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Abdominal height measures cardiometabolic risk better than body mass index: result of a preliminary study

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Abstract

Background: Obesity is associated with substantial cardiovascular morbi-mortality. The long acclaimed standard for assessing it, the BMI does not appropriately identify subjects at risk for CVD across all races. Given the varying habitus of Africans compared with people of Asian and European ancestry, and the fact that BMI does not discriminate the contribution and distribution of fat to overall weight; the need to determine what is more accurate for each group became compelling. **Aims and Objective:** This is an attempt to pilot the use of a new concept, the Abdominometer, in our local population in comparison the age long BMI. **Study Design**: Cross-sectional Descriptive. **Setting:** Community Forum. **Materials and Methods:** A small population of 31 seen during a group cardiovascular health survey with BMI and Abdominal Height data had their blood pressure and glycosylated haemoglobin measured. Ability of BMI and Abdominal height respectively to predict hypertension and diabetes was compared. **Statistics:** We applied sensitivity, specificity, positive and negative predictive values, accuracy as well as false positive and negative rates on data relating to AH, BMI, Blood pressure and Glycosylated haemoglobin. **Results:** For hypertension screening, abdominal height performed better than BMI but not impressively so for diabetes. Regarding detection of hypertension with BMI and abdominal height measurements, true positive was 4/31 and 11/31 respectively with accuracy of 61.3% and 67.9% in same sequence. With detection of diabetes using BMI and abdominal height, true positive was 2/31 and 4/31 respectively with accuracy of 29% and 41.9% in same sequence. **Conclusion:** For our environment, abdominal height cut-off of 25 cm is better to screen for initiation of preventive and curative action for obesity than BMI and should be more widely used for validation and acceptance.

Keywords: Obesity, Body Mass Index, Abdominal Height, Hypertension, Diabetes, Prediction.

INTRODUCTION

Obesity as a disease contributes substantially to cardiovascular morbidity and premature death [1]. Obesity is common-place in the United States of America (USA) [2], as well as among some sub-Saharan native groups [3]. The danger of obesity arises largely from its cardiometabolic consequences [4]; as it is known to contribute significantly to hypertension and type 2 diabetes mellitus among others [5]. These are two components of the metabolic syndrome also linked to cardiovascular disease (CVD) [6]. The body mass index (BMI) is the standard measure of overweight and obesity [7], which has recently been found to miss subjects whose cardiometabolic risk factors are related to increased adiposity [8]. Africans are among those in whom the current BMI definition of obesity may not be appropriate [9].

We had in a pilot study made a case for the utility of the abdominal height (AH) determined by a new tool – the abdominometer, as a useful cardiovascular anthropometric index in an African cohort [10]. We sought in this study to see how AH measured with the abdominometer compares with the old World Health Organisation (WHO) standard – BMI in predicting hypertension and diabetes mellitus; the 2 major components of metabolic syndrome involved in CVD. The finding if confirmed would result in a paradigm shift in cardiovascular anthropometry.

MATERIAL AND METHODS

As reported previously [10, the abdominometer was used in a limited African cohort to determine CVD risk. Other CVD risk factors measured include BMI, blood pressure and glycosylated haemoglobin (HbA1c). Details of BMI and blood pressure measurement are detailed in the said publication [10].

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Only male subjects were thereafter invited for HbA1c measurement; with the approval of our institutional Research and Ethics Committee. The study was done in accordance with the Declaration of Helsinki. All procedures were done with clear understanding and informed consent was requested and got from the subjects. Females were excluded from this analysis because of their small number of 5. In the laboratory, venous blood was collected from antecubital venepuncture and dispensed into EDTA container tubes. Haemolysates were treated with appropriate reagents (Inteco Diagnostics UK) and HbA1c assayed using a spectrophotometer (Apel PD-303 S from Apel Co. Ltd; Kawaguchi, Japan).

Statistical Analysis

We used the validity tests to compare the new index AH, with the standard BMI in correctly determining the presence of hypertension and diabetes mellitus. This is to determine if it would be useful in picking these cardiometabolic states, given its ease of application.

RESULTS

Thirty one (31) subjects had complete data on BMI, BP, AH, and HbA1c. AH the suggested new anthropometric measure correlated significantly with BMI; an old standard anthropometric measure ($r = 0.803$; $p = 0.01$). To determine a useful cut-off value for AH in screening for CVD risk in the cohort, the mean + 1 SE was calculated. It was 24.42 cm + 0.44 equalling 24.86 cm; rounded up to 25 cm. BMI of 30 kg/m^2 is already known as cut off point for obesity and 6% the cut off HbA1c value for dysglycaemia; while BP $\geq$ 140/90 mmHg defined hypertension. Table 1 compares validity indices of BMI and AH to screen for hypertension. The latter was more sensitive and accurate than the former. Table 2 on the other hand compared the validity indices of BMI and AH to screen for diabetes mellitus. Here, the latter was more accurate though less sensitive than the former.

Table 1: Using BMI (standard) and AH (novel) indices to screen for hypertension in cohort

	BMI		AH	
	TP (4)	FP (11)	TP (11)	FP (8)
	FN (1)	TN (14)	FN (2)	TN (10)
Sensitivity	80%		84.6%	
Specificity	57.7%		55.6%	
+ve Predictive value	26.7%		57.9%	
-ve Predictive value	93.8%		83.3%	
Accuracy	61.3%		67.9%	
False +ve rate	42.3%		44.4%	
False -ve rate	20%		15.4%	

Key: TP – True positive, FP – False positive, FN – False positive, TN – True negative

Table 2: Using BMI (standard) and AH (novel) indices to screen for diabetes in the cohort

	BMI		AH	
	TP (2)	FP (11)	TP (4)	FP (13)
	FN (3)	TN (7)	FN (9)	TN (5)
Sensitivity	40%		30.8%	
Specificity	26.9%		27.8%	
+ve Predictive value	9.5%		23.5%	
-ve Predictive value	70%		35.7%	
Accuracy	29%		41.9%	
False +ve rate	73.1%		72.2%	
False -ve rate	20%		69.2%	

Key: TP – True positive, FP – False positive, FN – False positive, TN – True negative

DISCUSSION

BMI as an anthropometric index has been used by W.H.O. to define obesity [11]. Though simple to use, it is not equally applicable to all ethnic groups [1], and ethnicity has been found to modify the relationship between measure of body size and blood pressure [12]. It has been the index in use for long but is deficient given its inability to distinguish contribution of body frame size, muscle fat and body fat to overall weight [13]. Our abdominometer which utility has been shown earlier [10] is an attempt to develop a means of efficiently identifying populations at risk for CVD; an important step towards desirable curative and preventive medicine [11]. AH measurement has been shown to correlate better with CVD risk factors than weight circumference (WC) and BMI [6]; being a stronger measure of abdominal fat [14]. Visceral adiposity which reflects in the AH has been shown to be the major contributor to cardiometabolic diseases as diabetes mellitus and hypertension [15]. Sagittal abdominal diameter, an anthropometric measure similar to AH has shown good validity and reliability as predictor of visceral abdominal fat in Brazil [16].

Using 25 cm (mean + SE) of the population as cut off, we sought to determine the accuracy or validity of this model compared with the standard (BMI) in predicting cardiometabolic risk. BMI $\geq$ 30 kg/m^2 defined obesity [17], BP $\geq$ 140/90 mm Hg defined hypertension [18] and HbA1C $\geq$ 6.0 % defined dysglycaemia [19]. A clinically useful screening tool needs to perform well in independent data sets and be generalisable to the wider population [20]. Such risk prediction models if they show good discrimination are potentially beneficial in identifying high risk individuals in a population screening exercise [21]. We used the full range of validity tests to assess the utility of abdominometer-measured AH by comparing its performance with an established screening index BMI. As posited by Ogbonna [22], it is only then that a new screening tool can have utility. As shown in Table 1, the AH had better validity than BMI with regard to picking out subjects with hypertension. Abdominal fat has been shown in the U. S. A. to be more strongly linked to hypertension risk than overall obesity [23]. In a Nigerian study in Zaria [24], body fat correlated with most components of cardiometabolic risk factors.

For diabetes, either by BMI or AH (Table 2) both sensitivity and specificity are low and almost similar. The accuracy of AH in detecting diabetes mellitus is however better than BMI. Why the predictive value of these anthropometric indices lags behind for diabetes compared to hypertension is not easy to tell. It may however have to do with the duration of the high BMI or AH; information that were not sought in this study and hard to tell. The biochemical derangements resulting in blood pressure elevation may develop before those altering glucose control. This would be a fruitful area for future research.

CONCLUSION

In conclusion, the AH determined by the newly conceptualized mobile abdominometer shows good promise as a screening tool for CVD in the general population. This is more important for our population where obesity is not held with opprobrium [5]. Body size perception in Nigerians is poor [25]. People tend to accept overweight/obesity as normal and sign of affluence de-motivating them to seek help with management. This simple tool will permit their detection and referral for curative and preventive action; to avert obvious CVD with disastrous consequences. The cut off value of 25 cm derived for this population of male subjects, interestingly is similar to abdominal sagittal diameter above 25 cm found in the work of Pouliot *et al* [26]. It should however be extended to women and people from other ethnic backgrounds.

Conflicts of interests

None declared.

What was already known

BMI as a measure of obesity is a satisfactory indicator of cardiometabolic diseases chiefly hypertension and diabetes, though accuracy is not equal across ethnic divide

What study adds to existing knowledge

Abdominal height measured by a newly conceptualized implement called the Abdominometer predicts cardiometabolic diseases better in Africans; and given its portability should be more widely applied in studies screening for cardiovascular disease risks.

Authors' Contribution

1. B N OKEAHIALAM – Concept design and write-up
2. U M DIALA – Participation in survey and data collection
3. J UWAKWE – Participation in survey and data collection
4. I EJEH – Participation in survey and data collection
5. U OZOILO – Participation in survey and data collection.

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