Asif *et al.* *Kesmas: Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. 2020; 15 (3): 106-112
DOI: 10.21109/kesmas.v15i3.3218

Evaluation of Anthropometric Parameters of Central Obesity among Professional Drivers: A Receiver Operating Characteristic Analysis

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Abstract

Different anthropometric parameters have been proposed for assessing central obesity. The diagnostic performance of these anthropometric parameters and their ability to correctly measure central obesity for the professional community, like drivers, is questionable and needs to be assessed. The study aimed to examine the diagnostic performance of anthropometric parameters as indicators of central obesity in drivers as measured by waist circumference (WC) and to determine the best cut-off values for these parameters that would identify obese drivers. Anthropometric measurements from a cross-sectional sample of 197 professional drivers were taken under standard protocol. Receiver operating characteristics (ROC) analysis was used to examine the diagnostic performance and to determine the optimal cut-off point of each anthropometric parameter to identify centrally obese drivers. It was found that WC had a significant positive correlation with all other obesity indicators. The ROC curve analysis indicated that all the parameters analyzed had a good performance, but the waist-to-height ratio (WHtR) had a more predictive value of the area under the curve. Optimal cut-offs to identify central obesity in drivers were 0.55, 2.06, 0.95, and 25.44 for WHtR, conicity index, waist-to-hip ratio, and body mass index, respectively. These cut-off points for different indicators can be used to detect central obesity for drivers.

Keywords: anthropometric parameters, central obesity, professional drivers, receiver operating characteristic curve, waist-to-height ratio

Introduction

Obesity, general and abdominal, is an intricate public health issue, and its prevalence has increased at a worrying level in different populations. Therefore, it has now become a global epidemic. In 2008, an estimated 1.5 billion adults across the globe were considered to be overweight or obese.[1] The numbers have doubled from 20 years ago.[2]

Obesity among transit workers particularly drivers is becoming an equal challenge now a day. Drivers are usually at a high risk of developing obesity because they have some unique occupational characteristics. These characteristics include long working hours, low-intensity physical activity as a consequence of a long time sitting time on the driving seat, irregular working shift, and exposure to stress. These have all been reported among these professionals and are the major contributors to health risk factors. Moreover, drivers usually take their lunch and dinner in restaurants that mostly carry high calories and low nutrition foods. Such an inadequate diet and sedentary behavior also trap these professionals to obesity and its consequences.[3]

Anthropometry is considered as a simple, quick, inexpensive, and internationally acceptable method that has been used in the preliminary diagnosis of overall body fat and abdominal (central) obesity. Some studies,[3-5] in recent decades expressed obesity (general or abdominal) in drivers by using different indicators like body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR). Abdominal (central) obesity is more important and sensitive than general obesity as it showed a strong association with risk for coronary heart disease and many other metabolic complications.[6,7]

In recent years, waist-to-height ratio (WHtR) and conicity index (CI) are some other increasingly used indicators that reflect the distribution of adiposity in the body's central region and related metabolic risks in children and adults.[8,9] Other studies,[10-13] of the drivers' community also used these different anthropometric indices and concluded that various adverse health outcomes such as hypertension, cardiovascular diseases, and stroke are all associated with excess weight. However,

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Received : July 25, 2019
Accepted : February 04, 2020
Published : August 28, 2020

studies that analyzed the efficacy of these anthropometric parameters (BMI, WHR, WHtR, and CI) to identify central obesity in drivers are scarce. Considering such negotiable gap, this study was carried out with the following objectives: (1) to examine the diagnostic performance of anthropometric parameters as indicators of central obesity in drivers as measured by WC and (2) to determine the best cut-off values for these parameters that would identify obese drivers.

Method

The present cross-sectional study was carried out between February 2014 and April 2014 in Multan City, located in the central region of Pakistan's map. Multan City has directly connected with other major industrial cities (e.g., Karachi, Lahore, Faisalabad, Rawalpindi, and Islamabad) by several means of transportation. Because of their proximity to each other, most of the drivers (loader vehicle and public transport vehicle) usually drove their vehicles on Multan road. This study collected a representative sample of 197 professional drivers (aged 18–68 years) from different transport stands existing in Multan. As this study was part of the study by Aslam, *et al.*,[3] complete sampling schemes and data collection details can thus be found in the said research. All the healthy drivers, who are driving a vehicle as a profession and not having any physical disability, were included in the study. All the drivers who did not meet these criteria were excluded. Before data collection, informed oral consent was also taken from each participant. The study was approved by the departmental ethics committee of Bahauddin Zakariya University, Multan, Pakistan.

The data were collected using a self-administered questionnaire. The data about sociodemographic and profession-related variables, that is, age (years), marital status, educational level, the vehicle type to drive, daily driving hours, and driving period (years) adapted to this profession were recorded after their interview. The anthropometric measurements such as height (cm), weight (kg), waist circumference (WC, cm), and hip circumference (HC, cm) were taken from each participant. Using the participants' height and weight, BMI was computed by dividing weight in kilograms (kg) by height in meters squared (m^2). The WC was measured midway between the lowest rib and the superior border of the iliac crest at the end of normal expiration and HC at the level of the widest portion of the buttocks. All these measurements were taken using a nonelastic plastic tape and recorded to the nearest 0.1 cm. Both WHR and WHtR were obtained by dividing WC by HC and dividing WC by height, respectively. Meanwhile, CI was obtained by using the Valdez mathematical equation.[9] During these measurements, the participant was in a standing position and asked to look straight ahead with shoulders in normal alignment.

In the present study, WC was used as a simple tool to detect abdominal (central) obesity in the drivers. A participant was considered centrally obese if his WC was ≥ 90 cm.[14] For the descriptive analysis, mean and standard deviation (SD) were computed for each quantitative variable. Two-sample independent t-test was used to compare means of different anthropometric indices for drivers according to their type of vehicle and Pearson's correlation to investigate the correlation between WC and other anthropometric indices. To find the optimal cut-off points and to examine the diagnostic performance of each anthropometric parameter as indicators of central obesity, this study used the receiver operating characteristics (ROC) curve analysis. The optimal cut-off point of each parameter was defined as a value that represented the maximum sum of sensitivity and specificity.[15] An anthropometric parameter value with the highest Youden's index was chosen as the cut-off point. The diagnostic test, areas under the curve (AUC), and 95% confidence intervals were determined. Swets,[16] proposed a set of guidelines to interpret the values of AUC. Accordingly, if an AUC was between 0.90 to 1.00 and 0.70 to 0.90, the test was considered "highly accurate" and "moderately accurate," respectively.

The "software", Free Version of Statistical Package for Social Sciences version 21.0, was used for all the statistical analyses, and a p-value of < 0.05 was considered statistically significant in our analysis.

Results

A total of 197 professional drivers (121 passenger vehicle drivers and 76 loader vehicle drivers) were included in the present study. Most of the drivers (n = 184, 93.4%) were married, and about half (n = 96, 48.7%) were found to be illiterate. The mean (±SD) daily driving hours and driving period (years) adapted to this profession were 9.10 (±3.45) hours and 14.59 (±9.41) years, respectively. The passenger vehicle drivers spent more time driving daily as compared with the loader vehicle drivers (e.g., passenger vs. loader: 9.34 ± 3.64 vs. 8.72 ± 3.12 hour, respectively). The central obesity (e.g., WC ≥ 90 cm) prevalence in all the drivers was 61.9%. The drivers of passenger vehicles (75.2%) were more prone to obesity than that of loader vehicles (40.2%).

The mean (±SD) age, BMI, WC, WHR, WHtR, and CI of all the participants were 36.53 (±10.47) years, 25.48 (±4.21) kg/m^2, 93.48 (±11.01) cm, 0.96 (±0.06), 0.56 (±0.07), and 2.10 (±0.21), respectively. The mean comparison of BMI, WC, WHR, WHtR, and CI for the participants corresponding to the types of vehicles are displayed in Table 1. Among the variables analyzed, the mean of all anthropometric parameters (e.g., BMI, WC, WHR, WHtR, and CI) for the drivers of passenger vehi-

Table 1. Mean Comparison for Age and Anthropometric Characteristics of the Study Subjects by Vehicle Type

Characteristic	Driver's Vehicle Type		p-value
	Passenger Vehicles (n = 121)	Loader Vehicles (n = 76)	
Body mass index (kg/m^2)	26.06 ± 3.62	24.57 ± 4.90	< 0.05
Waist circumference (cm)	96.69 ± 10.50	88.38 ± 19.86	< 0.05
Waist-to-hip ratio	0.97 ± 0.06	0.95 ± 0.05	< 0.05
Waist-to-height ratio	0.58 ± 0.06	0.53 ± 0.06	< 0.05
Conicity index*	2.14 ± 0.16	2.04 ± 0.26	< 0.05

Notes: *Calculated as waist circumference in meters/(0.109 × square root of weight in kilogram/height in meter). Values expressed as mean ± standard deviation.

Table 2. Correlation Coefficient between Waist Circumference and All the Other Anthropometric Parameters

	Anthropometric Parameter			
Central obesity and waist circumference	WHtR	WHR	CI	BMI
	0.94*	0.70*	0.64*	0.59*

Notes: *Significant values p-value < 0.001.
BMI: Body Mass Index; WHtR: Waist-to-height Ratio; WHR: Waist-to-hip Ratio; CI: Conicity Index.

cles were significantly (p-value < 0.05) higher than those for drivers of loader vehicles.

All the proxy measures of central obesity were positively correlated (p-value < 0.01) with the WC in all the participants studied. In the study sample, a stronger correlation between WC and WHtR was observed (0.94), indicating that the WHtR was a better independent predictor of central obesity than the other parameters (Table 2).

The ROC curves that accurately define central obesity among all drivers are shown in Figure 1. The probability of detecting central obesity expressed by the AUC is presented in Table 3. The results revealed that the WHtR had a higher probability and considered to be "highly accurate" for identifying central obesity than the other proxy measures among all the drivers. The AUC for WHtR was 0.951 (95% CI: 0.922–0.979). Meanwhile, the CI, WHR, and BMI occupied a lower AUC (e.g., AUC range: 0.80–0.90) among all the drivers, indicating that these measures were "moderately accurate" to produce the correct diagnosis of obesity.

The AUCs of different indices to detect central obesity among drivers with respect to the type of vehicle (e.g., loader and passenger vehicles) were also presented. The results showed that passenger vehicle drivers also occupied a high AUC for WHtR than loader vehicle drivers (passenger vs. loader vehicle drivers: 0.970 vs. 0.914, respectively). On the other hand, the loader vehicle drivers occupied a high AUC for WHR and CI than the passenger vehicle drivers (loader vs. passenger vehicle drivers: 0.894 vs. 0.864 for WHR; 0.868 vs. 0.830 for CI, respectively) (Table 4 and Table 5).

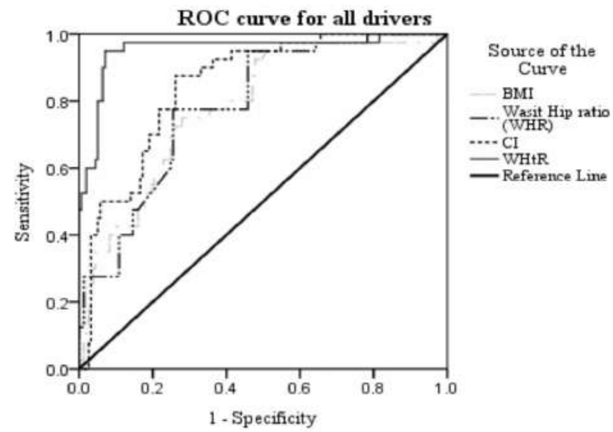

Figure 1. Receiver Operating Characteristic (ROC) Curve of Anthropometric Parameters as Indicators of Central Obesity among all Drivers

Based on the ROC analysis, highly sensitive and specific cut-off points for detecting obesity were presented. The WHtR parameter had more ability to correctly classify the subjects with centrally obesity, with a sensitivity of 88% and specificity of 95%. The suggested cut-off points of WHtR, WHR, CI, and BMI that discriminated drivers with central obesity were 0.55, 0.95, 1.30, and 25.44, respectively. The optimal cut-off points of different obesity indices for the drivers of two types of vehicles were also computed. It was found that the cut-off points for WHtR and CI discriminated both the loader and passenger vehicle drivers with central obesity (e.g., 0.55 and 2.05 for WHtR and CI, respectively). However, there were little differences in the cut-offs for WHR (0.97 and 0.95) and BMI (25.42 and 26.06) for loader and passenger vehicle drivers, respectively.

Discussion

Obesity in transit workers particularly in drivers is considered an escalating health issue in recent decades. Drivers are more prone to develop obesity, especially central obesity, because of the sedentary nature of their profession. Similar to the present study's obesity prevalence (61.9%), studies,[17–19] revealed that around 57% to 87%

Table 3. Comparison of Areas under the Curve for the Detection of Central Obesity Based on Different Anthropometric Parameters to all Drivers (n = 197)

Anthropometric Parameter	AUC (95% CI)	SE	p-value	Cut-off Point	Se	Sp
Waist-to-height ratio	0.951(0.922–0.979)	0.014	<0.001	0.55	0.88	0.95
Waist-to-hip ratio	0.869 ((0.813–0.926)	0.029	<0.001	0.95	0.88	0.81
Conicity index	0.859 (0.799–0.920)	0.031	<0.001	2.06	0.83	0.81
Body mass index	0.804 (0.740–0.868)	0.033	<0.001	25.44	0.80	0.72

Notes: AUC: Areas under the Curve; CI: Confidence Interval; SE: Standard Error; Se: Sensitivity; Sp: Specificity.

Table 4. Comparison of Areas under the Curve for the Detection of Central Obesity Based on Different Anthropometric Parameters to Loader Vehicle Drivers (n = 76)

Anthropometric Parameters	AUC (95% CI)	SE	p-Value	Cut-off Point	Se	Sp
Waist-to-height ratio	0.914 (0.850–0.980)	0.034	<0.001	0.55	0.81	0.93
Waist-to-hip ratio	0.894 (0.820–0.968)	0.038	<0.001	0.97	0.84	0.91
Conicity index	0.868 (0.783–0.954)	0.044	<0.001	2.05	0.84	0.82
Body mass index	0.730 (0.608–0.852)	0.062	<0.001	25.42	0.77	0.67

Notes: AUC: Areas under the Curve; CI: Confidence Interval; SE: Standard Error; Se: Sensitivity; Sp: Specificity.

Table 5. Comparison of Areas under the Curve for the Detection of Central Obesity Based on Different Anthropometric Parameters to Passenger Vehicle Drivers (n = 121)

Anthropometric Parameters	AUC (95% CI)	SE	p-Value	Cut-off Point	Se	Sp
Waist-to-height ratio	0.970 (0.945–0.995)	0.013	<0.001	0.55	0.85	1.00
Waist-to-hip ratio	0.864 (0.771–0.957)	0.047	<0.001	0.95	0.89	0.83
Conicity index	0.830 (0.733–0.927)	0.049	<0.001	2.05	0.85	0.80
Body mass index	0.875 (0.809–0.940)	0.034	<0.001	26.06	0.70	0.93

Notes: AUC: Areas under the Curve; CI: Confidence Interval; SE: Standard Error; Se: Sensitivity; Sp: Specificity.

of truck and bus drivers are overweight and obese worldwide, and obesity-related comorbidities such as hypertension, dyslipidemia, and type 2 diabetes are common among drivers.[17] Therefore, early prevention and treatment of obesity in the drivers' community should be on the top priorities of health practitioners because people employed in the transport sector form a considerable workforce of our nation. Health practitioners and researchers need some accurate diagnostic measures. Researchers often use different practical methods including BMI, WC, WHR, and WHtR to assess obesity or central obesity and their associated metabolic or cardiovascular diseases risks.[3,4,10,11] However, accepted cut-off points for the classification of central obesity in the drivers' community are scarce and need to be computed. So, in the present study, we compare the diagnostic accuracy of WHtR, WHR, CI, and BMI as identifiers of central obesity based on WC and also find the cut-off points of these anthropometric indices.

In our study, the results revealed that passenger vehicle drivers had significantly higher mean values for all the indicators of central obesity than loader vehicle drivers. This finding is supported by several studies,[12,20] indicating that drivers who carry passengers are more prone to obesity, stroke, and other different types of diseases than drivers who handle goods. This difference may also be accounted because loader drivers usually drive slow-moving and highly laden vehicles so they take many stops in their long routes and thus have more breaks from sitting. On the other hand, drivers of passenger vehicles, who spent more time driving daily and sitting on the driving seat, are led into the trap of obesity and its consequences.

Among the obesity indices analyzed, our study results showed that WHtR was strongly correlated with WC. Furthermore, the AUCs using the ROC curve analysis were between 0.80 and 0.95 for all the proxy indices of central obesity. The WHtR showed the largest area (AUC = 0.951; 95% CI: 0.922–0.979), followed by the WHR (AUC = 0.869; 95% CI: 0.813–0.926), CI (AUC = 0.859; 95% CI: 0.799–0.920), and BMI (AUC = 0.804; 95% CI: 0.740–0.868). These results explained that all these indices achieved good performance in diagnosing central obesity, but the AUC for WHtR was superior for all the drivers.

A cohort study by Aekplakorn, *et al.*,[21] in Thailand reported that WHtR was the best predictor than other indices (WHR, WC, and BMI) for predicting coronary artery disease in men. Another recent study of Indian children, accomplished by Bullappa, *et al.*,[22] demonstrated that WHtR was strongly correlated with WC for both genders and showed that WHtR had a robust diagnostic performance for identifying central obesity than other obesity parameters. A study with Chinese adults carried out by Shao, *et al.*,[23] indicated that WHtR might be an optimal anthropometric predictor of obesity and metabolic syndrome. Thus, all of the above-stated findings are consistent with those in our study.

In an earlier study,[24] the standard WHtR level of ≥ 0.50 was used as a tool to determine the risk of central obesity. In this study, the suggested 0.55 cut-off point of WHtR for drivers had the highest sensitivity and specificity to predict central obesity. This value was higher than the standard cut-off point.

Since the 1980s, WHR has been widely used for determining central obesity in adults. Our study shows that the cut-off value (0.95) of WHR in the drivers' community has 88.0% sensitivity and 81.0% specificity to differentiate central obesity. Meanwhile, the World Health Organization's,[25] WHR cut-off value for increased metabolic complication risk is more than 0.90 cm for men, which is lower than our cut-off point in this study.[26]

The CI is considered one of the good indicators of central obesity, but its use is scarce because of the lack of cut-off points.[27] The range of CI values lies between 1.00 (perfect cylinder) and 1.73 (perfect double cone). If the CI value is closer to 1.73, then it indicates a greater accumulation of abdominal fat.[28] In the present study, the CI cut-off value (2.06) was nearer to the perfect double cone, which means that the WC of a driver is 2.06 times larger than the circumference of a cone with the height and weight of that driver.

In the Chinese population,[29] the BMI cut-off value for metabolic syndrome is 24 kg/m^2 among men, and for the French population,[30] the BMI cut-off value as an indicator of metabolic risk factors is 27 kg/m^2. Consistent with these results, our suggested cut-off value for determining subjects with central obesity was 25.44 kg/m^2.

In this study of the drivers' community, the cut-off values for all the obesity indicators were higher than the cut-off points recommended for the general population. Such higher cut-off points are proof of the concept that this community has a higher risk of obesity and its health-related risks. These findings also make it debatable that health practitioners should work on some health-related awareness programs for drivers to control this alarming prevalence.

The major strength of our study is that this is the first study in the literature to determine the most sensitive and most specific cut-off points of central obesity-related indices for professional drivers using a ROC analysis. The data from all the subjects were collected by a trained data collection team that took the complete anthropometric measurements following standard procedure. The obtained results can be used exclusively as a reference to predict central obesity among professional drivers.

The limitation of the stated study was that any information, related to disease history and inherent profession, was not taken into account. This could be addressed in some future work.

Conclusion

Based on the present findings, we conclude that WC, WHtR, WHR, and CI can be used to predict central obesity among drivers. However, the WHtR with a cut-off point of 0.55 has the more predictive power of central obesity compared with the other proxy indices. Cut-off points for all the obesity indicators are higher than those recommended for the general population. Therefore, further studies for this community should be carried out to evaluate the usefulness of WHtR as an index of adiposity.

Abbreviations

WC: Waist Circumference; ROC: Receiver Operating Characteristic; WHtR: Waist-to-Height Ratio; BMI: Body Mass Index; WHR: Waist-to Hip Ratio; CI: Conicity Index; HC: Hip Circumference; SD: Standard Deviation; AUC: Area Under the Curve; 95% CI: 95% Confidence Interval; SE: Standard Error; Se: Sensitivity; Sp: Specificity.

Ethics Approval and Consent to Participate

Informed consent was obtained from all individuals included in this study. The study was approved by the Departmental Ethics Committee of Bahauddin Zakariya University, Multan, Pakistan (IRB# STAT - 293/2017).

Competing Interest

Author declares that there are no significant competing financial, professional, or personal interests that might have affected the performance or presentation of the work described in this manuscript.

Availability of Data and Materials

The datasets used for the current study are available from the corresponding author on reasonable request.

Authors' Contribution

Muhammad Asif, as principal investigator, conceived the idea, designed, analyzed, interpreted the study results, and drafted the manuscript. Muhammad Aslam gave his expert opinion in sampling design and data collection and critically analyzed the data for important intellectual content. Saima Altaf gave her input in the manuscript drafting and submission. Abdul Majid helped in finding the literature review and gave feedback and intellectual input during the study design, and Saima Atif conceived the study and codrafted the manuscript; all authors read and approved the manuscript as submitted.

Acknowledgment

Authors very well acknowledge all our data collection team members

and very thankful to all professional drivers for their continuous co-operation during data collection.
This research received no specific grant from any funding health agency in the public, commercial, or non-profit sectors.

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