European Journal of Obstetrics & Gynecology and Reproductive Biology 205 (2016) 110–114

Contents lists available at ScienceDirect

European Journal of Obstetrics & Gynecology and Reproductive Biology

journal homepage: www.elsevier.com/locate/ejogrb

# Could "a body shape index" and "waist to height ratio" predict insulin resistance and metabolic syndrome in polycystic ovary syndrome?

Samira Behboudi-Gandevani[a], Fahimeh Ramezani Tehrani[a,*], Leila Cheraghi[b], Fereidoun Azizi[c]

[a] Reproductive Endocrinology Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[b] Department of Biostatistics and Epidemiology, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[c] Endocrine Research Center, Research Institute for Endocrine Sciences, Shahid Beheshti University of Medical Sciences, Tehran, Iran

ARTICLE INFO

*Article history:*
Received 28 May 2016
Received in revised form 9 July 2016
Accepted 1 August 2016

*Keywords:*
A body shape index (ABSI)
Insulin resistance (IR)
Metabolic syndrome (MetS)
Polycystic ovary syndrome (PCOS)
Waist to height ratio (WHtR)

ABSTRACT

*Objective:* To investigate whether a body shape index (ABSI) and waist to height ratio (WHtR) could predict insulin resistance (IR) and metabolic syndrome (MetS) in women with polycystic ovary syndrome (PCOS) compared to healthy women.
*Study design:* In a population-based study a cohort of 754 reproductive-aged women including 704 eumenorrheic non-hirsute subjects and 50 PCOS women selected according to the national institutes of health's (NIH) criteria. The ability of ABSI and WHtR for the prediction of IR was estimated by the homeostasis model and metabolic syndrome according to the joint interim statement criteria.
*Results:* Age and BMI adjusted prevalence of IR and MetS in PCOS women vs. healthy controls were 34% vs. 26%, $P=0.041$ and 15% vs. 14%, $P=0.917$, respectively. Mean (SD) of ABSI in PCOS women and healthy women were 0.76 (0.05) and 0.76 (0.053), respectively ($P=0.363$). The area under curve (CI 95%) of WHtR for predicting IR and MetS among PCOS women vs. healthy women were 0.751 (0.60–0.89) vs. 0.69 (0.65–0.73) and 0.902 (0.81–0.98) vs. 0.802 (0.76–0.83), respectively. As such, the area under curve (CI 95%) of ABSI for ROC curve analysis for predicting IR and MetS among PCOS women vs. healthy women were 0.482 (0.31–0.64) vs. 0.537 (0.49–0.58) and 0.538 (0.35–0.72) vs. 0.584 (0.60–0.69), respectively.
*Conclusions:* These findings suggested that WHtR but not ABSI were a good predictor of IR and MetS among PCOS and healthy women. WHtR may be proposed as a screening tool for IR and MetS risk assessment among PCOS women as a sensitive, inexpensive, noninvasive, simple to assess and easy to calculate measurement tools.



## Introduction

Polycystic ovary syndrome (PCOS) is one of the most common heterogeneous endocrine disorders characterized by irregular menses, hyperandrogenism, and polycystic ovaries [1]. The prevalence of PCOS varies between 2% and 26% in different populations [1,2]. About 50%–70% of all women with PCOS have some degree of insulin resistance (IR) which could probably contribute to the hyperandrogenism that is closely linked to cardiovascular and metabolic feature of PCOS [3,4]. In this respect, it has been demonstrated that metabolic syndrome (MetS) is much more common in women with PCOS than in general population with the same age [5]. There is increasing evidence supporting the early detection of IR and MetS in this population that could ultimately reduce the incidence or severity of diabetes mellitus and cardiovascular diseases [3]. Therefore, a simple test for the early detection of IR or MetS in individuals is important both for research and practice. Obesity is the most prominent predictor of IR and MetS. Body mass index (BMI) has long been recognized as an anthropometric predictor for them. A lack of differentiation between fat and muscle mass and not affirming fat distribution are two important limitations of BMI [6]. To more accurately measure central adiposity, waist circumference (WC) has been suggested to modulate the limitations of BMI. However, the strong correlation between WC and BMI should not be neglected. Waist to hip ratio (WHR) has proposed a modification [7]. A general agreement on a single measure that best predict the adiposity-associated health risk is lacking. Recently, other indicators including "a body shape index" (ABSI) and WHtR have been

* Corresponding author at: Reproductive Endocrinology Research Center, Research Institute for Endocrine Sciences, No. 24, Parvane Street, Yaman Street, P.O. Box 19395 4763, Velenjak, Tehran, Iran.
*E-mail addresses:* ramezani@endocrine.ac.ir, fah.tehrani@gmail.com (F. Ramezani Tehrani).

http://dx.doi.org/10.1016/j.ejogrb.2016.08.011
0301-2115/

proposed. The new anthropometric index of ABSI has been developed as possible modified alternatives to BMI, WC and WHR [8]. ABSI has a little association with height, body weight, and BMI. Also, it has a very modest correlation with WC and a higher correlation with the amount of visceral than peripheral fat. Hence, it could be considered that ABSI and WHtR potentially could be good predictors of IR and MetS in PCOS women and healthy women. However, it is unclear whether there is any difference between those most appropriate adiposity indexes of women with PCOS and the normo-ovulatory non-hirsute women. Therefore, this study aimed to investigate ABSI and WHtR as predictors of IR and MetS in women with PCOS compared to healthy women in a population-based study.

## Material and methods

### *Participants*

The ethical review board of the Research Institute for Endocrine Sciences approved the study proposal. Written informed consent was obtained from the women after explanation of the purpose of the study. This population-based cross-sectional study was conducted with reproductive aged women (18–45 years) who participated in the Tehran Lipid and Glucose Study (TLGS), an ongoing prospective population-based cohort study that began in 1998 to explore the prevalence and risk factors of non-communicable diseases. Detailed information regarding TLGS has been published elsewhere [9]. Briefly, a multistage stratified cluster random sampling technique was used to select 15,005 ethnic Iranian residents aged > 3 years, of district 13 of Tehran. The comprehensive interview, physical and laboratory examination with regard to chronic diseases were performed at the time of recruitment and every 3 years follow-up.

For the current study, menopause (natural or surgical) and pregnant women were excluded. Furthermore, women with only androgen excess, only ovulatory dysfunction, only polycystic ovaries, thyroid dysfunction and hyperprolactinemia were excluded from the study. Finally, the remaining participants ($n = 754$) were divided into two study groups as follows: women with PCOS ($n = 50$) and healthy women ($n = 704$).

### *Biochemical measurements*

All analytical determinations were performed at the TLGS reference laboratory at the everyday of blood collection. Participants were asked to abstain from physical activity for 24–48 h before blood sampling. They were tested in the morning after 12–14 h overnight fasting. Plasma glucose concentration was determined by an enzymatic colorimetric method using glucose oxidase kit (Pars Azmoon®, Tehran, Iran); inter- and intraassay coefficients of variation (CV) were both 2.2%. Serum levels of total cholesterol (TC) and triglyceride (TG) were checked using enzymatic colorimetric assays (TC & TG Kit, Pars Azmoun®, Iran) in all four visits. High-density lipoprotein cholesterol (HDL-C) was measured after the precipitation of the apolipoprotein B containing lipoproteins with phosphotungistic acid. Lowdensity lipoprotein cholesterol (LDL-C) was calculated by the Friedewald formula; LDL-C calculation was not done if TG concentration was > 4.52 mmol/L. Lipid standard (C.f.a.s., Boehringer Mannheim®, Germany; Cat. no. 759350) was used to calibrate the Selectra 2 Autoanalyzer for each day of laboratory analyses. All samples were analyzed when internal quality control met the acceptable criteria. Inter- and intra-assay coefficients of variation were 2% and 0.5% for TC and 1.6% and 0.6% for TG, respectively. Fasting serum insulin was determined by the electrochemiluminescence immunoassay (ECLIA) method using Roche Diagnostics kits & Roche/Hitachi Cobas e-411 analyzer (GmbH, Boehringer Mannheim®, Germany) with both intra- and inter-assay CVs of less than 3.2%.

### *Terms definition*

In this study, PCOS was defined according to the national institutes of health (NIH) 1990 criteria as the both criteria presence of chronic anovulation, clinical and/or biochemical signs of hyperandrogenism (with the exclusion of other etiologies, e.g., congenital adrenal hyperplasia) [10].

The MetS was defined according to the joint interim statement (JIS), [11] as the presence of any three or more of following five risk factors: (i) fasting TG $\geq$ 150 mg/dL or specific treatment, (ii) fasting HDL $\leq$ 50 mg/dL or specific treatment, (iii) raised systolic blood pressure $\geq$ 130 mmHg or raised diastolic blood pressure $\geq$ 85 mmHg or specific treatment, (iv) fasting plasma glucose $\geq$ 100 mg/dL or treatment and (v) high WC using WC cut-off points of $\geq$ 90 cm for women according population and country-specific cut-off point for Iranians [12].

IR was also estimated by the homeostasis model assessment (HOMA-IR) as a surrogate reference standard for measurement of IR according to the following formula [13]: HOMA-IR = [(Fasting insulin level ($\mu$U/mL) $\times$ FPG (mmol/L)]/22.5.

IR was defined as HOMAIR more than 2.63. HOMAIR = 2.63 was considered a cut-off value of IR among reproductive-aged Iranian women. The details were published in a previous study [14]. Briefly, to determine cut-off value of IR, 129 women with normal BMI less than 25 kg/m$^2$, nondiabetic with fasting blood glucose (FBG) lower 126 (mg/dL) and nonhypertensive with BP lower 130/85 (mmHg) and without any metabolic abnormalities, hirsutism or polycystic morphology in ultrasonography were selected; among them, HOMA-IR distribution were skewed and 90th percentile was considered for the definition of IR (HOMAIR = 2.63) [14].

A body shape index (ABSI) was calculated according to Krakauer and Krakauer [8] with following formula: ABSI = WC (cm)/[BMI $^{2/3}$ $\times$ height (m)$^{1/2}$].

### *Statistical analysis*

The Statistical Package for Social Sciences (SPSS® version 16; SPSS Inc., Chicago, IL, USA), and software package STATA (version 12; STATA Inc., College Station, TX, USA) were used for data analysis.

For continuous variables, data were presented as mean (standard deviation) or median (interquartile range (IQR)), according to the distribution of the variables, and categorical variables were expressed by frequency counts. Normality of the distribution was assessed using the Kolmogorov–Smirnov test. Comparisons between groups were analyzed using the Student's *t*-test, chi-squared test and Mann–Whitney *U* test as appropriate. Moreover, baseline characteristics of healthy women and PCOS subjects were compared using the analysis of covariance (ANCOVA) and logistic model for age and BMI adjusted.

Age and BMI adjusted prevalence of IR and MetS were presented using the multiple logistic regression analysis. Based on this model, we estimated the parameters and recalculated the probability for both groups, using mean value for age and BMI.

To assess the ability of WHtR and ABSI to discriminate between women who were IR/MetS and those who were not, receiver operating characteristics curves (ROCs) were constructed and the area under the curves (AUCs) were calculated for ABSI. We identified the optimal cut point for sensitivity and specificity as the ones that keep $(1\text{-sensitivity})^2 + (1\text{-specificity})^2$ at minimum and