INTERNATIONAL JOURNAL OF HEALTH RESEARCH AND DEVELOPMENT (IJHRD)
ISSN 2601-6397 (Print)
ISSN 2601-6400 (Online)
ORIGINAL ARTICLE JUNE 2025 VOLUME: 8, ISSUE: 1 ARTICLE

KEY RISK-FACTORS CONTRIBUTING TO CARDIOVASCULAR DISEASE: LIFESTYLE MODIFICATIONS TO IMPROVE CARDIOVASCULAR HEALTH

Author Info:

Ejiofor Augustine Ezika PhD
School of Health and Life sciences, University of the West of Scotland, UK.

Adaobi Nwankwo-Ezika MBSS
Family medicine, Isle of Wight NHS Trust, UK.

Chibuzor Roselyn Ezendiokwelle PhD
Department of Social Work, University of East London, UK.

John Obeng PhD
School of Health and Society, University of Salford, UK.

Bolanle Ola PhD
Institute of Digital Health Care, University of Warwick, UK.

Abstract
Cardiovascular disease is a preventable public health issue. The aim of this review is to identify modifiable risk-factors for cardiovascular disease and recommend lifestyle modification to prevent cardiovascular disease. PubMed, ScienceDirect, SAGE, Google Scholar, World Health Organisation websites, as well as public and community health textbooks, were hand searched and academic resources which are relevant for this review were selected for inclusion. Cardiovascular disease is leading cause of deaths in all continents of the world. While deaths from cardiovascular disease are increasing in Africa and Asia, it is decreasing in Australia and fluctuating in the USA. Premature deaths from cardiovascular disease are preeminent across middle income countries in Europe compared with high income countries. Cardiovascular disease is higher in rural areas of South America compared with urban areas. Trends in lifestyle patterns, including physical inactivity, smoking behaviour, and diets contribute to cardiovascular disease-prone conditions. Prevention includes health promotion activities that facilitate healthy living across life course and limit the initial onset of cardiovascular disease. Investment in prevention is the critical sustainable solution for the cardiovascular disease epidemic. Adopting WHO existing policies within individual countries in Africa, Asia, and middle-income countries in Europe, and ensuring robust implementation of such policies across life course and from different layers of sectors such as education and workplaces would have wider impacts in reducing risk and cardiovascular disease burden in the respective continents. Government of countries with worsening cardiovascular events should also increase health financing and focus on strengthening primary health care services for prevention and treatment of cardiovascular disease.
Keywords: *Cardiovascular Disease Prevention, Tobacco Use, Physical Activity, Nutrition, Metabolic Syndrome.*

I. INTRODUCTION

Cardiovascular disease is a broad, umbrella term used to describe all conditions affecting the heart, blood vessels, or both (National Institute for Health and Care Excellence, 2023). Cardiovascular disease can be caused by arthrosclerosis or thrombosis. Atherosclerosis is a condition where there is a build-up of fatty deposits inside an artery that cause the artery to harden and narrow, restricting blood flow. Several cardiovascular conditions are caused by arthrosclerosis, including coronary heart disease, stroke, transient ischaemic attack, and peripheral arterial disease (National Institute for Health and Care Excellence, 2023). Thrombosis is when a blood clot forms inside a blood vessel, potentially blocking the flow of blood through the circulatory system and causing serious health issues. Arterial thrombosis and venous

thrombosis are two main types of thrombosis (Satoh et al., 2003).

There is overwhelming evidence that the cardiovascular disease is caused by risk factors that can be controlled, treated or modified, including hypertension, cholesterol, unhealthy diets, obesity, tobacco use, physical inactivity and diabetes (Ezika, 2021). Tobacco use and insufficient consumption of fruit and vegetables are key contributors to cardiovascular morbidity and mortality (Wang et al., 2014; Prasad and Das, 2009). Cardiovascular disease-prone conditions such as diabetes mellitus, and hypertension are increasingly significant contributors to cardiovascular disease and premature deaths in developing countries (Buttar, 2005). Cardiovascular disease remains the single leading cause of death around the globe (Ezika and Nwankwo-Ezika, 2020). An estimated 17.9 million people died from cardiovascular disease in 2019, representing 32% of all global deaths. Of these deaths, 85% were due to heart attack and stroke (WHO, 2021).

Cardiovascular disease is a highly preventable public health challenge. Prevention includes health promotion activities that promote healthy living and limit the initial onset of chronic diseases. Investment in prevention is the critical sustainable solution for the cardiovascular disease epidemic. A combination of population-wide and individual health-care strategies is required to prevent and control cardiovascular disease. The total risk approach for controlling cardiovascular risk factors is more cost effective than a single risk factor approach (Owolabi et al., 2016). Efforts to improve physical activity, fruit and vegetable consumption, as well as smoking cessation, should focus on health behaviour change (Thomson and Ravia, 2011). To date, most health behaviour change research address one behaviour in isolation (Vandelanotte et al., 2005). However, research focusing on multiple health behaviours at the same time is advocated to understand and effect complex change (Schuit et al., 2002). This review is focused on tobacco use, physical inactivity, and inadequate consumption of fruit and vegetable because they are primary modifiable risk factors that contribute to cardiovascular disease-prone conditions such as hypertension, obesity, diabetes mellitus, and hyperlipidaemia.

The impacts of tobacco use, physical inactivity, and low consumption of fruit and vegetable as modifiable primary risk factors that contribute to cardiovascular disease are well-documented in the literature. Therefore, the literature on these topics is reviewed here using a narrative approach. Current controversies that relate to these factors are also highlighted, for example, the impact of smokeless tobacco on cardiovascular disease risk. This study also reviews the recommended lifestyle modifications to prevent and manage cardiovascular disease. The aim of this review is to identify significant risk-factors for cardiovascular disease and recommend lifestyle modification to prevent cardiovascular disease. The objectives of this review are to explore i. the impacts of cardiovascular disease on global public health, ii. the key modifiable risk factors that contribute to cardiovascular disease, and iii. strategies for preventing cardiovascular disease.

II. METHODS

A review was conducted in electronic database, including PubMed, ScienceDirect, and SAGE. World Health Organisation website as well as public and community health textbooks were also searched. Meta-analyses and systematic reviews are rated higher in the hierarchy of medical evidence (Haidich, 2010) and were therefore favoured for inclusion in this review. Where the first two are not available, random controlled trials and other types of articles were included. Narrative literature review can help refine or focus a broad research question (Cronin et al., 2007) and was therefore used in this review. This study reviews the global impacts of cardiovascular disease, risk factors that contribute to cardiovascular disease, and recommended lifestyle modification to prevent cardiovascular disease. The keywords that were used during the search were 'cardiovascular disease' 'risk-factors' 'impacts of cardiovascular disease' and 'cardiovascular disease prevention'.

Global Impacts of Cardiovascular Disease

Cardiovascular disease is the leading cause of preventable deaths and rising

healthcare cost globally. The prevalence of cardiovascular disease almost doubled from 271 million in 1990 to 523 million cases in 2019. The global trend of deaths from cardiovascular disease indicated an increase from 12.1 million in 1990 to 18.6 million in 2019 (Roth et al., 2020). Years lived with disability because of cardiovascular disease doubled from 17.7 million to 34.4 million from1990 to 2019 globally. Africa disproportionately bears the impact of cardiovascular disease burden and has one of the highest risks of dying from the disease worldwide (Minja et al., 2022). An estimated 1 million deaths were attributable to cardiovascular disease in sub-Saharan Africa alone, which constituted 5.5% of all global CVD-related deaths world-wide and 11.3% of all deaths in Africa (Keafes et al., 20117). An approximately twice increase in the total number of cardiovascular disease-related deaths since 1990 has been reported, with a greater than 10% difference in mortality among women compared with men (Mensah et al., 2015).

In terms of leading cause of deaths in Europe, the trend is not different, and total number of deaths resulting from cardiovascular disease in Europe is higher than the total number of deaths from cancers in both males and females. Inequality in cardiovascular disease is higher for females, with a median of 36% of all premature deaths caused by cardiovascular disease in middle-income countries in Europe juxtaposed with 16% in high income countries. Ischaemic heart disease is responsible for 39% of the deaths in males and 45% in females in Europe (Timmis, et al., 2022). The increasing burden of cardiovascular disease in high- and middle-income countries in Europe is heightened by ageing population and increase in life expectancy (Timmis, et al., 2022). However, there is a significant inequality in cardiovascular disease burden between high-income and middle-income countries and across all member countries.

Just like in Europe, cardiovascular disease is the leading cause of mortality in Asia. The number of cardiovascular disease deaths in Asia nearly doubled from 5.6 million to 10.8 million from 1990 to 2019 (Zhao, 2021). Asia is responsible for 58% of deaths from cardiovascular disease out of 18.6 million recorded globally in 2019. Within Asia, cardiovascular disease was responsible for 10.8 million deaths which represent 35% of the total deaths in Asia. 39% of these cardiovascular disease deaths in Asia occurred in people below 70 years. The percentage of deaths below 70 years in Asia is comparatively higher than global average (34%) and Europe (22%) (Zhao, 2021). 87% of cardiovascular disease deaths in Asia was mainly due to ischemic heart disease (47%) and stroke (40%). In central, western, and Southern Asia, ischemic heart disease is the major contributor to cardiovascular disease deaths responsible for 62%, 60%, and 57% of cardiovascular disease deaths, accordingly (Zhao, 2021).

Cardiovascular disease is accountable for 31.1% deaths in South America. In all countries in South America, men experienced higher rates of cardiovascular disease and deaths compared with women. Cardiovascular disease related deaths are higher in rural areas of South America compared with urban areas (Jaramillo, 2022). The three major risk-factors for cardiovascular disease in urban areas in Soth America were hypertension (20.7%), abdominal obesity (16.7%), and tobacco use (12.5%) while rural areas have hypertension (16.2%), tobacco use (15.5%), and low education (12.5%) as the major risk-factors. In South American women, the major risk-factor for cardiovascular disease was hypertension (17.4%) and the least was poor diet (5.2%). In men, hypertension (20.2%) was the major risk factor for cardiovascular disease while the least risk-factor was low education (5.1%) (Jaramillo, 2022). Cardiovascular disease continues to impose a significant burden on Australians in terms of illness, disability, and premature deaths (Waters et al., 2013). Evidence indicates that Australians have experienced a significant burden of cardiovascular disease in terms of incidence, hospitalisations and deaths (Peng and Wang, 2018). Cardiovascular disease is responsible for one-third (33%) of total deaths compared to any other disease group in Australia in the year 2009. There were almost 500,000 hospitalisations because of cardiovascular disease related issues. One in five Australians aged 45 – 74 years had a high risk of

cardiovascular disease in the next 5 years (Peng and Wang, 2018). However, the Australian rate of hospitalisation for cardiovascular disease reduced by 13% from 1988 to 2010. Cardiovascular disease remains a major health issue in Australia despite hospitalisation rate and decreasing deaths (Waters et al., 2013).

Since 1921, cardiovascular disease is the leading cause of deaths in the USA. Evidence suggests that 127.9% million (48.6%) of Americans that are 20 years and above are living with cardiovascular disease such as coronary heart disease, heart failure, stroke or hypertension (Martin et al., 2024a). The prevalence of cardiovascular disease is preeminent among non-Hispanic Black females (59%) and non-Hispanic Black males (58.9%). The leading risk-factors for cardiovascular disease in the USA include hypertension (male 50.4%, female 43%), overweight and obesity (71% adults), and physical inactivity (24.2% adults) (Martin et al., 2024a).

Deathrates from cardiovascular disease have reduced by 60% since 1950s in the USA. Over the years the death rates in the USA have fluctuated and had recently moved upwards. For example, mortality from cardiovascular disease in the USA increased steadily in the 1900s but reduced into 2010s and consequently increased again in later 2010s to 2020. In the USA, the number of people dying from heart attacks has declined from 50% to 12.5% (Laforgia et al., 2022). Much success has been recorded as stroke which was rated as the third leading cause of deaths in 1938 has been on decline since early 20th century and currently ranked as the fifth leading cause of mortality in the USA (Lackland et al., 2014). Despite the success story recorded so far, more concerted efforts are needed to arrest the current upward trend of cardiovascular disease in the USA which is attributed in parts to worsening risk-factors, including overweight, obesity, hypertension, diabetes, ageing population, and physical inactivity (Martin et al., 2024b).

Modifiable Risk Factors that Contribute to Cardiovascular Disease and Recommended Lifestyle Modifications

Tobacco Use

Cigarette smoking is a key contributor to cardiovascular morbidity and mortality (Hackshaw et al., 2017; Mons et al., 2015). Epidemiologic evidence shows that cigarette smoking, in both sexes, increases the incidence of cardiovascular events, myocardial infarction, fatal coronary artery disease, and stroke (Mons et al., 2015). Some important themes and debates emerged from the review of the literature on tobacco that may be relevant to cardiovascular disease risk. These themes and debates are discussed below.

Passive smoking and cardiovascular disease: Meta-analyses of cohort, case-control, and epidemiologic evidence show that passive smoking, in both sexes, increases the incidence of Coronary Heart Disease, ischemic heart disease, and stroke (Fischer and Kraemer, 2015; Barnoya and Glantz, 2005; Oono et al., 1999). A meta-analysis conducted by Barnoya and Glantz (2005) indicates a 25% to 30% elevation in risk of Coronary Heart Disease from exposure to passive smoke. The individual studies in Oono et al. (1999) varied in their inclusion criteria, design, definition of exposure, and statistical adjustment. Use of a random effects model enabled the authors to take account of these variations between studies and produce a more robust estimate of effect with only a moderate level of heterogeneity. The limitation is that the meta-analyses were based on published aggregate results. The authors did not have access to individual patient data.

Smokeless tobacco and cardiovascular disease: There are debates on whether smokeless tobacco products contribute to cardiovascular disease. A meta-analysis of observational studies conducted by Boffetta (2009) which examined whether individuals who use smokeless products are at elevated risk of myocardial infarction and stroke reported an increased risk of death from myocardial infarction and stroke as a result of smokeless tobacco use. Also, data from the international INTERHEART study, which included a variety of smokeless tobacco products, indicate that smokeless tobacco product use is associated with an increased risk of acute myocardial infarction (Teo et al., 2006). It is likely that differences in the risk of myorcardial infarction

in smokeless tobacco users reported in different studies are due to use of different types of smokeless products and/or different patterns of smokeless tobacco use in the various study groups as well as different research designs and methods. Although the study by Teo et al. (2006) is a case-control study, it was included in this study because it is a massive study involving participants from fifty-two countries.

A review by Piano et al. (2010) suggest that clinicians should continue to discourage use of all tobacco products and emphasise the need for prevention of smoking initiation and support for smoking cessation as primary goals for tobacco control. The limitation of the meta-analysis study conducted by Boffetta (2009) was that it did not provide evidence of a difference in the effect of smokeless tobacco products consumed in North America and northern Europe on cardiovascular health. There is paucity of systematic review studies that incorporate data on the impacts of smokeless tobacco products on health and wellbeing in Africa despite the common use of smokeless tobacco products in the continent.

Physical Activity

An evaluation study reveals that physical inactivity, including long sitting time is directly related to cardiovascular disease mortality (Katzmarzyk et al, 2009). There are two types of non-exercise behaviours: first, sedentary behaviour which include sitting, lying down, and involves very little energy expenditure of 1.0 – 1.5 metabolic equivalents, second, the light-intensity activity, including standing, self-care activities, and slow walking, which require low energy expenditure of nearly 1.6 – 2.9 METS (Owen et al., 2010). The low-intensity physical activity is otherwise known as non-exercise activity thermogenesis or NEAT (Loeffelholz and Birkenfeld, 2022). Accumulating short bouts of low-intensity physical activity throughout the day can have significant health benefits, which may even rival those linked with more active sessions. Individuals should elevate their daily step count by 1,000 steps/day with a goal of reaching at least 10, 000 steps per day (Loeffelholz and Birkenfeld, 2022). The step count can be measured by a pedometer which is a beep-sized device worn around the waist and keep track of the number of steps taken each day. Targeting and reducing sedentary behaviour may prove to be an effective cardiovascular risk reduction in addition to increasing physical activity (Katzmaryzyk, 2009).

A meta-analysis by Li and Siegrist (2012) suggest that high level of leisure time physical activity and moderate level of occupational physical activity have a beneficial effect on cardiovascular health by reducing the overall risk of incident coronary heart disease and stroke among men and women by 20 to 30 percent and 10 to 20 percent, respectively. Interestingly, many human studies show that consistent aerobic physical activities improve cardiovascular function. These studies apply to healthy individuals without any underlying risk factors as well as people with cardiovascular risk. There is compelling evidence from observational studies and a review of randomised controlled trials that individuals who are physically active minimise their risk of developing coronary heart disease, stroke and type 2 diabetes, by up to 50% (Warburton et al., 2006; Williamson, 2004). People who are physically active minimises the risk of premature deaths by 20-30% and are nearly two times less likely to die prematurely from a heart attack than their inactive contemporaries (Warburton et al., 2006). Besides, intense physical activity decreases both systolic and diastolic blood pressure in individuals with increased blood pressure by nearly 3.8mmHg and 2.6mmHg respectively (Golbidi and Laher, 2012).

The individuals having diabetes, a risk factor for cardiovascular disease, are advised to involve in increased physical activity to improve blood glucose control, which minimises the negative impact of diabetes on cardiovascular health (Avery et al., 2012). Patients living with high blood pressure, metabolic syndrome, cardiovascular disease, myocardial infarction, and congestive heart failure benefit from physical activities compared with an individual who does not participate in any physical activity (Golbidi and Laher, 2012; Vona et al., 2004). Physical activity appears to benefit those who have diabetes compared with non-diabetic patients. The healthy individuals fail to gain from

physical activity that improves endothelial function compared with patients living with diabetes (Golbidi and Laher, 2012).

Some studies reported a positive relationship between levels of physical activity and overweight (Planinsec and Matejek, 2004; Collins et al., 2008; Mahfouz et al., 2008). The study by Planinsec and Matejek (2004) was conducted among children while Collins et al. (2008) and Mahfouz et al. (2008) were carried out among adolescents. Although many studies included in the remaining part of this section are not meta-analyses, they are included to enhance understanding of relationship between physical inactivity and overweight. Intense physical activity decreases adiposity especially in those with the excess upper body and abdominal fat (Golbidi and Laher, 2012). A study found that children and adolescent who had a low level of vigorous physical activity were more likely to be overweight or obese and have a high-risk waist circumference than those with a high level of vigorous physical activity. The study was carried out by Ortega and Sjostrom (2007) involving 557 Swedish children and used logistic regression analyses in examining the association of physical activity with total and central adiposity. The study further found that participants who had a low or middle level of physical activity were more likely to be overweight than those who have a high level of physical activity. Birth weight and television viewing were also linked with higher odds of having a high-risk waist circumference, but these associations were attenuated once vigorous physical activity variable was included in the model. The study concluded that low levels of physical activity might play a vital role in the development of overweight and excess of central adiposity in children and adolescents, in spite of some factors including, television viewing and birth weight.

However, three independent studies carried out by Thompson et al. (2005), Al-Nakeeb et al. (2007), and Senbanjo and Oshikoya (2010) report no association between physical activity and weight status. However, Senbanjo and Oshikoya (2010) specifically explain that the lack of association between physical activity and weight status may be as a result of a small sample of overweight participants recruited for their studies. On the other hand, the study reported a higher prevalence of underweight in the physically active children which reflects a negative balance between the energy expended in doing exercise and energy intake.

WHO developed the 'Global Recommendations on Physical Activity for Health' with the goal of providing national and regional level policy makers with guidance on the dose-response relationship between the frequency, duration, intensity, type and the total amount of physical activity required for the prevention of non-communicable diseases, including cardiovascular disease (WHO, 2010a). For example, WHO (2009) recommends that children and youth aged 5 – 17 should be involved in moderate to vigorous intensity physical activity daily for at least 60 minutes.

It is recommended that the vigorous intensity physical activity that is aerobic should be carried out at least three times per week (WHO, 2009). Physical activity greater than 60 minutes provides additional health benefits. WHO (2010a) recommends that adults aged 18-64 years should do at least 150 minutes of moderate-intensity aerobic physical activity throughout the week. Aerobic activity should be performed in bouts of at least ten minutes duration. Adults should elevate their moderate-intensity aerobic physical activity to 300 minutes per week to increase the accruable health benefits. It is recommended that individuals within the age group of 5-17 should be engaged in playing games, running, turning or jumping. People within 18-64 years of age should involve in recreational activities, walking and cycling. Work activities, household chores, and games, planned exercise in the context of daily, family and community activities were also recommended (WHO 20009; WHO 2010). Meta-analyses had shown that at high-intensity interval training, relative risks to coronary heart disease were relatively lower while cardiorespiratory fitness is higher, compared with moderate-intensity continuous training (Hannan et al., 2018; Sattelmair et al., 2011).

Nutrition

Unhealthy diets including foods high in sugars, saturated and trans-fats, low fibre foods and high sugar drinks contribute to coronary heart disease and other health challenges (Hou et al., 2015; Malik et al., 2010). Over the years, a low-fat diet was advocated because the high caloric density of fat could elevate the possibility of obesity (Benatti et al., 2004). A high intake of fat (more than one-third of total calories) elevates the intake of saturated fats, and it is linked to the consumption of excess calories and weight gain (WHO, 2007a). Given this, the current clinical practice guideline recommends a diet that provides less than 30% of calories from dietary fat, less than 10% of calories from saturated fats, up to 10% of calories from polyunsaturated fats, and about 15% from monounsaturated fats (Mosca et al., 2004). In support of this assertion, a cohort study involving 1551 middle-aged men, conducted by Laaksonen et al. (2005) indicate that replacing saturated and trans-unsaturated fats with monounsaturated and polyunsaturated fat are more effective in preventing coronary heart disease events than minimising overall fat intake.

Polyunsaturated fats contain omega-3 fatty acids and omega-6 fatty acids. Omega-3 fatty acid primarily from fish lowers triglycerides and apoprotein, raise HDL, and protect against stroke (Djousse et al., 2012; Bradbury and Hilleman, 2013). Eating fish which is rich in omega-3 fatty acids including, tuna, halibut, catfish, flounder, and salmon twice a week protects the cardiovascular health, and this practice can minimise the risk of stroke by as much as 50% (Djousse et al., 2012; Bradbury and Hilleman, 2013; Holub and Holub, 2004). Mosca (2004) agrees, however, point out that women of childbearing age, particularly pregnant women should avoid shark, swordfish, mackerel, and tilefish due to the high content of mercury in these fish which may impair foetal neurological development. High doses of fish oil and omega-3 fatty acid may elevate the risk of bleeding and individuals who eat more than three grams of omega-3 fatty acids per day (the equivalent of 3 servings of fish per day) may have a higher risk for haemorrhagic stroke (Clark et al., 2005).

Other sources of omega-3 fatty acids include flaxseed oil, walnut oil, soybean oil, and walnuts (Mosca et al., 2004). However, there is less evidence supporting cardiovascular benefits from these sources of omega-3 fatty acids (Djousse et al., 2012). WHO (2007a) reports a systematic review of 27 studies, comprising 30, 902 individuals which assessed the effects of advice about minimising or changing dietary fat intake. The interventions involved both direct provisions of food and, in most cases, nutritional advice to reduce consumption of total fat or saturated fat or dietary cholesterol or to shift from saturated to unsaturated fat. The pooled results show that decreasing or changing dietary fat minimises the incidence of combined cardiovascular events by 16% and cardiovascular mortality by 9%. Emily et al. (2008) warn that switching to unsaturated fats, especially oxidised polyunsaturated fatty acids contained in most types of vegetable oil is not without health risk as its high consumption may elevate the possibility of postmenopausal women developing breast cancer. Contrarily, Feldeisen and Tucker (2007) argue that diets containing too little fat can worsen dyslipidaemia.

There is a wealth of evidence on the importance of getting five (400g) portions of fruit and vegetables every day (WHO, 2007a). Health promotion campaign known as 'Five a day' is predicated on the advice from the WHO, which recommends eating a minimum of 400g of fruit and vegetables a day to lower the risk of serious health problem, including heart disease, stroke, type 2 diabetes, and obesity (Aune et al., 2017; Wang et al., 2014; Hung et al., 2004).

Metabolic Syndrome: CVD Risk and Recommended Lifestyle Modification

According to Rakesh and Viswanathan (2012), the International Diabetes Federation (IDF) released a global consensus definition for metabolic syndrome, along with race- and gender-specific waist circumference (WC) cutoffs. This definition identified central obesity as a key component of metabolic syndrome and defined metabolic syndrome as central obesity (based on race- and gender-specific WC cutoffs) in addition to any two of the following four parameters:

Raised triglycerides: ≥150 mg/dl (1.7 mmol/l) or history of specific treatment for this lipid abnormality
Reduced HDL cholesterol: < 40 mg/dl (1.03 mmol/l) in males and < 50 mg/dl (1.29 mmol/l) in females or history of specific treatment for this lipid abnormality
Raised blood pressure: systolic BP ≥130 mm Hg or diastolic BP ≥85 mm Hg or on treatment for previously diagnosed hypertension
Raised Fasting Plasma Glucose: ≥ 100 mg/dl or previously diagnosed type 2 diabetes mellitus (DM).
The suggested race- and gender-specific waist circumference cutoffs are shown in Table 1.

Table 1: Race- and gender-specific waist circumference cutoffs: Adapted from changing the definitions of metabolic syndrome (Rakesh and Viswanathan, 2012)

Country/Ethnic group	Waist circumference cutoff	
	Male	Female
Europe, USA Waist circumference ≥102 cm in men and ≥88 cm in women used for clinical purposes	≥94cm	≥80cm
South Asians, Chinese, Malays, Indians, Japanese	≥90cm	≥80cm
South and Central Americans	South Asians recommendations	
Sub-Saharan Africans	Use European data until more specific data are available	
Eastern Mediterranean and Middle East populations	Use European data until more specific data are available	

There are other definitions of the metabolic syndrome, including the definitions of the WHO, European Group for Study of Insulin Resistance (EGIR), the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III), and the American Association of Clinical Endocrinologists (AACE) (Rakesh and Viswanathan, 2012; Einhorn et al., 2003; Balkau and Charles, 1999). One of the two main differences between the definition of metabolic syndrome by WHO (1999) and International Diabetic Federation (2012) is that the former used raised blood pressure cutoff point ≥140/90 mm of Hg, compared with ≥130/85 mm Hg by the latter. The second difference is that WHO (1999) included microalbuminuria, i.e., urinary albumin excretion rate ≥ 20 µgm/minute or albumin/creatine ratio ≥ 30 µgm/mg as one of the cutoff points. In contrast to WHO, EGIR excluded patients with type 2 DM in the definition because insulin resistance was viewed primarily as a risk factor for diabetes. The cutoff points used for BP and HDL by IDF and NCEP AT III are stringent as compared to those suggested in the WHO definition, and by avoiding the need for measurement of microalbuminuria, all other definitions are much more practically applicable compared with the definition suggested by the WHO.

Despite the higher incidence of abdominal obesity in Nigerian women (16.9%) than men (7.3%), women (11.8%) and men (12.7%) had a similar prevalence of metabolic syndrome (Adegoke et al., 2010). The

procedures used to determine metabolic syndrome by Adeoke and colleagues align with the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) criteria (Rakesh and Viswanathan, 2012). Waiste circumference cutoff used by Adegoke and colleagues and how it was measured were not stated. A meta-analysis of prospective studies that examined the association between the metabolic syndrome and risk of cardiovascular disease in individuals with the metabolic syndrome, compared to those without, had an increased mortality from all causes and cardiovascular disease; as well as an increased incidence of cardiovascular disease, coronary heart disease and stroke (Galassi et al., 2006).

A meta-analysis of randomised controlled trial found that a reduction in habitual dietary salt intake of 6g was associated with reductions in systolic/diastolic blood pressure of 7/4 mm Hg in people with hypertension and 4/2 mm Hg in those without hypertension (He, and MacGregor, 2002). WHO (2007b) recommends salt intake of fewer than 5 grams per day for the prevention of cardiovascular disease. However, data from many countries show that most populations are consuming much more salt than recommended by WHO (Brown et al., 2009; WHO 2010b). Minimising dietary salt intake from the current global level of 9 - 12grams per day to the recommended level of 5grams per day would be expected to have a crucial impact on decreasing blood pressure and cardiovascular disease. Universal reduction in dietary intake of sodium by about 1g of sodium a day (approximately 3g of salt) would lead to 50% reduction in the number of people needing treatment for high blood pressure (He and MacGregor, 2008). The same reduction would lead to a 22% drop in the number of deaths resulting from strokes and a 16% fall in the number of deaths from coronary heart disease. Furthermore, two independent studies carried out by Cook et al. (2007) and Strazzulo et al. (2009) found a reduction rate of stroke by 23% and cardiovascular disease rates by 17% when dietary sodium was reduced from 10grams to 5grams.

On the contrary, recent studies demonstrated the harmful effect of sodium reduction on patients with established heart failure (Paterna, 2008; Paterna, 2009) and diabetes (Thomas, 2011; Ekinci, 2011), questioning the advisability of a general recommendation of minimising sodium intake. A randomised controlled trial by Meckling and Sherfey (2007) found that high protein may be better than carbohydrate as the vital energy source for those with metabolic syndrome as it helps to promote weight loss and improve lipid or glucose profiles. High-protein and low-carbohydrate diet will enhance weight reduction because protein offers satiety that is absent with carbohydrates (Foster et al., 2003). However, an experimental study by Mitch (2005) found that high-protein foods of any sort are not well tolerated by individuals with chronic renal diseases who have markedly minimised glomerular filtration rate, and the study further found that excess protein enhances phosphorous load which can cause acidosis and worsen insulin resistance. The detection, prevention, and treatment of the underlying risk factors of the metabolic syndrome should become an important approach for the reduction of the cardiovascular disease burden in the general population.

III. CONCLUSION

Cardiovascular disease is the leading cause of deaths across all continents of the world. Africa disproportionally bears the impacts of cardiovascular disease burden and has one of the highest risks of dying from the disease worldwide. Premature deaths from cardiovascular disease are preeminent across middle income countries in Europe compared with high income countries. The number of deaths from cardiovascular disease in Asia has nearly doubled within two decades and the percentage of deaths in people below 70 years is higher than global average. Cardiovascular disease is higher in rural areas of South America compared with urban areas. The deathrates from cardiovascular disease have fluctuated over the years and has recently moved up in the USA.

Investing in population-wide interventions such as promoting physical activity, increasing fruit and vegetable intake, reducing excess salt consumption through

designing new policies or adopting WHO existing policies within individual countries and ensuring robust implementation of such policies across life course and from different layers of sectors such as education and workplaces would have wider impacts in reducing risk and disease burden in Africa. Government of countries within Africa should also increase health financing and focus on strengthening primary health care services for prevention and treatment of cardiovascular disease. Investing in data collection and research outputs in relation to cardiovascular disease within various countries in Africa will improve the accuracy of the cardiovascular disease profile and burden which will inform policy adoption on interventions. Trends in lifestyle patterns, including physical inactivity, smoking behaviour, and diets contribute to cardiovascular disease-prone conditions.

Increasing the awareness of the members of the public, policy makers and other relevant stakeholders about impacts of cardiovascular disease through cardiovascular research and robust healthcare delivery will be helpful in tackling cardiovascular disease as a leading cause of deaths in Europe. To prevent cardiovascular disease in Asia, it is important to understand the present epidemiologic features of cardiovascular disease in Asia via a thorough study and analysis of numerous data on epidemiology of cardiovascular disease from many sources in Asian countries. There is paucity of studies on the effect of smokeless tobacco products in Africa despite the common use of smokeless tobacco products in the continent. As a result, future researchers should explore this area.

REFERENCES

Adegoke, O., A., Adedoyin, R., A., Balogun, M., O., Adebayo, R., A., Bisiriyu, L., A. and Salawu, A., A. (2010). Prevalence of metabolic syndrome in a rural community in Nigeria. Metabolic Syndrome and Related Disorders, Vol. 8 (1), pp.59-62.

Al-Nakeeb, Y., Duncan, M., J., Lyons, M. & Woodfield, L. (2007). Body fatness and physical activity levels of young children. Annals of Human Biology, 34, 1-12

Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L., T., Keum, N., Norat, T., Greenwood, D., C., Elio Riboli, E., Lars J Vatten, L., J., & Tonstad, S. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality—a systematic review and dose-response meta-analysis of prospective studies. International Journal of Epidemiology, 46 (3), 1029–1056.

Avery, L, Flynn, D., Trenell, M (2012). Changing physical activity behaviour in type 2 diabetes. Diabetes Care, 35 (12), 281 – 2689.

Balkau, B., Charles, M., A. (1999). Comment on the provisional report from the WHO consultation European Group for the Study of Insulin Resistance (EGIR) Diabetic Medicine, 16, 442–3.

Barnoya, J., Glantz, S. (2005). Cardiovascular effects of second-hand smoke: nearly as large as smoking. Circulation, 111 (20), 2684 98.

Benatti, P., Peluso, G., Nicolai, R. & Calvani, M. (2004). Polyunsaturated fatty acids: biochemical, nutritional and epigenetic properties. Journal of the American College of Nutrition, 4, 281-302.

Boffetta, P. & Straif, K. (2009). Use of smokeless tobacco and risk of myocardial infarction and stroke: systematic review with meta-analysis. British Medical Journal, 339, 1136.

Bradbury, J., C. & Hilleman, D. E. (2013). Overview of omega-3 fatty acid therapies. Pharmacy and therapeutics, 38 (11), 681 – 690.

Brown, I., J., Tzoulaki, I., Candeias, V. & Elliott, P. (2009). Salt intakes around the world: implications for public health. International Journal of Epidemiology, 38, 791-813.

Buttar, H., S., Li, T., Ravi, N (2005). Prevention of cardiovascular disease: Role of exercise,

dietary interventions, obesity and smoking cessation. Experimental and Clinical Cardiology, 10 (4), 229 – 249.

Clarke, J., Herzberg, G., Peeling, J., Buist, R., Corbett, D. (2005). Dietary supplementation of omega-3 polyunsaturated fatty acids worsens forelimb motor function after intracerebral hemorrhage in rats. Experimental Neurology, 191(1):119-27.

Collins, A., E., Pakiz, B., Rock, G., L. (2008). Factors associated with obesity in Indonesian adolescents. International Journal of Paediatrics Obesity, 3, 58-64.

Cook, N., R., Cutter, J., A., Obarzanek, E., Burning, J., E., Rrxrode, K., M., Kumanyika, S., Appel., L., J., & Whelton, P, K. (2007). Long term effects of dietary sodium reduction on cardiovascular disease outcomes: observational follow-up of the trials of hypertension prevention (TOHP) British Medical Journal, 334, 1-8.

Cronin, P., Ryan, F., Coughlan., M. (2007). Undertaking a literature review: a step-by-step approach. British Journal of Nursing, 17 (1), 38 – 43.

Djousséa, L., Akinkuolieb, J., A, O., Wu, H., Y., Eric, L., Dingg, L., & Gazianoa, M., J. (2012). Fish consumption, omega-3 fatty acids and risk of heart failure: a meta-analysis. Clinical Nutrition, 31 6), pp. 846–853.

Einhorn D., Reaven, G., M., Cobin, R., H., Ford, E., Ganda, O., P., Handelsman (2003). American College of Endocrinology position statement on the insulin resistance syndrome. Endocrinology Practice, 9, 237–52.

Ekinci, E., I., Clarke, S., Thomas, M., C, Moran, J., L., Cheong, K., MacIsaac, R., J., & Jerums, G (2011). Dietary salt intake and mortality in patients with type 2 diabetes. Diabetes, 34, 703-709.

Emily, S., Ulrika, E., Bo, G., Kerstin, S., Hakan, O. & Elsabet, W. (2008). Do both heterocyclic amines and omega -6 polyunsaturated fatty acids contribute to the incidence of breast cancer in postmenopausal women of the Malmo diet and cancer cohort? International Journal of Cancer, 123 (7), 1637-1643.

Ezika, A, E (2021). Cardiovascular disease prevention; impacts of an intervention on clinical practice. Journal of Medical Science and Clinical Research, 09 (05), 60 – 71.

Ezika, A., E., Nwankwo-Ezika, A (2020). Transtheoretical model as a framework for promoting cardiovascular health through behaviour change: a systematic review. International Research Journal of Public Health, 4 (46), 1 – 11.

Feldeisen, S., E., Tucker, K., L. (2007). Nutritional strategies in the prevention and treatment of metabolic syndrome. Applied Physiology, Nutrition, and Metabolism, 32 (1), 191-198.

Fischer, F. and Kraemer, A. (2015). Meta-analysis of the association between second-hand smoke exposure and ischaemic heart disease, COPD and stroke. BMC Public Health, 15, 2 – 18.

Foster, G., D., Wyatt, H., R., Hill, J., O., McGuckin, B., G., Brill, C., Mohammed, B., S., Szapary, P., O, Rader, D., J., Edman, J., S., & Klein, S. (2003). Randomised trial of a low-carbohydrate diet for obesity. New England Journal of Medicine, 348, 2082 – 2090.

Galassi A, Reynolds K, He J (2006). Metabolic syndrome and risk of cardiovascular disease: a meta-analysis. American Journal of Medicine, 119(10), pp. 812-9.

Golbidi, S., & Laher, I. (2012). Exercise and the cardiovascular system. Cardiology Research and Practice, 21 (2), 135-145.

Hackshaw, A., Morris, J., K., Boniface, S., Tang, J., Milenkovic, D. (2017). Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports. British Medical Journal, 360, 1-13.

Haidich (2010). Meta-analysis in medical research. Hippokratia, 14 (1), 29 – 37.

Hannan, A., L., Hing, W., Simas, V., Climstein, M., Coombes, J., Jayasinghe, R., Byrnes, J, & Furness, J. (2018). High-intensity interval training versus moderate intensity continuous training within cardiac rehabilitation: a systematic review and meta-analysis. Journal of Sports Medicine, 9, 1 – 7.

He, F., J., MacGregor, G., A (2002). Effect of modest salt reduction on blood pressure: a meta-analysis of randomised trials. Implications for public health. Journal of Human Biology, 16, 761 – 770.

He, F., J., MacGregor (2008). A comprehensive review of salt and health and current experience of world salt reduction programmes. Journal of Human Hypertension, 23, 363 – 384.

Holub, D., J. & Holub, B., J. (2004). Omega-3 fatty acids from fish oils and cardiovascular disease. Molecular and Cellular Biochemistry, 263 (1), 217 – 225.

Hou, L., Li, F., Wang, Y., Ou, Z., Xu, D., Tan, W., Dai, M. (2015). Association between dietary patterns and coronary heart disease: a meta-analysis of prospective cohort studies. International Journal of Clinical and Experimental Medicine, 8 (1), pp. 781 – 790.

Hung, H., Joshipura, K., J., Jiang, R., Hu, F., B., Hunter, D., Smith-warner, S., Colditz, G., A., Rosner, B., Spiegelman, D. & Willett, W., C. (2004). Fruit and vegetable intake and risks of major chronic disease. Journal of National Cancer Institute, 96 (2), 1577 – 1584.

International Diabetic Federation (2012). Metabolic syndrome in children and adolescents. https://idf.org/media/uploads/2023/05/attachments-31.pdf

Jaramillo, P., L., Joseph, P., Lopez, J., P., Lanas, F., Avezum, A., Diaz, R., Camacho, P., Seron, P., Oliveira, G (2022). Risk-factors, cardiovascular disease, and mortality in South Africa: a pure sub study. European Heart Journal, 43 (30), 2841 – 2851.

Katzmarzyk, P., T., Church, T., S., Craig, C., L., & Bouchard, C. (2009). Sitting times and mortality from all causes, cardiovascular disease, and cancer. Medicine & Science in Sports &Exercise, 41, 998-1005.

Keafes, A., K., Mocumbi, A., O., Ntsekhe, M., Sliwa, K., Stewart, M (2017). cardiovascular disease in Africa: epidemiological profile and challenges. Nature Reviews Cardiology, 14, 273–293.

Laaksonen, D., E., Nyyssonen, K., Niskanen, L., Rissanen, T., H., & Salonen, J., T. (2005). Prediction of cardiovascular mortality in middle-aged men by dietary and serum linoleic polyunsaturated fatty acids. Archives of Internal Medicine, I65 (2), 193-199.

Lackland, D., T, Roccella, E., J, Deutsch, A., F, Fornage, M, George, M., G, Howard, G, Kissela, B.,M, Kittner S.,J, Lichtman, J., H, Lisabeth, LD, (2014). on behalf of the American Heart Association Stroke Council; Council on Cardiovascular and Stroke Nursing; Council on Quality of Care and Outcomes Research; Council on Functional Genomics and Translational Biology. Factors influencing the decline in stroke mortality: a statement from the American Heart Association/American Stroke Association. Stroke, 45, 315–353.

Laforgia P., L, Auguadro C, Bronzato S., Durante A. (2022). the reduction of mortality in acute myocardial infarction: from bed rest to future directions. International Journal of Preventive Medicine, 13, 56.

Li and Siegrist (2012). Physical Activity and Risk of Cardiovascular Disease—A Meta-Analysis of Prospective Cohort Studies. International Journal of Environmental Research, 9, 391 – 407.

Loeffelholz, C., O, & Birkenfeld, A. Non-Exercise activity thermogenesis-it's NEAT (2022) Available from: Non-Exercise Activity

Thermogenesis in Human Energy Homeostasis - Endotext - NCBI Bookshelf (nih.gov)

Mahfouz, A., A., Abdelmoneim, I., Khan, M., Y., Daffalla, A., A., Diab, M., M., Al-Gelban, K., S., Moussa, H. (2008). Obesity and related behaviours among adolescent schoolboys, Abha city, south western Saudi Arabia. Journal of Tropical Paediatrics, 54 (2), 120-124.

Malik, V., S., Popkin, B., M., Bray, G., A., Despres, J., Hu, F., B (2010). Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular risk. Circulation, 121, pp. 1356 – 1364.

Martin, S., S., Aday, A., W., Almarzooq, Z., A., Anderson, C., A., M., Arora, P., Avert, C., L (2024a). 2024 heart disease and stroke statistics: a report of US and global data from the American heart association. Circulation, 144 (8), 347 – 913.

Martin S., S, Aday A., W, Almarzooq Z., I, Anderson C., A., M., Arora P., Avery C., L, Baker-Smith C., M, Barone G., B, Beaton A., Z, Boehme AK, (2024b). On behalf of the American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics: a report of US and global data from the American Heart Association. Circulation, 49, 312–913.

Meckling, K, A, and Sherfey, R. (2007). A randomised trial of a hypocaloric high-protein diet, with and without exercise, on weight loss, fitness, and markers of the metabolic syndrome in overweight and obese women. Applied Physiology, Nutrition and Metabolism, 32 (4), 743-752.

Mensah, G., A., Sampson, Uchechukwu, K., A., Roth, G., A., Forouzanfar, M., H., Naghavi, M., Murray, C., Moran, A., E., Feigin, V., L (2015). Mortality from cardiovascular diseases in sub-Saharan Africa, 1990-2013: a systematic analysis of data from the Global Burden of Disease Study 2013. Cardiovascular Journal of Africa, 26, 6–10.

Minja, N., W., Nakagaayi, D., Aliku, T., Zhang, W., SSinabulya, I., Nabaale, J., Amutuhaire, W., Loizaga, S., Nagire, E., Rwebembera, J., Okeilo, E., Kayima, J. (2022). Cardiovascular diseases in Africa in the twenty-first century: gaps and priorities going forward. Frontiers in Cardiovascular Medicine, 10, 1 – 20.

Mitch, W., E. (2005). Beneficial responses to modified diets in treating patients with chronic kidney disease. Kidney International Supplements, 94, 133-135.

Mons, U., Müezzinler, A., Gellert, C., Schöttker, B., Abnet, C., C., Bobak, M., Groot, L., Freedman, N., D., Jansen, E., Kee, F., Kromhout, D., Kuulasmaa, K., Laatikainen, T., O'Doherty, M., G., Bueno-de-Mesquita,, B, Orfanos, P., Peters, A., Schouw, Y., T., Wilsgaard, T., Wolk, A., Trichopoulou, A., Boffetta, P., Brenner, H. (2015). Impact of smoking and smoking cessation on cardiovascular events and mortality among older adults: meta-analysis of individual participant data from prospective cohort studies of the CHANCES consortium. British Medical Journal, 350, pp. 1 -11.

Mosca, L., Appel, L., J., Benjamin, E., J., Berra, K., Chandra-Strobos, N., Fabunmi, R., Grady, D., Haan, C., K, Hayes, S., N., Judelson, D., R., Keenan, N., L., McBride, P.., Oparil, S., Ouyang, P., Oz, M., C., Mendelssohn, M., E., Pasternak, R., C., Pinn, U., W., Robertson, R., M., Schenck-Gustafsson, K., Sila, C., A., Smith, S.,C Sopko, G., Taylor, A., L., Walsh, B.,W., Wenger, N.,K. & Williams, C., L. (2004). Evidence-based guidelines for cardiovascular disease prevention. Circulation Vol.109, pp.672-693.

National Institute for Health and Care Excellence (2023). What is CVD? Definition of CVD | Background information | CVD risk assessment and management | CKS | NICE

Oono, I., P., Mackay, D., F., Pell, J., P. (2011). Meta-analysis of the association between second-hand smoke exposure and stroke. Public Health, 33 (4), pp. 496–502.

Ortega, F., B., Ruiz, J., R., & Sjostrom, M. (2007). Physical activity, overweight and central adiposity in Swedish children and adolescents: the European youth heart study. International Journal of Behavioural Nutrition and Physical Activity, 4, (61), 1-24.

Owen, N., Sparling, P., E., & Mathews, C., E. (2010). Sedentary behaviour: emerging evidence for new health risk. Mayo Clinic Proceedings, 85 (12), 1138-1141.

Owolabi TOS, Ezika EA, Lewitt M, Cross B. (2016). Communication media and cardiovascular health promotion as factors for sustainable development in Nigeria. Journal of Sustainable Development in Africa, 18(1): 156 – 172.

Paterna, S., Gaspare, P., Fasullo, S., Sarullo, F., M., & Di Pasquale, P. (2008). Normal-sodium diet compared with low-sodium diet in compensated cognitive heart failure: is sodium an old enemy or a new friend? Clinical Science, 114, 221-230.

Paterna, S., Parrinello, G., Cannizzaro, S., Fasulo, S., Torres, D., Sarullo, F., M., & Di Pasquale, P. (2009). Medium term effects of different dosage of diuretic, and fluid administration on neuro-hormonal and clinical outcome in patients with recently compensated heart failure. American Journal of Cardiology, 103, 93-102.

Peng, Y., Wang, Z (2018). Cardiovascular health status among Australian adults. Clinical Epidemiology, 10, 167 – 178.

Piano, M., R., Benowitz, N., L., FitzGerald, G., A., Coatbridge, S., Heath, J., Hahn, E., Pechalek, T., F., and Howard, J. (2010). Impact of smokeless tobacco products on cardiovascular disease: implications for policy, prevention, and treatment. Circulation, 122, 1520-1544.

Planinsec, J., and Matejek, C. (2004). Differences in physical activity between non-overweight and obese children. Collegiums Antropologicum, 28, 747-754.

Prasad, D. S., Das, B., C., (2009). Physical inactivity, a cardiovascular risk factor. Indian Journal of Medical Science, 63 (1), pp. 33 – 42.

Rakesh, M., P. & Viswanathan, M. (2012). Changing definitions of metabolic syndrome. Indian Journal of Endocrinology and Metabolism, Vol.16 (1), pp. 7 – 12.

Roth, G., A., Mensah, G., A., Johnson, G., O., Addolorato, G (2020). Global burden of cardiovascular disease and risk - factors, 1990 – 2019. Journal of the American College of Cardiology, 76 (25), 2982 – 3021.

Schuit, A, J, Van Loon J., M., Tijhuis, M, Ocke, M., C. (2002). Clustering of lifestyle risk factors in a general adult population. Preventive Medicine, 35, 219-224.

Satoh, K., Satoh, T., Yaoita, N., Shimokawa, H (2019). Recent Advances in the understanding of thrombosis. Arteriosclerosis, Thrombosis, and Vascular Biology, 39 (6), 1 – 11.

Sattelmair, J., Pertman, J., Ding, E., L., Kohl, H., W., Haskell, W., & Lee. I (2011). Dose response between physical activity and risk of coronary heart disease: a meta-analysis. Circulation, 124 (7), pp. 789 – 795.

Sebanjo, O. and Oshikoya, K., A. (2010). Physical activity and body mass index of school children and adolescents in Abeokuta, southwest Nigeria. World Journal of Paediatrics, 6 (3), pp. 217-222.

Strazzulo, P., D'Elia, L., Kandala, N., B., & Cappuccio, F., P. (2009). Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. British Medical Journal, 339, 4567.

Thomas, M., C., Moran, J., Forsblom, C., Hargutsalo, V., Thorn, L., Ahola, A.,

Waden, J., Tolonen, N., Sarahelmo, M., Gordin, D., Groop, P., H., Diane, F.and Study Group (2011). The association between dietary sodium intake, ESRD, and all-cause mortality in patients with type 1 diabetes. Diabetes Care, 34, 861-866.

Thomson, C., A., Ravia, J. (2011). A systematic review of behavioural interventions to promote intake of fruit and vegetables. Journal of American Diet Association, 111, 1523 – 1535.

Teo, K., K., Ounpuu S., Hawken, S., Pandey, M., R., Valentin, V., Hunt, D., Diaz, R., Rashed, W., Freeman, R., Jiang, L., Zhang., X, Yusuf, S., INTERHEART Study Investigators (2006). Tobacco use and risk of myocardial infarction in 52 countries in the INTERHEART study: a case-control study. Lancet, 368, 647–658.

Thompson, A., M., Campagna, P., D., Rehman, L., A., Murphy, R., J., Rasmussen, R., L. & Ness, G., W. (2005). Physical activity and body mass index in grade 3, 7, and II Nova Scotia students. Medicine & Science in Sports & Exercise, 37 (11), 1902-1908.

Timmis, A., Vardas, P., Townsend, N., Torbica, A., Katus, H., Smedt, D., Gale, C., P., Maggioni, A., P (2022). European Society of cardiology: cardiovascular disease statistics 2021. European Heart Journal, 8 (43), 716 – 799.

Vandelanotte, C., De Bourdeaudhuij I., Sallis, J., F., Spittaels, H., Brug, J. (2005). Efficacy of sequential and simultaneous interactive computer tailored interventions for increasing physical activity and decreasing fat intake. Annals of Behavioural Medicine, 29, 138-146.

Vona, A., Rossi, P., Capodaglio, P., Rizzo, S., Servi, P., De Marchi, M. and Cobeli, F. (2004). Impact of physical training and detraining on endothelium-dependent vasodilation in patients with recent acute myocardial infarction. American Heart Journal, 147 (6), 1039-1046.

Wang, X., Ouyang Y., Liu, J., Zhu, M., Zhao, G., Bao, W., Hu, F., B (2014). Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. British Medical Journal, 349, 1 – 14.

Warburton, D., E., R, Nicol C., W, & Bredin, S., S., D. (2006). Health benefits of physical activity: the evidence. Canadian Medical Association Journal 174 (6): 801 – 809.

Waters, A., Trinh, L., Chau, T., Bourchier, M., Moon, L (2003). Latest statistics on cardiovascular disease in Australia. Clinical and Experimental Pharmacology and Physiology, 40 (6), 347 – 356.

World Health Organization. (1999). Definition, diagnosis and classification of diabetes mellitus and its complications: report of a WHO consultation. Part 1, Diagnosis and classification of diabetes mellitus. World Health Organization. WHO_NCD_NCS_99.2.pdf

WHO (2007a). Prevention of cardiovascular disease: guidelines for assessment and management of cardiovascular risk. DocHdl1tmpTarget (who.int)

WHO (2007b). Prevention of cardiovascular disease: pocket guidelines for assessment and management of cardiovascular risk. Prevention of Cardiovascular Disease. Pocket Guidelines for Assessment and ... - World Health Organization - Google Books

WHO (2010a). Global recommendations on physical activity for health. Available from: Global recommendations on physical activity for health (who.int)

WHO (2010b). Creating an enabling environment for population-based salt reduction strategies: report of a joint technical meeting held by WHO and food standards agency, United

Kingdom, July 2010. 9789241500777_eng.pdf (who.int)

WHO (2009). Physical activity for children and young people. Available from: Recommendations | Physical activity for children and young people | Guidance | NICE

WHO (2021). cardiovascular diseases (CVDs) cardiovascular diseases (CVDs) (who.int)

Williamson, D., F., Vinicor, F., Bowman, B., A. (2004). Primary prevention of type 2 diabetes mellitus by lifestyle intervention: implications for health policy. Annals of Internal Medicine, 140, 951 – 957.

Zhao, D (2021). Epidemiological features of cardiovascular disease in Asia. Journal of American College of Cardiology, 1 (1), 1 – 13.