

THE ASSOCIATION BETWEEN BMI, WAIST-TO-HEIGHT RATIO AND BLOOD  
PRESSURE IN RUSSIAN, SOMALI AND KURDISH MIGRANTS RESIDING IN  
FINLAND

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ALENA AGAFONOVA: THE ASSOCIATION BETWEEN BMI, WAIST-TO-HEIGHT RATIO AND BLOOD PRESSURE IN RUSSIAN, SOMALI AND KURDISH MIGRANTS RESIDING IN FINLAND

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**Background:** Obesity is a known risk factor for hypertension, leading to premature cardio-vascular morbidity and mortality. In Finland, overweight and obesity have increased over the past decades. Additionally, during the last two decades the proportion of migrant population in Finland increased more than five folds. Hence, migrants' health has become a matter of scientific interest. There is limited research on obesity among migrants and its association with blood pressure and hypertension. Existing evidence suggests that weight and blood pressure association varies by ethnicity.

**Objectives:** Current study aims to investigate the relationship between obesity indices and blood pressure in three major migrant groups in Finland.

**Subjects and Methods:** The cross-sectional study about migrant health and wellbeing was conducted in Finland during 2010-2012. A random sample of 3000 migrants of Russian, Somali and Kurdish origin, aged 18-64 years, residing in Helsinki, Espoo, Vantaa, Tampere, Turku and Vaasa was selected for the study. Data were collected by means of a face-to-face interview/brief questionnaire and health examination. In this study a sub-sample of migrants, aged 30-64 years, who participated in health examination (n=899) was used. Comparison data on the general Finnish population were obtained from the Health 2011 Study (n=885). The linear regression was used to assess the association between anthropometric indices and blood pressure, and logistic regression was used for the association between categorical variables and hypertension.

**Results:** Overweight and obesity rates were highest among Somali and Kurdish migrants. The associations between BMI and systolic blood pressure were significant only for Russian and Kurdish women and the general population. Similar results were obtained for the association between Waist-to-height ratio and systolic blood pressure. Participants with higher BMI or WHtR had higher blood pressure. However, the strength of the association varied by ethnic groups. All migrant groups had significantly lower levels of systolic blood pressure than the general population.

**Conclusions:** There were significant variations in the association between obesity indices and blood pressure in migrants compared with the general population. Blood pressure regulating mechanisms seem to differ in Somali and Kurdish migrants in comparison to the native population. Further research is required to clarify the BP-regulating mechanisms in East African (Somali) and Middle Eastern (Kurdish) migrant populations.

**Key words:** BMI, waist-to-height ratio, blood pressure, migrants, Finland

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## **ABBREVIATIONS**

BMI – body mass index

WHtR – waist-to-height ratio

WC – waist circumference

BP – blood pressure

SBP – systolic blood pressure

DBP – diastolic blood pressure

CVD – cardiovascular diseases

CHD – coronary heart disease

## 1. INTRODUCTION

Over the past few decades, overweight and obesity have increased substantially worldwide and nowadays almost every third adult is overweight/obese (World Health Organization, 2016). Excess body weight represents a major health issue. The negative impact of overweight/obesity on health has been studied in many surveys. However, the research on overweight/obesity and its influence on health is not as extensive in migrants.

Overweight and obesity are known risk factors for CVD and hypertension (Calle, Thun, Petrelli, Rodriguez, & Heath, 1999; Hubert, Feinleib, McNamara, & Castelli, 1983; Manson et al., 1990). Several anthropometric measures of obesity are widely used and two of them are competing for being more consistently related to adverse cardiovascular outcomes: body mass index (BMI) and Waist-to-height ratio (WHtR). It has been discovered that in various ethnic groups and migrants there are sometimes different patterns of the association between body weight and blood pressure (Bennet & Nilsson, 2014; Colin Bell, Adair, & Popkin, 2002). Some studies have demonstrated that WHtR is a better discriminator for the risk of hypertension in ethnically diverse populations (Obesity in Asia Collaboration, 2008). The question is whether this association could be explained merely by ethnic features (biologic mechanisms of regulation) or there are some other factors at work, such as socio-economic position, lifestyle choices or migration.

Hypertension is a leading risk factor for disease burden globally, accounting for 9.4 million deaths in 2010 (Lim et al., 2012). In comparison with 1990, the impact of high blood pressure (BP) has increased by approximately 2.1 million deaths (Lim et al., 2012). Elevated BP is a risk factor for CVD. The risk increases linearly from BP levels of 115 mmHg systolic and 75 mmHg diastolic upwards (Lewington et al., 2002). The most important modifiable risk factors for hypertension are high salt intake, alcohol intake, obesity and low physical activity (Kornitzer, Dramaix, & De Backer, 1999).

Few studies have focused on BP and hypertension in migrants. Some surveys conducted in the UK revealed that people of African origin had higher BP and prevalence of hypertension than European origin white people (Agyemang & Bhopal, 2003). A study from Netherlands showed that gender differences in hypertension rates are not consistent

among ethnic groups with ethnic minority women demonstrating similar rates of hypertension to ethnic minority men (Agyemang, de Munter, van Valkengoed, van den Born, & Stronks, 2008). A recent study from Finland found ethnic differences in BP and hypertension between Russian, Somali and Kurdish migrants and the general population (Skogberg et al., 2016). Prevalence of hypertension was notably lower among Kurdish and Somali migrants, whereas obesity was higher among Kurdish men and Somali women. Bennet and Nilsson reported earlier the similar findings in a Swedish study, where Iraqi migrants had higher BMI and lower BP than native swedes (Bennet & Nilsson, 2014). Authors concluded that different BP-regulation mechanisms exist in the population of Middle East descent. If differences in these regulation mechanisms exist also in other groups of migrants, it is important to address these differences in the health programmes targeting diverse ethnic groups.

Like in many other countries the number of migrants in Finland grows and it is projected that by the year 2020 ten percent of the population will have foreign origin (Sisäministeriö, 2013). Until recently there have been no large-scale studies on migrants' health in Finland. The Finnish Migrant Health and Wellbeing Study (Maamu) was first population-based survey, which covered various aspects of health and well-being of Russian, Somali and Kurdish migrants living in Finland. To our knowledge, no previous study has examined the association between BP, hypertension and anthropometric indices among migrants in Finland. Moreover, little is known about these associations in Somalian and Kurdish people and especially as migrants in European settings. Data on health of Russian migrants in Europe is also scarce. Therefore, the aim of the current study is to investigate the association between BMI, WHtR and BP in Russian, Somali and Kurdish migrants residing in Finland. Additional aim of the study is to look into the associations between BMI, WHtR and hypertension in these migrant groups.

## **2. LITERATURE REVIEW**

### **2.1. Definitions of migrants and ethnic minorities**

The terms ‘migrant’ and ‘ethnic minority’ are intertwined and used widely in scientific research and partially overlap (Bhopal, 2014). It is important to distinguish between these two words, as such important socio-demographic factors as length of residence, generation of migration (first-, second-generation migrant) are very different for these groups of people and have different implications for their health.

United Nations (UN) defines migrant as “any person who lives temporarily or permanently in a country where he or she was not born, and has acquired some significant social ties to this country” (United Nations Educational, Scientific and Cultural Organization, ). Similar definition comes from the UN convention on migrants’ rights and describes an international migrants as “ persons who live temporarily or permanently in a country of which they are not nationals” (United Nations Educational, Scientific and Cultural Organization, 2003). UN stresses that term ‘migrant’ refers only to persons, who decided to migrate in their own free will, i.e. without the intervention of external factors, and thus should be differentiated from refugees and asylum seekers. While the concept of ‘migrant’ is clear and straightforward for understanding, the ‘ethnic minority’ term is more complex and broad.

A definition of ethnic minority as “a group of people of a particular race or nationality living in a country or area where most people are from a different race or nationality” is simple and understandable (Cambridge Dictionary, 2017). However, it is important to add that ethnic minority groups may include both migrants and people born in the country, i.e. second-generation migrants. Here is where the overlap between terms migrants and ethnic minorities takes place. Some people indeed immigrated to the host country while others were born and raised in this country and are not migrants per se, but have different ethnic background from most of the population. As an example, one could think of indigenous groups of Australian aboriginals or Indians in the US. These people represent ethnic minority groups that were originally inhabiting the mentioned countries prior to colonization. In his book, professor Raj Bhopal emphasizes that, for example, in the UK the term ethnic minority usually refers to minority groups of non-European origin

(Bhopal, 2014). In chapter 2 of the book, Bhopal discusses the term ethnic minority, as a term related to a group of humans having a common national or cultural tradition. The term is usually used to refer to non-Whites, although it may be used to describe specific groups, such as Gypsy travelers, Roma people (Bhopal, 2014). Thus, it is clear that concept of ethnic minority is broad and may include or exclude migrants, whereas migrants are usually (but not necessarily) representatives of ethnic minority groups.

In the current literature review were included articles operating with both ‘migrant’ and ‘ethnic minority’ terms. Thus, the possible search area was broadened and intertwining between the two terms was addressed. Additionally, it was possible to see from various studies, how the different definitions affected the results, i.e. first-generation migrants vs. ethnic minority nationals (persons born in the host country of their parents/grandparents).

Kurdish migrants in Finland represent an ethnic minority with most of its’ individuals originating from Iraq and the rest from Iran and Turkey (Wahlbeck, 2012). Therefore, whenever information on Kurdish migrants was not available per se, in the present literature review information on people from Iraq and Iran was used as a proxy for Kurdish ethnicity.

## **2.2. Migrant population in Finland**

Over the past few decades, the migrant population in Finland has grown substantially and it is projected that by the year 2020 ten percent of the population will have foreign origin (Sisäministeriö, 2013). The corresponding number of migrants was as low as 0.5% in 1990. By the year 2015, there were 339,925 people with foreign origin residing permanently in Finland, which was 6.2% of the population (Official Statistics of Finland (OSF), 2015). Out of all people with foreign background, 23% (79,016 persons) were Russians, followed by Estonians 14% (49, 960 persons), Somalians 5% (17,761 persons) and Iraqis 4% (13, 967 persons).

According to Statistics Finland, over 30,000 of persons moved to Finland in 2016, which was 21% greater than the year before (Official Statistics of Finland (OSF), 2016). Immigration gain was largest from Iraq (3, 069 migrants), Russia (2,087 migrants) and Afghanistan (1,097 persons). It is expected that the number of migrants will grow during



the next few years. Thus, it is important to study the health and well-being of this growing population group.

Until recently there have been no large-scale studies on migrants' health in Finland. The Finnish Migrant Health and Wellbeing Study (Maamu) was first population-based survey, which covered various aspects of health and well-being of Russian, Somali and Kurdish migrants living in Finland (Castaneda et al., 2012). The study enrolled 1,000 of each of Russian, Somali and Kurdish background participants and consisted of an extensive interview and health examination. Maamu has discovered health disparities among the aforementioned migrant groups and produced abundance of data for further scientific research. As this survey was performed according to the similar protocol as Health 2011 study, it is possible to compare data on migrants with data on the general population.

### **2.3. Overweight and obesity**

#### **2.3.1 Definitions of overweight and obesity**

World Health Organization (WHO) defines overweight and obesity as “abnormal or excessive fat accumulation that presents a risk to health” (World Health Organization, 2017a). Body mass index (BMI) is the most commonly used measure for overweight and obesity in adults. BMI is defined as the weight in kilograms divided by the height in meters squared ( $\text{kg}/\text{m}^2$ ). According to WHO, a person is overweight if his/her BMI is equal or exceeds 25.0 and obese if BMI is equal or greater than 30.0 (World Health Organization, 2000). Table 1 demonstrates BMI cutoffs for overweight and obesity recommended by WHO.

Table 1. BMI classification (kg/m<sup>2</sup>)

Underweight	<18.5
Normal range	18.5 – 24.9
Overweight:	≥ 25.0
Preobese	25.0 – 29.9
Obese:	≥ 30.0
Obese class I	30.0 – 34.9
Obese class II	35.0 – 39.9
Obese class III	≥ 40.0

Source: WHO, [http://www.who.int/dietphysicalactivity/childhood\\_what/en/](http://www.who.int/dietphysicalactivity/childhood_what/en/)

Apart from BMI, a whole range of other weight indices is used to measure overweight and obesity, for example, waist circumference (WC), waist-to-height ratio (WHtR), waist-to-hip ratio (WHR) and others. WHtR, also called waist-to-stature ratio (WSR), is defined as an individual's waist circumference divided by his/her height. WHtR is correlated with abdominal obesity (Lee, Huxley, Wildman, & Woodward, 2008). Unlike for BMI, there are no generally approved cut off points for overweight and obesity as indicated by WHtR, rather WHtR predicts health risks related to overweight. A general healthy cut off for WHtR is 0.5 for both men and women (Browning, Hsieh, & Ashwell, 2010). Readings of WHtR exceeding 0.5 indicate increased cardiometabolic risk (Ashwell, Gunn, & Gibson, 2012).

During the recent decades, it has been debated that WHtR is a better predictor for cardiovascular diseases (CVD) and diabetes than BMI (Ashwell & Hsieh, 2005; Browning et al., 2010; Schneider et al., 2010). BMI does not account for muscle or fat accumulation, and therefore may be improper measure of overweight for men. Moreover, some studies demonstrated that similar BMI thresholds for overweight may be inappropriate for diverse ethnic groups (Razak et al., 2007; WHO Expert Consultation, 2004). In general, it is agreed that abdominal obesity is a better predictor for CVD risk and mortality.

In the present study, both BMI and WHtR indices were included to see, whether any of them is strongly associated with BP and if there are differences in the distribution of overweight according to BMI and WHtR.

### **2.3.2 Global and regional trends in overweight and obesity**

Since 1980s overweight and obesity have increased substantially and, according to WHO, obesity has more than doubled. In 2014, more than 1.9 billion adults, aged 18 years and over, were overweight and, out of these, over 600 million were obese (World Health Organization, 2016).

The Global Burden of Disease Study (GBD study) estimated that in 2013 36% men and 37% of women were obese worldwide (Ng et al., 2014). There are considerable variations in the prevalence and trends of overweight and obesity among regions, countries and genders. Community is concerned with a global epidemic of obesity, which has affected both developed and developing countries. According to GBD study, over the past three decades increase in obesity in developed countries has somewhat stabilized, whereas in developing countries, where almost two in three of the world's obese live, there are likely to be continued increases (Ng et al., 2014). Interestingly, in developed countries, men have higher rates of overweight and obesity, while in developing countries, women are more overweight/obese than men (Ng et al., 2014).

In the European region prevalence of overweight and obesity is second largest in the world after Americas with the prevalence of 54.8% and 61.1%, respectively (Yatsuya et al., 2014). Most European countries have similar prevalence of overweight and obesity in adults, however, a few demonstrate highest rates (Turkey 63.8%, Czech Republic 61.7%, Malta 61.6%) and some show the lowest share (Tajikistan 33.8%, Turkmenistan 43.8%, Switzerland 44.3%). The same group of countries with the highest and lowest prevalence of overweight also had the highest and lowest prevalence of obesity in the region (Yatsuya et al., 2014). Yatsuya and colleagues also discovered that overweight/obesity was more common among men than women, but the likelihood of obesity was similar for both genders (Yatsuya et al., 2014).

The prevalence of overweight/obesity was the lowest in the South-East Asia (13.3%), followed by Western Pacific (25.4%), Africa (26.9%) and Eastern Mediterranean

(46.0%). However, notable heterogeneity among countries was present in the three of four regions (Yatsuya et al., 2014).

### **2.3.3 Prevalence of overweight and obesity in Finland, Russia, Somalia, Iran and Iraq**

The focus of the present study is on Finnish, Russian, Somalian and Iranian/Iraqi populations. As the majority of Kurdish people originate from Iran and Iraq, the prevalences of overweight and obesity in these countries were used as proxies for the prevalence of the same conditions among Kurdish individuals.

In 2014, prevalence of overweight/obesity in Finland was 62% for males and 48.6% for females (World Health Organization, 2017b). In 2012, prevalence of obesity among adults ( $\geq 25$  years) was 20.4% and 19.0% for men and women, respectively (World Health Organization, 2013b). It has been reported recently that BMI increase in Finland during the recent decades has leveled off (Borodulin et al., 2015). Yet, the proportion of overweight/obese individuals is high and the National Obesity Programme has been launched in 2012 to reduce overweight and obesity in the population by promotion of healthy diet and physical activity.

WHO estimated in 2014 that in the Russian Federation 60.3% of men and 54.8% of women were overweight or obese (World Health Organization, 2017b). Shukla et al. reported that 58% of Russians were overweight and out of this 22% were obese (Shukla, Kumar, & Singh, 2014). According to the same study, females were more likely to be obese than males (Shukla et al., 2014). WHO estimates of obesity in 2008 were 18.6% for men and 32.9% for women. Adulthood obesity prevalence forecasts (2010-2030) predicted that by 2020, 31% of males and 26% of Russian females will be obese (World Health Organization, 2013c). Up to now, no national programme for reduction of overweight and obesity exists in Russia, although the overweight/obesity problem is recognized. Population studies on overweight and obesity are scarce.

Data on overweight and obesity in Somalia is mostly limited by WHO estimates. According to WHO, in 2014, 14.6% Somalian males and 25.3% females were overweight/obese (World Health Organization, 2017b). Similarly to Russia, women in Somalia were more likely to be overweight or obese than men (Yatsuya et al., 2014). A

systematic analysis of GBD 2013 study showed that since 1980 prevalence of overweight and obesity in Somalia has not changed considerably and stayed around 24% for males (> 20 years) and around 27.5% for females (> 20 years). Prevalence of obesity remained the same and was around 7 % for men and 12% for women throughout the 1980-2013 period (Ng et al., 2014).

In 2014 prevalence of overweight/obesity in Iran was 56.5% for males and 64.2% for females (World Health Organization, 2017b). Proportion of overweight/obese Iraqis in 2014 was 53.7% among men and 63.7 among women (World Health Organization, 2017b). According to Ng and colleagues, prevalence of overweight/obesity in both Iran and Iraq has elevated considerably since 1980 and increased for Iranian men (> 20 years) from 39.9% in 1980 to 49.4% in 2013 and for Iranian women (> 20 years) from 53.4% in 1980 to 63.3% in 2013. Similar trend has been observed for Iraqis, where prevalence of overweight/obesity increased for males from 50.8% in 1980 to 62.4% in 2013 and for females from 57.4% in 1980 to 68.1% in 2013 (Ng et al., 2014).

Overall, prevalence of overweight and obesity has grown substantially over the past three decades in the majority of developed and developing countries. This phenomenon was called an ‘obesity epidemic’ and represents a serious threat to population health worldwide. Overweight and obesity prevalence is at high levels in Finland, Russia, Iran and Iraq but it stays at lower levels in Somalia.

#### **2.3.4 Overweight and obesity among migrants and ethnic minorities**

In the present literature review the focus is on Russian, Somali and Kurdish migrants as these populations will be studied.

One of the countries which accepts more migrants than any other country in the world is the US. Therefore, not surprisingly, an extensive research on migrants’ health and related factors has been conducted in the United States. In addition, data on various migrant groups is available from the United States’ research, including people of Middle Eastern, Russian (and former USSR) and African descent.

A large study from the United States pooled data on 34 456 migrants from the two National Health Interview Surveys held in 1997 and 2005 years and estimated prevalence of overweight and diabetes in migrants from the nine regions of the world (Oza-Frank &

Narayan, 2010). Self-reported information on health was obtained from adults (18 and over years). Foreign birth was considered a proxy for migrant status. Among the nine regions were Russia (former USSR republics), Africa (all African countries) and Middle East (including Iran, Iraq and Turkey). Majority of the migrants had resided in the United States for at least 15 years. On average, 50% of Europeans, 51% of Russians, 52% of Africans and 51% of Middle Eastern migrants were overweight or obese. The multivariable adjusted prevalence of overweight among Russians was 65% for men and 47,7% for women, among Africans 52% for men and 55% for women, and among Middle Eastern migrants 61.3% for men and 38.4% for women. Among European migrants similar prevalences were 60.6% for males and 43.1% for females. Over the same period of time, prevalence of overweight and obesity in the general population of the US stayed around 64.5% (Ogden & Carroll, 2010). These findings suggested that migrant men had higher prevalence of overweight compared with women from the same region, except Africans. However, for the purpose of the current literature review, where Russian, Somali and Kurdish migrants are of particular interest, it might be a limitation that this study pooled all former soviet republics together under 'Russians' variable, as well as all African countries as 'Africans' and Middle East countries as 'Middle East' category. Thus, the prevalence values were somewhat diluted. Moreover, although this study presented ORs for overweight among migrants, the reference group was not Americans, but European migrants, which might as well has lowered the accuracy of the estimated prevalences. A drawback which authors considered as well, was self-reported data, and assumed that weight and diabetes were underreported. Nevertheless, this large nationally representative study provided valuable information on the general prevalence of overweight in various migrant groups in the US.

Overweight and obesity are sometimes studied in the association with acculturation. A systematic review from the United States investigated the association between acculturation and obesity among migrants (Delavari, Sonderlund, Swinburn, Mellor, & Renzaho, 2013) and discovered inverse correlation between acculturation score and obesity among women from the former Soviet Union. Authors concluded that length of residence in the United States had positive influence on women's health behaviour. In that longitudinal study there were no male participants from the former USSR. Among other migrant groups discussed in the review, males tended to report higher obesity with

higher acculturation rates. This study gives an important insight into complexity of overweight and obesity among migrant populations.

Hofmann investigated health outcomes among migrants from the former Soviet Union in the United States and revealed that although former Soviet Union people tended to have lower mean BMI than US-born individuals (26.17 vs. 27.10), they were more likely to be overweight (Hofmann, 2012). Interestingly, prevalence of obesity was also lower among former Soviet Union migrants compared to US-born (15.73% vs. 23.21%). Hofmann speculated that the better health among former Soviet Union migrants could be explained by positive selection prior to migration to US, namely, that group of migrants was highly educated and had lower prevalence of binge drinking and smoking than US-born individuals.

Information on overweight and obesity among Somali and Kurdish migrants is limited. However, overweight and obesity have been studied in populations of African descent in context of CVD risk factors (Agyemang, Addo, Bhopal, Aikins Ade, & Stronks, 2009; Gele & Mbalilaki, 2013; Kaufman, Durazo-Arvizu, Rotimi, McGee, & Cooper, 1996). Agyemang and colleagues concluded that overweight and obesity are highly prevalent among African migrants in Europe, and especially among women. Literature suggests that this can be explained by westernization of health behaviours of migrants (unhealthy food choices, transition from undernutrition to overnutrition, low physical activity) (Misra & Ganda, 2007; Renzaho, 2004). Sub-Saharan men and African Caribbean men had lower rates of overweight and obesity than European men. It has been reported that overweight/obesity is highly prevalent among migrant Somalians (Njeru et al., 2016; Skogberg et al., 2016). A study from Oslo, Norway, revealed high prevalence of overweight/obesity among Somali women (66%) and low physical activity in this group of migrants (Gele & Mbalilaki, 2013). There is evidence that Somalis do not consider overweight and obesity as a disease, but rather as a sign of success, good health and happiness (Renzaho, 2004). A study from the UK revealed that while young Somali women were concerned about having healthy body size, they were restrained by older Somali's perception associating large body with high self-esteem (Gardner, Salah, Leavey, & Poncellato, 2009).

Data about the prevalence of overweight and obesity among Kurdish migrants is sparse. A study from Finland, based on the Migrant Health and Well-being (Maamu) survey, indicated that obesity (waist circumference  $\geq 102$  cm(M)/  $\geq 88$  cm(F) or BMI  $\geq 30$  kg/m<sup>2</sup>.) among Kurdish men and women was 26.3% and 54.4%, respectively (Skogberg et al., 2016). Prevalence of obesity based on BMI  $\geq 30$  kg/m<sup>2</sup> was 20.7% for Kurdish males and 33.2% for Kurdish females. Faskunger et al. studied the risk of obesity in migrants and native Swedes in two deprived areas of Sweden and discovered that Middle Eastern women were the most obese group (BMI  $\geq 30$  in 42.9% participants) compared with Swedes and other European migrants (Faskunger, Eriksson, Johansson, Sundquist, & Sundquist, 2009). However, higher prevalence of obesity in migrants from Middle East can be partially explained by their residence in the deprived areas.

## **2.4 Hypertension**

### **2.4.1 Definition, prevalence and trends in different countries**

WHO defines hypertension as a systolic blood pressure (SBP) equal to or above 140 mm Hg and/or diastolic blood pressure (DBP) equal to or above 90 mm Hg regardless of antihypertensive medication (World Health Organization, 2013a). According to European guidelines on CVD, hypertension is categorized into Grade I hypertension, when SBP is in the range of 140-159 mm Hg and/or DBP is within 90-99 mm Hg range; Grade II hypertension if SBP is between 160-179 mm Hg and DBP is between 100-109 mm Hg; Grade III hypertension, when SBP is equal to or greater than 180 mm Hg and DBP is equal or over 100 mm Hg; Isolated systolic hypertension if SBP is equal or exceeds 140 mm Hg, whereas DBP stays below 90 mm Hg (Piepoli et al., 2016). There are few synonyms of hypertension: elevated/increased/raised blood pressure, high blood pressure. These terms will be used in this literature review together with the word hypertension. In the majority of the studies included in this literature review hypertension was defined as SBP  $\geq 140$  mm Hg and/or DBP  $\geq 90$  mm Hg and/or antihypertensive medication. If the study did not include intake of antihypertensive medicines in their definition of hypertension, this was mentioned separately.



Hypertension is an important risk factor for the development of CVD and is a leading risk factor for disease burden globally, accounting for 9.4 million deaths in 2010 (Lim et al., 2012). Hypertension contributes to at least 45% of deaths due to heart disease, and 51% of deaths due to stroke (World Health Organization, 2008). The risk of death from either CHD or stroke increases linearly from BP levels of 115 mmHg systolic and 75 mmHg diastolic upwards (Lewington et al., 2002).

The prevalence of hypertension worldwide is 30-45% in persons older than 18 years, with a steep increase with age (Piepoli et al., 2016). The prevalence of hypertension is highest in the African region with 46% of adults ( $\geq 25$  years) suffering from the condition, while the lowest prevalence of 35% is found in the Americas (World Health Organization, 2011). Globally, the number of people with raised BP increased from 600 million in 1980 to nearly 1 billion in 2008 (World Health Organization, 2011). The increasing trend of elevated BP can be attributed to population growth, ageing and behavioural changes, such as unhealthy diet, excess use of alcohol, lack of physical activity, overweight and obesity and exposure to chronic stress (World Health Organization, 2013a).

The prevalence of hypertension in Europe was 40% in 2008 with percentage higher among men (World Health Organization, 2013a). A study on prevalence, awareness and treatment of high blood pressure in Finland showed that during 1982-2007 the prevalence of hypertension decreased in both sexes. In males, it fell from 63.3% to 52.1%, and in women, from 48.1 to 33.6% (Kastarinen et al., 2009). During the same period, the mean SBP and DBP in the Finnish population also decreased (Kastarinen et al., 2009). According to the latest national health survey (Health 2011 study), the prevalence of hypertension in Finland was 53.3% and 45.6% in men and women respectively (Koskinen, Lundqvist, Ristiluoma, & editors, 2012). Although it might seem that the prevalence of high blood pressure is rising in Finland, uptake of antihypertensive treatment has almost doubled over the past decade, and as a result of that the mean BP has decreased (Koskinen et al., 2012).

In the 1990-ies, the prevalence of hypertension (BP medication not included) in Russia was 39% and 41% among adult men and women, respectively (Petrukhin & Lunina, 2012). The prevalence of elevated blood pressure in Russia, as estimated by the European cardiovascular disease statistics, was 46.2% for men (aged 25 years and over) and 41.3%

for women (aged 25 years and over) in 2008 (Nichols et al., 2012). According to the WHO Study on Global Aging and Adult Health (SAGE) study, there were 52% of hypertensive adults in Russia in 2010 (Basu & Millett, 2013). As provided by WHO Global Health Observatory, the prevalence of hypertension in the Russian Federation in 2015 was 32.6% for males (over 18 years) and 22.3% for females (over 18 years) with a visible declining trend since 1990s (World Health Organization, 2017c). The WHO estimates for hypertension are calculated without including persons on antihypertensive medication. Compared to the 1990-ies WHO estimates, hypertension prevalence has decreased. Additionally, declining trends in mean SBP levels have been documented in Russia (Nichols et al., 2012). Since 1980 SBP levels slightly decreased for men and women. However, the WHO estimates and a study by Petrukhin and Lunina did not account for BP lowering medication and thus should be taken with caution because it is unknown whether hypertension rate has decreased due to improved diagnostics, better awareness or higher BP medication use. The high prevalence of hypertension in Russia reported by Basu and Millet may be partially explained by the oversampling of individuals aged 50 and over years in the SAGE study.

The prevalence of hypertension in Iran was 20.4% for males (over 18 years) and 18.9% for females (over 18 years) in 2015 with a notable decreasing trend over the past few decades (World Health Organization, 2017c). A third national surveillance of risk factors of non-communicable diseases (SuRFNCD-2007) study performed in Iran in 2007 recruited over 5000 participants aged from 15 to 64 years and revealed that the prevalence of hypertension was 26.6% (Esteghamati et al., 2009). According to SuRFNCD-2007, among Iranian males and females aged 25-64 years, the prevalence of hypertension was 24.7% and 28.6%, respectively. Ebrahimi and colleagues found out that Kurdish ethnicity was independently associated with higher prevalence of hypertension (OR 1.34,95%CI 1.09-1.65) in Iran (Ebrahimi et al., 2010). The prevalence of elevated blood pressure seems to be lower in Iran than in European countries on average.

According to WHO, the prevalence of high blood pressure in Iraq in 2015 was 25.6% for men (over 18 years) and 24.4% for women (over 18 years) (World Health Organization, 2017c). Data on hypertension prevalence in Iraq is scarce. Study results from the selected Primary Health Care Centres in Nasiriya city, published in 2011, showed that 46.1% of the visiting patients had elevated blood pressure (Al-Lami & Mousa, 2011).

The prevalence of hypertension in Somalia among adults aged 18 and over years was 33.5% for men and 32.2% for women in 2015 (World Health Organization, 2017c). High blood pressure prevalence was stable for the past two decades without clear down- or upward trend. Information about the rates of hypertension in Somalia is very limited.

#### **2.4.2. Prevalence of hypertension among migrants and ethnic minorities**

A study from the United States assessed the prevalence of self-reported hypertension in migrants in relation to the length of residence in the country (Yi, Elfassy, Gupta, Myers, & Kerker, 2014). Yi and colleagues discovered that white migrants (especially those, coming from the Eastern Europe and former Soviet Union) reported higher hypertension rates, compared with native-born whites: 25.3% vs. 22.5%, respectively. Additionally, those speaking Russian had higher self-reported hypertension than English speakers. Moreover, longer residence in the United States was associated with higher prevalence of self-reported hypertension among foreign-born. Authors emphasized the importance of considering the baseline rates of disease in the country of origin. It is also known that in Eastern Europe prevalence of hypertension is high (Bielecka-Dabrowa, Aronow, Rysz, & Banach, 2011). An older study from Denver metropolitan area in the United States found higher prevalence of hypertension in Russian migrants, when compared to their United States' counterparts (Mehler et al., 2001). In the younger age group 20-34 years, 35.7% Russians vs. 6.1% United States' individuals had hypertension ( $p < 0.001$ ) and among those aged 55-64 years, the prevalence of hypertension was over 65% compared to 46.6% among Americans. The difference was most pronounced in 65-74 years groups.

A study from Sweden investigated CVD in relation to diabetes status in migrants from the Middle East in comparison to Swedes (Bennet, Agardh, & Lindblad, 2013). Bennet and colleagues revealed that self-reported hypertension was 11.2% among Iraqi migrants (mean age 45.8 years) and 14% among Swedes aged 49.2 years. Although these percentages seem to be low, it should be born in mind that hypertension was self-reported in this study. Skogberg and colleagues found that the prevalence of hypertension was 19.9% in Kurdish migrants and 36% in the general Finnish population in the age group of 40+ years (Skogberg et al., 2016).

An extensive literature review produced by Agyemang and colleagues revealed that populations of sub-Saharan African descent in Europe have higher rates of hypertension than European populations (Agyemang et al., 2009). In this study, the term sub-Saharan African referred to persons and their offspring with ancestral African origin who migrated via sub-Saharan Africa to Europe. Included in this literature review, a study from the United States showed that African Americans have an increased prevalence of hypertension compared to white counterparts in the United States (Cooper & Rotimi, 1997). Another study from the US, found higher prevalence of obesity, overweight and hypertension among Somali patients compared to non-Somali patients: 34.6 vs. 32.1%, 33.2 vs. 30.4% and 17.0 vs. 15.5%, respectively, although the difference for hypertension was not significant (Njeru et al., 2016). A cross-sectional study by Sewali et al. assessed the prevalence of CVD risk factors among six African migrant groups in Minnesota, the United States (Sewali et al., 2015). The prevalence of hypertension among Somalians was 5.9% and overall prevalence of hypertension in all six migrant groups was 8.3%. The mean age in the Somali group was 35.0 years. The two studies present totally different rates of hypertension among Somali individuals; however, it is important to note that the survey by Njeru included hospital patients, which might have resulted in higher rates of hypertension. While in the study by Sewali and colleagues, hypertension was self-reported, which might have lowered the actual prevalence of the condition.

To sum up, data on prevalence of hypertension among Russian migrants mostly suggest that Russians have higher hypertension rates than their white counterparts, although this conclusion is true for the US, it is yet unknown if the same holds true in European settings. Regarding Middle Eastern and Kurdish migrants, data is sparse. However, the small evidence available shows that Middle Eastern migrants tend to have lower BP levels and rates of hypertension than Europeans. The situation is more complex within African migrants in the US; while some studies report higher hypertension rates among Somalians and other African origin migrants, other suggest that hypertension prevalence is low in these groups. Thus, it is of great interest to researchers and importance for health policies, to reveal the hypertension rates in these migrant groups in Europe.

## **2.5. Overweight and obesity as risk factors for cardiovascular diseases and hypertension**

The negative influence of excess body weight on health has been well documented. Overweight and obesity are known to cause a number of adverse health outcomes such as CVD, hypertension, diabetes (Calle et al., 1999; Droyvold, Midthjell, Nilsen, & Holmen, 2005; Field, Coakley, Must, & al, 2001; Guh et al., 2009; Hubert et al., 1983; Huxley, Mendis, Zheleznyakov, Reddy, & Chan, 2009; Kannel, 1997; Manson et al., 1990; Manson et al., 1995).

In the systematic review by Guh et al. overweight and obesity were studied in relation to 18-comorbidities, including CVD (Guh et al., 2009). Out of 89 studies selected for the review, 27 were related to hypertension, CHD, congestive heart failure, pulmonary embolism and stroke. Relative co-morbidity risks (RRs) related to overweight and obesity among CVD outcomes ranged from 1.23 to 3.51. Interestingly, almost for all health conditions, RRs were greater for females than males. WC measure was considered a better predictor for CVD risk than BMI in all co-morbidities but pulmonary embolism.

As reported by Hubert and colleagues in 1983, degree of obesity in Framingham men and women was an important long-term predictor of CVD. Participants aged from 28 to 62 years, free of clinically recognizable CVD were enrolled into the study and followed up for 26 years (Hubert et al., 1983). Authors discovered that, compared to their lean counterparts, heaviest men had twice the risk of coronary heart disease (CHD), and the risk was 2.4-fold among obese women. Already at that time it was speculated that obesity may influence the onset of one of the CVD risk factors – hypertension. Although this study employed the Metropolitan Relative Weight (MRW) index of obesity, it is highly probable that the results would have been similar if BMI or any other obesity index was used.

Manson et al. studied The Nurses' Health Study cohort and concluded that obesity is a major risk factor for CHD and CHD mortality in the United States middle aged women (Manson et al., 1990). The follow up period lasted for eight years from 1976 to 1984. A fairly large sample of over 100 000 women aged 30-55 years, free from CHD was enrolled into the survey. Relative risk (RR) of CHD rose progressively with each category of increasing relative weight and was 2.6 in women with  $BMI \geq 29$  compared to the

leanest. Moreover, among the heaviest women ( $BMI \geq 29$ ), more than two thirds of CHD events were attributable to obesity (40% in the overall study population). In their later analysis of the Nurses' Health Study cohort, Manson and colleagues investigated the influence of overweight on mortality from various diseases (Manson et al., 1995). Women with BMI over 32 had 4.1 RR of death from CVD and 2.1 RR of death from cancer when compared with the risk among women who had  $BMI < 19$ . Authors also concluded that body weight and mortality from all causes were directly related in these women.

Another large cohort study was performed by Calle et al. in the United States (Calle et al., 1999). The primary aim of the study was to investigate the relationship between BMI and mortality. Risk of death from all causes increased in all age groups with an increasing BMI.

These studies are the few of many that have been carried out in the field. However, already after familiarizing with these several studies, it becomes clear that there is a definite association between body weight and health risks. Overweight and obesity are predisposing risk factors not only for CVD, but also for cancer, diabetes and other causes of morbidity and mortality. There are age and gender variations in this association, although generally, increased BMI is associated with increased health risks, elevated BP.

## **2.6. The association between BMI, WHtR and level of blood pressure**

### **2.6.1 Study methods and types of the association existing between anthropometric indices and BP**

Studies about the association between BMI and BP have been published since 1950-ies and later research interest focused more on measures of central obesity, such as WC and WHtR. The association between various anthropometric indices and level of BP is not uniform. Some anthropometric indices are more strongly associated with elevated blood pressure than others, while other indices are better predictors of CVD events. Nevertheless, in this literature review the focus is only on BMI and WHtR indices and their relationship with BP.

There is a well-established association between BMI and level of BP (Droyvold et al., 2005). Increased body mass is associated with higher BP and increased risk of cardiovascular diseases (Calle et al., 1999). Several studies explored the association between BMI and BP and/or hypertension (Droyvold et al., 2005; Dyer & Elliott, 1989; Kaufman et al., 1997; Masuo, Mikami, Ogihara, & Tuck, 2000; Wolf et al., 1997). As found by Drøyvold, there was a causal association between change in BMI and change in BP in both sexes independent of initial and attained BMI in a prospective cohort study with 11 years of follow-up (Droyvold et al., 2005). Weight gain, according to Drøyvold, leads to increase in SBP and DBP, whereas weight loss leads to decrease in BP. Both Masuo's and Drøyvold's research groups stated that weight gain stimulates sympathetic activation and thus predisposes to increased BP (Masuo et al., 2000). Kaufman and colleagues studied the association between BMI and BP in seven lean African populations and found that in these groups the relationship was nonlinear and varied between men and women (Kaufman et al., 1997). If for men the association between BMI and SBP was more or less linear, for women the association was age-dependent with steeper slopes in those over 45 years. The important conclusion of this study is that obesity, per se, is not required for the association between BMI and BP to be manifest. The INTERSALT study showed that the correlation between BP and BMI was independent of 24-hour sodium and potassium excretion, alcohol consumption and smoking, and gender and age (Dyer & Elliott, 1989). The WHO MONICA project studied the CVD risk factors in 41 populations in 22 countries and discovered that age-adjusted BMI was correlated to SBP and accounted for 14% of the variance in SBP in men and 32% in women (Wolf et al., 1997). Many other studies have found persistent association between increase in BMI and increase in BP. But lately it has been argued that indices of central obesity such as WHtR can be stronger associated with CVD and BP elevation (Ashwell et al., 2012; Browning et al., 2010; Cai, Liu, Zhang, & Wang, 2013).

The association between WHtR and BP is mostly studied in the context of CVD risk and hypertension. In a systematic review of seventy-eight papers, Browning et al. stated that while BMI, WHtR and WC were all predictors of CVD, diabetes and related risk factors, WHtR and WC were probably more reliable predictors than BMI (Browning et al., 2010). In their systematic review authors investigated the association between anthropometric indices and health outcomes by the means of receiver operator characteristic (ROC) curve

analysis, which revealed mean area under ROC curve (AUC) values of 0.704, 0.693 and 0.671 for WHtR, WC and BMI, respectively. The ROC curve analysis assesses the discriminatory capability of different indices in relation to the studied outcome. The greater is the AUC the greater is discriminatory power of the index. Therefore, Browning and colleagues concluded that WHtR and WC were similar predictors of CVD and diabetes, and both were stronger than, and independent of, BMI (Browning et al., 2010).

A systematic review and meta-analysis by Ashwell et al. revealed that WHtR is a better predictor for hypertension than BMI (Ashwell et al., 2012). The inclusion criteria for this systematic review were stricter than in a review by Browning et al., only studies about adults and studies that reported ROC analyses were included. This has probably resulted in a smaller number of retrieved papers. Authors studied thirty-one paper that used ROC analysis to assess discriminatory power of various anthropometric indices in predicting hypertension, type-2 diabetes, dyslipidemia, metabolic syndrome and general CVD outcomes in adults. Regarding hypertension, WHtR had 3-4% better discrimination power than BMI. Mean areas under the ROC curve (AUCs) were 0.65 for BMI and 0.69 for WHtR ( $P=0.047$ ) for men and 0.73 and 0.69 for women ( $P=0.06$ ) (Ashwell et al., 2012). Another important conclusion of this systematic review was that WHtR was a better predictor for CVD risks, diabetes and hypertension in both sexes in various populations and ethnic groups.

A literature review by Huxley et al. included studies on the relation of BMI, WC and WHtR to diabetes, CVD risk and dyslipidemia (Huxley et al., 2009). The authors focused on the associations between obesity indices and mentioned diseases. The conclusion was that although all three indices were associated with CVD, there was no evidence for any of them to be a better predictor of CVD than another. Huxley and colleagues also briefly discussed the association between WHtR and CVD risk and noted that despite stronger association with CVD risk than BMI, the actual difference between two measures was unlikely to be clinically significant.

Not included in the previous literature reviews, a cross-sectional study from China was published in 2013 (Cai et al., 2013). Cai and colleagues investigated the relationship between WHtR and CVD risk factors among 5720 adults in Beijing and found that WHtR performed better than BMI and WC for the association with hypertension and diabetes



(Cai et al., 2013). This survey also applied ROC analysis as the previous papers mentioned. The AUCs for WHtR were 0.661-0.773 and significantly higher than those for BMI for all outcomes in both sexes, except for dyslipidemia in men, where WHtR and BMI had similar AUCs (Cai et al., 2013). Moreover, WHtR yielded the greatest ORs for hypertension and diabetes for both sexes. This study also proposed optimal cut-off for WHtR at levels 0.51-0.53 for men and 0.48-0.50 for women, which in fact is very close to the recommended WHtR of 0.5.

To sum up, there is an established association between BMI, WHtR and CVD risk factors, including hypertension. Recently it has been argued that WHtR can be a better predictor for CVD and its risk factors. A growing number of studies gives support to the idea that indices of central obesity (WHtR among them) are better at distinguishing CVD risk factors and hypertension than BMI. Yet, more longitudinal studies are needed to confirm these findings.

#### **2.6.2. Associations between BMI, WHtR and level of blood pressure in different ethnic groups**

Data on the association between body mass and level of BP in different ethnic groups is inconsistent. Some studies suggest that there is a linear uniform pattern of association for various populations (Kaufman et al., 1996), whereas others suggest that there is nonlinearity in the association between anthropometric indices and BP (Bunker et al., 1995; Colin Bell et al., 2002; Dyer & Elliott, 1989; Kaufman et al., 1997). Term nonlinearity implies that a certain cut-off/threshold point exists, below which there is no clear association between the index and the outcome.

A study about cut-offs for anthropometric indices that confer increased risk of diabetes and hypertension in Iraqi adults revealed that, in general, overweight/obesity thresholds for BMI and WHtR were similar to those of the WHO (recommended for European populations), and that WHtR was a better predictor for hypertension in both men and women (Mansour & Al-Jazairi, 2007). In the Asian populations, lower BMI values than recommended by the WHO, represent increased risk for CVD and diabetes and it has been suggested that Asians have different pattern of association between BMI, body fat, and health risks than European populations (WHO Expert Consultation, 2004). A large cross-sectional study from China suggested the optimal cut-offs for BMI at 24.0 and 23.0  $\text{kg}/\text{m}^2$

for men and women, respectively, and authors concluded that WC and WHtR were better indicators of CVD risk factors in Chinese population (Zeng et al., 2014). A study from the UK found that people of South Asian origin have a more adverse CVD risk profile than those of European descent at the same levels of BMI and WC (Lear, Toma, Birmingham, & Frohlich, 2003). However, despite the worse risk profile in the south Asians, south Asian women had significantly lower levels of BP. Authors suggested that the relationship between anthropometric indices and risk factors for CVD was modified by ethnic background. A study from the United States revealed that ethnic differences in the association between BMI and hypertension remain even after adjustment for differences in body fat distribution (Colin Bell et al., 2002). In their cross-sectional survey, authors studied 3 ethnic groups from China, Philippines and the US, respectively. Unlike two other groups, in Chinese subjects lower BMI levels were associated with higher risk of hypertension, suggesting a stronger relationship between BMI and hypertension in this population.

The studies focusing particularly on the strength of the association between anthropometric indices and blood pressure and/or hypertension in migrants or ethnic minority groups are scarce.

Bennet and colleagues studied the association between BMI with level of BP in Middle Eastern migrants in Sweden and revealed that the relationship between BMI and BP is modified by the country of birth (Bennet & Nilsson, 2014). This cross-sectional study involved 1311 Iraqis and 698 Swedish-born individuals. Being born in Iraq independently decreased the risk of elevated BP and, moreover, higher BMI and WC presented weaker associations with BP in Iraqis, compared to Swedes. In their discussion section Bennet et al. reveal that, although it is generally agreed that increased body weight increases sympathetic nervous system (SNS) activity and thus predisposes to higher BP in overweight/obese individuals (Hall, Brands, Hildebrandt, Kuo, & Fitzgerald, 2000), studies have also revealed that SNS activity can be different in various ethnic groups. For instance, Pima Indians have lower SNS activity compared to Europeans (Spraul et al., 1993) and there is no increase in SNS activity with increasing adiposity in this group (Weyer et al., 2000). It is probable, that similar mechanism was at work in the Iraqi population studied.

A few studies from Norway and Germany comparing CVD risk factors among native populations and migrants from the Middle East discovered lower BP levels in migrants despite higher levels of other CVD risk factors (smoking, plasma triglycerides) (Haas, Parhofer, & Schwandt, 2010; Kumar et al., 2009). The study by Kumar et al. included migrants from the Middle East (Turkey, Iran, Pakistan), Sri Lanka and Vietnam. The 10-year risk of the fatal CVD event was predicted in asymptomatic individuals using the Systematic Coronary Risk Evaluation project (SCORE) algorithm. Migrants from the Middle East had lower BP, higher triglycerides and lower high-density lipoproteins (HDL) compared with native Norwegians. Prevalence of obesity ( $BMI \geq 30$ ) varied widely between the groups, ranging from 3 % in Vietnam men to 21% in Pakistani men, and from 4% in Vietnamese women to 40% among Pakistani women. A study from Germany revealed similar prevalences of the CVD risk factors and lower prevalence of hypertension in the migrants from the Middle East (only Turkish) (Haas et al., 2010). Although these studies did not specifically investigate the relationship between body weight and blood pressure, they gave an important insight into the complexity of these associations in migrants compared with the general population. Despite having high prevalence of triglycerides and smoking, migrants had lower BP and/or hypertension rates. The summary of the studies' main methods can be found in the table 2.

From the several studies, observed in this literature review, it becomes clear that the debate about the type and strength of the association between body weight indices and BP in various ethnic groups is still ongoing. It is also unknown if migration itself affects the relationship between body weight and BP, as comparative studies about this association in the home countries of migrants and host countries are scarce. This ongoing debate warrants our study, which investigates the association between BMI, WHtR and BP in the three migrant groups residing in Finland.

Table 2. Summary of the study methods in the chapter 2.6 ‘The association between BMI, WHtR and level of blood pressure’

Authors	Country	Ethnic groups /Participants (N)	Design	Mean age (years)/ (age of enrollment)	Risk factors	Outcome	Main findings
<b>2.6.1 Study methods and types of the association existing between anthropometric indices and BP</b>							
Drøyvold et al., 2005	Norway	General population 15 971 women, 13 862 men	2 cross-sectional studies (1984-86, 1995-97)	40.9 (20+) 40.9 (20+)	BMI	hypertension	20-49-year olds, who increased BMI OR=1.8 (1.5-2.2) women, OR= 1.6 (1.4-1.8) men
Calle et al., 1999	USA	General population, black/white 588 369 women, 457 785 men	Prospective cohort (14 years)	57 (30+) 57 (30+)	BMI	death from all causes, death from CVD	Significantly increased risk of CVD death for women with BMI $\geq$ 25 and men with BMI $\geq$ 26.5
Dyer & Elliott, 1989	International study	General population 10 079	Cross-sectional	20-59	BMI	SBP, DBP	10kg increase in weight associated with +3mmHg SBP and +2.2 mmHg DBP increase
Kaufman et al., 1997	Nigeria, Cameroon, Zimbabwe, Jamaica,	Africa and Caribbean 11 235	Cross-sectional	Varied between sites from 40 to 46	BMI	SBP, DBP	Nonlinearity in the association BMI-BP for women (threshold at BMI=21kg/m <sup>2</sup> )
Masuo et al., 2000	Japan	Japanese 1897 men	Prospective cohort (1 year)	37 $\pm$ 6	BMI, obesity	SBP, DBP, hypertension	At 6 months, BMI and Norepinephrine were significant predictors in the change of BP. BP higher in obese subjects than in lean subjects at entry.

Wolf et al., 1997	International study	General population 32 422 men, 32 554 women	Cross-sectional	35-64	BMI	SBP, DBP	Age-adjusted BMI accounted for 14% of the SBP variance in men and 32% in women.
Cai et al., 2013	China	Chinese 2371 men, 3349 women	Cross-sectional	43.4± 14, 44.3± 13 18-79	WHtR, BMI	SBP, DBP, hypertension	Adjusted OR of WHtR for hypertension: men 3.14 (2.59, 3.82), Women 3.60 (3.00, 4.33). WHtR yielded greatest ORs compared to WC or BMI.
2.6.2 Associations between BMI, WHtR and level of blood pressure in different ethnic groups							
Kaufman et al., 1996	Nigeria, Cameroon, Jamaica, St. Lucia, Barbados	Africa and Caribbean 9102	Cross-sectional	25-74	BMI, overweight/obesity	hypertension	All adjusted RRs for hypertension: for overweight and obesity ranged between 1.3-2.3 For BMI as continuous predictor, RRs ranged 1.01-1.12 between seven sites, men and women.
Bunker et al., 1995	Nigeria	Africa 500 men, 299 women	Cross-sectional	42.3 (men) 38.6 20-64	BMI	SBP, DBP, hypertension	Below 21.5kg/m <sup>2</sup> BMI threshold there is little association between BMI and BP in lean African population.
Bell et al., 2002	China, Philippines, USA	China 3424, Philippines 1929, USA 7957	Cross-sectional	30-65	BMI, overweight/obesity	SBP, DBP, hypertension	The ORs of hypertension increased more steeply for Chinese compared to non-Hispanic whites. Comparisons done through ranges in BMI.
Mansour & Al-Jazairi, 2007	Iraq	Iraq 6693 men, 6293 women	Cross-sectional	44.9±16, 46.5±15.4	BMI, WC, WHtR, WHpR	Hypertension	Index with strongest association with hypertension was WHtR (AUCs 0.76 for men, 0.73 for women).

Zeng et al., 2014	China	China 137 256 men, 84 014 women	Cross-sectional	45.6±14, 43.8±13 ≥20	BMI, WHtR	SBP, DBP, hypertension	Age adjusted ORs for hypertension: in men BMI 2.04 (AUC 0.66), WHtR 2.09 (AUC 0.69); in women BMI 2.06 (AUC 0.76), WHtR 2.00 (AUC 0.80). WHtR had higher AUCs for all CVD risk factors.
Lear et al., 2003	UK	European 88, South Asian 93	Cross-sectional	36.5± 9.6 (19-56), 38.2±12.7 (19-67)	BMI, WHpR	SBP, DBP	Ethnicity was an independent predictor for the analysed risk factors, showing more adverse CVD risk profile in South Asians than in Europeans at the same levels of BMI.
Bennet & Nilsson, 2014	Sweden	Sweden 698, Iraq 1311	Cross-sectional	49.2±11.1, 45.7±9.4/ 30-75	BMI	SBP, DBP	Stronger association between BMI and SBP in Swedish participants. Otherwise burdened by CVD risk factors, Middle Eastern migrants had lower BP levels and lower prevalence of hypertension than Swedes.
Kumar et al., 2009	Norway	Norway 11027, Turkey 533, Iran 722, Pakistan 779, Sri Lanka 1145, Vietnam 650	Cross-sectional	Varied between 39 – 44.6	BMI, overweigh t/obesity, WHpR	10- year CVD mortality	Despite otherwise having higher levels of triglycerides and higher prevalence of smoking, migrants had lower BP/ hypertension level than Norwegians. Predicted 10-year CVD mortality was highest among Norwegians and Turkish men.
Haas, Parhofer, & Schwandt, 2010	Germany	Germany 2491; Turkey, Eastern	Cross-sectional	Varied for men between 35.0 – 39.9, for women	BMI, CVD risk factors	prevalence study	-

		Europe, German immigrants from the former Soviet Union (GFSU) 363		between 34.0 – 39.1			
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## References

- Agyemang, C., Addo, J., Bhopal, R., Aikins Ade, G., & Stronks, K. (2009). Cardiovascular disease, diabetes and established risk factors among populations of sub-saharan african descent in europe: A literature review. *Globalization and Health, 5*, 7-8603-5-7. doi:10.1186/1744-8603-5-7 [doi]
- Agyemang, C., & Bhopal, R. (2003). Is the blood pressure of people from african origin adults in the UK higher or lower than that in european origin white people? A review of cross-sectional data. *Journal of Human Hypertension, 17*(8), 523-534. doi:10.1038/sj.jhh.1001586 [doi]
- Agyemang, C., de Munter, J., van Valkengoed, I., van den Born, B. J., & Stronks, K. (2008). Gender disparities in hypertension among different ethnic groups in amsterdam, the netherlands: The SUNSET study. *American Journal of Hypertension, 21*(9), 1001-1006. doi:10.1038/ajh.2008.227 [doi]
- Al-Lami, F., & Mousa, A. (2011). Prevalence of undetected, untreated, and uncontrolled hypertension among attendants of primary health care centers in naseriya city, iraq. *61st Annual Epidemic Intelligence Service (EIS) Conference, Atlanta, Georgia, USA. , 61* 99.
- Ashwell, M., Gunn, P., & Gibson, S. (2012). Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systematic review and meta-analysis. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity, 13*(3), 275-286. doi:10.1111/j.1467-789X.2011.00952.x [doi]



- Ashwell, M., & Hsieh, S. D. (2005). Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *International Journal of Food Sciences and Nutrition*, 56(5), 303-307. doi:V628527571519144 [pii]
- Basu, S., & Millett, C. (2013). Social epidemiology of hypertension in middle-income countries: Determinants of prevalence, diagnosis, treatment, and control in the WHO SAGE study. *Hypertension*, 62(1), 18-26.  
doi:10.1161/HYPERTENSIONAHA.113.01374 [doi]
- Bennet, L., Agardh, C. D., & Lindblad, U. (2013). Cardiovascular disease in relation to diabetes status in immigrants from the middle east compared to native swedes: A cross-sectional study. *BMC Public Health*, 13, 1133-2458-13-1133.  
doi:10.1186/1471-2458-13-1133 [doi]
- Bennet, L., & Nilsson, P. M. (2014). Country of birth modifies the associations of body mass and hemoglobin A1c with office blood pressure in middle eastern immigrants and native swedes. *Journal of Hypertension*, 32(12), 2362-70; discussion 2370.  
doi:10.1097/HJH.0000000000000345 [doi]
- Bhopal, R. S. (2014). *Migration, ethnicity, race, and health in multicultural societies*. Oxford: OUP Oxford.
- Bielecka-Dabrowa, A., Aronow, W. S., Rysz, J., & Banach, M. (2011). The rise and fall of hypertension: Lessons learned from eastern europe. *Current Cardiovascular Risk Reports*, 5(2), 174-179. doi:10.1007/s12170-010-0152-2 [doi]
- Borodulin, K., Vartiainen, E., Peltonen, M., Jousilahti, P., Juolevi, A., Laatikainen, T., . . . Puska, P. (2015). Forty-year trends in cardiovascular risk factors in finland.

*European Journal of Public Health*, 25(3), 539-546. doi:10.1093/eurpub/cku174  
[doi]

Browning, L. M., Hsieh, S. D., & Ashwell, M. (2010). A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. *Nutrition Research Reviews*, 23(2), 247-269. doi:10.1017/S0954422410000144 [doi]

Bunker, C. H., Ukoli, F. A., Matthews, K. A., Kriska, A. M., Huston, S. L., & Kuller, L. H. (1995). Weight threshold and blood pressure in a lean black population. *Hypertension*, 26(4), 616-623. doi:10.1161/01.HYP.26.4.616

Cai, L., Liu, A., Zhang, Y., & Wang, P. (2013). Waist-to-height ratio and cardiovascular risk factors among chinese adults in beijing. *PloS One*, 8(7), e69298. doi:10.1371/journal.pone.0069298 [doi]

Calle, E. E., Thun, M. J., Petrelli, J. M., Rodriguez, C., & Heath, C. W., Jr. (1999). Body-mass index and mortality in a prospective cohort of U.S. adults. *The New England Journal of Medicine*, 341(15), 1097-1105. doi:MJBA-411501 [pii]

Cambridge Dictionary. (2017). Cambridge advanced learner's dictionary & thesaurus. Retrieved from <http://dictionary.cambridge.org/dictionary/english/ethnic-minority>

Castaneda, A., Rask, S., Koponen, P., Mölsä, M., Koskinen, S., & editors. (2012). *Migrant health and wellbeing. A study of persons of russian, somali and kurdish origin in finland.* national institute for health and welfare. ( No. 61/2012). Tampere: Juvenes Print - Suomen Yliopistopaino Oy.

- Colin Bell, A., Adair, L., S., & Popkin, B., M. (2002). Ethnic differences in the association between body mass index and hypertension. *American Journal of Epidemiology*, 155(4), 346-353. doi:10.1093/aje/155.4.346 [doi]
- Cooper, R., & Rotimi, C. (1997). Hypertension in blacks. *American Journal of Hypertension*, 10(7), 804-812. doi:[https://doi.org/10.1016/S0895-7061\(97\)00211-2](https://doi.org/10.1016/S0895-7061(97)00211-2)
- Delavari, M., Sonderlund, A. L., Swinburn, B., Mellor, D., & Renzaho, A. (2013). Acculturation and obesity among migrant populations in high income countries - a systematic review. *BMC Public Health*, 13(1), 458. doi:10.1186/1471-2458-13-458
- Droyvold, W. B., Midthjell, K., Nilsen, T. I., & Holmen, J. (2005). Change in body mass index and its impact on blood pressure: A prospective population study. *International Journal of Obesity (2005)*, 29(6), 650-655. doi:0802944 [pii]
- Dyer, A. R., & Elliott, P. (1989). The INTERSALT study: Relations of body mass index to blood pressure. INTERSALT co-operative research group. *Journal of Human Hypertension*, 3(5), 299-308.
- Ebrahimi, M., Mansournia, M. A., Haghdoost, A. A., Abazari, A., Alaeddini, F., Mirzazadeh, A., & Yunesian, M. (2010). Social disparities in prevalence, treatment and control of hypertension in iran: Second national surveillance of risk factors of noncommunicable diseases, 2006. *Journal of Hypertension*, 28(8), 1620-1629. doi:10.1097/HJH.0b013e32833a38f2 [doi]
- Esteghamati, A., Meysamie, A., Khalilzadeh, O., Rashidi, A., Haghazali, M., Asgari, F., . . . Abbasi, M. (2009). Third national surveillance of risk factors of non-communicable diseases (SuRFNCD-2007) in iran: Methods and results on

prevalence of diabetes, hypertension, obesity, central obesity, and dyslipidemia.

*BMC Public Health*, 9(1), 167. doi:10.1186/1471-2458-9-167

Faskunger, J., Eriksson, U., Johansson, S. E., Sundquist, K., & Sundquist, J. (2009).

Risk of obesity in immigrants compared with swedes in two deprived neighbourhoods. *BMC Public Health*, 9, 304-2458-9-304. doi:10.1186/1471-2458-9-304 [doi]

Field, A. E., Coakley, E. H., Must, A., & al, e. (2001). Impact of overweight on the risk

of developing common chronic diseases during a 10-year period. *Archives of Internal Medicine*, 161(13), 1581-1586.

Gardner, K., Salah, S., Leavey, C., & Poncellato, L. (2009). The perfect size':

Perceptions of and influences on body image and body size in young somali women living in liverpool; a qualitative study. *Diversity & Equality in Health and Care*, (7 (1)), 23-34.

Gele, A. A., & Mbalilaki, A. J. (2013). Overweight and obesity among african

immigrants in oslo. *BMC Research Notes*, 6, 119-0500-6-119. doi:10.1186/1756-0500-6-119 [doi]

Guh, D. P., Zhang, W., Bansback, N., Amarsi, Z., Birmingham, C. L., & Anis, A. H.

(2009). The incidence of co-morbidities related to obesity and overweight: A systematic review and meta-analysis. *BMC Public Health*, 9, 88-2458-9-88. doi:10.1186/1471-2458-9-88 [doi]

Haas, G. M., Parhofer, K. G., & Schwandt, P. (2010). Prevalence of cardiovascular

disease risk factors in migrants participating in the PEP family heart study, nuremberg. *International Journal of Preventive Medicine*, 1(1), 19-28.

- Hall, J. E., Brands, M. W., Hildebrandt, D. A., Kuo, J., & Fitzgerald, S. (2000). Role of sympathetic nervous system and neuropeptides in obesity hypertension. *Brazilian Journal of Medical and Biological Research = Revista Brasileira De Pesquisas Medicas E Biologicas*, 33(6), 605-618. doi:S0100-879X2000000600001 [pii]
- Hofmann, E. T. (2012). The burden of culture? health outcomes among immigrants from the former soviet union in the united states. *Journal of Immigrant and Minority Health*, 14(2), 315-322. doi:10.1007/s10903-010-9436-3
- Hubert, H. B., Feinleib, M., McNamara, P. M., & Castelli, W. P. (1983). Obesity as an independent risk factor for cardiovascular disease: A 26-year follow-up of participants in the framingham heart study. *Circulation*, 67(5), 968-977.
- Huxley, R., Mendis, S., Zheleznyakov, E., Reddy, S., & Chan, J. (2009). Body mass index, waist circumference and waist:Hip ratio as predictors of cardiovascular riskdash]a review of the literature. *European Journal of Clinical Nutrition*, 64(1), 16-22.
- Kannel, W. B. (1997). Effect of weight on cardiovascular disease. *Nutrition (Burbank, Los Angeles County, Calif.)*, 13(2), 157-158. doi:S0899900796003930 [pii]
- Kastarinen, M., Antikainen, R., Peltonen, M., Laatikainen, T., Barengo, N. C., Jula, A., . . . Tuomilehto, J. (2009). Prevalence, awareness and treatment of hypertension in finland during 1982-2007. *Journal of Hypertension*, 27(8), 1552-1559. doi:10.1097/HJH.0b013e32832c41cd [doi]
- Kaufman, J. S., Durazo-Arvizu, R. A., Rotimi, C. N., McGee, D. L., & Cooper, R. S. (1996). Obesity and hypertension prevalence in populations of african origin. the

- investigators of the international collaborative study on hypertension in blacks. *Epidemiology (Cambridge, Mass.)*, 7(4), 398-405.
- Kaufman, J. S., Asuzu, M. C., Mufunda, J., Forrester, T., Wilks, R., Luke, A., . . . Cooper, R. S. (1997). Relationship between blood pressure and body mass index in lean populations. *Hypertension*, 30(6), 1511-1516. doi:10.1161/01.HYP.30.6.1511
- Kornitzer, M., Dramaix, M., & De Backer, G. (1999). Epidemiology of risk factors for hypertension: Implications for prevention and therapy. *Drugs*, 57(5), 695-712.
- Koskinen, S., Lundqvist, A., Ristiluoma, N., & editors. (2012). *Health, functional capacity and welfare in finland in 2011. national institute for health and welfare (THL)*. ( No. 68/2012). Tampere: Juvenes Print - Suomen Yliopistopaino Oy: THL. doi:URN:ISBN:978-952-245-769-1
- Kumar, B. N., Selmer, R., Lindman, A. S., Tverdal, A., Falster, K., & Meyer, H. E. (2009). Ethnic differences in SCORE cardiovascular risk in oslo, norway. *European Journal of Cardiovascular Prevention and Rehabilitation : Official Journal of the European Society of Cardiology, Working Groups on Epidemiology & Prevention and Cardiac Rehabilitation and Exercise Physiology*, 16(2), 229-234. doi:10.1097/HJR.0b013e3283294b07 [doi]
- Lear, S. A., Toma, M., Birmingham, C. L., & Frohlich, J. J. (2003). Modification of the relationship between simple anthropometric indices and risk factors by ethnic background. *Metabolism: Clinical and Experimental*, 52(10), 1295-1301. doi:S0026049503001963 [pii]
- Lee, C. M., Huxley, R. R., Wildman, R. P., & Woodward, M. (2008). Indices of abdominal obesity are better discriminators of cardiovascular risk factors than

BMI: A meta-analysis. *Journal of Clinical Epidemiology*, 61(7), 646-653.

doi:10.1016/j.jclinepi.2007.08.012 [doi]

Lewington, S., Clarke, R., Qizilbash, N., Peto, R., Collins, R., & Prospective Studies Collaboration. (2002). Age-specific relevance of usual blood pressure to vascular mortality: A meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet (London, England)*, 360(9349), 1903-1913.

doi:S0140673602119118 [pii]

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., . . . Memish, Z. A. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the global burden of disease study 2010. *Lancet (London, England)*, 380(9859), 2224-2260. doi:10.1016/S0140-6736(12)61766-8

[doi]

Manson, J. E., Colditz, G. A., Stampfer, M. J., Willett, W. C., Rosner, B., Monson, R. R., . . . Hennekens, C. H. (1990). A prospective study of obesity and risk of coronary heart disease in women. *The New England Journal of Medicine*, 322(13), 882-889. doi:10.1056/NEJM199003293221303 [doi]

Manson, J. E., Willett, W. C., Stampfer, M. J., Colditz, G. A., Hunter, D. J., Hankinson, S. E., . . . Speizer, F. E. (1995). Body weight and mortality among women. *N Engl J Med*, 333(11), 677-685. doi:10.1056/NEJM199509143331101

Mansour, A. A., & Al-Jazairi, M. I. (2007). Cut-off values for anthropometric variables that confer increased risk of type 2 diabetes mellitus and hypertension in Iraq. *Archives of Medical Research*, 38(2), 253-258. doi:S0188-4409(06)00344-4 [pii]

- Masuo, K., Mikami, H., Ogihara, T., & Tuck, M. L. (2000). Weight Gain–Induced blood pressure elevation. *Hypertension*, *35*(5), 1135-1140.  
doi:10.1161/01.HYP.35.5.1135
- Mehler, P. S., Scott, J. Y., Pines, I., Gifford, N., Biggerstaff, S., & Hiatt, W. R. (2001). Russian immigrant cardiovascular risk assessment. *Journal of Health Care for the Poor and Underserved*, *12*(2), 224-235.
- Misra, A., & Ganda, O. P. (2007). Migration and its impact on adiposity and type 2 diabetes. *Nutrition (Burbank, Los Angeles County, Calif.)*, *23*(9), 696-708.  
doi:S0899-9007(07)00185-2 [pii]
- Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., . . . Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the global burden of disease study 2013. *Lancet (London, England)*, *384*(9945), 766-781. doi:10.1016/S0140-6736(14)60460-8 [doi]
- Nichols, M., Townsend, N., Luengo-Fernandez, R., Leal, J., Gray, A., Scarborough, P., & Rayner, M. (2012). *European cardiovascular disease statistics 2012*. ( ).European Heart Network, Brussels, European Society of Cardiology, Sophia Antipolis.
- Njeru, J. W., Tan, E. M., St. Sauver, J., Jacobson, D. J., Agunwamba, A. A., Wilson, P. M., . . . Wieland, M. L. (2016). High rates of diabetes mellitus, pre-diabetes and obesity among somali immigrants and refugees in minnesota: A retrospective chart review. *Journal of Immigrant and Minority Health*, *18*(6), 1343-1349.  
doi:10.1007/s10903-015-0280-3



Obesity in Asia Collaboration. (2008). Is central obesity a better discriminator of the risk of hypertension than body mass index in ethnically diverse populations? *Journal of Hypertension*, 26(2), 169-177. doi:10.1097/HJH.0b013e3282f16ad3 [doi]

Official Statistics of Finland (OSF). (2015). Official statistics of finland (OSF): Population structure [e-publication]. ISSN=1797-5395. annual review 2015. helsinki: Statistics finland [referred: 27.5.2017]. Retrieved from [http://www.stat.fi/til/vaerak/2015/01/vaerak\\_2015\\_01\\_2016-09-23\\_tie\\_001\\_en.html](http://www.stat.fi/til/vaerak/2015/01/vaerak_2015_01_2016-09-23_tie_001_en.html)

Official Statistics of Finland (OSF). (2016). Official statistics of finland (OSF): Migration [e-publication]. ISSN=1797-6782. 2016. helsinki: Statistics finland [referred: 27.5.2017]. Retrieved from [http://www.stat.fi/til/muutl/2016/muutl\\_2016\\_2017-05-17\\_tie\\_001\\_en.html](http://www.stat.fi/til/muutl/2016/muutl_2016_2017-05-17_tie_001_en.html)

Ogden, C. L., & Carroll, M. D. (2010). Prevalence of overweight, obesity, and extreme obesity among adults: United states, trends 1960–1962 through 2007–2008. Retrieved from <https://pdfs.semanticscholar.org/d976/15e7e20ff07710b012e0bb13cf7cebd0112c.pdf>

Oza-Frank, R., & Narayan, K. M. V. (2010). Overweight and diabetes prevalence among US immigrants. *American Journal of Public Health*, 100(4), 661-668. doi:10.2105/AJPH.2008.149492

- Petrukhin, I. S., & Lunina, E. Y. (2012). Cardiovascular disease risk factors and mortality in russia: Challenges and barriers. *Public Health Reviews*, 33(2), 436-449.
- Piepoli, M. F., Hoes, A. W., Agewall, S., Albus, C., Brotons, C., Catapano, A. L., . . . Authors/Task Force Members. (2016). 2016 european guidelines on cardiovascular disease prevention in clinical practice: The sixth joint task force of the european society of cardiology and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of 10 societies and by invited experts)developed with the special contribution of the european association for cardiovascular prevention & rehabilitation (EACPR). *European Heart Journal*, 37(29), 2315-2381. doi:10.1093/eurheartj/ehw106 [doi]
- Razak, F., Anand, S. S., Shannon, H., Vuksan, V., Davis, B., Jacobs, R., . . . Yusuf, S. (2007). Defining obesity cut points in a multiethnic population. *Circulation*, 115(16), 2111-2118. doi:CIRCULATIONAHA.106.635011 [pii]
- Renzaho, A. M. N. (2004). Fat, rich and beautiful: Changing socio-cultural paradigms associated with obesity risk, nutritional status and refugee children from sub-saharan africa. *Health & Place*, 10(1), 105-113. doi:[https://doi.org/10.1016/S1353-8292\(03\)00051-0](https://doi.org/10.1016/S1353-8292(03)00051-0)
- Schneider, H. J., Friedrich, N., Klotsche, J., Pieper, L., Nauck, M., John, U., . . . Wittchen, H. U. (2010). The predictive value of different measures of obesity for incident cardiovascular events and mortality. *The Journal of Clinical Endocrinology and Metabolism*, 95(4), 1777-1785. doi:10.1210/jc.2009-1584 [doi]

- Sewali, B., Harcourt, N., Everson-Rose, S., Leduc, R. E., Osman, S., Allen, M. L., & Okuyemi, K. S. (2015). Prevalence of cardiovascular risk factors across six african immigrant groups in minnesota. *BMC Public Health*, *15*, 411. doi:10.1186/s12889-015-1740-3
- Shukla, A., Kumar, K., & Singh, A. (2014). Association between obesity and selected morbidities: A study of BRICS countries. *Plos One*, *9*(4), e94433.
- Sisäministeriö. (2013). Valtioneuvoston periaatepäätös maahanmuuton tulevaisuus 2020 strategiasta, 2013. Retrieved from <http://www.intermin.fi/maahanmuutto2020>
- Skogberg, N., Laatikainen, T., Koskinen, S., Vartiainen, E., Jula, A., Leiviskä, J., . . . Koponen, P. (2016). Cardiovascular risk factors among russian, somali and kurdish migrants in comparison with the general finnish population. *The European Journal of Public Health*, doi:10.1093/eurpub/ckw041
- Spraul, M., Ravussin, E., Fontvieille, A. M., Rising, R., Larson, D. E., & Anderson, E. A. (1993). Reduced sympathetic nervous activity. A potential mechanism predisposing to body weight gain. *The Journal of Clinical Investigation*, *92*(4), 1730-1735. doi:10.1172/JCI116760 [doi]
- United Nations Educational, Scientific and Cultural Organization. International migration. migrant/migration. Retrieved from <http://www.unesco.org/new/en/social-and-human-sciences/themes/international-migration/glossary/migrant/>
- United Nations Educational, Scientific and Cultural Organization. (2003). United nations convention on migrants' rights. Retrieved from <http://unesdoc.unesco.org/images/0014/001435/143557e.pdf>

- Wahlbeck, Ö. (2012). The kurdish refugee diaspora in finland. *Diaspora Studies*, 5(1), 44-57. doi:<http://dx.doi.org/10.1080/09739572.2013.764124>
- Weyer, C., Pratley, R. E., Snitker, S., Spraul, M., Ravussin, E., & Tataranni, P. A. (2000). Ethnic differences in insulinemia and sympathetic tone as links between obesity and blood pressure. *Hypertension (Dallas, Tex.: 1979)*, 36(4), 531-537.
- WHO Expert Consultation. (2004). Appropriate body-mass index for asian populations and its implications for policy and intervention strategies. *Lancet (London, England)*, 363(9403), 157-163. doi:S0140-6736(03)15268-3 [pii]
- Wolf, H. K., Tuomilehto, J., Kuulasmaa, K., Domarkiene, S., Cepaitis, Z., Molarius, A., . . . Rywik, S. (1997). Blood pressure levels in the 41 populations of the WHO MONICA project. *Journal of Human Hypertension*, 11(11), 733-742.
- World Health Organization. (2000). *Obesity: Preventing and managing the global epidemic*. ( No. 894).WHO.
- World Health Organization. (2008). Causes of death 2008 [online database]. Retrieved from [http://www.who.int/healthinfo/global\\_burden\\_disease/cod\\_2008\\_sources\\_methods.pdf](http://www.who.int/healthinfo/global_burden_disease/cod_2008_sources_methods.pdf)
- World Health Organization. (2011). *Global status report on noncommunicable diseases 2010*. (). Geneva: WHO.
- World Health Organization. (2013a). A global brief on hypertension. Retrieved from [http://www.who.int/cardiovascular\\_diseases/publications/global\\_brief\\_hypertension/en/](http://www.who.int/cardiovascular_diseases/publications/global_brief_hypertension/en/)

World Health Organization. (2013b). WHO country profile. finland. Retrieved from [http://www.euro.who.int/\\_data/assets/pdf\\_file/0008/243296/Finland-WHO-Country-Profile.pdf](http://www.euro.who.int/_data/assets/pdf_file/0008/243296/Finland-WHO-Country-Profile.pdf)

World Health Organization. (2013c). WHO country profile. russian federation. Retrieved from [http://www.euro.who.int/\\_data/assets/pdf\\_file/0015/243321/Russian-Federation-WHO-Country-Profile.pdf](http://www.euro.who.int/_data/assets/pdf_file/0015/243321/Russian-Federation-WHO-Country-Profile.pdf)

World Health Organization. (2016). Obesity and overweight. fact sheet. Retrieved from <http://www.who.int/mediacentre/factsheets/fs311/en/>

World Health Organization. (2017a). Global strategy on diet, physical activity and health. what is overweight and obesity? Retrieved from [http://www.who.int/dietphysicalactivity/childhood\\_what/en/](http://www.who.int/dietphysicalactivity/childhood_what/en/)

World Health Organization. (2017b). Overweight (body mass index  $\geq 25$ ), age-standardized (%). estimates by country. Retrieved from <http://apps.who.int/gho/data/view.main.CTRY2430A?lang=en>

World Health Organization. (2017c). WHO global health observatory data repository [online database]. Retrieved from <http://apps.who.int/gho/data/view.main.2464ESTSTANDARD?lang=en>

Yatsuya, H., Li, Y., Hilawe, E. H., Ota, A., Wang, C., Chiang, C., . . . Aoyama, A. (2014). Global trend in overweight and obesity and its association with cardiovascular disease incidence. *Circulation Journal : Official Journal of the Japanese Circulation Society*, 78(12), 2807-2818. doi:DN/JST.JSTAGE/circj/CJ-14-0850 [pii]

Yi, S., Elfassy, T., Gupta, L., Myers, C., & Kerker, B. (2014). Nativity, language spoken at home, length of time in the united states, and race/ethnicity: Associations with self-reported hypertension. *American Journal of Hypertension*, 27(2), 237-244. doi:10.1093/ajh/hpt209 [doi]

Zeng, Q., He, Y., Dong, S., Zhao, X., Chen, Z., Song, Z., . . . Wang, Y. (2014). Optimal cut-off values of BMI, waist circumference and waist:Height ratio for defining obesity in chinese adults. *The British Journal of Nutrition*, 112(10), 1735-1744. doi:10.1017/S0007114514002657 [doi]

**The association between body mass index, waist-to-height ratio and blood pressure in Russian, Somali and Kurdish migrants residing in Finland.**

Alena Agafonova, Tarja I. Kinnunen, Natalia Skogberg and Eero Lilja

## Abstract

**Background:** Although overweight and obesity are known risk factors for hypertension, information on the association of excess weight with blood pressure in migrants is limited. We investigated relationship between body mass index (BMI), waist-to-height ratio (WHtR) and blood pressure and hypertension in three migrant groups in Finland. **Methods:** Cross-sectional data for men and women, aged 30-64 years, who participated in health examination (n=899) of the Migrant Health and Wellbeing study (2010-2012) were used. Data were collected by a face-to-face interview/questionnaire and health examination. Comparison data on the general Finnish population were obtained from the Health 2011 survey (n=885). Linear regression was used for continuous variables and logistic regression for categorical variables. **Results:** Prevalence of overweight/obesity (BMI $\geq$ 25 or WHtR $\geq$ 0.5) was highest among Kurdish migrants (over 75%) and Somali women (90.4%). All migrants but Russian men had significantly lower levels of systolic blood pressure (SBP) than the Finns. Higher BMI and WHtR were both associated with higher SBP only in Russian and Kurdish women and in the general population. However, strength of the association varied by ethnic group. Overweight and obesity were associated with higher OR of hypertension only for Russian women and general population. ORs of hypertension by BMI $\geq$ 30 in Russian women were 6.05 (95%CI 2.81-13.02) and in Finnish men 2.9 (95% CI 1.47-5.87) and Finnish women 4.36 (95% CI 2.50-7.60). **Conclusions:** There were significant variations in the association between obesity indices and blood pressure in migrants compared with the general population. Further research is warranted to clarify the BP-regulating mechanisms in East African (Somali) and Middle Eastern (Kurdish) migrant populations.

**Key words:** BMI, waist-to-height ratio, blood pressure, migrants, Finland



## **Introduction**

Overweight and obesity are known risk factors for cardiovascular diseases (CVD) and hypertension, which is a leading risk factor for disease burden globally, accounting for 9.4 million deaths in 2010 (Lim et al., 2012). The risk of death increases linearly from blood pressure (BP) levels of 115 mmHg systolic and 75 mmHg diastolic upwards (Lewington et al., 2002). Both genetic and environmental factors affect the onset of hypertension. The most important modifiable environmental risk factors are high salt intake, alcohol intake, obesity and low physical activity (Kornitzer, Dramaix, & De Backer, 1999). The association between body mass index (BMI) and cardiovascular diseases is well-established (Kannel, 1997; Manson et al., 1990; Singh, Lindsted, & Fraser, 1999). Besides, growing evidence shows that similar BMI cutoff points may be improper for different ethnic groups (Razak et al., 2007; Tillin et al., 2015; WHO Expert Consultation, 2004). Recently, Waist-to-height ratio (WHtR) has been suggested to be a better predictor of cardiovascular events (Ashwell & Hsieh, 2005; Browning, Hsieh, & Ashwell, 2010; Hsieh & Yoshinaga, 1995). WHtR is more strongly associated with CVD risk factors than other anthropometric indices (Ashwell, Gunn, & Gibson, 2012; Ho, Lam, Janus, & Hong Kong Cardiovascular Risk Factor Prevalence Study Steering Committee, 2003). Some studies have demonstrated that WHtR is also a better discriminator of the risk of hypertension in ethnically diverse populations (Obesity in Asia Collaboration, 2008).

A few studies have focused on the association between weight indices and blood pressure and/or hypertension in migrants. One of the UK studies revealed that in African women higher blood pressure coincided with higher BMI but in men of African origin higher BP was not related to higher BMI (Agyemang & Bhopal, 2003). A recent study from Finland revealed ethnic differences in BP and hypertension prevalence between migrants and general Finnish population (Skogberg et al., 2016). Prevalence of hypertension was notably lower among Kurdish and Somali migrants, despite high obesity rates among Kurdish men and Somali women (Skogberg et al., 2016). Bennet and Nilsson earlier reported similar results in a Swedish study, where Iraqi migrants had higher BMI and lower BP than native Swedes (Bennet & Nilsson, 2014). A study about overweight and obesity among Somali migrants in Minnesota, USA, discovered that despite high

overweight and obesity rates in this group, prevalence of hypertension was only 4% (Dalmar et al., 2005). If differences in BP-regulation mechanisms exist in various migrant populations, it is important to address these differences in health programmes targeting diverse ethnic groups.

The number of migrants in Finland grows and it is projected that by the year 2020 ten percent of the population will have foreign origin (Sisäministeriö, 2013). Hence, migrants' health is a matter of growing interest in Finland. The Finnish Migrant Health and Wellbeing Study (Maamu) was first population-based study which covered various aspects of health and wellbeing of migrants, including hypertension (Castaneda et al., 2012). To our knowledge, there are no Finnish studies about migrants that focused on WHtR and blood pressure associations, although WHtR nowadays is used widely in scientific research and is deemed to be a better predictor of CVD risk than BMI. Therefore, the aim of the current study is to investigate the association between BMI, WHtR and mean blood pressure in Russian, Somali and Kurdish migrants residing in Finland, compared with the general population. Additional goal of the study is to look into associations between BMI, WHtR and prevalence of hypertension in these groups.

## **Materials and methods**

### **Study design**

This cross-sectional study uses data from the Maamu study (Castaneda et al., 2012), carried out between 2010 and 2012 by the National Institute for Health and Welfare (THL). Three migrant groups were included in the study: Russian, Somali and Kurdish (mostly from Iraq or Iran) origin migrants. Russians represent the largest migrant group in Finland migrating mainly to reunite with their family or to work (Official Statistics of Finland (OSF): Population structure [e-publication]., ). Somalis mostly arrive as refugees or for family reunification and form the third largest cluster of migrants (Official Statistics of Finland (OSF): Population structure [e-publication]., ), whereas Kurdish migrants have constituted one of the largest quota refugee groups over the past two decades (Wahlbeck, 2012).

The Maamu study was conducted in six cities: Helsinki, Espoo, Vantaa, Tampere, Turku and Vaasa, where a significant majority of migrants (93% Somali, 67% Kurdish, 47% Russian) meeting the inclusion criteria lived at the planning stage of the study. A random representative sample of 3000 people of Russian, Somali and Kurdish origin migrants (1000 per migrant group) was drawn from the National Population Register. This register contains information on the country of birth, mother tongue and history of residence in Finland. Selection criteria were age 18-64 years, country of birth (Russia/ Soviet Union, Somalia and Iran/Iraq), mother tongue (Russian/Finnish, Somali and Sorani dialect of Kurdish), city of residence and a minimum of 1 year of residence in Finland.

Health 2011 survey (Koskinen, Lundqvist, Ristiluoma, & editors, 2012) was conducted to monitor the health and wellbeing of the general population in Finland (later referred to as Finns). Health 2011 survey followed a similar study protocol to the Maamu study. Participants from the Health 2011 survey, residing in the six above mentioned municipalities were selected as a reference group. Each participant gave written informed consent. Both studies were approved by the Coordinating Ethics Committee of the Helsinki and Uusimaa Hospital District.

### **Study participants**

The Maamu study participants were 18-64 years of age. Comparable data on health examination from the Health 2011 study were available for the group of 30-64 years. Hence, this study is limited to 30-64-year olds. Blood pressure measurements were missing for 11 and 7 participants of the Maamu and Health 2011 study, respectively. Participants over 20 weeks of pregnancy were excluded from this study. The sample for the current study consists of 341 Russian, 214 Somali and 344 Kurdish migrants, aged from 30 to 64 years, who participated in both health examination and face-to-face interview / brief questionnaire of the Maamu study. The sampling procedure is depicted in the flow chart (Figure 1) and was reported previously (Skogberg et al., 2016). The reference group are 885 participants of the Health 2011 study.

## Data collection and variables

The Maamu study included a structured face-to-face interview and a standardized health examination (including blood pressure, weight and height measurements), conducted by trained multilingual staff. To those, who did not participate in the face-to-face interview, a brief questionnaire was offered. In the Health 2011 survey, questionnaire and invitation for the health examination were sent to all subjects from the random sample. All persons unable or not willing to attend full health examination, were invited to attend a phone interview. A short questionnaire was mailed to those who did not participate in the health examination or the phone interview.

In the Maamu study, blood pressure was measured thrice with 1-minute intervals with a digital blood pressure monitor (Omron i-C10, Oriola) after 5 minutes of rest from the right arm while seated. In the Health 2011 study, blood pressure was measured twice with a standard mercury manometer (Riester Diplomat Presameter Desk Set). The mean value of the first and second measurements (both for the Maamu and the Health 2011 participants) was used in current study. Hypertension was defined as mean systolic blood pressure  $\geq 140$  mm Hg and/or mean diastolic blood pressure  $\geq 90$  mmHg and/or self-reported use of hypertension medication (Piepoli et al., 2016). Isolated systolic hypertension was defined as SBP  $\geq 140$  mm Hg and DBP  $\leq 90$  mm Hg (Piepoli et al., 2016).

In both studies, waist circumference was measured with a soft measuring tape half-way between lowest rib and top of iliac crest on bare skin or wearing light clothing. Height was measured without shoes with a stand-alone stadiometer (Seca 213). Weight was measured wearing light clothing and without shoes. In the Maamu study, weight was measured with a balanced beam scale (Seca709), whereas in the Health 2011 study, as part of the bio impedance body composition analysis (Seca 514). BMI was calculated as weight in kilograms divided by height in meters squared. WHtR was calculated as waist circumference (cm) divided by height (cm). Obesity was defined as BMI  $\geq 30$  kg/m<sup>2</sup>. Overweight value for BMI was higher than 25 kg/m<sup>2</sup> and for WHtR higher than 0.5 for men and women (Browning et al., 2010).

Basic education was categorized into 3 groups: no basic education, comprehensive school (in Finland until 9th grade) and high school (completed 12 years of school). Income sufficiency was asked as a self-perceived ability to cover living costs. Income was categorized as sufficient if subjects answered ‘very easy’, ‘easy’ or ‘quite easy’ to cover living costs, when all income sources are taken into account’ (this question was not asked from the general population in the Health 2011 study). Marital status was categorized to ‘married or cohabiting’ or ‘other’. Daily consumption of fresh vegetables and fruit or berries was considered positive if participant ate fresh vegetables and fruit or berries at least on 6-7 days a week. Smoking was categorized to ‘daily smoking’ and ‘no smoking’ for all other answers.

Alcohol consumption of participants was analyzed with the AUDIT-C screen, a shorter version of the 10-question AUDIT (Babor, Higgins-Biddle, Saunders, Monteiro, & Dependence, 2001). The scores over 6 for men and over 5 for women were considered as excess drinking.

Leisure time physical activity was categorized as active, if person was engaged in cycling, walking and other moderate or strenuous physical exercises during his or her free time. Reading, watching television and performing other non-physically straining activities was categorized as inactive.

### **Statistical analyses**

Statistical analyses were performed using SAS version 9.3 (SAS Institute Inc., 2011) and SUDAAN 11.0.1 (Research Triangle Institute., 2012) software packages. SAS software was used for constructing outcome variables and calculating crude values, whereas SUDAAN software was used for data analysis. Different sampling probabilities and nonresponse were handled using inverse probability weights (Härkänen, Kaikkonen, Virtala, & Koskinen, 2014, Nov 6) based on age group, sex, ethnic group, study location and marital status. The strata structure (of the data) was taken into account in the variance estimation. Finite population correction was applied in all analyses (Lehtonen & Pahkinen, 2004). Descriptive data on age, length of residence, basic education, marital status, daily smoking, eating habits, physical activity is reported as means or weighted percentages. Linear regression analysis was applied for continuous outcome variables

(SBP, DBP) and logistic regression analysis for categorical outcome variables (hypertension). Age-adjusted scatter plots with  $\beta$ -coefficients were built based on linear regression analysis of the association between BMI, WHtR and BP. All analyses were controlled for age and every variable (BMI and WHtR as continuous and categorical variables) was assessed separately for the association with SBP, DBP. Age-adjusted means and percentages were calculated using predictive margins (Graubard & Korn, 1999). Interactions between gender and obesity indices (BMI, WHtR) were assessed for SBP and DBP as the outcomes. All analyses were conducted separately for men and women due to significant interactions between gender and studied factors in relation to blood pressure. Interaction between gender and both BMI and WHtR in relation to SBP was significant for Russian, Somali and Kurdish migrants ( $p < 0.001$ ,  $p < 0.001$ ,  $p < 0.001$  respectively). All tests were two-sided and a  $p$ -value of less than 0.05 was considered statistically significant. The tests of significance were based on Satterthwaite adjusted F-statistic.

## **Results**

### **Socio-economic and lifestyle factors**

All migrants but Russian women were younger than Finns on average (Table 1). Many Somali and Kurdish migrants, especially women, had no basic education compared to the Finns. In relation to the sufficiency of income, Kurdish group was substantially worst off than other migrant groups. Consumption of fresh vegetables and fruit did not differ significantly among groups, and surprisingly, there were no Somali migrants who reported that they eat fresh fruit and vegetables daily. Smoking and consumption of alcohol were rare among Somali migrants. All migrant groups had lower prevalence of excess drinking compared with the general population. Compared with the Finns, Kurdish migrants were less likely to be active in their free time.

### **Distribution and mean values of BMI, WHtR and BP, hypertension**

Table 2 shows that in comparison with the general population, prevalence of BMI-based overweight (BMI 25.0-29.99) and obesity (BMI  $\geq 30$ ) was highest among Kurdish men and Somali women. Somali men had the lowest prevalence of obesity. However, prevalence of overweight (based on WHtR  $\geq 0.5$ ) was higher in Kurdish group, compared

with the Finns. This implies that probably central obesity is more common for Kurdish people.

Mean blood pressure was significantly lower in all migrant groups compared with the general population (Table 2). Prevalence of hypertension among Russian migrants was similar to the Finns but significantly lower in Somali and Kurdish groups. The majority of subjects with elevated blood pressure had grade I hypertension and severe hypertension (grade III) was rare among all groups (results not shown).

### **BMI and systolic blood pressure**

Scatter plots with regression lines illustrate the association between BMI and SBP in Figure 2 and Figure 3. Somali and Kurdish migrants had lower levels of SBP almost at all values of BMI. For Somali men and men from the general population SBP increased steadily with growing BMI. For Russian and Kurdish men the association was weaker. Among women, SBP was less related to BMI in Somali group compared with other groups.

In linear regression analysis BMI (categorized to  $\geq 30$  and  $< 30$ ) was significantly associated with SBP for Russian women ( $p < 0.001$ ), Kurdish women ( $p < 0.001$ ), Finnish men and women ( $p < 0.001$ ,  $p < 0.001$  respectively). Obese participants had higher SBP than non-obese participants (Table 3). Difference in SBP among obese and non-obese women was especially pronounced in Russian group, where age-adjusted mean SBP in obese group was 126.4 (95%CI 121.2-131.5) mmHg vs. 113.0 (95%CI 110.8-115.2) mmHg in non-obese group. For Kurdish women age-adjusted mean SBP for obese participants was 110.8 (95%CI 108.2-113.4) mmHg vs. 105.5 (95%CI 103.6-107.4) mmHg in non-obese participants. The association between BMI and SBP was stronger for women. Logistic regression analysis for hypertension variable demonstrated significant associations with BMI (categorized to  $\geq 30$  and  $< 30$ ) only for Russian women and Finns (Table 4). Obese Russian women had 6.05 OR for having hypertension as compared with non-obese counterparts.

## **Waist-to-height ratio and systolic blood pressure**

We found that the association between WHtR and SBP in each group was similar to the trends observed for BMI and SBP (Figure 2, Figure 3). Interestingly, WHtR seemed to be stronger related to SBP in women than in men (regression lines are steeper).

In linear regression analysis WHtR was significantly associated with SBP for Russian women ( $p<0.001$ ), Kurdish women ( $p<0.001$ ), Finnish men and women ( $p<0.001$ ,  $p<0.001$  respectively). Higher WHtR was associated with higher SBP (Table 3). Among Russian women, the age-adjusted means for SBP were 120.5 (95%CI 117.2-123.9) mmHg in women with  $WHtR\geq 0.5$  and 111.4 (95%CI 109.0-113.7) mmHg in women with  $WHtR<0.5$ . For Kurdish women age-adjusted mean SBP in those with  $WHtR\geq 0.5$  was 108.8 (95%CI 106.9-110.7) mmHg vs. 101.7 (95%CI 99.1-104.2) mmHg. In logistic regression analysis association between WHtR and hypertension was significant only for Russian women ( $p=0.001$ ) and Finns (Table 4). Obese Russian women had 4.5 OR for having hypertension as compared with non-obese participants.

Analyses and results for DBP were similar (results not shown).

## **Discussion**

Our study shows that the association between BMI, WHtR and SBP or hypertension is different in migrants (specifically Somali and Kurdish) in comparison with the general population. These associations seem to be weaker in Somali and Kurdish groups than in Finns. Moreover, obesity does not show any significant relationship with higher SBP in Somali and Kurdish migrants. Our data also suggest that the association between body weight and SBP is modified by gender.

Gender variations in the relationship between BMI and BP have been reported previously (Kaufman et al., 1997). Other research suggests that there might be differences in the association between BMI and BP in different ethnic groups (Bennet & Nilsson, 2014; Colin Bell, Adair, & Popkin, 2002; Tesfaye et al., 2007). Somali women represent the highest prevalence of obesity in our sample, yet no significant association with blood pressure levels. This is in agreement with another study from the US (Dalmar et al., 2005).



High prevalence of obesity in Somali migrant women was reported previously (Gele & Mbalilaki, 2013). Somali men being the leanest migrant group, demonstrated no significant association between weight indices and blood pressure. In Kurdish migrants weight indices and blood pressure were associated significantly only for women. Interestingly, in Kurdish women the difference in SBP levels among obese and non-obese subjects was smaller than in Finnish women. These findings lead to the idea that in Somali and Kurdish migrants the association between weight and blood pressure is different from the general Finnish population. One of the mechanisms leading to BP increase is weight gain induced increase in sympathetic nervous system (SNS) activity (Hall, Brands, Hildebrandt, Kuo, & Fitzgerald, 2000; Masuo, Mikami, Ogihara, & Tuck, 2000). It has been speculated that in some ethnic groups SNS activity differs from that of Europeans (Weyer et al., 2000). Similar studies on Somali and Kurdish populations or migrants were not found. This forms a knowledge gap available for the future research.

Increased BMI is associated with higher BP and higher prevalence of hypertension and CVD (Droyvold, Midthjell, Nilsen, & Holmen, 2005; Dyer & Elliott, 1989; Masuo et al., 2000). Many other studies published since 1950-ies have found persistent association between BMI and level of BP. Although it is generally agreed that there is an association between BMI and BP, it has been argued that in some populations this association changes with age and gender, demonstrating stronger associations in women over 45 years (Kaufman et al., 1997). In our study, we found significant associations between BMI and BP only in the Finns, Russian and Kurdish women. To our knowledge, association between obesity indices and BP has not been studied particularly in Somalia and Somali migrants. Absence of the robust association in this group can be explained by different pattern of the BMI-BP relationship, cross-sectional study design or some other factors that were not accounted for.

It has been argued that WHtR can be a better predictor for CVD events and shows consistently stronger association to CVD outcomes than BMI (Ho et al., 2003; Schneider et al., 2010). In our study, we found similar association patterns for BMI and WHtR with BP among all groups. Whereas WHtR  $\geq 0.5$  indicates increased risk of CVD (Ashwell et al., 2012; Browning et al., 2010), it was significantly associated with increased SBP and hypertension in Russian women and Finns, thus it might be more precise / sensitive

parameter than  $BMI \geq 30$  (obesity). WHtR being more sensitive weight index than BMI, may be used as an earlier predictor of CVD with preventive measures taken at earlier stages of the disease or even in premorbid period. Furthermore, WHtR helps to distinguish abdominal obesity, which results in poorer CVD outcomes compared to general obesity (Browning et al., 2010). In our study, we revealed that central obesity was more common for Kurdish migrants, whereas general obesity was highest among Somali women.

This study contributes novel findings that the associations of CVD risk factors ( $BMI \geq 30$ ,  $WHtR \geq 0.5$ ) and BP are not uniform in various ethnic groups. Presence of interaction by the country of origin can explain the paradoxically lower BP levels in a population with similar or higher prevalence of obesity. This interaction may be a result of some other factors, not taken into account, that affect the BMI/WHtR – BP association. Our findings are in agreement with existing research (Bennet & Nilsson, 2014). Bennet and colleagues have previously reported that the association between BMI and BP was modified by the country of origin in the Middle Eastern migrants living in Sweden. Higher BMI and waist circumference were less associated with BP in Iraqis than in Swedes. Bennet speculated that BP-regulation mechanisms can contribute to the differences in the associations between obesity indices and BP in Iraqi population.

This study contributes to the limited body of research on the association between obesity indices (BMI, WHtR) and blood pressure among migrant populations. This is one of a few studies on migrants' health that has used a wide range of objective measures, which has significantly reduced self-report bias. The Maamu study was performed by a multilingual team of trained specialists, which reduced language bias. Other strength is random, stratified sampling. Furthermore, a comparison group from the general population, studied according to the same protocol, was available.

One of the weaknesses of this study is the inability to infer causality due to the cross-sectional design. Despite the satisfactory participation rates, there is a possibility of selection bias due to non-response. To reduce this bias we used Inverse Probability Weighting (Härkänen et al., 2014, Nov 6). Another limitation of this study was the small number of participants in some groups after gender stratification, which resulted in unreliable results for some statistics. Moreover, we were not able to find significant associations between proven CVD risk factors (e.g. smoking, alcohol consumption) and

blood pressure/hypertension in migrant groups and therefore did not include these analyses results into the article. One of the potential explanations may be the small number of participants with positive smoking/alcohol consumption answers among migrants. Additional limitation to our study are differences in BP measurements in Maamu and Health 2011 survey, described elsewhere (Skogberg et al., 2016). However, we do not believe that differences in blood pressure measurement methods could have affected the results of our study.

In conclusion, this study reports that Somali and Kurdish migrants, despite having higher obesity rates, have in general lower BP levels and lower prevalence of hypertension compared to Finns. These findings suggest that there might be different mechanisms at work explaining different association patterns between body weight and BP in migrants. Further research is needed to explain these mechanisms or factors that contribute to the difference. It is for the future studies to reveal whether WHtR is a better predictor of elevated BP than BMI in these populations.

## References

- Agyemang, C., & Bhopal, R. (2003). Is the blood pressure of people from african origin adults in the UK higher or lower than that in european origin white people? A review of cross-sectional data. *Journal of Human Hypertension*, 17(8), 523-534. doi:10.1038/sj.jhh.1001586 [doi]
- Ashwell, M., Gunn, P., & Gibson, S. (2012). Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systematic review and meta-analysis. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, 13(3), 275-286. doi:10.1111/j.1467-789X.2011.00952.x [doi]
- Ashwell, M., & Hsieh, S. D. (2005). Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *International Journal of Food Sciences and Nutrition*, 56(5), 303-307. doi:V628527571519144 [pii]
- Babor, T., Higgins-Biddle, J., Saunders, J., Monteiro, M. & Dependence, W. (2001). AUDIT : The alcohol use disorders identification test : Guidelines for use in primary health care.geneva : *World health organization*. . Retrieved from Retrieved from <http://www.who.int/iris/handle/10665/67205>
- Bennet, L., & Nilsson, P. M. (2014). Country of birth modifies the associations of body mass and hemoglobin A1c with office blood pressure in middle eastern immigrants and native swedes. *Journal of Hypertension*, 32(12), 2362-70; discussion 2370. doi:10.1097/HJH.0000000000000345 [doi]

- Browning, L. M., Hsieh, S. D., & Ashwell, M. (2010). A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0.5 could be a suitable global boundary value. *Nutrition Research Reviews*, 23(2), 247-269. doi:10.1017/S0954422410000144 [doi]
- Castaneda, A., Rask, S., Koponen, P., Mölsä, M., Koskinen, S., & editors. (2012). *Migrant health and wellbeing. A study of persons of russian, somali and kurdish origin in finland.* national institute for health and welfare. ( No. 61/2012). Tampere: Juvenes Print - Suomen Yliopistopaino Oy.
- Colin Bell, A., Adair, L., S., & Popkin, B., M. (2002). Ethnic differences in the association between body mass index and hypertension. *American Journal of Epidemiology*, 155(4), 346-353. doi:10.1093/aje/155.4.346 [doi]
- Dalmar, A., Pryce, D., Grim, C., Ali, H., Jama, S., & Magan, S. (2005). *Overweight and obesity in somali immigrants to usa.* Unpublished manuscript.
- Droyvold, W. B., Midthjell, K., Nilsen, T. I., & Holmen, J. (2005). Change in body mass index and its impact on blood pressure: A prospective population study. *International Journal of Obesity (2005)*, 29(6), 650-655. doi:0802944 [pii]
- Dyer, A. R., & Elliott, P. (1989). The INTERSALT study: Relations of body mass index to blood pressure. INTERSALT co-operative research group. *Journal of Human Hypertension*, 3(5), 299-308.

- Gele, A. A., & Mbalilaki, A. J. (2013). Overweight and obesity among african immigrants in oslo. *BMC Research Notes*, 6, 119-0500-6-119. doi:10.1186/1756-0500-6-119 [doi]
- Graubard, B. I., & Korn, E. L. (1999). Predictive margins with survey data. *Biometrics*, 55(2), 652-659.
- Hall, J. E., Brands, M. W., Hildebrandt, D. A., Kuo, J., & Fitzgerald, S. (2000). Role of sympathetic nervous system and neuropeptides in obesity hypertension. *Brazilian Journal of Medical and Biological Research = Revista Brasileira De Pesquisas Medicas E Biologicas*, 33(6), 605-618. doi:S0100-879X2000000600001 [pii]
- Härkänen, T., Kaikkonen, R., Virtala, E., & Koskinen, S. (2014, Nov 6). Inverse probability weighting and doubly robust methods in correcting the effects of non-response in the reimbursed medication and self-reported turnout estimates in the ATH survey. *BMC Public Health.*, 14, 1150.
- Ho, S. Y., Lam, T. H., Janus, E. D., & Hong Kong Cardiovascular Risk Factor Prevalence Study Steering Committee. (2003). Waist to stature ratio is more strongly associated with cardiovascular risk factors than other simple anthropometric indices. *Annals of Epidemiology*, 13(10), 683-691. doi:S104727970300067X [pii]
- Hsieh, S. D., & Yoshinaga, H. (1995). Waist/height ratio as a simple and useful predictor of coronary heart disease risk factors in women. *Internal Medicine (Tokyo, Japan)*, 34(12), 1147-1152.

- Kannel, W. B. (1997). Effect of weight on cardiovascular disease. *Nutrition (Burbank, Los Angeles County, Calif.)*, 13(2), 157-158. doi:S0899900796003930 [pii]
- Kaufman, J. S., Asuzu, M. C., Mufunda, J., Forrester, T., Wilks, R., Luke, A., . . . Cooper, R. S. (1997). Relationship between blood pressure and body mass index in lean populations. *Hypertension*, 30(6), 1511-1516. doi:10.1161/01.HYP.30.6.1511
- Kornitzer, M., Dramaix, M., & De Backer, G. (1999). Epidemiology of risk factors for hypertension: Implications for prevention and therapy. *Drugs*, 57(5), 695-712.
- Koskinen, S., Lundqvist, A., Ristiluoma, N., & editors. (2012). *Health, functional capacity and welfare in finland in 2011. national institute for health and welfare (THL)*. ( No. 68/2012). Tampere: Juvenes Print - Suomen Yliopistopaino Oy: THL. doi:URN:ISBN:978-952-245-769-1
- Lehtonen, R., & Pahkinen, E. (2004). *Practical methods for design and analysis of complex surveys (revised 2nd ed.)*. Chichester : John Wiley & Sons.
- Lewington, S., Clarke, R., Qizilbash, N., Peto, R., Collins, R., & Prospective Studies Collaboration. (2002). Age-specific relevance of usual blood pressure to vascular mortality: A meta-analysis of individual data for one million adults in 61 prospective studies. *Lancet (London, England)*, 360(9349), 1903-1913. doi:S0140673602119118 [pii]
- Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., . . . Memish, Z. A. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-

2010: A systematic analysis for the global burden of disease study 2010. *Lancet (London, England)*, 380(9859), 2224-2260. doi:10.1016/S0140-6736(12)61766-8  
[doi]

Manson, J. E., Colditz, G. A., Stampfer, M. J., Willett, W. C., Rosner, B., Monson, R. R., . . . Hennekens, C. H. (1990). A prospective study of obesity and risk of coronary heart disease in women. *The New England Journal of Medicine*, 322(13), 882-889. doi:10.1056/NEJM199003293221303 [doi]

Masuo, K., Mikami, H., Ogihara, T., & Tuck, M. L. (2000). Weight Gain–Induced blood pressure elevation. *Hypertension*, 35(5), 1135-1140.  
doi:10.1161/01.HYP.35.5.1135

Obesity in Asia Collaboration. (2008). Is central obesity a better discriminator of the risk of hypertension than body mass index in ethnically diverse populations? *Journal of Hypertension*, 26(2), 169-177. doi:10.1097/HJH.0b013e3282f16ad3  
[doi]

Official Statistics of Finland (OSF): Population structure [e-publication].ISSN=1797-5395. Annual Review 2015. helsinki: Statistics finland [referred: 20.10.2016].  
Retrieved from [http://www.stat.fi/til/vaerak/2015/01/vaerak\\_2015\\_01\\_2016-09-23\\_tie\\_001\\_en.html](http://www.stat.fi/til/vaerak/2015/01/vaerak_2015_01_2016-09-23_tie_001_en.html)

Piepoli, M. F., Hoes, A. W., Agewall, S., Albus, C., Brotons, C., Catapano, A. L., . . . Authors/Task Force Members. (2016). 2016 european guidelines on cardiovascular disease prevention in clinical practice: The sixth joint task force of the european society of cardiology and other societies on cardiovascular disease prevention in



clinical practice (constituted by representatives of 10 societies and by invited experts) developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *European Heart Journal*, 37(29), 2315-2381. doi:10.1093/eurheartj/ehw106 [doi]

Razak, F., Anand, S. S., Shannon, H., Vuksan, V., Davis, B., Jacobs, R., . . . Yusuf, S. (2007). Defining obesity cut points in a multiethnic population. *Circulation*, 115(16), 2111-2118. doi:CIRCULATIONAHA.106.635011 [pii]

Research Triangle Institute. (2012). *SUDAAN language manual, volumes 1 and 2, release 11. research triangle park, NC*. Research Triangle Park, NC: Research Triangle Institute.

SAS Institute Inc. (2011). *SAS\_ 9.3 SQL procedure user's guide*. (3rd ed.). Cary, NC: SAS Institute. doi:(ISBN 978-1-60764-892-5)

Schneider, H. J., Friedrich, N., Klotsche, J., Pieper, L., Nauck, M., John, U., . . . Wittchen, H. U. (2010). The predictive value of different measures of obesity for incident cardiovascular events and mortality. *The Journal of Clinical Endocrinology and Metabolism*, 95(4), 1777-1785. doi:10.1210/jc.2009-1584 [doi]

Singh, P. N., Lindsted, K. D., & Fraser, G. E. (1999). Body weight and mortality among adults who never smoked. *American Journal of Epidemiology*, 150(11), 1152-1164.

Sisäministeriö. (2013). Valtioneuvoston periaatepäätös maahanmuuton tulevaisuus 2020 strategiasta, 2013. Retrieved from <http://www.intermin.fi/maahanmuutto2020>

- Skogberg, N., Laatikainen, T., Koskinen, S., Vartiainen, E., Jula, A., Leiviskä, J., . . .  
Koponen, P. (2016). Cardiovascular risk factors among russian, somali and kurdish  
migrants in comparison with the general finnish population. *The European Journal  
of Public Health*, doi:10.1093/eurpub/ckw041
- Tesfaye, F., Nawi, N. G., Van Minh, H., Byass, P., Berhane, Y., Bonita, R., & Wall, S.  
(2007). Association between body mass index and blood pressure across three  
populations in africa and asia. *Journal of Human Hypertension*, 21(1), 28-37.  
doi:1002104 [pii]
- Tillin, T., Sattar, N., Godsland, I. F., Hughes, A. D., Chaturvedi, N., & Forouhi, N. G.  
(2015). Ethnicity-specific obesity cut-points in the development of type 2 diabetes -  
a prospective study including three ethnic groups in the united kingdom. *Diabetic  
Medicine : A Journal of the British Diabetic Association*, 32(2), 226-234.  
doi:10.1111/dme.12576 [doi]
- Wahlbeck, Ö. (2012). The kurdish refugee diaspora in finland. *Diaspora Studies*, 5(1),  
44-57. doi:<http://dx.doi.org/10.1080/09739572.2013.764124>
- Weyer, C., Pratley, R. E., Snitker, S., Spraul, M., Ravussin, E., & Tataranni, P. A.  
(2000). Ethnic differences in insulinemia and sympathetic tone as links between  
obesity and blood pressure. *Hypertension (Dallas, Tex.: 1979)*, 36(4), 531-537.
- WHO Expert Consultation. (2004). Appropriate body-mass index for asian populations  
and its implications for policy and intervention strategies. *Lancet (London,  
England)*, 363(9403), 157-163. doi:S0140-6736(03)15268-3 [pii]

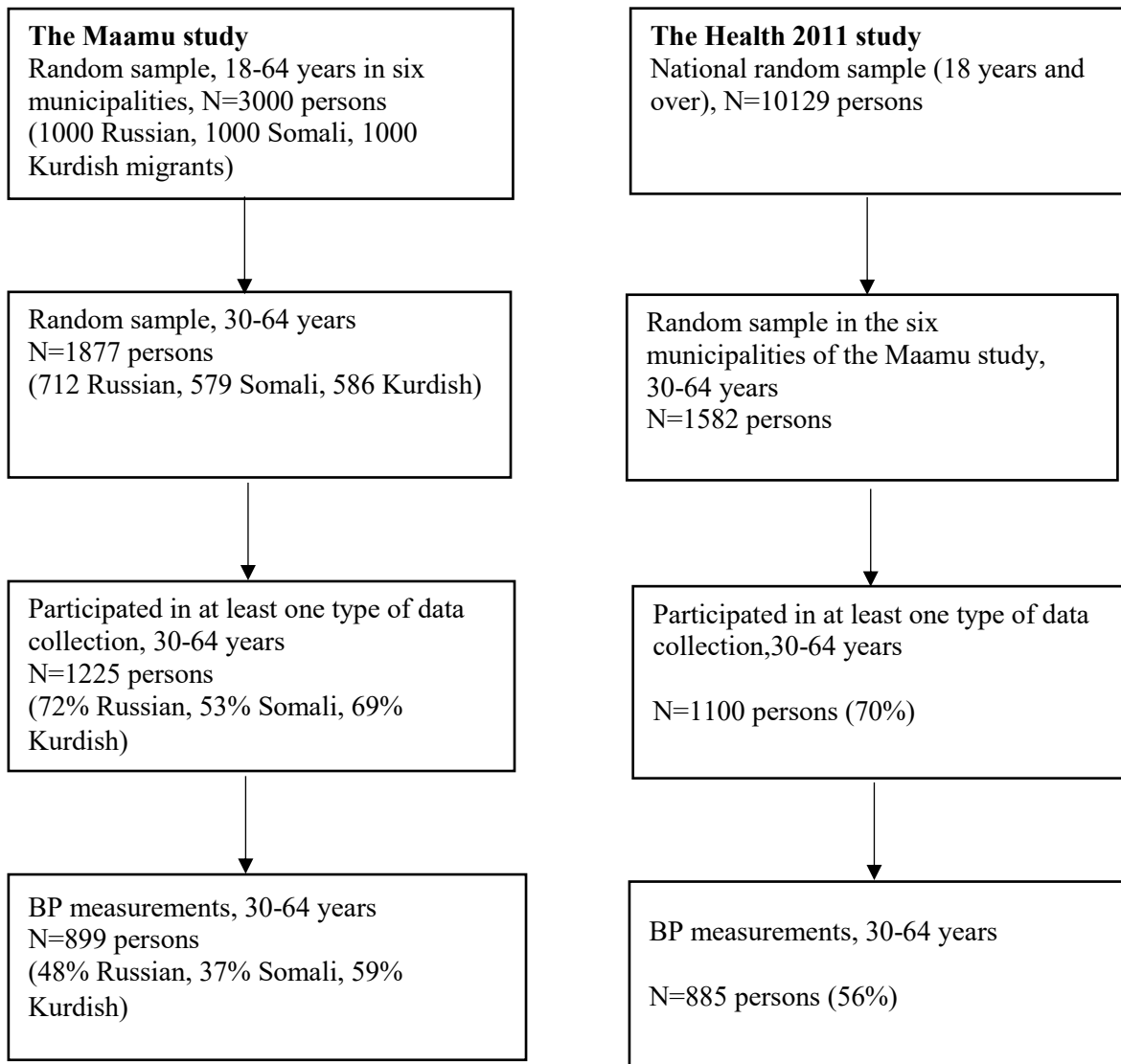


Figure 1. Flow chart of study participants (adopted from Skogberg, 2016).

Table 1. Distribution of socio-economic and lifestyle factors among Russian, Somali and Kurdish migrants compared with the Finns<sup>a</sup>.

Variables	Men (N)				Women (N)			
	Finns	Russian	Somali	Kurdish	Finns	Russian	Somali	Kurdish
	<b>396</b>	<b>118</b>	<b>85</b>	<b>179</b>	<b>489</b>	<b>223</b>	<b>129</b>	<b>165</b>
	%	%	%	%	%	%	%	%
Age (years), mean (SE)	47.2(0.7)	44.3(1.0)*	40.6(1.0)***	41.3(0.5)***	46.3(0.5)	46.7(0.6)	42.1(0.7)***	40.8(0.5)***
Length of residence, ≥ 10 years	N/A <sup>‡</sup>	54.7	53.3	50.9	N/A <sup>‡</sup>	64.0	63.7	61.8
Basic Education		***				***	***	***
no basic education	0	0	13.7	7.6	0	0	41.7	25.3
primary school	44.8	18.7	31.6	46.8	32.3	15.9	45.9	36.2
high school	55.2	81.3	54.6	45.6	67.7	81.1	12.4	38.5
Income sufficiency, yes	N/A <sup>b</sup>	77.9***	69.8***	42.6***	N/A <sup>b</sup>	67.6***	53.4***	38.2***
Marital status (married, cohabiting)	70.2	77.6	83.1*	85.1***	69	60.2**	70.8	74.5
Eating fresh vegetables and fruit or berries 6-7 days/ week	31.8	40.0	0	32.2	44.2	52.6	0	45.0
Daily smoker	22.0	30.3	3.9***	26.2	17.5	9.3**	0	3.6***
Excess drinking <sup>c</sup>	41.4	24.5**	0	8.5***	25.6	7.7***	0	1.4***
Leisure time physical activity, yes	72.3	64.1	85.5**	56.8***	75.1	64.4**	77.8	60.4***

*P*-values shown for the difference between migrant groups and the general population (except Length of residence and Income sufficiency) are based on Satterthwaite-adjusted F-test. a: weighted percentages b: the question was not asked in the Health 2011 study c: Excess drinking: AUDITC ≥ 6 for men and AUDITC ≥ 5 for women

\**p* ≤ 0.050

\*\* $p \leq 0.010$   
\*\*\* $p \leq 0.001$

Table 2. BMI, WHtR and blood pressure among Russian, Somali and Kurdish migrants compared with the Finns, mean (95% CI) or percentage (95% CI)

Variables	Finns	Russian	Somali	Kurdish
<b>Men (N)</b>	<b>396</b>	<b>118</b>	<b>85</b>	<b>179</b>
	<b>% (95% CI)</b>	<b>% (95% CI)</b>	<b>% (95% CI)</b>	<b>% (95% CI)</b>
BMI, kg/m <sup>2</sup>	26.8 (26.3-27.4)	26.6 (25.7-27.4)	24.4 (23.7-25.1)***	27.2 (26.8-27.7)
BMI, kg/m <sup>2</sup> ,				
< 25	36.8 (31.0-43.1)	34.1 (25.4-44.1)	54.7 (43.2-65.8)***	23.3 (18.2-29.3)**
25.0-29.99	44.7 (38.6-51.0)	48.8 (39.3-58.4)	40.1 (29.3-51.9)	55.4 (48.5-62.0)
≥ 30	18.4 (13.6-24.5)	17.1 (10.7-26.1)	5.2 (2.5-10.2)***	21.3 (16.2-27.6)
WHtR, mean	0.54 (0.53-0.55)	0.53 (0.51-0.54)	0.49 (0.48-0.51)***	0.54 (0.53-0.55)
WHtR ≥ 0.5	53.0 (45.0-60.8)	47.2 (40.1-54.4)	35.9 (28.1-44.6)**	65.3 (60.1-70.2)*
SBP, mmHg	128.2 (126.6-129.9)	125.6 (122.8-128.4)	123.0 (118.7-127.4)*	118.6 (117.2-119.9)***
DBP, mmHg	82.3 (81.1-83.5)	82.9 (81.1-84.7)	80.0 (77.3-82.7)	79.2 (78.1-80.2)***
Hypertension <sup>a</sup> ,	37.0 (31.6-42.8)	33.2 (25.5-41.9)	18.1 (10.6-29.2)**	17.2 (12.5-23.2)***
BP medication	10.9 (8.0-14.7)	8.8 (4.8-15.5)	6.5 (2.0-19.0)	9.4 (5.6-15.2)
<b>Women (N)</b>	<b>489</b>	<b>223</b>	<b>129</b>	<b>165</b>
BMI, kg/m <sup>2</sup>	26.4 (25.9-26.9)	26.8 (26.0-27.6)	30.3 (29.5-31.2)***	27.9 (27.4-28.5)***
BMI, kg/m <sup>2</sup>				
< 25,	50.1 (45.2-55.0)	45.8 (39.0-52.6)	9.6 (5.7-15.6)***	18.4 (13.7-24.2)***
25.0-29.99	29.3 (24.9-34.2)	32.3 (26.2-39.1)	39.0 (31.0-47.6)**	48.3 (41.2-55.5)
≥ 30	20.6 (17.1-24.6)	21.9 (16.9-27.9)	51.4 (42.9-59.9)***	33.3 (26.9-40.3)**
WHtR, mean	0.53 (0.52-0.54)	0.52 (0.51-0.54)	0.54 (0.53-0.55)	0.55 (0.54-0.56)***
WHtR ≥ 0.5	42.3 (35.8-49.1)	35.3 (30.0-40.9)	58.2 (51.7-64.3)**	63.0 (57.2-68.4)***
SBP, mmHg	122.3 (120.9-123.6)	114.9 (112.8-116.9)***	110.2(108.0-112.3)***	108.7 (107.1-110.3)***
DBP, mmHg	77.5 (76.5-78.5)	78.7 (77.2-80.2)	75.0 (73.5-76.6)**	74.8 (73.6-76.0)***
Hypertension <sup>a</sup> ,	25.2 (21.5-29.2)	20.6(15.8-26.4)	12.0(7.3-19.0)***	14.1(9.6-20.3)**
BP medication	11.5 (9.0-14.5)	9.2 (6.3-13.3)	8.2 (3.9-16.3)	13.1 (8.5-19.7)

Linear regression method used for means comparisons (age-adjusted ). Logistic regression used for comparisons between categorical variables (age-adjusted).

SBP, systolic blood pressure; DBP, Diastolic blood pressure; BMI, body mass index; WHtR, waist-to-height ratio

a: SBP≥140 and/or DBP≥90 and/or hypertension medication

\* $p \leq 0.050$

\*\* $p \leq 0.010$

\*\*\* $p \leq 0.001$

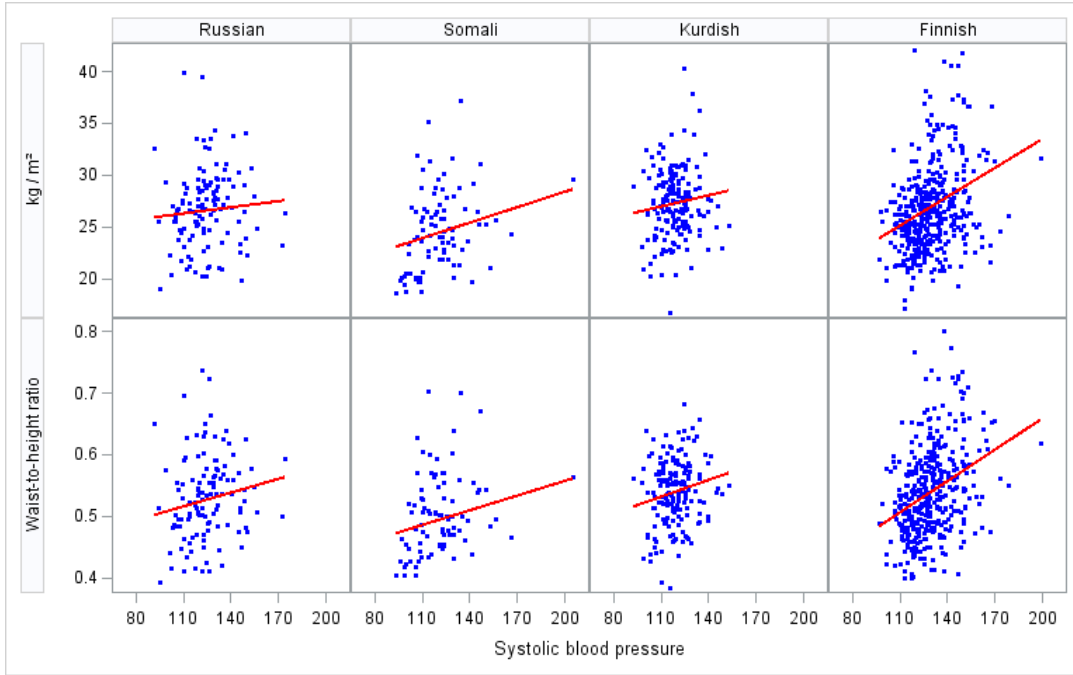


Figure.2 Association between BMI, WHtR and SBP in men.  
 Statistical method: linear regression (age-adjusted)

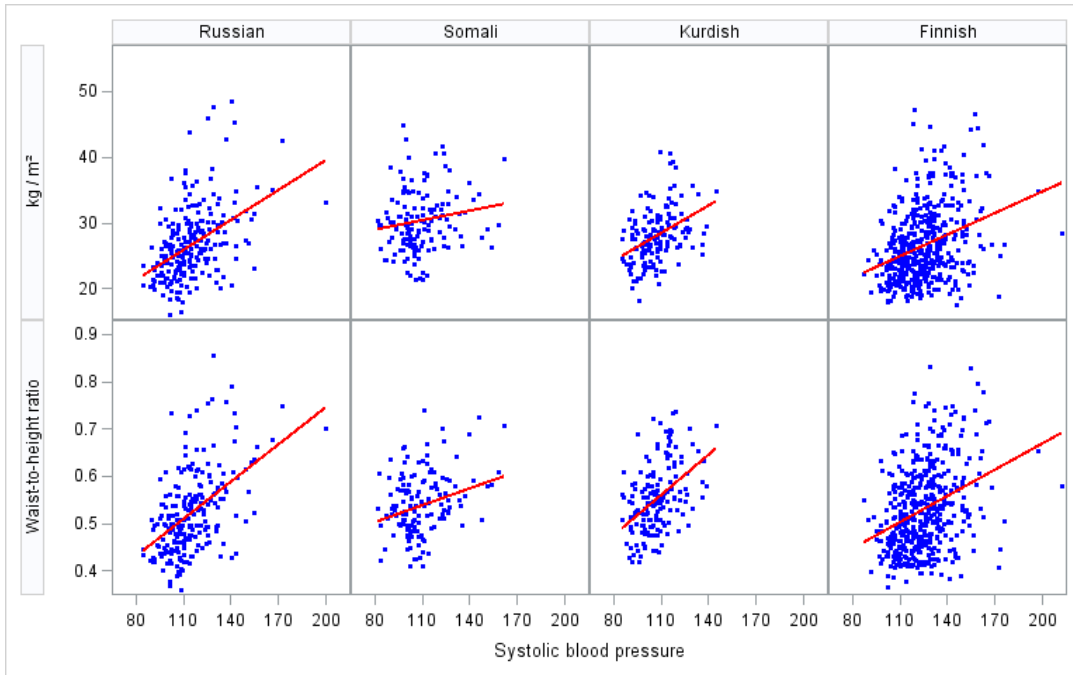


Figure. 3 Association between BMI, WHtR and SBP in women.  
 Statistical method: linear regression (age-adjusted)

Table 3. Associations between BMI, WHtR and SBP (mean,95% CI) in Russian, Somali and Kurdish migrants and the Finns.

Variables	Finns	Russian	Somali	Kurdish
<b>Men (N)</b>	<b>396</b>	<b>118</b>	<b>85</b>	<b>179</b>
	<b>SBP,mean (95% CI)</b>	<b>SBP,mean (95% CI)</b>	<b>SBP,mean (95% CI)</b>	<b>SBP,mean (95% CI)</b>
BMI,				
< 30	127.2 (125.4-129.1)***	125.6 (122.1-129.0)	122.2 (117.6-126.7)	117.9 (116.3-119.4)
≥ 30	136.9 (134.0-139.9)	125.9 (120.1-131.7)	116.3 (106.8-125.7)	118.9 (116.2-121.6)
WHtR,				
< 0.5	125.9 (123.3-128.5)**	122.5 (117.4-127.5)	120.1 (114.9-125.3)	117.1 (113.9-120.2)
≥ 0.5	130.4 (128.3-132.5)	127.1 (123.7-130.4)	124.3 (116.5-132.0)	118.5 (116.9-120.1)
<b>Women (N)</b>	<b>489</b>	<b>223</b>	<b>129</b>	<b>165</b>
BMI,				
< 30	121.7 (120.2-123.2)***	113.0 (110.8-115.2)***	107.9 (104.9-111.0)	105.5 (103.6-107.4)***
≥ 30	128.9 (125.7-132.2)	126.4 (121.2-131.5)	109.2 (106.0-112.5)	110.8 (108.2-113.4)
WHtR,				
< 0.5	120.2 (118.3-122.2)***	111.4 (109.0-113.7)***	107.8 (104.5-111.1)	101.7 (99.1-104.2)***
≥ 0.5	125.7 (123.8-127.6)	120.5 (117.2-123.9)	109.0 (106.2-111.9)	108.8 (106.9-110.7)

Statistical method: linear regression (age-adjusted)

\* $p \leq 0.050$

\*\* $p \leq 0.010$

\*\*\* $p \leq 0.001$

Table 4. Association between BMI, WHtR and hypertension (OR, 95% CI) in Russian, Somali and Kurdish migrants and the Finns.

Factors	Finns OR(95%CI)	Russian OR(95%CI)	Somali OR(95%CI)	Kurdish OR(95%CI)
<b>Men (N)</b>	<b>396</b>	<b>118</b>	<b>85</b>	<b>179</b>
BMI,				
< 30	reference	reference	reference	reference
≥ 30	2.9 (1.47-5.87)**	0.98(0.03-2.89)	1.21 (0.23-6.31)	0.77 (0.26-2.28)
WHtR,				
< 0.5	reference	reference	reference	reference
≥ 0.5	3.9 (2.18-6.95)***	1.06 (0.32-3.55)	1.42 (0.4-5.07)	3.2 (0.72-14.27)
<b>Women (N)</b>	<b>489</b>	<b>223</b>	<b>129</b>	<b>165</b>
BMI,				
< 30	reference	reference	reference	reference
≥ 30	4.36 (2.50-7.60)***	6.05 (2.81-13.02)***	0.98 (0.28-3.36)	1.58 (0.60-4.15)
WHtR,				
< 0.5	reference	reference	reference	reference
≥ 0.5	4.52 (2.69-7.59)***	4.5 (1.89-10.73)***	- <sup>a</sup>	2.45 (0.59-10.2)

Statistical method used: logistic regression

a: no reliable statistics for the variable were available

\* $p \leq 0.050$

\*\* $p \leq 0.010$

\*\*\* $p \leq 0.001$