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Research Article

Optimal Cutoff Values for Anthropometric Adiposity Measures of Sri Lankan Adult Women

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Anthropometric adiposity measures (AAMs) such as body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR) are used to evaluate obesity status. Country-specific cutoff values of AAMs would provide more accurate estimation of obesity prevalence. This cross-sectional study was designed to determine the optimal cutoff values for AAMs, BMI, WC, hip circumference (HC), and WHR, of Sri Lankan adult women. The study was conducted in Galle, Sri Lanka, with 350 healthy community-dwelling middle-aged women aged 30–60 years, divided into two groups (Group A, $n = 175$ and Group B, $n = 175$). Total body fat percentage (TBFP) (kg) was measured with DXA. Body weight (kg), height (m), and WC and HC (cm) were measured. BMI (kg/m^2) and WHR were calculated. Optimal cutoff values were determined by area under curve (AUC) in Receiver-Operating Characteristic (ROC) curve analysis using TBFP as the criterion at the TBFP level of 33% and 35% using the women in Group A. Then, the prevalence of obesity was determined in Group B while comparing the prevalence based on the cutoff values recommended by the World Health Organization (WHO) for Asians and the newly developed cutoff values for Sri Lankan women. Optimal cutoff values of AAMs which correspond to TBFP 33% are BMI, 24.5 kg/m^2; WC, 80 cm; HC, 95 cm; and WHR, 0.83. TBFP 35% corresponds to the optimal cutoff values of BMI, 25.0 kg/m^2; WC, 85 cm; HC, 100 cm; and WHR, 0.83. Prevalence of obesity (number, %) according to the WHO and newly defined cutoff values that correspond to TBFP 33% and 35% were as follows: BMI = 83 (47.4%), 98 (56.0%), 83 (47.4%); WC = 106 (60.6%), 106 (60.6%), 72 (41.1%); and WHR = 140 (80.0%), 106 (60.6%), 106 (60.6%). The observed cutoff values of BMI and WC in this study were within the ranges of those described by the WHO for Asian populations which correspond to the 33% and 35% TBFP levels, respectively. However, the WHR cutoff value of WHO (Asians) is lower when compared to the newly determined value for Sri Lankan females while overestimating the prevalence. More studies are needed to confirm these values before clinical use.

1. Introduction

Noncommunicable diseases (NCDs) have become a major health concern worldwide. Apart from genetic factors and improper lifestyles, obesity has been identified as the major contributor of certain NCDs such as insulin resistance, dyslipidemia, and high blood pressure [1]. The World Health Organization (WHO) defines obesity as a disease characterized by the excessive accumulation of body fat [2], and currently it is considered a major public health problem leading to serious social, psychological, and physical problems.

Anthropometric adiposity measures (AAMs) such as body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR) are the commonly used surrogates of body fat content in clinical practice [3]. Although less frequent, hip circumference (HC) also has been used [4]. All these measurements include the lean tissue and bones; hence, they are not direct measures of fat content. In contrast, advanced techniques such as dual-energy X-ray absorptiometry (DXA), quantitative CT, and MRI measure total body fat and regional fat in the central (android) and hip and thigh (gynoid) areas [5].

Although BMI and WC are used to determine global adiposity in patient evaluation due to the simplicity and low cost, the real definition of obesity is based on the body fat content. The WHO defines the total body fat percentage (TBFP) over 35% as obesity in women [6], but its application is mostly limited to research settings. Furthermore, even TBFP above 33% is also considered as obesity in some instances [7].

Currently, Sri Lanka follows the WHO-defined AAM cutoff values [2] modified for Asians. The usage of such cutoff values may not reflect the actual prevalence of generalized or central obesity since the TBFP and body fat distribution have a significant geographical variation even within the Asian continent. A previous study in Sri Lanka has attempted to define the cutoff values for AAMs in Sri Lankan women [4], but more studies are needed to reconfirm the values.

Given the high prevalence and clinical relevance of obesity, reliable cutoff values are required for accurate detection of the condition. Despite inherited measurement errors, AAMs will continue to be used in the clinical evaluation of patients in low-resource settings. As anthropometric parameters depend on sex, age, race/ethnicity, and geographical areas, the country specific cutoff values for AAMs need to be defined. Thus, this study was designed to determine the optimal cutoff values for AAMs, namely, BMI, WC, HC, and WHR, of Sri Lankan adult women using TBFP as the criterion.

2. Materials and Methods

2.1. Study Design, Subjects, and Setting. This descriptive cross-sectional study included 350 community-dwelling women aged 30–60 years, selected from the field study area of the Faculty of Medicine, Galle in southern Sri Lanka using multistage cluster sampling technique. The study was conducted during the period June 2015 to January 2017 as part of the study project titled "Effects of Menopause on Bodily Structure, Functions and Physical Health."

Of the 18 public health midwife's areas in the study area, three areas (Godakanda east and Kapuhempala and Kalegana) were selected randomly to recruit women for the development of cutoff values (Stage 01; Group A, $n = 175$), and two other areas (Hapugala and Kahaduwawaththa) were selected randomly to recruit women for the study on the prevalence of obesity (Stage 02; Group B, $n = 175$). Women who were pregnant or lactating and those who were suffering from NCDs, acute or chronic surgical conditions, and polycystic ovarian syndrome (PCOS) were excluded. Women on hormone replacement therapy (HRT) or hormonal contraceptives were also excluded from the study.

2.2. Measured Variables. Body weight was measured to the nearest 0.1 kg while wearing light clothes and standing height was measured without footwear and recorded to the nearest 0.1 cm with a calibrated stadiometer (NAGATA, Tainan, Taiwan). BMI (kg/m^2) was calculated as body weight divided by height squared (kg/m^2). WC (cm) was measured at midway between iliac crest and lower rib margin at the end of normal expiration and HC (cm) was measured at the widest part of the buttocks at intertrochanteric level using a plastic tape. WHR was calculated. All anthropometric indices were measured according to the standard protocol [8] by a single trained investigator to ensure the consistency of each measurement.

TBFP (total fat mass divided by total body mass, multiplied by 100) was measured with dual-energy X-ray absorptiometry (DXA) scanner (Hologic Discovery W, Hologic Inc., Bedford, MA, USA) adhering to the manufacturer's guidelines. All scans were performed by the same technician who calibrated the device each scanning day. Analytical software provided by the DXA manufacturer was used to analyze the TBFP.

The physical activity (PA) pattern was evaluated with the short version of International Physical Activity Questionnaire (IPAQ), which was forward-backward translated into the Sinhala language and pretested. Participants were asked to report the time duration spent for walking, moderate-intensity activity, and vigorous-intensity activity during the week prior to the interview. The PA data were converted to minutes per week and expressed as a metabolic equivalent (MET-min/week) according to the IPAQ guidelines for data processing [9]. Total PA score was calculated summating the three types of activities.

Daily total energy consumption was estimated by 24-hour dietary recall (HDR) method. The subjects were asked to recall all foods and beverages, consumed over the previous 24-hour period. Respondents were probed for the types of foods and food preparation methods. For uncommon mixed meals, the details of recipes and preparation methods were collected at the time of taking the 24-HDR. All foods recorded in 24-HDR were converted into grams, and then, the intake of total energy was analyzed using Indian food composition tables [10] and Sri Lankan food composition tables [11].

2.3. Statistical Analysis. Data were analyzed using SPSS version 20.0. Descriptive statistics, means (SD), median (IQR), or frequency (%), were used to describe the data. The group comparison of continuous data was performed with independent sample t-test, and the group comparison of categorical data was performed with Chi-square test. p value < 0.05 was considered statistically significant.

Women in Group A were used for the development of new cutoff values. Pearson's correlation (r) was performed to determine the correlation between TBFP and AAMs—BMI, WC, HC, and WHR. Receiver-operating characteristic (ROC) curves were drawn to decide on the optimal cutoff values of AAMs using TBFP as the criterion which correspond to TBFP 33% and 35%. The optimal cutoff points of AAMs were estimated with the Youden index (sensitivity + specificity-1) [12]. Area under curve (AUC) (95% confidence interval (CI)), sensitivity, and specificity were calculated for each cutoff value. Apart from that, posttest probability, positive likelihood ratio (Sensitivity/(1-Specificity)), and negative likelihood ratio ((1-Sensitivity)/Specificity) [13] were calculated and illustrated using the Fagan's nomogram [14]. The accuracy of the cutoff values derived from 33% to 35% of TBFP was also calculated.

Then, the prevalence of obesity based on the WHO cutoff values for Asians and the newly detected cutoff values corresponding to 33% and 35% TBFP levels in the current study were estimated among the women in Group B, and the two proportions were compared with Chi-square test of independence.

2.4. Ethical Clearance. The Ethics Review Committee of the Faculty of Medicine, University of Ruhuna, Sri Lanka, granted ethical clearance for the study (reference number: 24.09.2014 : 3.2). Each participant signed a written informed consent before answering the questionnaire.

3. Results

3.1. Basic Characteristics of Participants. Basic characteristics of Groups A and B are shown in Table 1. The characteristics, age, menopausal status, PA, calorie consumption, AAMs, and TBFP, of the two groups were not different ($p > 0.05$), indicating that the two groups were similar with regard to their basic characteristics.

3.2. Cutoff Values for AAMs. Except for the WHR ($r = 0.19$, $p = 0.04$), strong and significant positive correlations were observed between TBFP and AAMs ($r \geq 0.67$, $p < 0.001$) (Table 2).

The optimal cutoff values of BMI, WC, HC, and WHR derived from 33% to 35% TBFP are shown in Table 3, obtained with the maximum sensitivity and specificity derived through maximum Youden's index. Figure 1 illustrates the ROC curves drawn for the optimal cutoff value of AAMs derived from 33% to 35% TBFP. BMI, WC, and HC showed better discriminatory power (greater AUCs) compared to WHR.

The optimal cutoff values of BMI were equal to the WHO defined value in 35% TBFP, while WC cutoff value was equal to the WHO defined value in 33% TBFP. However, WHR cutoff values were lower compared to the WHO defined value in both TBFP levels.

Table 4 includes the positive and negative likelihood ratios, the posttest (posterior) probability (odds), and the accuracy of each cutoff value derived from 33% and 35% TBFP. Furthermore, Fagan's nomograms for posttest (posterior) probabilities of each cutoff value are shown in Figures 2 and 3 derived from 33% and 35% TBFP, respectively. The Fagan nomogram shows greater posttest (posterior) probabilities for all the AAMs cutoff values derived against 33% and 35% TBFP. Higher values of positive likelihood ratios and lower negative likelihood ratios were observed for all the AAMs in both TBFP levels. The posttest probabilities and positive likelihood ratios derived for WHR were lower compared to the other AAMs (Tables 3 and 4). Furthermore, the accuracy observed for each cutoff value is greater for both TBFP levels; however, the accuracy was lower for WHR cutoff values compared to other AAMs (Table 3).

3.3. Prevalence of Obesity. The prevalence of obesity based on the WHO recommended cutoff values for Asians and newly defined cutoff values in the current study are shown in Table 5. HC was not considered in the analysis as the WHO does not provide a cutoff value for this measure.

When the obesity was measured with the cutoff values derived from 33% TBFP, the prevalence was equal in WC-based obesity and significantly higher in BMI-based obesity ($p < 0.001$) compared to the prevalence determined with WHO cutoff values. When the obesity was measured with the cutoff values derived from 35% TBFP, the prevalence was equal in BMI-based obesity; however, it was significantly lower in WC-based obesity ($p < 0.001$) compared to the prevalence measured with WHO cutoff values. However, the prevalence of obesity was lower in both 33% and 35% TBFP levels, when newly determined WHR cutoff value was compared to the WHO cutoff values ($p < 0.001$).

4. Discussion

The BMI and WC cutoff values observed for 33% and 35% TBFP levels in this study were within the ranges recommended for the Asians by the WHO. However, WHR cutoff value was greater compared to the WHO recommended value. Also, we found the prevalence of obesity to vary, significantly, according to the cutoff values used to define obesity.

The high AUCs in the ROC curve analysis indicated the high discriminating ability of these measures in determining TBFP. Higher posttest probabilities were observed for all the AAM cutoff values derived against both 33% and 35% TBFP levels. Furthermore, high positive likelihood ratios and low negative likelihood ratios with greater accuracies indicate that when obesity is measured with the newly developed cutoff values, they provide greater number of true positive cases while the number of false negative cases is low. These qualities are a little lower in WHR compared to the other three measures.

The WHO has proposed lower cutoff points of overweight/obesity (BMI, $\geq 25\,kg/m^2$; WC, 80 cm; and WHR, 0.81) for Asian and Pacific populations to promote healthy lifestyles and weight control [2]. However, the accuracy of such values is questionable given the vast genetic diversity and lifestyle variations in the Asia-Pacific region.

A Sri Lankan study done by Nanayakkara and Lekamwasam previously proposed optimal cutoff values for BMI, WC, and HC as $24\,kg/m^2$, 72 cm, and 92 cm, developed with the study sample, included only premenopausal women of narrower age range selected from Galle district [4]. Apart from that, a recent Sri Lankan study done by Jayawardena and Hills suggested that TBFP 35% corresponds to BMI of $23\,kg/m^2$ and TBFP 40% equated a BMI of $25\,kg/m^2$, while the corresponding WC cutoff for 35% was 76 cm in women

Table 1: Basic characteristics of women in Groups A and B ($n = 350$).

Characteristic	Group A mean (SD) or frequency (%) ($n = 175$)	Group B mean (SD) or frequency (%) ($n = 175$)	p value
Age (years)	48.7 (8.5)	48.7 (8.3)	0.78[a]
Weight (kg)	58.10 (10.93)	57.04 (10.84)	0.24[a]
Height (m)	1.51 (0.60)	1.50 (0.06)	0.86[a]
BMI (kg/m^2)	25.23 (4.24)	25.12 (4.34)	0.41[a]
WC (cm)	83.22 (10.30)	83.08 (9.95)	0.82[a]
HC (cm)	97.91 (9.45)	97.83 (9.34)	0.47[a]
WHR	0.84 (0.05)	0.84 (0.05)	0.38[a]
TBFP (%)	34.88 (5.35)	34.79 (5.26)	0.31[a]
Total PA score (MET-min/week)	7413.0 (2180.0)	7367.0 (1992.0)	0.73[a]
Total energy consumption (kcal/day)	1251.47 (395.75)	1281.98 (386.46)	0.79[a]
PrMW	92 (47.4%)	92 (47.4%)	0.81[b]
PMW	83 (47.4%)	83 (47.4%)	

BMI = body mass index, WHR = waist-to-hip ratio, WC = waist circumference, TBFP = total body fat percentage, HC = hip circumference, PA = physical activity, PrMW = premenopausal women, and PMW = postmenopausal women. [a]p values were derived from independent sample t-test. [b]p value was derived from Chi-square test of independence.

Table 2: Correlation between TBFP and AAMs in Group A ($n = 175$).

Variable	Correlation with TBFP r (p value)
BMI	0.77 (<0.001)
WC	0.67 (<0.001)
HC	0.75 (<0.001)
WHR	0.19 (0.04)

BMI = body mass index, WHR = waist-to-hip ratio, WC = waist circumference, TBFP = total body fat percentage, and HC = hip circumference. All correlations (r) are Pearson's correlations.

[15], derived from a study sample comprised of nationally represented women ($n = 159$) above 18 years with the mean age of 45.6 years.

In the previous Sri Lankan study done by Nanayakkara and Lekamwasam [4], a similar cutoff value for the BMI was roughly observed; however, other cutoff values, especially the surrogates of central obesity, were different. This could be due to the fact that we included both pre- and post-menopausal women in our study, whereas the previous study in Sri Lanka included only premenopausal women. The recent Sri Lankan study done by Jayawardena and Hills [15] suggested lower BMI and WC cutoffs for women which correspond to 35% TBFP compared to the current study, and this disparity may be due to the differences in sampling and socioeconomic factors. Further, it may also partially relate to the method used to measure the TBFP; the cited study used the Deuterium Dilution Technique, while we used gold standard body composition measurement (DXA).

Zeng et al. in 2014 described BMI and WC cutoff values of 23 kg/m^2 and 75 cm for women in China [16]. In Korea, however, WC of 85 cm has been proposed as the threshold for abdominal obesity in women [17]. The WC cutoff of 96.25 cm has been suggested for Egyptian women [18], while in Turkey, the WC and WHR cutoff values of 95 cm and 0.93 have been proposed [19]. Our data are concordant with the BMI cutoff value of 23 kg/m^2, WC 80 cm, and WHR 0.81 described among Indian females [1]. Misra et al., however, later recommended a WC cutoff point of 72 cm (sensitivity 68.7%, specificity 71.8%) for Indian women [20].

The inconsistency of the cutoff values of AAMs observed between the cited studies could be due to many reasons. These include genuine geographical variations in fat content and distribution due to genetic and other variations and methodological discrepancies between studies. Furthermore, the statistical methods used to determine the cutoff value and the reference criteria used, TBFP or BMI, may vary between studies. The geographical variation of cutoff values observed in previous studies emphasizes the importance of using country- or ethnic-specific cutoff values for AAMs. However, Indian and Sri Lankan cutoff values are broadly similar [1].

Furthermore, we observed that BMI and WC have greater discriminatory power than WHR in determining TBFP observed with the AUC, positive and negative likelihood ratios, and accuracies. WC is a direct measure of abdominal obesity and a more accurate predictor of metabolic disorders such as type 2 diabetes mellitus [21] and even superior to the BMI [22]. Low discriminatory power of WHR would be due to a few reasons. Although WC is a single measurement, WHR includes both HC and WC; hence, it may be associated with a greater measurement error than WC.

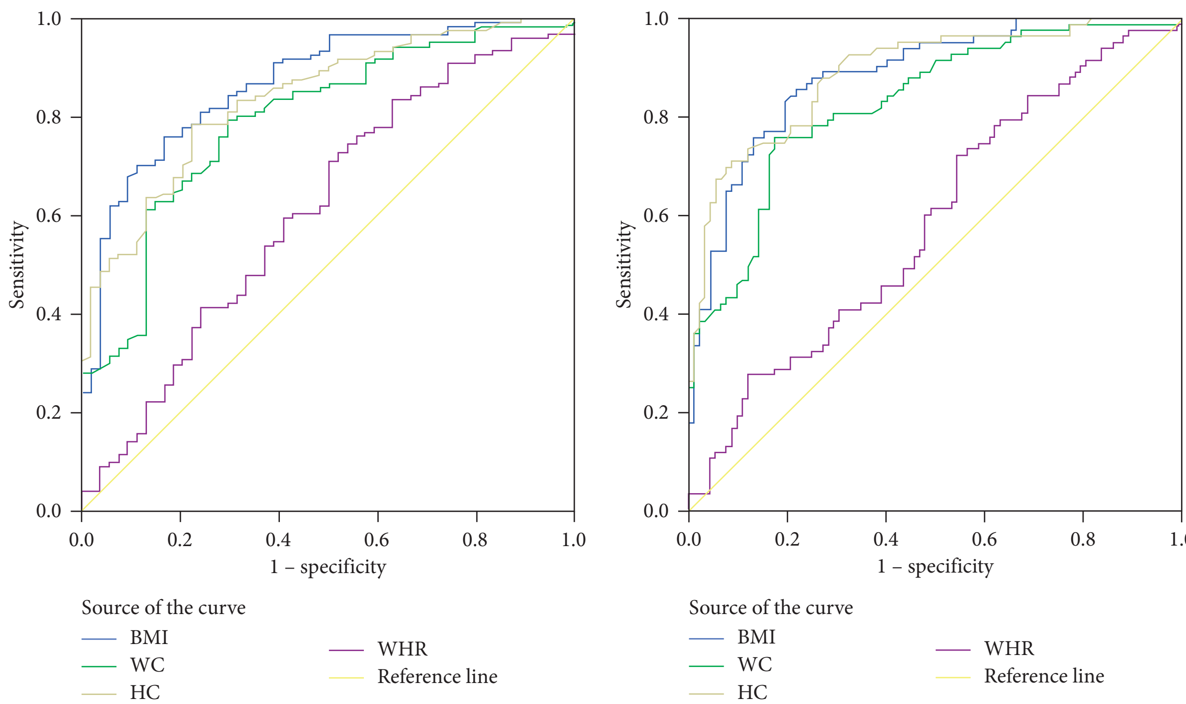
The evaluation of TBFP could be a daunting task for low-resource settings due to the restricted access to technology required. Apart from obesity management, TBFP is not widely used in clinical settings, and patient management guidelines are still based on anthropometric measures. Therefore, the observed cutoff values of AAMs are important as these values are specific to the Sri Lankan context and can be integrated into clinical practice.

Furthermore, we propose to use the BMI and other central adiposity surrogates corresponding to 33% which enable a more accurate and early identification of high-risk individuals for obesity-related metabolic diseases. This is because the studies suggest that high adiposity among South Asians has adverse metabolic outcomes such as diabetes and cardiovascular diseases [23]. Among the Sri Lankan adults

Table 3: Optimal AAMs cutoff values for diagnosing obesity in Sri Lankan middle-aged women.

TBFP	AAM	Optimal cutoff value	AUC (95% CI)	Sensitivity	Specificity	Accuracy	Youden's index	SE	p value
33	BMI	24.5 kg/m^2	0.87 (0.81–0.92)	0.76	0.83	078	0.58	0.02	<0.001
	WC	80.0 cm	0.79 (0.72–0.86)	079	0.70	0.76	0.49	0.03	<0.001
	HC	95.0 cm	0.83 (0.77–0.89)	0.78	0.77	0.77	0.56	0.03	<0.001
	WHR	0.83	0.61 (0.52–0.70)	0.72	0.50	0.65	0.20	0.04	0.01
35	BMI	25.0 kg/m^2	0.88 (0.83–0.93)	0.85	0.78	0.81	0.63	0.02	<0.001
	WC	85.0 cm	0.83 (0.77–0.89)	0.75	0.82	0.78	0.58	0.03	<0.001
	HC	100.0 cm	0.89 (0.84–0.93)	0.71	0.91	0.81	0.62	0.02	<0.001
	WHR	0.83	0.57 (0.50–0.67)	0.72	0.45	0.57	0.17	0.04	0.04

AAM = anthropometry adiposity measure, BMI = body mass index, WC = waist circumference, HC = hip circumference, WHR = waist-to-hip ratio, and SE = standard error.



(a) (b)

Figure 1: ROC curves to determine the optimal cutoff values for AAMs. (a) Derived from 33% of TBFP. (b) Derived from 35% of TBFP.

Table 4: Likelihood ratios and posttest (posterior) probability of AAMs cutoff values for diagnosing obesity in Sri Lankan middle-aged women.

		Positive likelihood				Negative likelihood			
TBFP (%)	AAM	Positive likelihood ratio	95% CI	Posttest (posterior) probability (odds)	95% CI	Negative likelihood ratio	95% CI	Posttest (posterior) probability (odds)	95% CI
33	BMI	4.47	2.46–8.12	91% (9.9)	85%–95%	0.29	0.21–0.41	39% (0.6)	32%–48%
	WC	2.63	1.74–3.99	85% (5.9)	79%–90%	0.30	0.20–0.44	40% (0.7)	31%–49%
	HC	3.39	2.07–5.57	88% (7.5)	82%–93%	0.29	0.20–0.41	39% (0.6)	31%–48%
	WHR	1.44	1.08–1.92	76% (3.2)	71%–81%	0.56	0.38–0.83	55% (1.2)	46%–65%
35	BMI	3.86	2.60–5.75	78% (3.6)	71%–84%	0.19	0.11–0.32	15% (0.2)	9%–23%
	WC	4.17	2.64–6.57	79% (3.8)	71%–86%	0.30	0.21–0.45	22% (0.3)	16%–29%
	HC	7.89	4.05–15.0	88% (7.5)	79%–93%	0.32	0.23–0.45	23% (0.3)	18%–29%
	WHR	1.31	1.04–1.65	55% (1.2)	49%–60%	0.62	0.41–0.94	36% (0.6)	27%–46%

AAM = anthropometry adiposity measure, BMI = body mass index, WC = waist circumference, HC = hip circumference, WHR = waist-to-hip ratio, and CI = confidence interval.

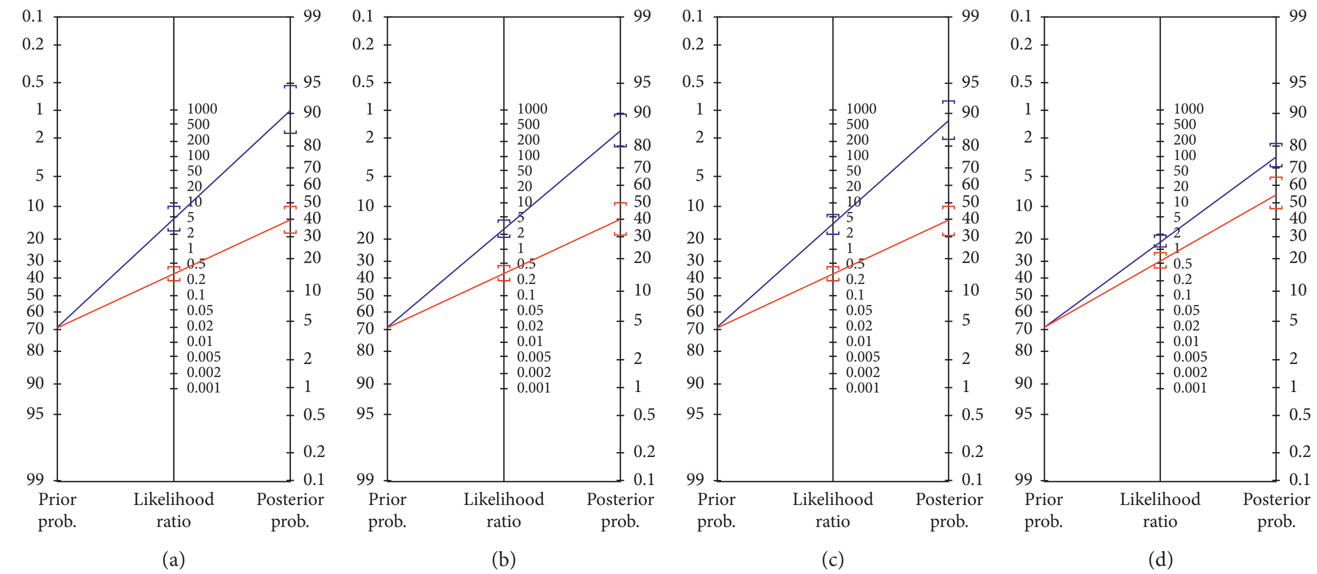


Figure 2: Fagan's nomograms showing the likelihood ratios and posttest (posterior) probabilities for derived AAM cutoff values for 33% of TBFP. (a) Fagan's nomogram for BMI, (b) Fagan's nomogram for WC, (c) Fagan's nomogram for HC, (d) Fagan's nomogram for WHR. —— Positive likelihood ratio and —— negative likelihood ratio.

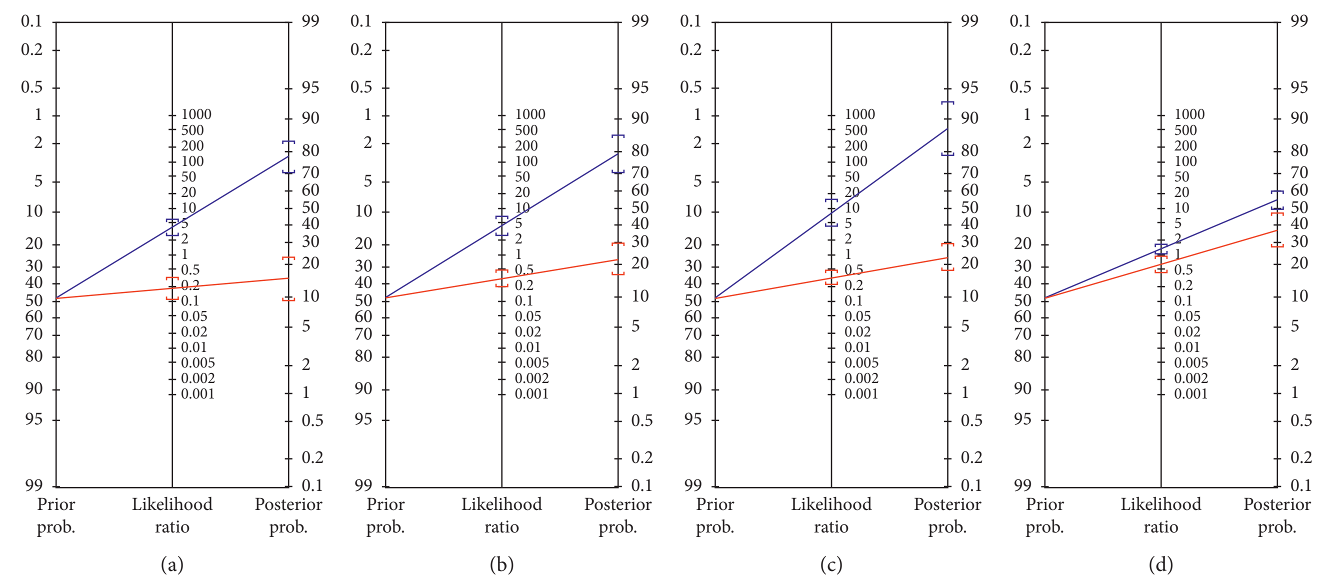


Figure 3: Fagan's nomogram showing the likelihood ratios and posttest (posterior) probabilities for derived AAM cutoff values for 35% of TBFP. (a) Fagan's nomogram for BMI, (b) Fagan's nomogram for WC, (c) Fagan's nomogram for HC, (d) Fagan's nomogram for WHR. —— Positive likelihood ratio and —— negative likelihood ratio.

also there is a very high prevalence of diabetes and cardiovascular diseases such as metabolic syndrome and hypertension especially among the women [24, 25].

This analysis was based on a sample of women selected from one study area in the southern province, Sri Lanka. This may affect the external validity of data and generalizability of results. We, however, selected these women in a random manner to represent the population living there, applied strict inclusion and exclusion criteria to increase the internal validity of data, and measured the TBFP with the gold standard DXA technology. Also, both pre- and postmenopausal women with considerable sample size were used. Because of the lack of data in the field and the above strategies we followed to maintain the quality, our data would provide a platform for future research in this increasingly important area of health sciences. More future studies are recommended to confirm these cutoff values before clinical use in the Sri Lankan context or elsewhere if they are being planned to be used among the other Asian countries. Furthermore, it is important to define the cutoff values for these measures for clustering of cardiovascular disease risk in the future steps.

Table 5: Prevalence of obesity determined based on the WHO defined cutoff values for Asians and newly defined cutoff values derived from 33% to 35% TBFP for Sri Lankan middle-aged women.

AAM	Prevalence based on WHO defined cutoff values for Asians frequency (%)	Prevalence based on newly defined cutoff values for 33% TBFP of Sri Lankan women frequency (%)	Comparison of prevalence between WHO defined cutoff values and newly defined cutoff values for 33% TBFP of Sri Lankan women p value*	Prevalence based on newly defined cutoff values for 35% TBFP of Sri Lankan women frequency (%)	Comparison of prevalence between WHO defined cutoff values and newly defined cutoff values for 35% TBFP of Sri Lankan women p value**
BMI	83 (47.4)	98 (56.0)	<0.001	83 (47.4)	1.00
WC	106 (60.6)	106 (60.6)	1.00	72 (41.1)	<0.001
WHR	140 (80.0)	106 (60.6)	<0.001	106 (60.6)	<0.001

AAM = anthropometric adiposity measure, BMI = body mass index, WC = waist circumference, WHR = waist-to-hip ratio, WHO = World Health Organization, and TBFP = total body fat percentage. p value* derived from Chi-square test of independence comparing the prevalence between WHO defined cutoff values and newly defined cutoff values for 33% TBFP of Sri Lankan women. p value** derived from Chi-square test of independence comparing the prevalence between WHO defined cutoff values and newly defined cutoff values for 35% TBFP of Sri Lankan women.

5. Conclusions

The observed cutoff values of BMI and WC in this study were within the ranges of those described by the WHO for Asian populations which correspond to the 33% and 35% TBFP levels, respectively. However, the WHR cutoff values which correspond to both 33% and 35% TBFP levels were greater compared to the WHO (Asians) values. The accuracy of the BMI, WC, and HC cutoff values derived from both 33% and 35% TBFP levels was high while it was lower in WHR cutoff values compared to others. Though both 33% and 35% TBFP derived cutoff values are applicable to the Sri Lankan context. Cutoff values of AAMs derived from 33% TBFP level would be more appropriate for diagnosing the obesity status considering the greater risk of morbidity associated with Sri Lankan females. However, more studies are needed to confirm these values before clinical use.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Disclosure

This manuscript was derived from the corresponding author's Ph.D. study at the University of Ruhuna, Sri Lanka.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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