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Assessment of anthropometric indices in women with polycystic ovary syndrome and their correlation with high-sensitivity C-reactive protein levels; a descriptive-analytical study

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Abstract

Introduction: Polycystic ovary syndrome (PCOS) is a prevalent endocrine disorder among women of reproductive age, often associated with metabolic and inflammatory complications.
Objectives: This study aims to evaluate the association between anthropometric parameters and high-sensitivity C-reactive protein (hs-CRP) levels, a marker of systemic inflammation, in women with PCOS.
Patients and Methods: This descriptive-analytical study involved 139 women diagnosed with PCOS and referred to Firouzabadi Hospital in Tehran between November 2021 and June 2022. Participants aged 15 to 45 years were included based on a definitive diagnosis of PCOS. Data were collected using a checklist that recorded demographic information and anthropometric measurements, including body mass index (BMI), waist circumference (WC), hip circumference, and waist-to-hip ratio (WHR). Additionally, hs-CRP was measured using venous blood samples in the laboratory. The primary outcome was evaluating the correlation between the anthropometric indices and serum hs-CRP concentration in women with PCOS.
Results: The results demonstrated significant correlations between hs-CRP levels and various anthropometric indices, comprising age, BMI, WC, and hip circumference. Each of these indices was positively associated with elevated hs-CRP levels, indicating that increases in these measurements corresponded to a higher likelihood of elevated hs-CRP. Additionally, the diagnostic accuracy of these anthropometric indices in predicting high hs-CRP levels indicated that WC exhibited the highest area under the curve (AUC), indicating superior predictive capability among the indices evaluated. The other anthropometric indices showed average sensitivity and specificity.
Conclusion: In conclusion, the results reveal a significant relationship between hs-CRP levels and various anthropometric indices, incorporating age, BMI, WC, and hip circumference. The findings highlight anthropometric indices as the significant predictor of elevated hs-CRP levels, emphasizing its importance in clinical assessments. These insights support the routine monitoring of anthropometric indices to identify individuals at risk for inflammation-related health issues, particularly in women with PCOS.

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Introduction

Polycystic ovary syndrome (PCOS) is a complex endocrine disorder affecting 4% to 20% of women of reproductive age globally, characterized by irregular menstrual cycles, hyperandrogenism, and polycystic ovaries (1,2). The pathophysiology of PCOS is multifaceted, often involving insulin resistance, which can exacerbate metabolic issues and lead to infertility. Recent studies highlight the role of inflammation and oxidative stress in PCOS, suggesting that dietary interventions, such as calorie restriction and the use of supplements like cinnamon and ginger, may help alleviate symptoms by improving hormonal balance and insulin sensitivity (1,3). Additionally, therapeutic approaches including metformin and inositol have shown promise in managing insulin resistance associated with PCOS, although the effectiveness of newer treatments like glucagon-like peptide-1 (GLP-1) receptor agonists requires further investigation (4,5). Overall, individualized treatment strategies are essential for effectively managing the diverse manifestations of this syndrome.

High-sensitivity C-reactive protein (hs-CRP) is a biomarker that indicates systemic inflammation and is increasingly recognized for its role in predicting cardiovascular diseases, metabolic disorders, and other chronic conditions. Elevated levels of hs-CRP have been associated with an increased risk of non-communicable diseases such

Key point

In this study, we found that there is a significant direct correlation between the elevated high-sensitivity C-reactive protein (hs-CRP) levels and various anthropometric indices. By establishing a significant association between serum hs-CRP values and anthropometric indices, healthcare providers can enhance clinical assessments and risk stratification for inflammation-related conditions. This underscores the need for policies that promote the integration of routine anthropometric measurements in patient evaluations, particularly for populations at higher risk, such as women with polycystic ovary syndrome (PCOS). Additionally, further research should focus on the mechanisms linking these indices to inflammation.

as cardiovascular disease, diabetes, and certain cancers, highlighting its potential as a prognostic tool in clinical settings. Research has demonstrated that lifestyle modifications, pharmacological treatments, and dietary interventions can effectively lower hs-CRP levels, thereby potentially reducing the risk of associated diseases. Moreover, hs-CRP has been detected to associate with various health conditions, including its predictive value for cardiovascular events in individuals with end-stage kidney failure and its association with cognitive function in psychiatric disorders (6-8).

Anthropometric indices are critical tools used to assess body composition and nutritional status, providing insights into health risks associated with obesity, metabolic syndrome, and diabetes. Various indices, such as waist-to-hip ratio (WHR), body mass index (BMI), waist circumference (WC), and hip circumference serve as indicators of fat distribution and overall health. Recent studies have demonstrated that specific anthropometric indices, including the body roundness index (BRI) and Visceral Adiposity Index (VAI), are particularly effective in predicting conditions like type 2 diabetes mellitus (T2DM) among at-risk populations, outperforming traditional measures like BMI in some cases (9). Furthermore, these indices have been shown to correlate with skeletal muscle mass, highlighting their utility in identifying malnutrition and muscle atrophy, especially in older adults and patients with chronic conditions (10,11). The application of anthropometric indices extends beyond mere measurements; they are integral in clinical settings for early detection of health issues, guiding interventions to improve patient outcomes (12). Overall, anthropometric indices remain essential for monitoring health and guiding clinical decisions.

The hs-CRP levels have been shown to correlate with various anthropometric parameters in various clinical conditions. Studies indicate that women with PCOS exhibit elevated hs-CRP levels compared to controls, with a notable positive correlation between hs-CRP and BMI and WHR (13,14). Specifically, one study found hs-CRP levels to be positively correlated with BMI and WHR, suggesting that increased adiposity may contribute to chronic low-grade inflammation in this population (14). Furthermore, normal-weight women with PCOS also demonstrated higher hs-CRP concentrations compared to their non-PCOS counterparts, indicating that inflammation may occur independently of obesity (15). These findings highlight the role of hs-CRP as a potential marker for assessing heart disease risk and metabolic disturbances in women with PCOS, emphasizing the need for targeted interventions to manage these risks (13,16). Therefore in this study, we evaluate the correlation between anthropometric indices and hs-CRP levels to identify the possible predictive role of these parameters in the diagnosis of inflammation.

Objectives

The aim of this study is to assess the anthropometric indices in women with PCOS and analyze their correlation with hs-CRP levels, aiming to elucidate the relationship between body composition and inflammation in this population. This investigation seeks to enhance understanding of how anthropometric measurements may serve as indicators of inflammatory status, thereby contributing to better management strategies for women affected by PCOS.

Patients and Methods

Study design and participants

This descriptive-analytical study was conducted on 139 women diagnosed with PCOS who were referred to Firouzabadi Hospital in Tehran from November 2021 to June 2022, to assess the anthropometric indices in PCOS women and investigate their correlation with hs-CRP levels, aiming to understand the relationship between body measurements and inflammatory markers in this population.

Inclusion and exclusion criteria

The inclusion criteria for this study comprise women with a definitive diagnosis of PCOS who are between the ages of 15 and 45 years. Participants with systemic inflammation, hyperprolactinemia, and acromegaly were excluded. Additionally, individuals taking medications known to interfere with normal ovarian function and recent or chronic infections were also excluded.

PCOS diagnosis

The diagnosis of PCOS was confirmed using trans-vaginal ultrasonography, a procedure conducted by a gynecologist. This diagnostic approach involved assessing ovarian morphology, including follicle count and ovarian volume, which are key indicators of PCOS. The gynecologist utilized the ultrasonography results to confirm the presence of PCOS, leveraging their expertise to interpret the findings accurately and ensure a reliable diagnosis (17).

Data collection

Data collection utilized a structured checklist to gather demographic information, including age, and

anthropometric measurements such as BMI, WC, hip circumference, and WHR. To assess hs-CRP levels, venous blood samples were obtained from participants after an overnight fast, specifically on the second or third day of their follicular phase. These samples were then analyzed in the laboratory to determine hs-CRP levels.

The hs-CRP categorization

We categorized serum hs-CRP values into two main risk groups (low to moderate- risk and high risk) based on the three-tier system to assess hs-CRP levels. The low to moderate-risk group includes hs-CRP levels under 3 mg/L, divided into low-risk (less than 1 mg/L) and moderate-risk (between 1 and 3 mg/L). In contrast, the high-risk group consists of hs-CRP levels exceeding 3 mg/L (18,19).

Outcomes

The primary outcome of this investigation is to consider the correlation between anthropometric indices, such as BMI, WC, hip circumference, and WHR, and hs-CRP levels in women diagnosed with PCOS. By analyzing these relationships, the study aimed to determine how variations in body measurements relate to inflammatory markers, thereby providing insights into the potential impact of obesity and body composition on the inflammatory status of women with PCOS.

Statistical analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS, IBM Corp, USA) software version 27. Data normality was evaluated using the Kolmogorov-Smirnov test, while mean differences between groups were examined with the independent t-test. Univariate and multivariate logistic regression analyses were employed to evaluate the correlation between anthropometric indices and hs-CRP levels. The optimal cut-off values for high hs-CRP levels were determined by receiver operating characteristic (ROC) curve analysis, utilizing the ROC area under the curve (AUC) to compare each anthropometric indexes predictive effectiveness. Additionally, diagnostic accuracy metrics such as sensitivity and specificity were computed for anthropometric indices. A P value < 0.05 was determined statistically significant.

Results

The analysis of 139 samples revealed that 41.7% exhibited low to moderate levels of high-sensitivity hs-CRP, while 58.3% demonstrated elevated levels. Statistical evaluations indicated significant mean differences in age and anthropometric indices, BMI, WC, and hip circumference, amongst the two groups, with the high serum hs-CRP group presenting significantly greater values across all these parameters. Conversely, the difference in WHR did not reach statistical significance (Table 1).

The multivariate logistic regression analysis disclosed significant correlations between hs-CRP levels and various anthropometric indices. For unadjusted models, age, BMI, WC, and hip circumference were all positively correlated with hs-CRP levels, with odds ratios (ORs) indicating that for each unit increase in these indices, the likelihood of elevated hs-CRP high levels increased. Specifically, the OR for age was 1.15, suggesting a substantial increase in risk with advancing age. Similarly, BMI and WC had ORs of 1.13 and 1.19, respectively, reflecting their strong association with higher hs-CRP levels. Hip circumference also showed a significant correlation with an OR of 1.14. When variables adjusted for confounding factors, the associations remained robust; the OR for age increased to 1.19, while BMI and WC demonstrated ORs of 1.15 and 1.26, respectively. Hip circumference maintained a significant relationship with an OR of 1.11 in the adjusted model. These findings suggest a notable association between increased inflammatory markers and specific anthropometric characteristics in women, highlighting the importance of monitoring these anthropometric indices as potential indicators of inflammatory status in clinical settings (Table 2).

The analysis of the diagnostic accuracy of various anthropometric indices in predicting elevated levels of hs-CRP revealed notable findings based on the ROC curve. The AUC for age was 0.704, indicating a good level of accuracy, with a cut-off point established at 24.5 years, achieving a sensitivity of 72% and specificity of 56%. BMI demonstrated an AUC of 0.684, with a cut-off of 24.5 kg/m^2, resulting in a sensitivity of 71% and specificity of 66%. WC showed the highest AUC at 0.711, with a cut-off value of 94.5 cm, yielding a sensitivity of 72% and a specificity

Table 1. The frequency distribution of demographic characteristics and anthropometric indices in included participants according to hs-CRP levels

Variable	hs-CRP levels (mg/L)						*P* value*
	Low/moderate (n = 58)		High level (n = 81)		Total (N = 139)		
	Mean	SD	Mean	SD	Mean	SD	
Age (y)	24.43	4.23	29.19	6.75	27.20	6.27	<0.001
BMI (kg/m^2)	24.86	4.93	28.28	7.07	26.85	6.47	0.001
WC (cm)	94.76	4.19	98.68	5.72	97.04	5.47	<0.001
Hip circumference (cm)	95.56	4.68	98.93	5.82	97.53	5.61	<0.001
WHR	0.98	0.06	1.01	0.08	0.99	0.07	0.568

hs-CRP, High-sensitivity C-reactive protein; SD, Standard deviation; BMI, Body mass index; WC, Waist circumference; WHR, Waist-to-hip ratio.
*Independent T-test.

Table 2. The correlation between hs-CRP levels and anthropometric indices by univariate and multivariate logistic regression

Anthropometric indices		hs-CRP levels (mg/L)			
		P value	OR	95% CI	
				Lower	Upper
Unadjusted	Age (y)	<0.001	1.15	1.07	1.23
	BMI (kg/m²)	0.002	1.13	1.04	1.22
	WC (cm)	<0.001	1.19	1.09	1.31
	Hip circumference (cm)	<0.001	1.14	1.05	1.23
Adjusted	Age (y)	<0.001	1.19	1.09	1.30
	BMI (kg/m²)	0.003	1.15	1.04	1.26
	WC (cm)	<0.001	1.26	1.12	1.42
	Hip circumference (cm)	0.030	1.11	1.01	1.22

OR; Odds ratio, CI; Confidence interval, hs-CRP; High-sensitivity C-reactive protein, BMI; Body mass index; Waist circumference.

of 49%. Lastly, hip circumference had an AUC of 0.672, with a cut-off of 95.5 cm, which provided a sensitivity of 63% and specificity of 74%. These results underscore the varying predictive capabilities of these anthropometric indices in assessing inflammation as indicated by hs-CRP levels in PCOS women (Table 3 and Figure 1).

Discussion

The results showed significant correlations between hs-CRP levels and various anthropometric indices, including age, BMI, WC, and hip circumference. All these indices were positively associated with elevated hs-CRP levels, suggesting that higher measurements correspond to an increased likelihood of high hs-CRP level. Moreover, the diagnostic accuracy analysis revealed that all anthropometric indices demonstrated good sensitivity and specificity in predicting high hs-CRP levels. The findings of our study align with the research conducted by Lin et al, which established a meaningful relationship between high serum levels of hs-CRP and various anthropometric measurements, including BMI and WC. However, our result is in contrast to theirs in that Lin et al reported a positive correlation between hs-CRP and WHR, whereas our analysis did not find this relationship to be statistically significant (20). Cabral et al corroborated our findings by indicating that all anthropometric measurements, except WHR, are significantly correlated with elevated levels of hs-CRP. Their research specifically noted that WHR does not demonstrate an association with high hs-CRP levels (21), reinforcing the notion that certain anthropometric indices may be more indicative of systemic inflammation than others. Similarly, Festa et al reported findings consistent with our study, demonstrating a significant correlation between serum hs-CRP concentration and anthropometric indices such as BMI and WC (22). Yang et al demonstrated a moderate correlation between serum hs-CRP levels and BMI while observing a weaker correlation between hs-CRP and other anthropometric measures, including WC, hip circumference, and WHR (23). Sanip et al reported a positive correlation between hs-CRP levels and various anthropometric measures, including weight, hip circumference, BMI, and WC (24). This finding underscores the relationship between obesity-related metrics and systemic inflammation, as indicated by elevated hs-CRP levels, suggesting that these anthropometric indices may serve as important indicators of inflammatory status in individuals. In a study examining South Asian and European populations in London, Forouhi et al found a significant association between obesity measures and CRP concentrations in both ethnic groups. This research highlights the relationship between obesity and systemic inflammation, suggesting that elevated CRP levels may serve as a biomarker for obesity-related health risks across diverse populations (25). The positive correlation between hs-CRP levels and anthropometric indices has been validated also in other previous studies (17,26).

In the present study, older age emerged as a significant predictor of elevated hs-CRP levels, corroborating findings from Pannacciulli et al, who identified a positive relationship amongst age and CRP concentrations (27). This association suggests that as individuals age, there may be an increase in systemic inflammation, as indicated by rising hs-CRP levels, which could have implications for understanding age-related health risks and the management of chronic inflammatory conditions.

Table 3. Diagnostic accuracy of anthropometric indices in predicting high levels of hs-CRP in PCOS women using ROC curve

Anthropometric indices	Diagnostic accuracy for high levels of hs-CRP (mg/L)						
	AUC (0-1)	*P* value	95% CI		Cut-off	Sensitivity (%)	Specificity (%)
			Lower	Upper			
Age (y)	0.704	<0.001	0.619	0.789	24.5	72	56
BMI (kg/m²)	0.684	<0.001	0.593	0.775	24.50	71	66
WC (cm)	0.711	<0.001	0.625	0.796	94.5	72	49
Hip circumference (cm)	0.672	0.001	0.582	0.792	95.5	63	74

AUC, Area under curve; CI, Confidence Interval; hs-CRP, high-sensitivity C-reactive protein; BMI, Body mass index; WC, Waist circumference.

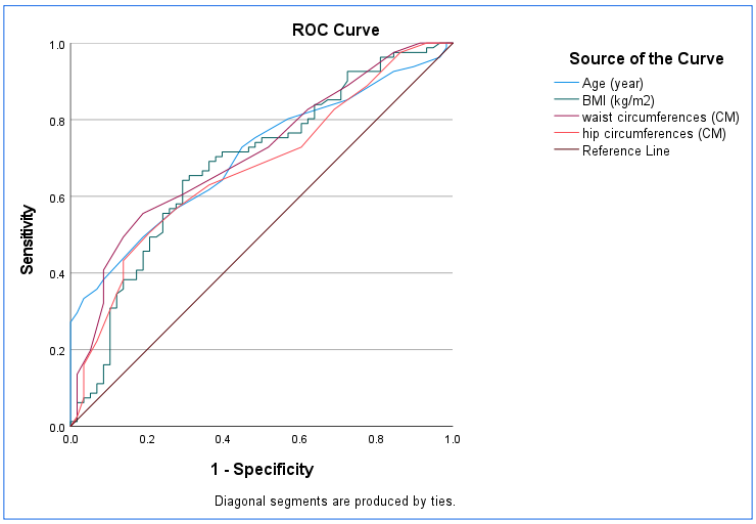

Figure 1. The ROC curve analysis of anthropometric indices and hs-CRP levels in women with PCOS.

The study by Sun et al has similarly highlighted the relationship between advancing age and increased hs-CRP concentrations, suggesting that aging may contribute to heightened systemic inflammation (28). This association is critical as it underscores the potential for older adults to face greater health risks related to chronic inflammatory conditions, including cardiovascular diseases. Overall, the evidence supports the notion that age is an important factor in understanding variations in hs-CRP levels, reinforcing the need for targeted strategies in managing inflammation-related health issues in older populations.

Overall, our findings are consistent with existing literature that underscores the role of obesity and age as critical factors influencing systemic inflammation, as indicated by elevated hs-CRP levels. The strong associations observed suggest that these anthropometric measures may serve as valuable indicators for assessing inflammation-related health risks in individuals, particularly in populations at risk for chronic diseases. In conclusion, the significant correlations identified in this study highlight the importance of monitoring hs-CRP levels alongside anthropometric indices to better understand and manage inflammation-related health issues, particularly in older adults and those with higher BMI or WC.

Conclusion

In conclusion, the results indicate a clear and significant relationship between hs-CRP levels and various anthropometric indices, such as age, BMI, WC, and hip circumference. The positive associations suggest that as these measurements increase, the likelihood of elevated hs-CRP levels also rises, highlighting the role of these indices as potential markers for inflammation. Notably, WC emerged as the most effective predictor of high hs-CRP levels, demonstrating superior diagnostic accuracy compared to the other indices assessed. This underscores the importance of monitoring anthropometric indices, especially WC in clinical settings as a valuable tool for identifying individuals at risk for inflammation-related health issues. Overall, these findings support the integration of anthropometric assessments into routine evaluations to better understand and manage inflammatory conditions in women with PCOS.

Limitations of the study

This study has several limitations that should be acknowledged. First, the sample size of 139 women may limit the generalizability of the findings, as a larger and more diverse population could provide more robust data. Additionally, the study's cross-sectional design restricts the ability to establish causal relationships between anthropometric indices and hs-CRP levels, making it difficult to determine whether changes in these indices directly influence inflammation. Furthermore, reliance on self-reported demographic information may introduce biases or inaccuracies in data collection. Lastly, the study was conducted at a single hospital in Tehran, which may not reflect the broader population of women with PCOS, potentially affecting the external validity of the results.

Authors' contribution

Conceptualization: Samaneh Saghafian Larijani, Narges Sadeghi.
Data curation: Samaneh Saghafian Larijani.
Formal analysis: Samaneh Saghafian Larijani.
Investigation: Samaneh Saghafian Larijani.
Methodology: Samaneh Saghafian Larijani.
Project management: Samaneh Saghafian Larijani.
Resources: Samaneh Saghafian Larijani.
Supervision: Samaneh Saghafian Larijani.
Validation: Samaneh Saghafian Larijani.
Writing-original draft: Samaneh Saghafian Larijani.
Writing-reviewing and editing: Samaneh Saghafian Larijani, Narges Sadeghi.

Conflicts of interest

The authors declare no conflict of interest.

Ethical issues

The research was conducted in accordance with the Declaration of

Helsinki. This study resulted from the research project (No; 18827), with the Ethical code (IR.IUMS.FMD.REC.1400.476; https://ethics.research.ac.ir/EthicsProposalView.php?id=231603), approved by the Iran University of Medical Sciences, Tehran, Iran. Accordingly, written informed consent taken from all participants before any intervention. Besides, the authors have ultimately observed ethical issues (including plagiarism, data fabrication, and double publication).

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