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**Preventive Medicine** 

### Differences in anthropometric measures in immigrants and Swedish-born individuals: Results from two community-based cohort studies



Axel C. Carlsson <sup>a,b,\*</sup>, Per Wändell <sup>a</sup>, Ulf Riserus <sup>c</sup>, Johan Ärnlöv <sup>b,d</sup>, Yan Borné <sup>e</sup>, Gunnar Engström <sup>e</sup>, Karin Leander <sup>f</sup>, Bruna Gigante <sup>f</sup>, Mai-Lis Hellénius <sup>g</sup>, Ulf de Faire <sup>f,h</sup>

<sup>a</sup> Centre for Family Medicine, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Huddinge, Sweden

<sup>b</sup> Department of Medical Sciences, Molecular Epidemiology and Science for Life Laboratory, Uppsala University, Uppsala, Sweden

<sup>c</sup> Clinical Nutrition and Metabolism, Department of Public Health and Caring Sciences, Uppsala University, Uppsala, Sweden

<sup>d</sup> School of Health and Social Studies, Dalarna University, Falun, Sweden

<sup>e</sup> Department of Clinical Sciences, Lund University, Malmö, Sweden

<sup>f</sup> Division of Cardiovascular Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden

<sup>g</sup> Cardiology Unit, Department of Medicine, Karolinska Institutet, Stockholm, Sweden

<sup>h</sup> Department of Cardiology, Karolinska University Hospital, Stockholm, Sweden

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#### ABSTRACT

*Aim.* To study differences in body mass index (BMI), waist-hip ratio (WHR), waist circumference (WC), sagittal abdominal diameter (SAD), waist-hip-height ratio (WHHR) and percent body fat in immigrants and Swedish-born men and women in two large population-based samples.

*Methods.* A cross-sectional analysis of 60-year-old individuals, n = 4232. To replicate the results, we also assessed another large independent cohort cross-sectionally, the Malmö Diet and Cancer Study (MDC, n = 26777). The data from both cohorts were collected in the 1990s in Sweden.

*Results.* Significant differences between Finnish-born, Middle Eastern and women from the rest of the world were seen for all anthropometric measures, using Swedish-born women as referent. However, WHHR was the only anthropometric measure that identified all these three groups of immigrant women as different from Swedish-born women with high statistical certainty (p < 0.001). Apart from WHHR that identified differences in anthropometry in all immigrant groups of men using Swedish-born men as referent, few significant differences were seen in anthropometry among groups of immigrant men. These finding were observed in both cohorts, and remained after adjustments for smoking, physical activity and educational level.

*Conclusion.* The present study confirms previous findings of more obesity among immigrants and is the first to report that WHHR measurements may detect anthropometric differences between different ethnic groups better than other anthropometrical measures.

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#### Introduction

Obesity is increasing worldwide and has been proposed as the main upstream driver of cardiometabolic risk factors and associated outcomes such as hypertension, diabetes and myocardial infarction (Haslam and James, 2005). Moreover, obesity is the leading risk factor for mortality in the world (Narayan et al., 2010). Yet differences in the association between obesity and adverse outcomes in ethnic groups have been shown and there are separate body mass index (BMI) cutoffs for overweight and obesity in individuals of Asian and Caucasian descent (Anuurad et al., 2003). The risk differences with regard to cardiovascular disease and diabetes between different ethnic groups are well known and have been studied in multiple studies in Sweden, where Swedish-born individuals have been compared with groups of foreign-born individuals (Carlsson et al., 2008a, 2013b; Gadd et al., 2003, 2005a, 2005b, 2006; Wandell et al., 2010, 2011). The overall risk of cardiovascular disease and mortality are higher in certain groups (Gadd et al., 2003, 2006), which may partly be explained by more diabetes among immigrants from north Africa, parts of Asia and the Middle East (Carlsson et al., 2013b; Wandell et al., 2010), a higher prevalence of hypertension among Finnish-born (Carlsson et al., 2008a). Different dyslipidemic patterns (Wandell et al., 2011) as well as smoking habits have additionally been shown in certain immigrant groups (Gadd et al., 2005b). Similar studies have been conducted in many other European countries including England (Khattar et al., 2000) and Norway (Jenum et al., 2012; Tran

<sup>\*</sup> Corresponding author at: Centre for Family Medicine, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Huddinge, Sweden. Fax: +46852488706. *E-mail address:* axelcefam@hotmail.com (A.C. Carlsson).

et al., 2011), and studies where populations in different countries have been compared has also been undertaken (Wolf-Maier et al., 2003).

Limited information is available regarding obesity and more specifically measures that depict central obesity and body composition, such as waist circumference (WC), waist-hip ratio (WHR) sagittal abdominal diameter and the novel measure waist-hip-height ratio (WHHR)(Carlsson et al., 2013a) in different ethnic groups. We hypothesize that different anthropometric measures identify differences in anthropometry between groups of individuals to a different extent and aimed to compare BMI, waist circumference (WC), waist-hip ratio (WHR), sagittal abdominal diameter (SAD) and the novel measure WHR/height-ratio(WHHR) between immigrants (including different subgroups) and Swedish-born in a large community-based cohort. We also aimed to verify the results obtained by performing similar analyses in an independent large cohort (except for SAD which was not available). Further, the aim was to compare percent body fat between immigrants and Swedish-born in the replication cohort.

#### Methods

#### Main study population: the cohort of 60-year-old men and women

All men and women living in Stockholm County who were born between July 1, 1937, and June 30, 1938, were identified from a register of the population in Sweden. From August 1997 to March 1999, every third individual (male or female) was invited to participate in a thorough cardiovascular and metabolic health screening. Of 5460 citizens of Stockholm County invited to participate in the study, 4232 (78%) agreed to do so.

Smoking was categorized as current, former, or daily. Physical activity was defined as moderate or intensive leisure time physical activity more than once a week and determined by questionnaire. Education level was defined as follows: lower level education, i.e., compulsory school, 10- to 12-year education, i.e., high school, and >12-year education, i.e., university. A more detailed description of the methods has been published previously (Carlsson et al., 2008b, 2009a, 2009b).

The study was approved by the ethics committee at Karolinska Institutet, and all subjects agreed to participate.

Height was measured without shoes to the nearest 0.5 cm. An electronic scale was used to weigh the participants to the nearest 0.1 kg. BMI was calculated as weight (kg) divided by height (m) squared (Wandell et al., 2009). WC was measured in underwear after a normal expiration with the subject standing up, at the midway point between the iliac crest and the lower rib margin (Riserus et al., 2010). Hip circumference was measured horizontally at the point of largest lateral extension at the hips or over the buttocks. The WHR was calculated as WC divided by hip circumference. WHHR was calculated as the WHR divided by height. SAD was measured with the subject in the subjence with straight legs on a firm examination table without clothes in the abdominal area after normal expiration, using a ruler and water level (Nordhann et al., 2000). SAD was defined as the distance between the table up to the top of the body at the level of the iliac crest and was measured to the nearest 0.1 cm.

Finland n 327, Eastern Europe n 100 (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Ukraine), South/Western Europe/North America n 235 (Albania, Austria, Belgium, Denmark, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Switzerland, United Kingdom, USA, Yugoslavia), Middle East n 48 (Lebanon, Iran, Iraq, Syria, Turkey) and The rest of the world n 67 (Algeria, Angola, Bangladesh, Bolivia, Burma, China, Chile, Colombia, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, French Guyana, India, Indonesia, Morocco, Peru, Philippines, Singapore, Somalia, Swaziland, Thailand, Trinidad and Tobago, Tunisia, Uganda, Uruguay, Vietnam, Zaire).

#### Replication cohort: Malmö Diet and Cancer (MDC) cohort

All women born between 1923 and 1950 and men born between 1923 and 1945 living in Malmö city were invited to the MDC study during the period March 1991 to September 1996 (Berglund et al., 1993; Manjer et al., 2001). After exclusion of subjects with missing information for one or more of the variables used in this study, 26,777 subjects remained (61.6% women, age 45–73 years). All participants agreed to participate, and the study was approved by the Ethical Committee at Lund University, Lund, Sweden (LU 51/90).

The examinations were performed by trained nurses at the screening center. Standing height was measured with a fixed stadiometer calibrated in centimeters. Weight was measured to the nearest 0.1 kg using a balance beam scale with subjects wearing light clothing and no shoes. BMI was calculated as weight (kg) divided by the square of the height  $(m^2)$ . WC was measured as the circumference (cm) between the lowest rib margin and iliac crest and hip circumference (cm) as the largest circumference between waist and thighs. WHR was defined as the ratio of circumference of waist to hip. WHHR was defined as the ratio of WHR to height. Bioelectrical impedance analyzers (BIAs) were used for estimating body composition and BF% was calculated using an algorithm, according to procedures provided by the manufacturer (BIA 103, JRL systems, single-frequency analyzer, Detroit, USA). A total of 2016 individuals were immigrants (7.8%) and subdivided into the following groups: Denmark (n = 338), Finland (n = 239), Eastern Europe (n = 426) (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Ukraine), Western Europe/North America (n = 443) (Austria, Belgium, France, Germany, Iceland, Norway, Switzerland, the Netherlands, United Kingdom), Southern Europe (n = 374) (Albania, Former Yugoslavia, Greece, Italy, Portugal, Spain), and Middle East (n = 53) (Iraq, Iran, Lebanon, Syria, Turkey). The rest of the world, n = 143 (Algeria, Angola, Argentina, Bangladesh, Bolivia, Chile, China, Colombia, Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Ethiopia, French Guyana, Gambia, Ghana, Guyana, India, Indonesia, Israel, Japan, Jordan, Kenya, Korea, Namibia, Pakistan, Peru, Philippines, Somalia, Sudan, Seychelles, Thailand, Trinidad and Tobago, Tunisia, Uganda, Uruguay, USA and Vietnam).

#### Statistical analysis

Each anthropometric measure was divided with its standard deviation in women and in men. Linear regression models were used to calculate differences in Swedish born and foreign-born individuals (immigrants). The crude model was unadjusted/age-adjusted (MDC only). We also estimated multivariable models where we adjusted for factors known to affect obesity as well as to differ in different ethnic groups: education, smoking and physical activity (Gadd et al., 2005b), as well as in individuals in low resource settings (Modesti et al., 2014).

#### Results

Baseline characteristics for the individuals in the cohort of 60-yearold men and women are shown in Table 1, and the baseline characteristics for men and women in the MDC cohort are shown in Table 2.

Supplementary Table 1 shows unadjusted linear regression models of country of birth as an explanatory variable for each anthropometric measure separately. Significant differences between Finnish-born, Middle Eastern and women from the rest of the world were seen for all anthropometric measures, using Swedish-born women as referent. However, WHHR was the only anthropometric measure that identified all these three groups of immigrant women as different from Swedish-born women with high statistical certainty (p < 0.001). Surprisingly, few differences were seen in SAD.

Apart from WHHR that identified differences in anthropometry in all immigrant groups of men using Swedish-born men as referent, few significant differences were seen in anthropometry among groups of immigrant men. These findings were verified in age-adjusted models in the MDC cohort, Supplementary Table 2, where more significant differences between Swedish-born individuals and immigrants were seen.

Adjusted models corresponding to the crude models (Supplementary Tables 1 and 2) are shown in Table 3 (the cohort of 60-year-old men and women) and Table 4 (MDC cohort). The percentage body fat had a high resemblance to WHR and even more so with WHHR in identifying groups with significant differences (Table 4). The essential aforementioned results in the crude models remained when adjustments were made for education, smoking and physical activity. When it was possible to identify differences between Swedish-born individuals and any immigrant group, the differences were detected by WHHR. WHHR identified differences between Finnish-born, Middle Eastern and women from the rest of the world using Swedish-born women as referent (p < 0.001) and identified significant differences between Swedish-born individuals and all studied immigrant groups of men in both cohorts.

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