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# ESTIMATION OF OPTIMAL OBESITY CUT-OFFS AMONG TRIPURI AND HALAM WOMEN OF TRIPURA, NORTHEAST INDIA

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## ABSTRACT

Obesity is one of the risk assessments for various non-communicable diseases (NCDs), while anthropometric measurements are one of the measures of obesity, which has been demonstrated as a time-tested important technique for risk assessment of NCDs. Due to variation of anthropometric measurements, it seems difficult to classify obesity using world cut-offs in different population groups.

The objective of the present study is to discern the population-specific obesity cut-offs and the best obesity predictor among two indigenous ethnic groups (Tripuri and Halam women) of Tripura, North East India.

The subjects of the present study were 88 Tripuri and 98 Halam adult women whose anthropometric measurements were obtained by using standard techniques. The area under curve (AUC) and Youden index (YI) were used to evaluate the performance of each anthropometric adiposity indicator as well as optimal obesity cut-offs.

The age and waist-hip ratio (WHR) was significantly higher ($p < 0.05$) in Tripuris compared to Halams. However, no significant ($p > 0.05$) differences were observed in obesity categorized by body mass index (BMI) using the WHO 2004 cut-off between the populations. Waist stature ratio (WSR) (AUC = 0.959) and waist circumference (WC) (AUC = 0.804) were better obesity predictors for Halams and Tripuris respectively. The present study envisaged the optimal cut-off points, which were 84.95 cm for WC, 96.45 cm for hip circumference (HC), 29.95% for the percentage of body fat (PBF), 0.89 for WHR, 0.57 for WSR and 1.27 for conicity index (CI) in Halams, while for the Tripuris, the optimal cut-off points were 89.6 cm for WC, 97.5 cm for HC, 33.1% for PBF, 0.95 for WHR, 0.55 for WSR and 1.02 for CI.

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In conclusion, the present study indicated the optimal anthropometric cut-offs which could be the redefined the parameters for assessment of obesity in Halam and Tripuri women.

***Keywords****: obesity; cut-offs; ROC; Youden Index; Tripuri; Halam; Northeast India.*

## INTRODUCTION

Obesity is a metabolic disorder characterized by excess body fat mass accumulation [1, 2]. The prevalence of obesity has increased in both developed and developing countries due to modernization, urbanization, and an economic shift in lifestyle [3]. Throughout the world, 600 million adults are obese [4], which is causing certain chronic and non-communicable diseases (NCDs) like diabetes and cardiovascular disease [2, 5]. Anthropometric measurements are one of the measures for obesity and has proved to be an important technique for risk assessment of NCDs. Body mass index (BMI) has widely been used all over the world for assessment of general obesity. Subsequently, waist circumference (WC), waist hip ratio (WHR), waist stature ratio (WSR) and percentage of body fat (PBF) have also been used as better predictors of obesity than BMI for evaluation of the risk of metabolic syndromes [1, 6, 7]. The majority of studies have used world cut-offs for assessment of obesity and its related effects on NCDs [8]. Obesity assessment has been misclassified in several populations because of using worldwide cut-offs [9, 10], which is misleading in risk assessment for NCDs [10]. India is a land of heterogenous populations with enormous genetic, cultural, and linguistic diversity [11]. Therefore, the diversity of populations is expressed through their phenotypic character like fat patterning [12]. Therefore, worldwide/generalized cut-offs might not be suitable for classifying obesity appropriately in such diversified populations. For that reason, determination of population-specific cut-offs might be helpful for better understanding of the obesity pattern and its related consequences. On this background, the objective of the present study was to discern the population-specific obesity cut-offs and best obesity predictor among Tripuri and Halam women of Tripura, North East India.

## MATERIALS AND METHODS

The subjects of the present study were adult female participants from among Halams (98) and Tripuris (88) of West Tripura, Northeast India. There are 19 indigenous populations in Tripura in the North-East region of India. The indigenous populations of Tripura are usually divided into two major groups – aborigines and immigrants. Both populations considered in the present study belong among the aborigines [13]. Halams belong to Kuki-chin tribes and linguistically within the Tibeto-Burman linguistic family. Halams are divided into several subclans like Koloi, Korbong, Kaipeng, Bong, Sakachep, Thangachep, Dab or Nabin, Bongcher, Molsom, Rupini, Rangkhowl, Chorai, Lankai, Kaireng (Darlong), Ranglong, Marchafang and Saihmar. Tripuris are the largest tribal community in Tripura. Tripuris are of Indo-Mongoloid origin and linguistically belong to the Tibeto-Burman linguistic family. They use the Kok-Borok dialect for speaking [13]. Informed consent was obtained from each participant prior to the study. Measurements like height (HT), weight (WT), hip circumference (HC), waist circumference (WC) were taken from each participant using the standard anthropometric protocol [14].

BMI [WT (kg) / HT ($m^2$)], WHR [WC (cm) / HC (cm)], WSR [WC (cm) / HT(cm)] and CI (conicity index) [WC (m) / $[(0.109) \times \sqrt{\{WT(kg)/HT\ (m)\}}]$ were calculated using the standard formulae [15, 16, 17, 18]. The percentage of body fat (PBF) was assessed by a Rossmax fat monitor with a scale (model WF260) following the instruction manual. The participants were categorized as of normal weight (BMI>18.5–22.9 kg/$m^2$), overweight (BMI ≥ 23–27.5 kg/$m^2$) and obese (BMI ≥ 27.6 kg/$m^2$) as per Asian cut-offs [19].

Apart from descriptive statistics (mean ± SD) and inferential statistics to compare the mean values of continuous variables, the Mann-Whitney test was performed. For inter-group comparisons of categorical variables, chi-square tests were performed. Receiver-operating characteristic (ROC) curve analysis and the area under the curve (AUC) were used to identify the optimal anthropometric obesity cut-off values (Figure 1). Cut-offs were determined using the highest value of the Youden Index. The data were analysed by the Statistical Package for Social Science (SPSS, Inc., Chicago, IL; version, 16.00). The cut-off was set as $p = 0.05$.

## RESULTS

Age and WHR were significantly higher ($p < 0.05$) in Tripuris compared to Halams (Table 1). However, no significant ($p > 0.05$) differences in obesity were

observed between the Tripuris and the Halams when categorized by BMI using the WHO 2004 cut-off (Table 2).

AUC was used to evaluate the performance of each anthropometric obesity indicator for screening of obesity (Table 3 and Figure 1). WSR (AUC = 0.959) and WC (AUC= 0.926) exhibited the largest AUC in Halams. HC (AUC = 0.850) and WC (AUC = 0.804) demonstrated the largest AUC in Tripuris. Significantly ($p < 0.05$) higher AUC was found for WC, HC, PBF, WHR, WSR and CI in Halams. On the other hand, significantly ($p < 0.05$) higher AUC was found for WC, HC, PBF and WSR in Tripuris. Furthermore, population-specific optimal cut-offs for obesity were identified through the Youden Index and are presented in Table 4. Eventually, the optimal cut-off points were found to be 84.95 cm for WC, 96.45 cm for HC, 29.95% for PBF, 0.89 for WHR, 0.57 for WSR and 1.27 for the conicity index in Halams. However, in case of Tripuris, the optimal cut-off points were revealed as 89.6 cm for WC, 97.5 cm for HC, 33.1% for PBF, 0.95 for WHR, 0.55 for WSR and 1.02 for the conicity index.

**Table 1.** Characteristics of the studied population

| VARIABLES | HALAM Mean (SD) (n=98) | TRIPURI Mean (SD) (n=88) | *p* |
|---|---|---|---|
| ***AGE (years)*** | 44.89 (17.40) | 39.32 (14.74) | **< 0.05** |
| ***HEIGHT (cm)*** | 154.09 (7.32) | 156.21 (8.83) | > 0.05 |
| ***WEIGHT (kg)*** | 54.27 (8.89) | 56.48 (12.93) | > 0.05 |
| ***WC (cm)*** | 79.38 (10.21) | 81.24 (9.19) | > 0.05 |
| ***HC (cm)*** | 91.26 (6.45) | 91.41 (8.13) | > 0.05 |
| ***PBF (%)*** | 24.83(13.86) | 26.07 (7.25) | > 0.05 |
| ***WHR*** | 0.86 (0.07) | 0.89 (0.08) | **< 0.05** |
| ***WSR*** | 0.51 (0.07) | 0.52 (0.05) | > 0.05 |
| ***BMI (kg/m$^2$)*** | 22.85 (3.45) | 22.98 (3.97) | > 0.05 |
| ***CONICITY INDEX*** | 1.22 (0.10) | 1.24 (0.14) | > 0.05 |

**Mann-Whitney test, $p < 0.05$*

**Table 2.** Classification of studied participants by BMI categories (WHO, 2004)

| | HALAM (n = 98) | TRIPURI (n = 88) | *p* |
|---|---|---|---|
| ***NORMAL*** | 56 (57.14) | 46 (52.27) | >0.05 |
| ***OVERWEIGHT*** | 31 (31.63) | 29 (32.95) | |
| ***OBESE*** | 10 (10.20) | 12 (13.63) | |

*Figures in parenthesis indicate percentage.*

**Table 3.** ROC (receiver operating characteristics) curve for anthropometric obesity indicators using the BMI classification by WHO, 2004.

| | Area under the ROC curve (95% CI) | | Area under the ROC curve (95% CI) | |
|---|---|---|---|---|
| **VARIABLES** | **HALAM (n = 98)** | ***p*** | **TRIPURI (n = 88)** | ***p*** |
| ***WC (cm)*** | 0.926 (0.872–0.981) * | < 0.05 | 0.804 (0.638–0.971) * | < 0.05 |
| ***HC (cm)*** | 0.847 (0.732–0.962) * | < 0.05 | 0.850 (0.691–1.009) * | < 0.05 |
| ***PBF (%)*** | 0.771 (0.596–0.946) * | < 0.05 | 0.707 (0.546–0.868) * | < 0.05 |
| ***WHR*** | 0.855 (0.742–0.968) * | < 0.05 | 0.561 (0.386–0.736) | > 0.05 |
| ***WSR*** | 0.959 (0.920–0.997) * | < 0.05 | 0.739 (0.551–0.927) * | < 0.05 |
| ***Conicity index*** | 0.741 (0.592–0.891)* | < 0.05 | 0.393 (0.215–0.572) | > 0.05 |

*p-values for rejecting the null of AUC = 0.05*

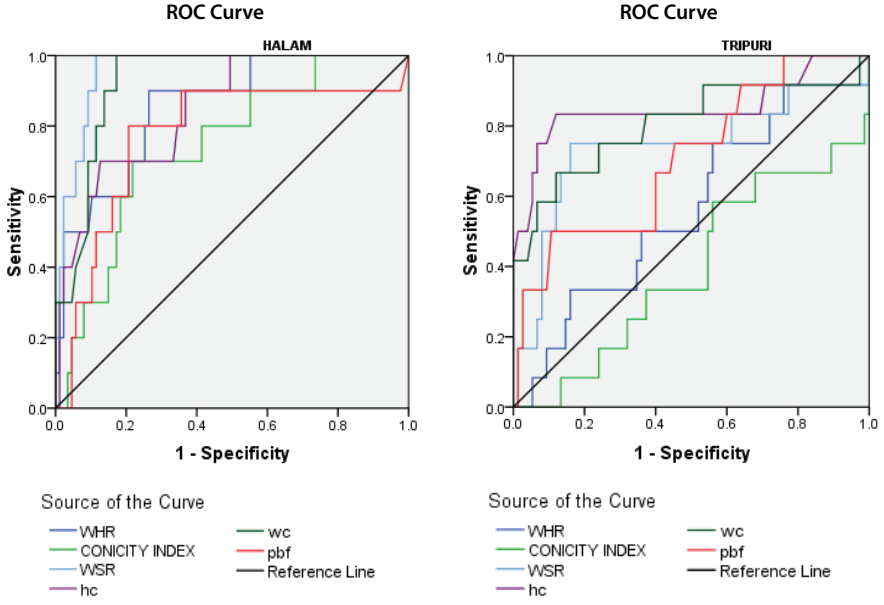


**Figure 1.** ROC curve of anthropometric variables pertaining to obesity in Halam and Tripuri women.

**Table 4.** Optimal cut off points for the studied population.

| | HALAM (n = 98) | | | | TRIPURI (n = 88) | | | |
|---|---|---|---|---|---|---|---|---|
| **VARIABLES** | **Cut- off point** | **Sensitivity** | **Specificity** | **Youden index** | **Cut- off point** | **Sensitivity** | **Specificity** | **Youden index** |
| ***WC (cm)*** | 84.95 | 1.00 | 0.83 | 0.83 | 89.6 | 0.66 | 0.88 | 0.54 |
| ***HC (cm)*** | 96.45 | 0.70 | 0.87 | 0.57 | 97.5 | 0.83 | 0.88 | 0.71 |
| ***PBF (%)*** | 29.95 | 0.80 | 0.79 | 0.59 | 33.1 | 0.50 | 0.89 | 0.39 |
| ***WHR*** | 0.89 | 0.90 | 0.73 | 0.63 | 0.95 | 0.33 | 0.84 | 0.17 |
| ***WSR*** | 0.57 | 1.00 | 0.88 | 0.88 | 0.55 | 0.75 | 0.82 | 0.57 |
| ***Conicity index*** | 1.28 | 0.70 | 0.77 | 0.47 | 1.02 | 0.75 | 0.01 | 0.24 |

## DISCUSSION

Composition and distribution of body fat is important for understanding the adverse health outcomes [20] in different ethnic groups [21, 22]. The present study identified obesity among Tripuri and Halam females by using ROC generated optimal cut-offs [23]. WSR (cut-off 0.57) and HC (cut-off 0.85) were identified as better obesity predictors for Halams and Tripuris respectively. These findings partially agreed with earlier studies among Ethiopians [24] and Javanese [25] where WC and WSR were used as strong predictors of obesity. Ethiopians and Indians have comparatively higher body fat percentages in respect of lower or the same level of BMI than Caucasians [24]. Moreover, the identified optimal cut-off points for WC, WSR and WHR among the Tripuri and the Halam populations were comparatively higher than Asian Indian [26], Joint Scientific Statement (JIS) [27], Javanese [25] and Ethiopian [24] cut-off values. On the other hand, higher WC cut-off value compared to Halams and Tripuris was found in Brazilian women [28]. The inconsistency of cut-off values has been obtained in different populations primarily due to variability of regional fat distribution [24, 26].

Group differences in obesity cut-offs were also observed between the Tripuri and the Halam populations. The cut-off points for obesity parameters (except WSR and CI) were comparatively higher in Tripuri than Halams due to differential body fat distribution. Examination of patterns of fat distribution revealed greater amount of fat deposition in the truncal/central region of Tripuris compared to that of Halams irrespective of BMI and PBF, and that might lead to higher cut-off points for Tripuris.

Discrepancy of results was found in terms of optimal obesity cut-offs and strong obesity predictors, which requires population- or ethnic-specific cut-offs. Therefore, the optimal anthropometric cut-offs envisaged in the present study may redefine the parameters for assessment of obesity in Halam and Tripuri women.

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