Int J Med. Public Health. 2016; 6(2): 69-72
A Multifaceted Peer Reviewed Journal in the field of Medicine and Public Health
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Review Article

Site or Size of Waist Circumference, Which one is More important in Metabolic Syndrome?

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ABSTRACT

Abdominal obesity is one of the pivotal factors in defining the metabolic syndrome. Abdominal obesity is assessed by the various clinical surrogates among which waist circumference is considered to be simple, inexpensive & sensitive tool. But various controversies surround the exact cut offs and the ideal sites of waist circumference measurement, so in this review we discussed these issues.

Key words: Metabolic syndrome, Waist circumference, Cardio metabolic risk, Abdominal obesity, Harmonized Definition.

INTRODUCTION

Metabolic syndrome is a complex disorder and is characterized by clustering of a number of interrelated factors increasing the risk of coronary heart disease (CHD) and Type 2 Diabetes mellitus (T2DM). The defining components of metabolic syndrome include dyslipidemia (elevated triglycerides and apolipoprotein B (apoB)-containing lipoproteins, and low high-density lipoproteins (HDL)), elevation of arterial blood pressure (BP), dysregulated glucose homeostasis, abdominal obesity and/or insulin resistance (IR).[1] Abdominal obesity is one of the pivotal features in the pathogenesis of metabolic syndrome. In order to clearly define metabolic syndrome, it is the matter of prime importance to device simple clinical measures for precise measurement of abdominal obesity.

Since the first definition of metabolic syndrome by WHO,[2] to the most recent Harmonized definition,[3] various clinical tools ranging from waist –hip ratio to waist circumference have been used to quantify central obesity. Among the measures of central obesity waist circumference is considered to be simple & inexpensive measure with excellent correlation with abdominal imaging and is used in all definitions of metabolic syndrome except WHO criteria, as surrogate marker of central obesity.[4]

Waist circumference appears to better central obesity indicator than BMI and waist hip ratio.[5] Despite waist circumference being one of the basic components of every definition of metabolic syndrome, the ideal site & size which can define all the CV risk is still a matter of debate.

FINDING THE MAGICAL NUMBERS

The ideal waist measurement above which the risk of CVD & T2 DM increases significantly is not well defined since its introduction in the various definitions of the metabolic syndrome. The diagnostic cut offs of waist circumference used in the various guidelines are the result of expert deliberations but not the evidence based process & epidemiological studies.[6] "Same doesn't fit all", so the same cut off for metabolic syndrome can't be applied to all the ethnicities of the world having different genetic makeup, body fat content & distribution, environmental factors and life style which affect their susceptibility for metabolic syndrome. For example Asians tend to have greater body fat for the same BMI when compared with Caucasians so Asians develop hypertension, T2DM and dyslipidemia at a lower BMI.[5]This fact was realized very late in 2005 when IDF,[7] proposed different cut off for the waist circumference for the first time, as all previous definitions had same cut off for all the ethnicities. Though all the definitions coming after IDF,[7] definition have different cut offs for different ethnicities but the exact increase in the risk of CVD & T2DM is not well defined. A study entitled "Comparisons of waist circumferences measured at 4 sites" done by J. Wang *et al*. in 2003compared waist circumference at four different sites in 49 males and 62 females. In this study author measured the waist circumference at following sites: 1. Immediately below the lowest rib (WC1); 2. At the narrowest waist (WC2, recommended in the Anthropometric Standardization Reference Manual); 3. Midpoint between the lowest rib and iliac crest (WC3, recommended in the World Health Organization (WHO) guidelines) and 4. Immediately above the iliac crest (WC4, Recommended in the National Institutes of Health (NIH)

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History

- Submission Date: 31-12-15;
- Review completed: 03-05-16;
- Accepted Date: 06-05-16.

DOI : 10.5530/ijmedph.2016.2.4

Article Available online
http://www.ijmedph.org/v6/i2

Cite this article : Syed Mohd Razi Gutch Manish, Keshav GK, Sukriti K, Gupta A. Site or Size of Waist Circumference, Which one is More important in Metabolic Syndrome?. Int. J. Med. Public Health, 2016; 6(2):69-72.

guidelines and applied in the third National Health and Nutrition Examination Survey (NHANES III)). They found that mean values of waist circumference were WC2 < WC1 < WC3 < WC4 ($P < 0.01$) in females and WC2 < WC1, WC3, and WC4 ($P < 0.01$) in males. They found that for all 4 sites measurement reproducibility was high, with intra-class correlation (r) values > 0.99. WC values were significantly correlated with fatness; correlations with trunk fat were higher than correlations with total body fat in both sexes.[8] The waist circumference cut offs used in various guidelines are shown in Table 1

FINDING THE RIGHT SITE

As there are numerous controversies regarding the ideal cut off for waist circumference similar is the case for the ideal site for waist circumference measurement. Different waist circumference measuring sites are taken for different studies & guidelines. There are 10 documented sites noted in literature by Guerra *et al.* as shown in table 2, (1) Narrowest point between the iliac crest and the lower rib margin; (2) Midway between the lower rib margin and the iliac crest; (3) Narrowest point between the umbilicus and the xiphoid process; (4) One-third of the distance between the xiphoid process and the umbilicus; (5) Midway between the xiphoid process and the umbilicus; (6) Widest diameter between the xiphoid process and the iliac crest; (7) At the level of the iliac crest; (9) At the level of the umbilicus; (10) 2.5 cm above the umbilicus and (11) At the lower border of the 10thrib.[12] But the ideal site should be sensitive enough to point out the population at CV risk. One uniform site for waist circumference measurement is needed to bring about uniformity in diagnosis criteria, prevalence studies & intervention outcomes. There are various studies which focus on this issue that which site corresponds better to the CV risk & metabolic syndrome. In 2010, Mason *et al.* compared 4 sites of waist measurement namely iliac crest, midpoint, umbilicus, and minimal waist and found that more men & women met the criteria of metabolic syndrome when waist circumference was measured at umblicus, although correlation of CV risk & WC didn't varied significantly between the different sites.[13] A recent scientific statement issued in 2011 by AHA advocate WC measurement at iliac crest as it is the easiest & most consistent location.[4] R. S. Guerra *et al.* 2012, conducted a study on elderly subjects to find

Table 1: The waist circumference cut offs used in various guidelines {14}

Criteria	Male	Female
1. European Group on Insulin resistance (EGIR)1999 [9]	>94 cm	>80 cm
2. National Cholesterol Education Program / Adult Treatment Panel III (NCEP/ATP III 2001) [10]	> 102 cm	>88 cm
3. Updated NCEP/ATP III (2004) [11]	> 102 cm	>88 cm

4. International Diabetes Federation (IDF2005)[7]: Waist circumference was the essential criteria & was ethnicity based for the first time:

Country/ethnic group	Waist circumference (as measure of central obesity)	
	Male	Female
Europids	≥ 94 cm	≥ 80 cm
South Asians	≥ 90 cm	≥ 80 cm
Chinese	≥ 90 cm	≥ 80 cm
Japanese	≥ 85 cm	≥ 90 cm
Ethnic South and Central Americans	Use South Asian recommendations until more specific data are available	
Sub-Saharan Africans	Use European data until more specific data are available	
Eastern Mediterranean and Middle East	Use European data until more specific data are available (Arab) populations	

5. Harmonized Definition (2009) [3]

Population	Organization (Reference)	Recommended Waist Circumference Threshold for Abdominal Obesity	
		Men	Women
Europid	IDF	≥94 cm	≥80 cm
Caucasian	WHO	≥94 cm (increased risk)	≥80 cm (increased risk)
		≥102 cm (still higher risk)	≥88 cm (still higher risk)
United States	AHA/NHLBI (ATP III)	≥102 cm	≥88 cm
Canada	Health Canada	≥102 cm	≥88 cm
European	European Cardiovascular Societies	≥102 cm	≥88 cm
Asian (including Japanese)	IDF	≥90 cm	≥80 cm
Asian	WHO	≥90 cm	≥80 cm
Japanese	Japanese Obesity Society	≥85 cm	≥90 cm
China	Cooperative Task Force	≥85 cm	≥80 cm
Middle East, Mediterranean	IDF	≥94 cm	≥80 cm
Sub-Saharan African	IDF	≥94 cm	≥80 cm
Ethnic Central and South American	IDF	≥90 cm	≥80 cm

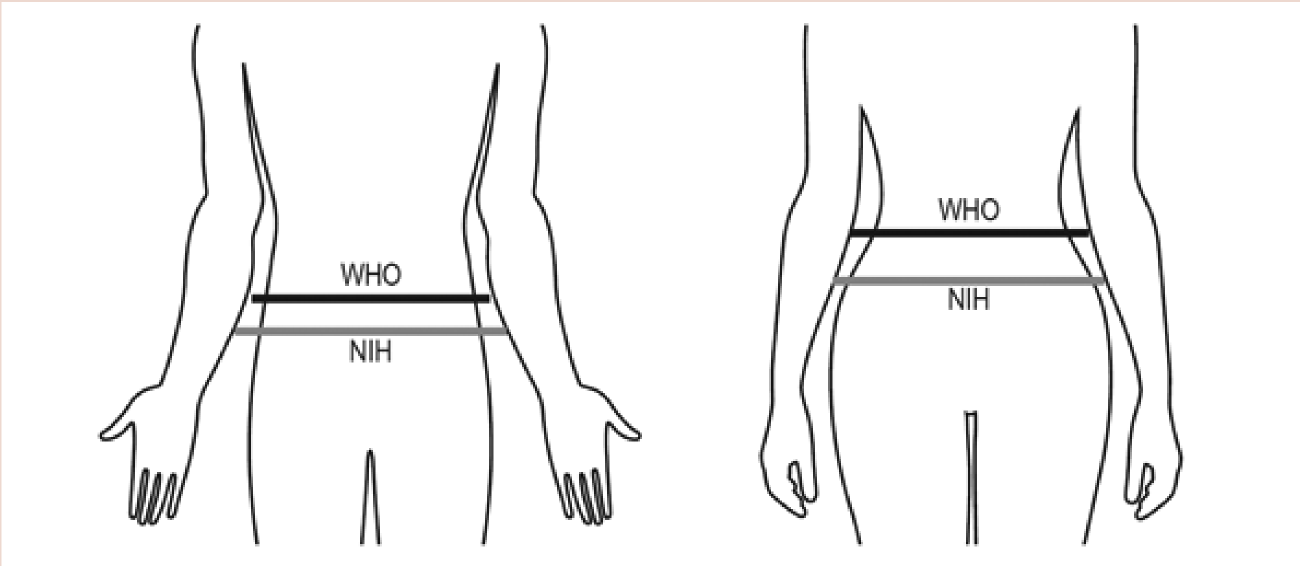

Figure 1: Waist circumference measurement sites for men and women based on World Health Organization (WHO) and National Institutes of Health (NIH) protocols[14]
Note: Following the WHO protocol, measure is taken midway between the highest point of the iliac crest and the bottom of the ribcage. Following the NIH protocol, the measure is taken at the highest point of the iliac crest.

out the best WC site out of 10 site, corresponding to the abdominal fat measured by DEXA scan, they concluded that best surrogate measure of abdominal fat was waist circumference measured 2.5 cm above the umbilicus.[12] WHO[4] & IDF guidelines[7] recommend measurement of waist circumference at mid- point between the lowest coastal margin & superior border of iliac crest while NIH, NHLBI[4] and NCEP/ATPIII guidelines,[11] recommend measurement at the upper-most point of the iliac crest and as shown in figure 1. Based on the WC measurement locations recommended by IDF & NCEP-ATPIII, Ma *et al*. conducted a prospective study on 1898 Asian subjects to compare the performance of the two locations.[5] The study found that IDF location i.e. mid-point between lowest rib & the iliac crest was better measure of central obesity and correlated better with hypertension, T2DM, metabolic syndrome & VFA (visceral fat area) than the NCEP-ATPIII location i.e. at iliac crest. The study also found that the variation in correlation at the two locations was more marked in females as compared to males.[5]

Problem in Indian Perspective

For a country like India where more than 2/3[rd] of the total population still lives in villages and nearly 1/4[th] of the population is still illiterate determining the right site and correct measurement of waist circumference is a real challenge. In our Indian society, religious beliefs and cultural traditions like 'Purdah' and not allowing the measurement of one's body are still deeply enrooted which pose practical difficulties in waist measurement particularly in case of females. This all leads to imprecise waist circumference measurements & creates a gender bias in accuracy and reporting. Some Indian studies tried to find out the correct cut-off for waist circumference measurement but unfortunately came up with different results. In 2005, A. Misra *et al.* conducted a large epidemiological study involving 883 male and 1167 female subjects.[15] The group measured Body mass index (BMI), WC, waist-to-hip circumference ratio, blood pressure, and fasting samples for bloodglucose, total cholesterol, serum triglycerides, and high-density lipoprotein cholesterol in the cohort population. The study group concluded that in males, a WC cutoff point of 78 cm (sensitivity 74.3%, specificity 68.0%), and in females, a cutoff point of 72 cm (sensitivity 68.7%, specificity 71.8%) were appropriate in identifying those with at least one cardiovascular risk factor and for identifying those with a BMI >21 kg/m^2. They further concluded that WC levels of ≥90 and ≥80cm for men and women, respectively, identified high odds ratio for cardiovascular risk factor(s) and BMI level of >25 kg/m^2. In a recent study by Pratyush DD (2012) the same issue of waist circumference cut off in Asian Indian population was studied on 349 males and 364 females.[16] They came to a conclusion that WC cut-off points for males was 90 cm with a sensitivity andspecificity of 71% and 96%, respectively, and for females was 85 cm with a sensitivity and specificity of 86% and 93%, respectively, associated with the risk factors of Metabolic Syndrome.

CONCLUSION

Waist circumference is an inexpensive & simple tool for assessment of abdominal obesity. Since different ethnicities have different genetic makeup along with different body fat content and distribution so single universal cut off for waist circumference can't be used. Site of waist measurement is also as important as the magnitude especially in case of females. Waist circumference cut offs should be according to the ethnicities and it should be measured just above the iliac crest based on the latest harmonizing definition of the metabolic syndrome till further research.

ACKNOWLEDGEMENT

We owe thanks to the patient and her relatives for having patience and their contribution to this undertaking.

CONFLICT OF INTEREST

None.

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Cite this article : Syed Mohd Razi Gutch Manish, Keshav GK, Sukriti K, Gupta A. Site or Size of Waist Circumference, Which one is More important in Metabolic Syndrome?. Int. J. Med. Public Health, 2016; 6(2):69-72.