Preventive Medicine 97 (2017) 100–108

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

Review Article

Is waist circumference ≥ 102/88 cm better than body mass index ≥ 30 to predict hypertension and diabetes development regardless of gender, age group, and race/ethnicity? Meta-analysis

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ARTICLE INFO

Article history:
Received 17 July 2016
Received in revised form 22 December 2016
Accepted 22 January 2017
Available online 27 January 2017

Keywords:
Waist circumference
Hypertension
Diabetes

ABSTRACT

Between body mass index (BMI) ≥30 and waist circumference (WC) ≥102/88 cm, we investigated which of the two measures is a better predictor of two of the most common chronic diseases – diabetes mellitus and hypertension while also examining differential association by gender, age group, and race/ethnicity. Meta-analysis was conducted for all longitudinal studies with at least 12 months of follow-up published up to April 2015. Ratio of relative risk (rRR) and relative risk of diseases were computed and compared by baseline obesity measurement. The final sample included 23 longitudinal observation studies involving 62 study arms with 259,200 individuals. WC ≥ 102/88 cm was a better predictor than BMI ≥ 30 for development of diabetes (rRR = 0.81, 95% CI = 0.68–0.96), but not for hypertension (rRR = 0.92, 95% CI = 0.80–1.06). Subgroup analyses showed WC ≥ 102/88 cm was a better predictor for diabetes in women than men, and for ages 60 and older than other ages. Only WC ≥ 102/88 cm, not BMI ≥ 30, predicted development of hypertension among Hispanic/Latinos. Neither BMI ≥ 30 nor WC ≥ 102/88 cm were significant predictors of hypertension when age group was controlled. Central obesity may be a more serious risk factor for diabetes development in women and for older ages. The predictive power of BMI ≥ 30 or WC ≥ 102/88 cm in hypertension development should not be emphasized as either could mask the effect of age.

Contents

Abbreviations: BMI, body mass index; CI, confidence interval; DM, diabetes mellitus; HT, hypertension; IRR, incidence rate ratio; RR, relative risk; rRR, ratio of relative risk (RR_{BMI}/RR_{WC}); SAT, subcutaneous adipose tissue; VAT, visceral adipose tissue; WC, waist circumference.

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http://dx.doi.org/10.1016/j.ypmed.2017.01.012
0091-7435/

1. Introduction

Obesity is one of the leading causes of preventable death in the U.S., and it is considered a global pandemic with its increased prevalence in recent decades (Swinburn et al., 2011). Individuals with obesity are generally at a higher risk of coronary heart disease, diabetes, dyslipidemia, and hypertension (Berglund et al., 1982; Wang et al., 2005). Studies have used several scales to measure obesity and its associated comorbidities, including body mass index (BMI), waist circumference (WC), waist to height ratio (WHtR), waist to hip ratio, conicity index, ponderal index, and percent ideal weight (Florey, 1970; Kim et al., 2000; NHLBI, 1998). Among these, BMI and WC are two of the most commonly used measures of obesity (NHLBI, 1998). Other measures may be effective at predicting disease outcome, but are considered less convenient, less effective, or more expensive compared to BMI and WC. For example, Kodama et al. suggested that WHtR is an effective predictor of diseases, but height measurement in addition to WC adds no significant benefit (Kodama et al., 2012). Hence, BMI and WC are still recommended measures of obesity under clinical guidelines, considered quick, inexpensive, yet effective predictors of disease outcomes (NHLBI, 1998).

Although both BMI and WC are recommended measures of obesity, it is unclear yet which of the two measures is a better predictor of diseases, especially for two of the most common chronic diseases – diabetes mellitus and hypertension. Generally, individuals with BMI ≥ 30 are considered obese, therefore at an increased risk of diabetes and hypertension (NHLBI, 1998). WC is a measure of central obesity, where men with WC ≥ 102 cm (40 in.) and women with WC ≥ 88 cm (35 in.) are at an increased risk of diabetes and hypertension (NHLBI, 1998; Klein et al., 2007). Central obesity indicates high visceral adipose tissue (VAT) and high subcutaneous adipose tissue (SAT) in the abdominal area, where VAT is a particularly well-known cardiometabolic risk factor (Klein et al., 2007). While the mechanism that explains the role of VAT on pathogenesis of diseases remains unclear, it is relatively well-established that VAT and WC effectively predict cardiometabolic risks (NHLBI, 1998; Klein et al., 2007). Previous studies have examined the efficacy of cutoff values for WC and BMI in predicting cardiovascular events (Ashwell et al., 2012; de Koning et al., 2007; Guh et al., 2009; Huxley et al., 2008; Lee et al., 2008; Neter et al., 2003; Savva et al., 2013; Vazquez et al., 2007). But, relatively little is known as to whether outcome prediction varies based on different age groups or race/ethnicity as well as based on those established cutoff values. Also, some of these studies (Huxley et al., 2008; Savva et al., 2013) were based on cross-sectional studies, which limit causal inference.

On one hand, BMI is more convenient than WC, as it is a gender-neutral scale based on weight and height (NHLBI, 1998). On the other hand, WC cutoff has been suggested to have higher predictive power than BMI (NHLBI, 1998; Lee et al., 2008). However, Misra, Wasir, and Vikram concluded that WC as a diagnostic tool of abdominal obesity does not apply uniformly across different racial/ethnic groups (Misra et al., 2005). It has also been suggested that disease prediction based on BMI and WC may vary by age group (NHLBI, 1998; Gallagher et al., 1996; Lemieux et al., 1996). However, there is a paucity of data that prospectively compare efficacy of BMI and WC in predicting diabetes and hypertension by age group and race/ethnicity in addition to gender. Hence, this meta-analysis compared predictive power of BMI and WC with regard to diabetes and hypertension among obese and non-obese individuals, while also examining heterogeneity by age group and race/ethnicity as well as gender. Based on the existing evidence, we hypothesized that (1) BMI ≥ 30 and WC ≥ 102/88 cm are both significant predictors of diabetes and hypertension, (2) WC ≥ 102/88 cm is a better predictor of diabetes and hypertension than BMI ≥ 30, and (3) predictive power of BMI ≥ 30 and WC ≥ 102/88 cm varies by gender, age group and race/ethnicity.

To the best of our knowledge, this is one of the first meta-analyses to address differential association of BMI and WC cutoffs with prospective risk for hypertension and diabetes by gender, age group and race/ethnicity. This study makes a significant contribution to our understanding of obesity by conducting a comprehensive review and meta-analysis of up-to-date literature with temporal validity to examine differential associations of BMI and WC cutoffs with incident diabetes mellitus and hypertension by gender, age group and race/ethnicity while previous studies only focused on gender differences. Additional contribution is use of categorical comparison using relative risk (RR) and ratio of relative risk (rRR) in this meta-analysis for intuitive interpretation.

2. Methods

2.1. Search strategy

Flow chart of study search and selection is shown in Fig. 1. Preliminary literature search involved electronic keyword search of Academic Search Premier, CINAHL, Educational Resource Information Center (ERIC), MEDLINE, PsycINFO, and SPORTDiscus via EBSCOhost. Search terms utilized various combinations of the following keywords: *obes*, abdom*, central, WC, waist, BMI, body-mass*, cardio*, hypertension,*

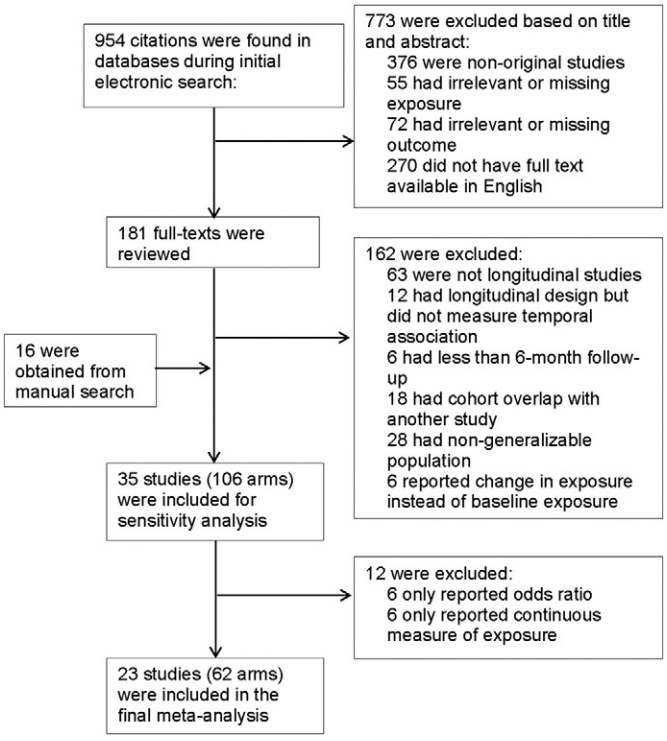

Fig. 1. Flow chart of study search and review (inclusion and exclusion for meta-analysis).