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Measurement of Erect and Supine Waist Circumference among Healthy Adults

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ABSTRACT

Background: Erect waist circumference is a key marker of obesity. However, it is not possible to measure erect waist circumference in all patients. This study aims to formulate an equation to calculate erect waist circumference from supine waist circumference for both males and females in our population.

Methods: Thirty female and thirty male volunteers were recruited. Erect and supine waist circumference measurements were taken as per WHO STEPS protocol. The measurements were made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest at the end of a normal expiration.

Results: Erect waist circumference was found to be greater than supine waist circumference with the mean difference in overall participants being 2.6 $\pm$ 1.4 cm. The difference between erect and supine waist circumference was significantly higher in females (Mean difference 3.1 $\pm$ 1.6 cm) than in males (Mean difference 2.2 $\pm$ 0.9 cm). A simple correction formula was derived as corrected erect waist circumference = -2.757 + 0.9 x Gender + 1.048 x Supine waist circumference.

Conclusion: This formula which has been derived can be used in situations where only supine waist circumference measurement is possible.

Keywords: obesity, abdominal; waist circumferences; sex; posture.

INTRODUCTION

Obesity is a risk factor for atherosclerosis and is associated with different atherosclerotic cardiovascular diseases including myocardial infarction and stroke.[1] One of the key markers of obesity is waist circumference which is one of the simplest methods to study a person's cardio -metabolic risk.[2] As a standard, waist circumference is measured when standing erect.[3] In some conditions when a patient cannot stand erect, it is possible to measure waist circumference only in the supine position, like in the case of stroke, disability, and severely morbid patients. A mathematical relation between supine and erect waist circumference would help to derive erect circumference in studies when only a supine measurement is available. A study was done in the western population comparing standing and supine waist circumference to derive a conversion formula from supine to erect waist circumference. The study showed that, among different variables studied, only gender had a significant value in estimating erect waist circumference from supine waist circumference.[4] However, on searching available literatures, no similar study among the Asian population was found. The objective of this study was to formulate an equation to calculate erect waist circumference from supine waist circumference for both males and females in our population.

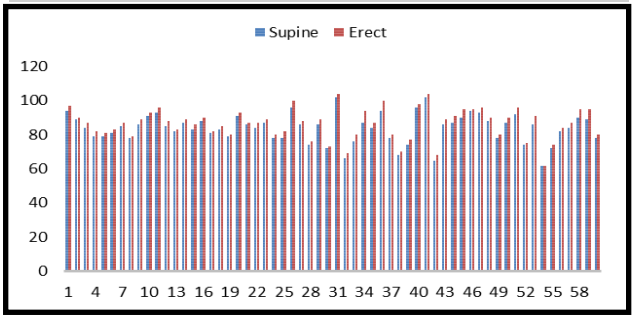
METHODS

An analytical cross-sectional study was conducted at the Department of Neurology, Tribhuvan University, Teaching Hospital, Kathmandu from March to May 2023. Healthy volunteers of both genders were recruited from among the visitors of the admitted patients. After obtaining a consent, 60 volunteers were recruited, 30 of each gender. Waist circumference of those volunteers was recorded in both supine and erect position as per WHO STEPS protocol.[3] The measurement was made at approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest at the end of a normal expiration in both the positions. An inelastic tape was used and kept snugly in the skin without constricting it. Supine measurement was taken lying down in a firm bed with no pillows and legs straight with arms by the side. Erect measurement was taken when standing with feet positioned close together, with arms by the side of the body and weight evenly distributed across the feet. As, recommended by WHO STEPS protocol, the participants were advised to relax and take a few deep, natural breaths before the actual measurement was made. Two repeated measures were taken. The average was calculated if the measurements were within 1 cm of one another. If the difference between the measurement exceeds 1 cm, the set of both the measurements was repeated. Single examiner carried out all the measurements to avoid inter-observer variability. The data was then tabulated and analyzed using SPSS version 18.0. Continuous data on the waist circumference was expressed as mean and standard deviation. Paired sample t-test was used to compare if the supine and erect waist circumference were different. Independent sample t-test was used to compare the mean difference between the erect and supine waist circumference between males and females. A multiple regression analysis was used to model the relation between the different waist circumference measurements and gender, once the individual analysis showed a significant relation association between them.

RESULTS

There were 60 people participating in this study of which 30 (50%) were female. The mean age of the participants was 42 ±11.2 years. Comparing the erect and supine waist circumference of individual participants showed that the erect waist circumference is always greater than supine waist circumference, as shown in (Figure 1).

Figure 1. Erect and Supine waist circumference of individual participants.



The distribution of the supine and erect waist circumference is as shown in figure 2 and 3 respectively. The mean supine waist circumference was 83.8 ± 8.4 cm whereas the mean erect waist circumference was 86.5 ± 8.9 cm. The distribution of the difference between erect and supine waist circumference is as shown in Figure 4. The mean difference between supine and erect measurement was 2.6 ± 1.4 cm and was statistically significant. ($p < 0.001$; Paired sample t-test).

Figure 2. Distribution of Supine waist circumference.

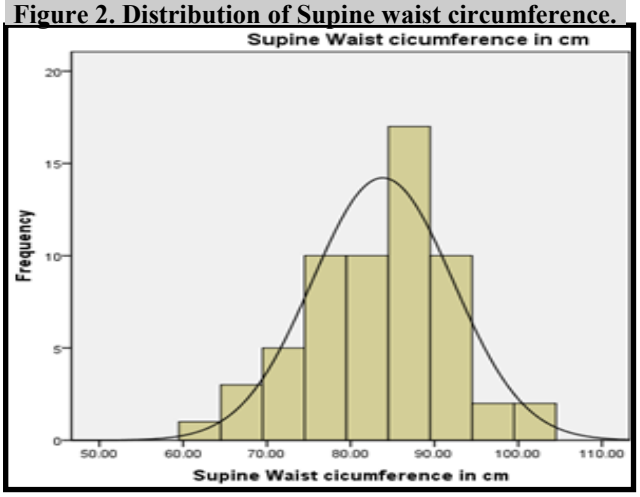


Figure 3. Distribution of Erect waist circumference

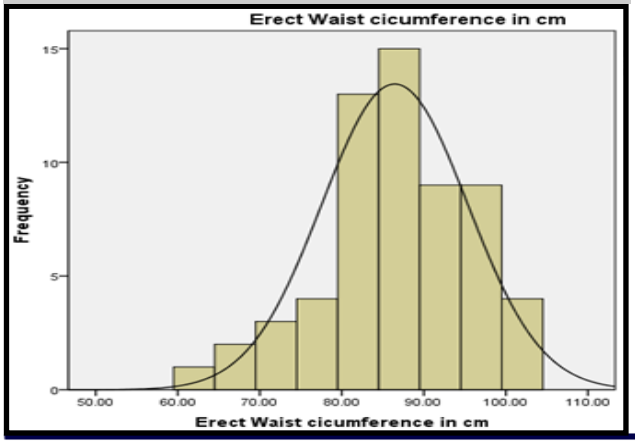
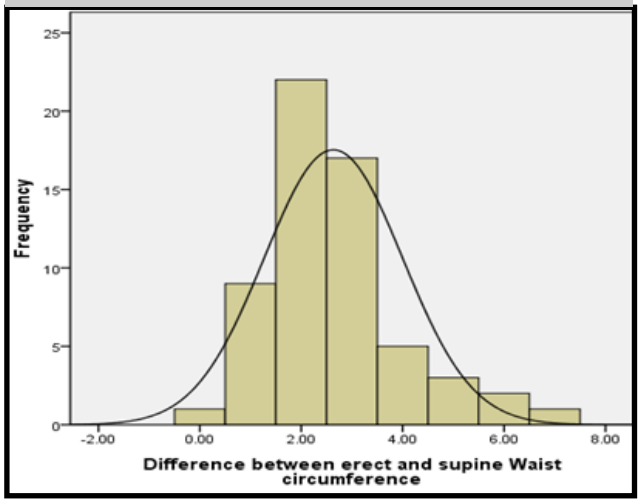
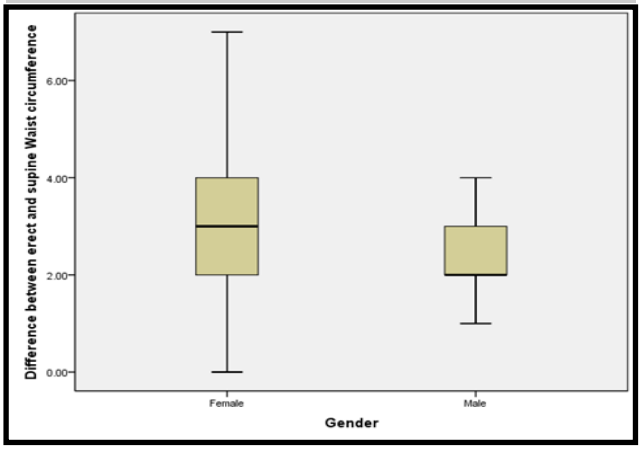


Figure 4. Distribution of difference between erect and supine waist circumference.



The mean supine waist circumference in male and female was 84.2 ± 5.7 and 83.5 ± 10.5 cm respectively. Similarly, the mean erect waist circumference in male and female was 86.4 ± 6.1 cm and 86.5 ± 11.1 cm respectively. The mean difference between erect and supine waist circumference was higher in female (Mean difference 3.1 ± 1.6 cm) than in males (Mean difference 2.2 ± 0.9 cm) and was statistically significant (p= 0.013, independent sample t test) (Figure 5).

Figure 5. Difference between erect and supine waist circumference in Males and Females.



A multiple regression model showed that erect waist circumference could be predicted by supine waist circumference with the simple correction formula: Corrected erect waist circumference = -2.757 + 0.9 x Gender + 1.048 x Supine waist circumference (Where gender = 1 for male and 2 for female)

Table 1. Multiple regression analysis of erect waist circumference using supine waist circumference and gender as predictors.

Model	Beta	p-Value	R^2
Supine waist circumference	0.991	<0.001	0.981 (p <0.001)
Gender	0.051	0.007	

DISCUSSION

The present study showed that erect waist circumference is greater than supine waist circumference in all the participants. This increment in circumference when erect is primarily due to the effect of gravity on the abdominal fat and contents.[5] The mean difference between erect and supine waist circumference in our study was 2.5 cm which is more than the mean difference of 1.5 cm seen in the study done the Netherlands. Although we didn't record the BMI of our participants, the mean BMI of the participants in the Dutch study was 24 in female and 25 in males. Asians have higher fat content for the same BMI as compared to Westerns.[6] This is the reason why Asian people have lower cut-off of BMI for diagnosis of obesity as compared to the westerns.[7] Owing to this extra fat content, our population probably had a greater difference between erect and supine waist circumference as compared to westerns. Similarly, our study showed that female had greater difference between erect and supine waist circumference than males. For the same BMI, it has been shown that females typically have around 10% more body fat as compared to males.[8] Thus, waist circumference measurement in female are expected to have greater variation in respect to the posture. Out of gender, age, BMI and past pregnancy as potential determinants of the difference between erect and supine waist circumference, only gender was found to be significant in the multiple regression analysis done by A. Waginge and researchers in their study. The formula they formulated was: corrected standing waist circumference = 1.017 - 1.961 x gender + 1.016 x supine waist circumference which is a quite different from ours.[4] This reflects the variability of fat content in different groups of population. The limitations of our study is that a relatively small sample size was used, and other potential variables like time of last meal and parity was not taken into account.

CONCLUSION

This formula which has been derived can be used in situations where only supine waist circumference measurement is possible to calculate erect waist circumference.

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