 2014;**127**(1):3-28. [PubMed ID: 24096619]. [PubMed Central ID: PMC3880612]. <https://doi.org/10.1007/s00401-013-1190-x>.
 10. Petrakis D, Vassilopoulou L, Mamoulakis C, Psycharakis C, Anifantaki A, Sifakis S, et al. Endocrine disruptors leading to obesity and related diseases. *Int J Environ Res Public Health*. 2017;**14**(10):1282. [PubMed ID: 29064461]. [PubMed Central ID: PMC5664782]. <https://doi.org/10.3390/ijerph14101282>.
 11. Garvey WT, Mechanick JL, Brett EM, Garber AJ, Hurley DL, Jastreboff AM, et al. American Association of Clinical Endocrinologists and American College of Endocrinology comprehensive clinical practice guidelines for medical care of patients with obesity. *Endocr Pract*. 2016;**22**:1-203. [PubMed ID: 27219496]. <https://doi.org/10.4158/EPI161365.GL>.
 12. Tutunchi H, Ebrahimi-Mameghani M, Ostadrahimi A, Asghari-Jafarabadi M. What are the optimal cut-off points of anthropometric indices for prediction of overweight and obesity? Predictive validity of waist circumference, waist-to-hip and waist-to-height ratios. *Health Promot Perspect*. 2020;**10**(2):142-7. [PubMed ID: 32296627]. [PubMed Central ID: PMC7146042]. <https://doi.org/10.34172/hpp.2020.23>.
 13. Huang PL. A comprehensive definition for metabolic syndrome. *Dis Model Mech*. 2009;**2**(5 - 6):231-7. [PubMed ID: 19407331]. [PubMed Central ID: PMC2675814]. <https://doi.org/10.1242/dmm.001180>.
 14. Tabatabaei-Malazy O, Qorbani M, Samavat T, Sharifi F, Larijani B, Fakhrazadeh H. Prevalence of dyslipidemia in Iran: a systematic review and meta-analysis study. *Int J Prev Med*. 2014;**5**(4):373-93. [PubMed ID: 24829725]. [PubMed Central ID: PMC4018586].
 15. Paramsothy P, Knopp R, Bertonni AG, Tsai MY, Rue T, Heckbert SR. Combined hyperlipidemia in relation to race/ethnicity, obesity, and insulin resistance in the Multi-Ethnic Study of Atherosclerosis. *Metabolism*. 2009;**58**(2):212-9. [PubMed ID: 19154954]. [PubMed Central ID: PMC2677914]. <https://doi.org/10.1016/j.metabol.2008.09.016>.
 16. Klop B, Elte J, Cabezas M. Dyslipidemia in obesity: mechanisms and potential targets. *Nutrients*. 2013;**5**(4):1218-40. [PubMed ID: 23584084]. [PubMed Central ID: PMC3705344]. <https://doi.org/10.3390/nu5041218>.
 17. Vatandost S, Jahani M, Afshari A, Amiri MR, Heidarimoghadam R, Mohammadi Y. Prevalence of vitamin D deficiency in Iran: a systematic review and meta-analysis. *Nutr Health*. 2018;**24**(4):269-78. [PubMed ID: 30296903]. <https://doi.org/10.1177/0260106018802968>.
 18. Dalvand S, Niksima SH, Meshkani R, Ghanei Gheshlagh R, Sadegh-Nejadi S, Kooti W, et al. Prevalence of metabolic syndrome among Iranian population: a systematic review and meta-analysis. *Iran J Public Health*. 2017;**46**(4):456-67. [PubMed ID: 28540261]. [PubMed Central ID: PMC5439034].
 19. Kalan Farmanfarma K, Kaykhaei MA, Adineh HA, Mohammadi M, Dabiri S, Ansari-moghaddam A. Prevalence of metabolic syndrome in Iran: a meta-analysis of 69 studies. *Diabetes Metab Syndr*. 2019;**13**(1):792-9. [PubMed ID: 30641809]. <https://doi.org/10.1016/j.dsx.2018.11.055>.
 20. Fatahi A, Doosti-Irani A, Cheraghi Z. Prevalence and incidence of metabolic syndrome in Iran: a systematic review and meta-analysis. *Int J Prev Med*. 2020;**11**(1):64. [PubMed ID: 32577194]. [PubMed Central ID: PMC7297433]. https://doi.org/10.4103/ijpvm.IJPPVM_489_18.
 21. Lafortuna CL, Agosti F, De Col A, Pera F, Adorni F, Sartorio A. Prevalence of the metabolic syndrome and its components among obese men and women in Italy. *Obes Facts*. 2012;**5**(1):127-37. [PubMed ID: 22433624]. <https://doi.org/10.1159/000336700>.
 22. Matilla-Santander N, Espinola M, Cartanyà-Hueso À, Lidón-Moyano C, González-Marrón A, Martín-Sánchez JC, et al. Prevalence and determinants of metabolic syndrome in Spanish salaried workers: evidence from 15 614 men and women. *J Public Health (Oxf)*. 2020;**42**(1). fdz003. [PubMed ID: 30715426]. <https://doi.org/10.1093/pubmed/fdz003>.
 23. Park E, Kim J. Gender-and age-specific prevalence of metabolic syndrome among Korean adults: analysis of the fifth Korean National Health and Nutrition Examination Survey. *J Cardiovasc Nurs*. 2015;**30**(3):256-66. [PubMed ID: 24695075]. <https://doi.org/10.1097/JCN.0000000000000142>.
 24. Mahdavi M, Amouzegar A, Mehran L, Madreseh E, Tohidi M, Azizi F. Investigating the prevalence of primary thyroid dysfunction in obese and overweight individuals: Tehran thyroid study. *BMC Endocr Disord*. 2021;**21**(1). 89. [PubMed ID: 33931052]. [PubMed Central ID: PMC8086289]. <https://doi.org/10.1186/s12902-021-00743-4>.
 25. Ebrahimi H, Emamian MH, Hashemi H, Fotouhi A. High incidence of diabetes mellitus among a middle-aged population in Iran: a longitudinal study. *Can J Diabetes*. 2016;**40**(6):570-5. [PubMed ID: 27476052]. <https://doi.org/10.1016/j.jcjd.2016.05.012>.
 26. Jalilian A, Kiani F, Sayehmiri F, Sayehmiri K, Khodae Z, Akbari M. Prevalence of polycystic ovary syndrome and its associated complications in Iranian women: a meta-analysis. *Iran J Reprod Med*. 2015;**13**(10):591-604. [PubMed ID: 26644787]. [PubMed Central ID: PMC4668346].
 27. Jeanes YM, Reeves S. Metabolic consequences of obesity and insulin resistance in polycystic ovary syndrome: diagnostic and methodological challenges. *Nutr Res Rev*. 2017;**30**(1):97-105. [PubMed ID: 28222828]. <https://doi.org/10.1017/S0954422416000287>.
 28. Terzolo M, Pia A, Ali A, Osella G, Reimondo G, Bovio S, et al. Adrenal incidentaloma: a new cause of the metabolic syndrome? *J Clin Endocrinol Metab*. 2002;**87**(3):998-1003. [PubMed ID: 11889151]. <https://doi.org/10.1210/jcem.87.3.8277>.
 29. Corona G, Vignozzi L, Sforza A, Mannucci E, Maggi M. Obesity and late-onset hypogonadism. *Mol Cell Endocrinol*. 2015;**418**:120-33. [PubMed ID: 26143633]. <https://doi.org/10.1016/j.mce.2015.06.031>.