UNIVERSITY OF TURKU

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ABSTRACT

Veera Veromaa

Cardiovascular health of Finnish women working in the public sector with special reference to psychosocial and work-related factors, self-rated health and physical capability

University of Turku, Faculty of Medicine, General Practice; Doctoral Programme in Clinical Research; Central Satakunta Health Federation of Municipalities, Harjavalta

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Background: In 2010 the American Heart Association (AHA) released the positive concept of ideal cardiovascular health (CVH) aiming to improve the population's health by setting goals and targets reachable with a healthy lifestyle. According to AHA, ideal CVH consists of not smoking, eating a healthy diet, and being physically active, together with maintaining normal weight, total cholesterol, blood pressure and fasting glucose.

Aims: The aim of the present study was to identify the prevalence of ideal CVH in females working in the municipal sector, and to study the relationships of ideal CVH metrics with the non-traditional cardiovascular disease (CVD) risk factors.

Participants and methods: The present study is part of the PORTAAT (PORi To Aid Against Threats) study designed to evaluate CVD risk factors among the employees of the city of Pori, Finland. Female participants of the 2014 study were included in this thesis with no exclusion criteria (n=732, age-range 19-66 years). Classical CVD risk factors were studied with the ideal CVH metrics of AHA, and health questionnaires were filled in by the subjects, including core questions about psychosocial risk factors, UWES-9 (Utrecht Work Engagement Scale), and self-rated health. Also, physical capability (grip strength, chair-rise time, one-legged standing balance, and six minutes' walking test) was measured.

Results: All 7 ideal CVH metrics were achieved only by 1.2% of the subjects, while 25.0% fulfilled 5-7 of the ideal CVH metrics. Psychosocial risk factors had a negative relationship, while work engagement had a positive relationship with the sum of ideal CVH metrics. The presence of even one psychosocial risk factor had the potential to associate negatively with work engagement regardless of the sum of ideal CVH metrics. In addition, even among women with 5–7 ideal CVH metrics, over 50.0% had at least one psychosocial risk factor. Our study also revealed that the sum of ideal CVH metrics positively associated with good self-rated health driven by favorable health behaviors (non-smoking, normal body mass index, healthy diet and physical activity). Moreover, physical capability was related to the sum of ideal CVH metrics, as well as the categories of recommended level of aerobic physical activity.

Conclusions: Ideal CVH was rare among female employees. Furthermore, all studied non-traditional CVD risk factors had an association with the ideal CVH concept. However, the causal relationship of the associations remains unsolved due to the cross-sectional study design.

Keywords: ideal cardiovascular health, psychosocial risk factors, work engagement, self-rated health, physical capability, non-traditional CVD risk factors

TIIVISTELMÄ

Veera Veromaa

Kunta-alalla työskentelevien suomalaisten naisten ihanteellinen sydänterveys – mielenkiinnon kohteina psykososiaaliset riskitekijät, työn imu, itsekoettu terveys sekä fyysinen suorituskyky

Turun yliopisto, Lääketieteellinen tiedekunta, Yleislääketiede; Turun kliininen tohtoriohjelma; Keski-Satakunnan terveydenhuollon kuntayhtymä, Harjavalta

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Tausta: Vuonna 2010 julkaistiin Yhdysvaltain sydänjärjestön toimesta ihanteellisen sydänterveyden konsepti, joka pyrkii parantamaan kansanterveyttä asettamalla tavoitteita, jotka ovat saavutettavissa terveellisillä elämäntavoilla. Ihanteellinen konsepti koostuu seitsemästä muuttujasta: tupakoimattomuudesta, terveellisestä ruokavaliosta ja riittävästä liikunnasta yhdessä normaalin painon, kokonaiskolesterolin, verenpaineen sekä paastosokerin kanssa.

Tavoite: Tämän tutkimuksen tavoitteena oli määrittää ihanteellisen sydänterveyden esiintyvyys naispuolisilla kuntatyöntekijöillä sekä tutkia konseptin yhteyttä ei-perinteisiin sydän- ja verisuonitautien riskitekijöihin.

Menetelmät: Tämä tutkimus on osa PORTAAT-tutkimusta, joka on suunniteltu tarkastelemaan sydän-ja verisuonitautien riskitekijöitä Porin kaupungin työntekijöillä. Tähän tutkimukseen otettiin ilman poissulkukriteereitä vuonna 2014 osallistuneet naistyöntekijät (n=732). Sydän- ja verisuonitautien riskitekijät määritettiin ihanteellisen sydänterveyden muuttujin sekä tutkittavien täyttämillä kyselykaavakkeilla, jotka sisälsivät psykososiaalisten riskitekijöiden avainkysymykset ja kyselyt työn imusta ja itsekoetusta terveydestä. Lisäksi fysioterapiaopiskelijat mittasivat tutkittavien fyysisen suorituskyvyn (puristusvoima, tuolilta ylösnousutesti, yhden jalan tasapainotesti ja kuuden minuutin kävelytesti).

Tulokset: Vain 1.2% tutkittavista saavutti ihanteellisen sydänterveyden määritelmän, vaikka 25.0% täytti 5-7 ihanteellista muuttujaa. Psykososiaalisilla riskitekijöillä oli negatiivinen yhteys, kun taas työn imulla positiivinen yhteys ihanteelliseen sydänterveyteen. Kuitenkin yhdenkin psykososiaalisen riskitekijän olemassaolo liittyi negatiivisesti työn imuun huolimatta ihanteellisesta sydänterveydestä. Vähintään yksi psykososiaalinen riskitekijä oli yli puolella naisista, joilla oli hyvä sydänterveyden taso (5-7 ihanteellista muuttujaa). Konsepti liittyi positiivisesti myös hyvään itsekoettuun terveyteen elintapojen välityksellä (tupakoimattomuus, normaali paino, terveellinen ruokavalio ja liikunnallinen aktiivisuus) sekä fyysiseen suorituskykyyn.

Johtopäätökset: Ihanteellinen terveys oli harvinaista työikäisillä naisilla. Lisäksi ei-perinteiset sydän- ja verisuonitautien riskitekijät olivat yhteydessä ihanteelliseen sydänterveyteen. Kuitenkin yhteyksien syy-seuraussuhde jää varmistumatta tutkimuksen poikkileikkausasetelman vuoksi.

Avainsanat: ihanteellinen sydänterveys, psykososiaaliset riskitekijät, työn imu, itsekoettu terveys, fyysinen suorituskyky, ei-perinteiset sydän- ja verisuonitautien riskitekijät

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ABBREVIATIONS

AHA	American Heart Association
AUDIT-C	Alcohol Use Disorders Identification Test
BMI	Body mass index
BP	Blood pressure
CHD	Coronary heart disease
CI	Confidence interval
CV	Cardiovascular
CVD	Cardiovascular disease
CVH	Cardiovascular health
DBP	Diastolic blood pressure
HbA1c	Glycated hemoglobin
HDL-C	High-density lipoprotein cholesterol
HF	Heart failure
HR	Hazard ratio
LDL-C	Low-density lipoprotein cholesterol
LTPA	Leisure-time physical activity
MET	A single metabolic equivalent value
MI	Myocardial infarction
NHANES	National Health and Nutrition Examination Survey
NRS	Numeric rating scale
OR	Odds ratio
PA	Physical activity
PAR	Population attributable risk
PORTAAT	PORi To Aid Against Threats
RR	Risk ratio
SBP	Systolic blood pressure
SD	Standard deviation
SRH	Self-rated health
T2D	Type 2 diabetes mellitus
TC	Total cholesterol
TG	Triglycerides
TWA-MET	Time-weighted average intensity in MET values
UK	The United Kingdom
US	The United States
UWES	Utrecht Work Engagement Scale
WAS	Work ability score
WHO	World Health Organization

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original articles referred to in the text by their Roman numerals:

I. **Veromaa V, Kautiainen H, Saxen U, Malmberg-Ceder K, Bergman E, Korhonen PE.** Ideal cardiovascular health and psychosocial risk factors among Finnish female municipal workers. Scand J Public Health. 2017 Feb;45(1):50-56.

II. **Veromaa V, Kautiainen H, Korhonen PE.** Physical and mental health factors associated with work engagement among Finnish female municipal employees: a cross-sectional study. BMJ Open. 2017 Oct 5;7(10):e017303.

III. **Veromaa V, Kautiainen H, Juonala M, Rantanen A, Korhonen PE.** Self-rated health as an indicator of ideal cardiovascular health among working-aged women. Scand J Prim Health Care. 2017 Dec;35(4):322-328.

IV. **Veromaa V, Juonala M, Wasenius N, Korhonen PE.** The associations of leisure-time physical activity and physical capability with cardiovascular health among working-age Finnish women. Submitted.

1 INTRODUCTION

Cardiovascular disease (CVD), the leading cause of death in developed and developing countries, is a group of disorders of the heart and blood vessels (WHO Fact Sheet CVDs 2017). The majority of the 17.7 million annual worldwide CVD deaths are due to heart attacks and stroke, which are the end-points of atherosclerosis progression of coronary heart disease (CHD) and cerebrovascular disease. A minor proportion of CVD deaths are due to peripheral arterial disease, rheumatic heart disease, congenital heart disease and pulmonary embolism (WHO Fact Sheet CVDs 2017). CVD affect both sexes equally (WHO Fact Sheet CVDs 2017), but compared to men CVD differs in women in terms of the level of awareness, age of onset, symptoms, treatment and survival (AHA Facts CVD 2016; Garcia et al. 2016; Stranges and Guallar 2012).

Evidence suggests that four out of five CVDs would be prevented by the adoption of a healthy lifestyle (Chomistek et al. 2015; Hu et al. 2000; Kelly 2010; K. Liu et al. 2012; Stampfer et al. 2000), which is challenged by increasingly adverse lifestyle habits, like physical inactivity, poor diet and smoking leading to excess weight, raised blood pressure (BP) and elevated blood glucose and cholesterol levels (WHO Fact Sheet CVDs 2017). The concept of ideal cardiovascular health (CVH) is formed from the absence of clinical CVD and ideal levels of these seven (physical activity, diet, smoking status, body mass index, BP, blood glucose and cholesterol levels) traditional CVD risk factors. The concept relies on primordial prevention, a construct presented by Strasser et al. already in the 1970s (Strasser 1978). It prevents risk factors occurring in the first place in the whole population, while traditional primary prevention has focused on modifying existing risk factors. According to recent studies, the concept of ideal CVH is strongly associated with reduced all-cause and CVD-related mortality, as well as with lower incidence of CVD irrespective of sex, race or ethnicity (Artero et al. 2012; Dong et al. 2012; Folsom et al. 2011; Ford et al 2012; Lachman et al. 2016; Yang et al. 2012).

Non-traditional risk factors are also linked to CVD, but the relationships with ideal CVH remain largely unstudied. Psychosocial risk factors, like low socio-economic status, lack of social support, stress, depression, anxiety, hostility, and type D personality increase the risk of CVD, and worsen the clinical course and prognosis of CVD (Albus 2010; Perk et al. 2012). Also, self-rated health (SRH) is linked to incident CVD and its mortality (Heistaro et al. 2001; Kuper et al. 2006; van der Linde et al. 2013; Mavaddat et al. 2014). Despite the studied relationship between psychosocial factors and work-related factors (Hakanen and Schaufeli 2012; K. Imamura et al. 2016; Shimazu et al. 2012), the associations between work engagement and physical health (i.e. CVH) are scarcely investigated. Moreover, the current studies of physical capability do not reveal whether physical capability is associated with ideal CVH in middle-aged women.

The present thesis was undertaken to investigate non-traditional risk factors of CVD and their associations with ideal CVH. Special attention was paid to women who have CVD as their number one health threat (AHA Facts CVD 2016) and manifest non-traditional risk factors more than men (Low et al. 2010).

2 REVIEW OF LITERATURE

2.1 Cardiovascular disease

Cardiovascular diseases (CVDs) are the leading cause of mortality globally, accounting for one in three deaths (Benjamin et al. 2018; Kochanek et al. 2014; Statistics Finland: Causes of death. 2016; WHO Fact Sheet CVDs 2017). According to the most recent United States (US) data, nearly half of CVD deaths are due to coronary heart disease (CHD) (43.8%), followed by stroke (16.8%), high blood pressure (BP) (9.4%), heart failure (HF) (9.0%), diseases of the arteries (3.1%), and other CVDs (17.9%) (Benjamin et al. 2018). The prevalence of CVDs increases with age in both sexes with an evaluation that one in ten have diagnosed heart disease (US National Center for Health Statistics 2016).

Since the 1980s the mortality rates of CHD have declined tremendously globally (Moran et al. 2014). Finland had the highest CHD mortality in the world in the late 1960s and a large community-based North Karelia Project was launched to reverse the rising tide of this epidemic in 1972 (Jousilahti et al. 2016). The project aimed to prevent CVD, reduce the high CHD mortality and lower the levels of CVD risk factors through a population-based approach to behavior change, while also targeting high-risk individuals. Now, 40 years later, this has resulted in an 80% decrease in CHD mortality among the working-age population in both sexes (Jousilahti et al. 2016) (Figure 1). Despite this favorable development, Finland still has the highest CVD death rate in both sexes among Nordic countries (Benjamin et al. 2018).

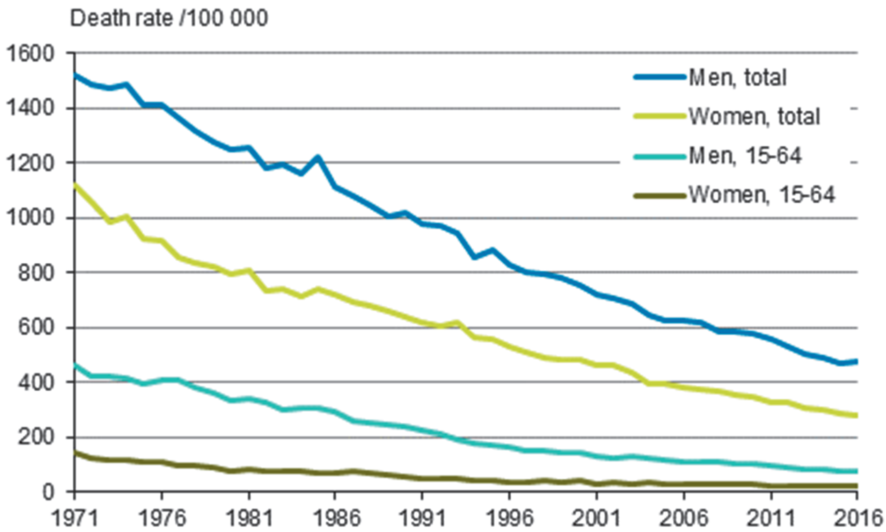

Figure 1. Age-standardized mortality from diseases of the circulatory system in 1971 to 2016. Source: Official Statistics of Finland (OSF): Causes of death [e-publication]. ISSN=1799-5078. 2016, Appendix figure 1. Age-standardised mortality from diseases of the circulatory system in 1971 to 2016. Helsinki: Statistics Finland [referred: 2.8.2018]. Access method: *http://www.stat.fi/til/ksyyt/2016/ksyyt_2016_2017-12-29_kuv_001_en.html*

2.2 Risk factors of impaired cardiovascular health

2.2.1 Hierarchy and population attributable risk of traditional risk factors

Already, in 1981 over 200 factors were suggested to associate with CVD (Hopkins et al. 1981). The essential factor for the development of atherogenic CVD is elevated low-density lipoprotein cholesterol (LDL-C) (Yusuf et al. 2004). Impact of other risk factors (mainly) provide elevated LDL-C, which is a new normal situation in most western countries and increasingly so in developing countries (Yusuf et al. 2004). Typically risk factors cluster, so if there is already one known, frequently there is more to find after systematic approach. Combination of risk factors increases the total risk more than the sum (Yusuf et al. 2004). Hypertension, dyslipidemia and smoking are the key risk factors for CVD with an estimation that 47-75% of the population has at least one of those in the US (Fryar et al. 2012; Mensah et al. 2005). After those comes obesity/overweight in a combination with impaired glucose metabolism and diabetes. The fourth important group is called psychosocial factors (see Table 1, described in detail in chapter 2.2.2.1). Combining the association of risk factor with the development of the disease and the frequency or prevalence of risk factor in population gives the estimate of population attributable risk (PAR), which vary between populations, the prevalence or combination of risk factors. The hierarchy of traditional risk factors of CVD vary according to the studied disease. For example, in a big, cross-sectional study of acute myocardial infarction (MI) the role of LDL-C was the most important worldwide (Yusuf et al. 2004) (Table 1), whereas in a prospective study of Swedish men (n=20,721) the PAR was 79% (95% CI: 34-93%) suggesting that 4 out of 5 coronary events could have been averted with healthy weight and diet, being physically active, and being nonsmoker with mild alcohol consumption (Åkesson et al. 2014). In 2005, 45% of all cardiovascular (CV) deaths were attributable to hypertension in the US, followed by overweight/obesity, low level of physical activity (PA), high LDL-C, smoking, high salt consumption, poor dietary fatty acids balance, and high blood glucose (Danaei et al. 2009). The evidence base of these traditional risk factors is reviewed in detail in the following sections.

Table 1. Association of nine risk factors and their population attributable risk (PAR) with acute MI in men and women after adjustment for age, sex, and geographic region (n=15,152 cases and 14,820 controls studied in 52 different populations, cross-sectional study).

Risk factor	Sex	Control (%)	Case (%)	Odds ratio (99% CI)	PAR (99% CI)
Smoking	F	9.3	20.1	2.86 (2.36-3.48)	15.8% (12.9-19.3)
	M	33.0	53.1	3.05 (2.78-3.33)	44.0% (40.9-47.2)
Diabetes	F	7.9	25.5	4.26 (3-51-5.18)	19.1% (16.8-21.7)
	M	7.4	16.2	2.67 (2.36-3.02)	10.1% (8.9-11.4)
Hypertension	F	28.3	53.0	2.95 (2.57-3.39)	35.8% (32.1-39.6)
	M	19.7	34.6	2.32 (2.12-2.53)	19.5% (17.7-21.5)
Abdominal obesity	F	33.3	45.6	2.26 (1.90-2.68)	35.9% (28.9-43.6)
	M	33.3	46.5	2.24 (2.03-2.47)	32.1% (28.0-36.5)
Psychosocial index	F	-	-	3.49 (2.41-5.04)	40.0% (28.6-52.6)
	M	-	-	2.58 (2.11-3.14)	25.3% (18.2-34.0)
Fruits/vegetables	F	50.3	39.4	0.58 (0.48-0.71)	17.8% (12.9-24.1)
	M	39.6	34.7	0.74 (0.66-0.83)	10.3% (6.9-15.2)
Exercise	F	16.5	9.3	0.48 (0.39-0.59)	37.3% (26.1-50.0)
	M	20.3	15.8	0.77 (0.69-0.85)	22.9% (16.9-30.2)
Alcohol	F	11.2	6.3	0.41 (0.32-0.53)	46.9% (34.3-60.0)
	M	29.1	29.6	0.88 (0.81-0.96)	10.5% (6.1-17.5)
ApoB/ApoA1 ratio	F	14.1	27.0	4.42 (3.43-5.70)	52.1% (44.0-60.2)
	M	21.9	35.5	3.76 (3.23-4.38)	53.8% (48.3-59.2)

Modified from (Yusuf et al. 2004). Apo; apolipoprotein, CI; confidence interval, F; female, M; male, PAR; population attributable risk.

2.2.1.1 Plasma cholesterol

High plasma total cholesterol (TC) is strongly linked to CVD in different populations and is a major risk factor of CVD (Stone et al. 2014). Research suggests that long-term exposure to even modestly elevated TC levels can lead to CHD later in life (Navar-Boggan et al. 2015). Ethnicity and sex influence the TC levels; females having higher TC than males, and blacks having lower TC than whites and Hispanics (Carroll et al. 2015). Moreover, high-income countries have twice the level of raised TC levels (>50% of adults) compared with low-income countries (Forouzanfar et al. 2016). Furthermore, genetic heritage influences the level of TC. For example, familial hypercholesterolemia is an inherited hypercholesterolemia, affecting one in 200 individuals (Nordestgaard et al. 2013) and leading to a 20-fold increased risk of CVD (Goldberg et al. 2011).

Atherogenic LDL-C is the main carrier of cholesterol in the blood stream with well documented association with the risk of CVD together with TC (Neaton et al. 1992). Atherogenesis starts when excess LDL-C accumulates in the subendothelial matrix, and with every 1.0 mmol/l reduction in LDL-C a 20-25% decrease in CVD mortality has been shown (Cholesterol Treatment Trialists' (CTT) Collaborators et al. 2012). Furthermore, according to gene studies, a lifelong exposure to each 1.0 mmol/l lower LDL-C decreases the risk of CHD over 50%, which is a three times greater reduction in the risk compared to current practice with statins started later in life (Ference et al. 2012). Also, a higher CVD risk is associated with low high-density lipoprotein cholesterol (HDL-C) (Chapman et al. 2011).

In Finland, the mean level of TC of the adult population decreased 20% from the 1970s until 2007. This change alone explains about 40% of the decrease in the CVD mortality of Finnish working-age people (Jousilahti et al. 2016). Still, in 2017 only 40% of women (>30 years) had the recommended level of TC <5,0 mmol/l, even though the cholesterol levels continued to decrease during the time period of 2011-2017 (Koponen et al. 2018). This decline in TC levels in high-income countries is a worldwide trend according to a study which involved 199 countries (Finucane et al. 2011).

For secondary prevention, lipid-lowering medication, mainly statins, are proved to reduce CVD morbidity and mortality and regress coronary atherosclerosis by reducing LDL-C levels in women and men (Colhoun et al. 2004; R. Collins et al. 2003; Downs et al. 1998; Nissen et al. 2006; Pedersen 2004; Walsh and Pignone 2004). Unfortunately, in women statin therapy targets poorly to the high-risk individuals (e.g. smokers and diabetics) (Vartiainen et al. 2013). Of Finnish women (>30y) 15% used cholesterol-lowering medication in 2017 (Koponen et al. 2018).

2.2.1.2 Blood pressure

Hypertension, as referring to elevated BP levels, is an enormous risk factor for death, CVD events and disability-adjusted life-years (Piepoli et al. 2016). High BP is associated with different forms of CVDs, like the incidence of stroke, myocardial infarction (MI), sudden death, peripheral artery disease and HF (Chobanian et al. 2003; Piepoli et al. 2016). At 50 years of age normotensive (untreated BP <140/90 mm Hg) individuals had five years longer overall life expectancy and lived an average of seven years longer without CVD than hypertensive people (Franco et al. 2005). Among persons under 50 years the diastolic BP (DBP) is a more important cardiovascular risk factor, but systolic BP (SBP) is more potent after middle age (Franklin et al. 2001). Furthermore, the patterns of the development of hypertension are meaningful for the risk of CVD. Increased risk of CVD is associated with steeply increasing, elevated stable, and elevated very high BP compared with people who have low stable or low but increasing BP levels (Petruski-Ivleva et al. 2016). Also, SBP has a heritability of 48% to 60% and DBP 34% to 67% (Hottenga et al. 2005).

The risk of stroke and CHD mortality doubles for each 20 mmHg rise in SBP or 10 mmHg rise in DBP (Lewington et al. 2002). From 115 mm Hg SBP and 75 mm Hg DBP levels the CHD or stroke death risk increases linearly and progressively, but the absolute risk curves are not as deep in the low range of BP (Lewington et al. 2002). Among 30-year-old people the lifetime risk of CVD was 63% among hypertensive adults compared with 46% in normotensive people in a large study set of almost one million hypertensive people (Rapsomaniki et al. 2014).

Many other CV risk factors modify the associations with CV morbidity and mortality with BP. Lifestyle changes are recommended to all patients with suboptimal BP including salt restriction, regular PA, weight control and healthy diet. The impact of elimination of hypertension was estimated to reduce CVD mortality by 30.4% among males and 38.0% among females (Patel et al. 2015). Eliminating hypertension would affect CVD mortality more than elimination of all other risk factors among females (Patel et al. 2015).

Currently, in Finland every other woman over 30 years has either hypertension or treatment for hypertension. Among the women of 30-64 years, the prevalence of hypertension is 33%, whereas in those over 65 years it is already 82% (Koponen et al. 2018). Antihypertensive medication has been shown to be cost-saving and to increase quality-adjusted life-years in both sexes (Tajeu et al. 2017). Also, treatment of hypertension has been proven to be effective in reducing the incidence of CVD (Neal et al. 2000).

2.2.1.3 Glucose homeostasis

Diabetes is a major risk factor for CVDs, such as CHD, stroke, peripheral arterial disease, HF, atrial fibrillation, and CVD mortality among females and males (Fox et al. 2015; L. Liu et al. 2016). There is a 2-3-fold risk for CVDs with a type 2 diabetes mellitus (T2D) diagnosis (Emerging Risk Factors Collaboration et al. 2010) compared to nondiabetic counterparts (Manson et al. 1991). Even pre-diabetic individuals are proven to have a modestly higher risk of CHD than non-diabetic individuals (Donahue et al. 2007; Haffner et al. 1997; Emerging Risk Factors Collaboration et al. 2010). Furthermore, in a meta-analysis consisting of 97 prospective studies, T2D associated with all-cause mortality (hazard ratio (HR) 1.80; 95% CI 1.71–1.90), cancer death (HR 1.25; 95% CI 1.19–1.31), and vascular death (HR 2.32; 95% CI 2.11–2.56) (Rao Kondapally Seshasai et al. 2011). Thus, two out of three people over 65 years of age with T2D die of some form of CVD (The United States National Diabetes Fact Sheet 2011).

The prevention of T2D has been found to be cost-effective (Reini and Honkatukia 2016) and possible with lifestyle counseling (Lindström et al. 2013). In patients with T2D it is essential to focus on risk factor management, e.g. weight control, healthy diet, regular PA, smoking abstinence and lowering the levels of lipids and BP (Piepoli et al. 2016). Management of hyperglycemia reduces the risk of CVD (Piepoli et al. 2016). In the study by Wong et al (2016), achieving 1, 2 or 3 CVD risk factors (BP, LDL-C, glycated hemoglobin (HbA_{1c})) at target level was associated with 36%, 52% and 62% lower risk of CVD events, respectively, compared with none of the risk factors at target level (Wong et al. 2016). Furthermore, each serving/day higher consumption of sugar-sweetened beverages increased the risk of T2D by 18% according to a recent meta-analysis (F. Imamura et al. 2016). Further, each 1-SD (standard deviation) higher childhood body mass index (BMI) increased the risk of T2D in adulthood (Llewellyn et al. 2016). Also, a meta-analysis carried out by Biswas et al (Biswas et al. 2015) identified five studies (4 of them prospective) that assessed the association between sedentary time and T2D and found that even after adjustment for PA, higher sedentary time was associated with elevated risk of T2D (relative risk (RR) 1.91; 95% CI 1.64–2.22).

The American Diabetes Association has set favorable fasting blood glucose level at < 5,6 mmol/l (100 mg/dL) (American Diabetes Association 2007), while in Europe and in Finland it is still kept at < 6,1 mmol/l. Diabetes affects nearly one in ten adults, with T2D accounting for the majority of cases (The United States National Diabetes Statistics Report. 2014). The estimates of diabetes heritability vary from 30% to 70% (Almgren et al. 2011) depending on the age of onset of the disease. T2D disproportionately affects racial/ethnic minorities, but the prevalence among males and females is quite the same (Benjamin et al. 2018). T2D has steadily increased while its costs, together with its complications, have risen in the last decades (Peltonen et al. 2015). For now, 429 000 people in Finland have T2D with a prevalence rate of 10% in women. In addition, every fourth Finnish woman is at intermediate risk of having T2D in the next 10 years according to the Finnish Diabetes Risk Score (Koponen et al. 2018).

2.2.1.4 Smoking

Smoking is a major risk factor for CVD and stroke (Carmona et al. 2004) and together with passive smoking contributes to nearly one third of CHD deaths (Benjamin et al. 2018). On an average, male smokers die 13.2 years earlier than male nonsmokers, and female smokers die 14.5 years earlier than female nonsmokers (Carmona et al. 2004). Thus, tobacco use is the largest preventable cause of death globally (Frieden et al. 2010).

Smoking doubles the risk of developing CHD or a 10-year fatal CVD risk (Prescott et al. 1998). The risk for CHD rises with the number of cigarettes smoked daily, the total number of smoked years, the degree of inhalation, and early age at initiation of smoking (Lloyd-Jones et al. 2010). In a meta-analysis of 75 cohort studies, women had a 25% increased risk for CHD compared to smoking men (RR 1.25; 95% CI 1.12–1.39) (Huxley and Woodward 2011). In addition, a higher risk of hypertension and other forms of CVD are related to smoking among women (Satcher 2001). Moreover, compared to men, women smokers tend to have CVDs more prematurely (Grundtvig et al. 2009). Smoking doubles the risk of sudden cardiac death in smoking women compared to non-smokers (Sandhu et al. 2012).

The role of oxidative stress and its adverse effects on endothelial function, platelet function, fibrinolysis, inflammation, lipid oxidation and vasomotor function are blamed for the development of atherosclerosis and thrombotic phenomena (Piepoli et al. 2016). Even short exposures to passive smoking can cause platelet activation, damage the lining of blood vessels, and decrease coronary blood flow, potentially increasing the risk of an acute MI (Frieden et al. 2010). Thus, a large meta-analysis demonstrated 18%, 23%, 23%, and 29% increased risks for total mortality, total CVD, CHD, and stroke, respectively, in those exposed to passive smoking (Xiaofei et al. 2015). Over the past five years, there has been a sharp increase in electronic cigarette use among adolescents, but the CVD risks associated with electronic cigarette use are not known (Benjamin et al. 2018). Smoking acts together with other risk factors, particularly elevated plasma cholesterol, hypertension and T2D, to greatly increase the risk for CHD (Frieden et al. 2010).

In Finland, 11% of women over 30 years were smoking daily in 2017 (Koponen et al. 2018). The goal of the Tobacco-free Finland 2030 program is that less than 5% of working-age Finnish people would smoke in 2030 (Tobacco-free Finland 2030 2008). Antman et al. (2014) estimated that since 1990, smoking rates have declined globally by 28% in males and 34% in females (Antman et al. 2014). This decrease is mostly attributed to smoking legislation and tax pricing. The decline in smoking, along with other risk factors (like decrease in the prevalence of hypertension or cholesterol), is a contributing factor in the sharp decline in the CVD death rate (Lushniak 2014). Smoking cessation is proven to be effective in decreasing CVD morbidity and mortality in persons with or without CHD. Smoking cessation shows a rapid, partial decline in CHD risk, followed by a gradual decline that after approximately 10 years reaches the level of risk among persons who have never smoked (Satcher 2001).

2.2.1.5 Body mass index

Excess body weight is among the leading causes of death and disability globally. Overweight (BMI >25.0-29.9 kg/m^2) and obesity (BMI ≥30.0 kg/m^2) are major risk factors for CVD (Piepoli et al. 2016), including CHD, stroke (Klein et al. 2004; Poirier et al. 2006), atrial fibrillation (Tedrow et al. 2010), and venous thromboembolism (Wattanakit et al. 2012). Furthermore, higher BMI predisposes individuals to most of the major risk factors of CVD, including physical inactivity, hypertension, dyslipidemia, and T2D (Emerging Risk Factors Collaboration et al. 2011; Goff et al. 2012; Panel 2014). In a meta-analysis of 1.46 million white adults, all-cause mortality was lowest at BMI levels of 20.0 to 24.9 kg/m^2 in a mean 10-year (range, 5 to 28) follow-up period (Berrington de Gonzalez et al. 2010).

Singh et al (2013) suggested in their meta-analysis that BMI 21.0 to 23.0 kg/m^2 is the most advantageous to avoid CVD events. They studied 123 cohorts with over one million adults aged 55 to 64 years, and reported RRs for a 5-kg/m^2 higher BMI to be 1.44 (95% CI 1.40–1.48) for CHD, and 2.32 (95% CI 2.04–2.63) for T2D (Singh et al. 2013). In a meta-analysis of 58 cohorts representing 221,934 people in 17 developed countries with 14,297 incident CVD outcomes, the adiposity measures (BMI, waist circumference, and waist-to-hip ratio) were strongly and positively associated with diabetes, SBP, TC, and lower HDL-C. The associations of adiposity measures with CVD outcomes were attenuated after adjustment for these risk factors, along with age, sex, and smoking status (Emerging Risk Factors Collaboration et al. 2011). Obesity is also associated with subclinical atherosclerosis among adults even after adjustments for other CVD risk factors (Burke et al. 2008). Furthermore, a meta-analysis from 2016 suggested that CVD risk was higher (RR 1.45, 95% CI 1.20-1.70) in obese individuals without metabolic syndrome than in metabolically healthy normal-weight participants, but the risk was lower than in normal weight participants with metabolic syndrome compared to healthy individuals (RR 2.07, 95% CI 1.62-2.65), which suggests that obesity is a risk factor even in the absence of high BP, high cholesterol, and T2D (Eckel et al. 2016).

Overweight and obesity are on-going trends and in the US it has been estimated that obesity will offset the positive effects of reduced smoking in the future (Stewart et al. 2009). In Finland, only 36% of women were of normal weight and every fourth was obese in 2017. The mean BMI was 27.5kg/m^2 among women. According to FinHealth 2017 Study, the prevalence of obesity among working-age (30-64 years) women increased from 22% to 26% and in men from 24% to 27% during the years 2011-2017 (Koponen et al. 2018).

The obesity problem has its roots in childhood, since according to a meta-analysis of 15 prospective studies, 55% of obese children will be obese in adolescence, and 80% of obese adolescents will be obese in adulthood (Simmonds et al. 2016). Genetics influence overweight and obesity with heritability estimates ranging from 40% to 75% (Wardle et al. 2008). Mutations in genes controlling appetite and energy balance together with genetic obesity syndromes explain a minority of obesity (Kaur et al. 2017), but an obesogenic environment is still the leading explanation of the current obesity trend.

2.2.1.6 Physical activity

Low PA is independently associated with fatal and nonfatal CVDs (Mathieu et al. 2012; Shiroma and Lee 2010). In a Norwegian study, an increase of at least one hour of strenuous PA per week was found to explain 9% of the decline in CHD events (Mannsverk et al. 2016). In a meta-analysis involving only females, RRs of incident CHD were 0.83 (95% CI 0.69–0.99), 0.77 (95% CI 0.64–0.92), 0.72 (95% CI 0.59–0.87), and 0.57 (95% CI 0.41–0.79) across increasing quintiles of PA compared with the lowest quintile (Oguma and Shinoda-Tagawa 2004). Also, later studies have shown the inverse dose-response relation of PA with CVD (Sattelmair et al. 2011; Shiroma and Lee 2010). Also, prolonged sitting (≥10h/day vs ≤5h/day) (HR 1,18, 95% CI 1.09-1.29) increased CVD risk and low PA associated with higher CVD risk ($p < 0.001$) in a large prospective Women's Health Initiative Observational Study (Chomistek et al. 2013). Furthermore, there is no evidence that performing ≥10 times the recommended minimum level of PA (75 vigorous-intensity or 150 moderate-intensity minutes per week of aerobic activity) would be harmful (Arem et al. 2015).

It has been suggested that in women over half of the CVD risk reduction associated with PA would be mediated by decreased levels of inflammatory/hemostatic biomarkers, BP, plasma lipids and BMI (Mora et al. 2007). PA has been shown to decrease plasma lipid levels by 5% (Kraus et al. 2002; Leon and Sanchez 2001), BP levels by 3-5mmHg (S. Whelton et al. 2002), and the HbA1c level by 1% (Thompson et al. 2001). Also, decreased PA predisposes to weight gain (Mozaffarian et al. 2011). After a 10-year follow-up in a Swedish study the CVD risk factors (obesity, hypertension, hypertriglyceridemia, and impaired glucose tolerance) were lower among those who bicycled to work than in those using passive transportation (Grøntved et al. 2016). Also, light-intensity activities, like yoga, are reported to decrease BMI, BP, triglycerides (TG), LDL-C, and raise HDL-C (Chu et al. 2016).

Most health benefits of PA can be obtained by at least 150 minutes a week of moderate-intensity aerobic PA or at least 75 minutes of vigorous intensity aerobic PA (US Department of Health and Human Services. 2008). In the US general population, 50% (53% of males and 47% of females) met the aerobic PA guidelines (The US National Health Interview Survey. 2015). Moreover, the guidelines recommend muscle-strengthening activities at least twice a week (US Department of Health and Human Services. 2008), but only 22% of adults achieve the goal for both recommendations, and 30% do not engage in any leisure-time PA (The US National Health Interview Survey. 2015). Similarly in Finland, the recommended level of aerobic PA was achieved by 50% of the general population (Koponen et al. 2018). The low rate of the recommended PA level is a global concern and mainly due to the sedentary behavior at work and during leisure time.

2.2.1.7 Diet

Healthy diet is hard to define and complex to measure. In 2012, a comparative risk assessment model study suggested that poor dietary habits were to blame for 45% of deaths caused by CVDs, stroke, and T2D (cardiometabolic mortality) in the US. Too much sodium, processed meats and sugar-sweetened beverages with low levels of nuts/seeds, seafood, omega-3 fats, vegetables and fruits were the top poor diet factors attributable to deaths (Micha et al. 2017). Evidence is clear that healthy diet is linked to lower risk of CVD, but the question remains how to encourage the population to eat healthily.

In a Spanish trial, a Mediterranean diet which contains most of the guideline-specific diet metrics (higher intakes of vegetables, legumes, nuts, fruits, whole grains, fish, and unsaturated fat, as well as lower intakes of red and processed meat), was related to a 29% reduced risk of stroke, MI and death attributable to CV causes

(Estruch et al. 2013). Further, in a large female study of nurses a 28% (RR 0.72; 95% CI 0.60–0.87) reduced risk of CV mortality was discovered with a similar diet, whereas a 22% (RR 1.22; 95% CI 1.01–1.48) greater risk of CV mortality was linked to a diet with a higher intake of processed meat, red meat, refined grains, French fries, and sweets/desserts (Heidemann et al. 2008). Unfortunately, a US meta-analysis showed that a healthy diet cost around $1.50 more per person per day compared to an unhealthy diet (Rao et al. 2013).

Diet associates with CVD through the effects on BP, cholesterol, weight and glucose balance (European Heart Network 2011). Of the fatty acids, polyunsaturated fatty acids seem to be the best for the heart, because of their tendency to lower LDL-C levels. In a meta-analysis, a 10% (RR 0.90; 95% CI 0.83–0.97) reduced risk for CHD events was accomplished for each 5% energy exchange replacing saturated fatty acids with polyunsaturated ones (Mozaffarian et al. 2010). Trans fatty acids were shown to increase the risk of CHD by 23% with each 2% increase of their consumption in diet (Mozaffarian et al. 2006). The diet guidelines suggest an intake of less than 7-10% of saturated fats of total energy intake (Lloyd-Jones et al. 2010; Piepoli et al. 2016). In addition, nut consumption improves blood lipid levels (Sabaté et al. 2010) and decreases the risk of developing T2D (Afshin et al. 2014). Consumption of 30g of nuts per day lessen the risk of CVD by 30% (Luo et al. 2014). Also, the n-3 fatty acid content of fish is speculated to influence the 16% reduction of CHD, when fish was eaten at least once a week (Zheng et al. 2012).

Sodium intake is shown to increase SBP in a dose-dependent fashion (Mozaffarian et al. 2014). Furthermore, sodium intake is associated with increased CVD events (Poggio et al. 2015). Processed foods contain 80% of the salt consumed, so public health efforts are needed to solve the problem. European guidelines suggest a salt intake of less than 3g/day (Piepoli et al. 2016), whereas mean salt intake was approximately 10 g/d worldwide in 2010 (Powles et al. 2013). Processed meat contains a lot of salt and each 50-g serving per day (e.g., sausage, bacon, hot dogs, deli meats) is associated with an elevated risk of CHD (RR 1.42; 95% CI 1.07–1.89) (Micha et al. 2010).

High intake of fiber in the diet is linked to reduced risk of CHD (HR 0.81; 95% CI 0.75–0.87) and CVD (HR 0.78, 95% CI 0.73–0.85) (Aune et al. 2016), stroke (Z. Zhang et al. 2013) and T2D (Yao et al. 2014). Furthermore, the risk of CV mortality (X. Wang et al. 2014) and CHD (Dauchet et al. 2006) has been shown to decrease by 4% with each additional fruit or vegetable serving per day. Also, regular use of sugar-sweetened beverages (2 servings/day) has been shown to increase the risk of CHD by 35% (Piepoli et al. 2016) and T2D in women (Hu and Malik 2010).

The dietary habits of Finnish people have been improving during the last decades. The change in fatty acid profile explains most of the 20% decrease in the mean TC level of the population, which has been reflected in the decreased incidence of CVD (Uusitupa and Rautalahti 2017). According to the Finravinto 2012 health survey, there is still much to do in increasing the fruit, vegetable and whole grain intake, together with reducing salt intake and unsaturated fatty acids (Ovaskainen et al. 2015). In particular, the consumption of fruits and vegetables has decreased among the working-age population between the years 2011 and 2017 (Koponen et al. 2018).

2.2.2 Non-traditional risk factors

2.2.2.1 Psychosocial risk factors

Psychosocial risk factors can act as barriers to treatment adherence and efforts to improve lifestyle, as well as deterring the promotion of health and well-being in patients and populations (Perk et al. 2012). Also, they have a tendency to accumulate on each other. Low socio-economic status, lack of social support, stress, depression, anxiety, hostility, and type D personality also contribute to the risk of developing CVD and worsening of clinical course and prognosis of CVD (Albus 2010; Perk et al. 2012). In type D personality, D stands for "distressed", and a person with this type of personality has negative feelings (negative affectivity) and avoids social contacts (social inhibition) (Perk et al. 2012). In the European 2012 guidelines on CVD prevention in clinical practice it is recommended to evaluate psychosocial risk factors with core questions (Perk et al. 2012). Furthermore, if the core question is answered positively, it is suggested that a valid questionnaire be used in further evaluation of the particular risk factor. In the 2016 guidelines also questions about post-traumatic stress disorder and other mental disorders are recommended (Piepoli et al. 2016).

Evidence suggests that psychosocial risk factors might be more powerful risk factors in young and middle-aged women than in men in the same age groups (Korkeila et al. 2010; Nabi et al. 2010; Wyman et al. 2012). Even though young women are not the specific focus group of CVD (E. S. Ford and Capewell 2007), early prevention by identifying psychosocial risk factors could be useful in the long term (Lloyd-Jones et al. 2006), as it is known that the lifetime risk for CVD is 40% among 50-year-old persons.

2.2.2.1.1 Work and family stress

In regard to work-related stress, the association with the risk of CVD is debatable among women (Steptoe and Kivimäki 2013). Particularly work stress has been linked to CHD in men (Karasek et al. 1981). Also, general daily stress was associated with increased CHD mortality among healthy Danish men but not among women (N. Nielsen et al. 2008). In the Framingham Offspring Study (n=3,039, 18-77 years) only women were affected by the high demands of a high control job, resulting in a 2.8-fold increased risk of CHD (95% confidence interval (CI): 1.1-7.2) (Eaker et al. 2004). On the contrary, in The Swedish Women's Lifestyle and Health Cohort Study (N=49,259 women aged 30–50 years) job strain (high demand and low control job), passive job (low demand and low control job) or active job (high demands-high control job) were not associated with the risk of CHD (Kuper et al. 2006).

In a Swedish study of 292 women (aged 30-65 years) with CHD the recurrent CVD events were studied in a five-year follow-up. Family stress increased the risk of a new CVD event threefold (95% CI 1.3-6. 5), while work stress did not have an impact at all (Orth-Gomér et al. 2000). Patients themselves often think that stress is a key factor for CVD and elevated levels of risk factors (Cohen et al. 2015).

2.2.2.1.2 Social isolation

The evidence of social isolation and lack of social support affecting CVD risk is mixed, changing from null finding (Kuper et al. 2006) to 50% enhanced risk for CVD events and poor prognosis (Cohen et al. 2015; Lett et al. 2005; Mookadam and Arthur 2004). According to a large Danish study, there is a twofold risk for CHD among singles compared with among cohabiting people (K. Nielsen et al. 2006). The protective effect of a spouse against incident CHD is stronger among men than women (Eaker et al. 2007). Nevertheless, loneliness has been shown to increase the CHD risk in women but not in men (Thurston and Kubzansky 2009).

2.2.2.1.3 Depression

Depression is one of the most disabling single conditions (Wittchen et al. 2011) and also a well-known risk marker for CVD (Frasure-Smith and Lespérance 2005; van Melle et al. 2004; Nicholson et al. 2006). The association of depression and CVD is multifactorial with behavioral and biological factors playing a key role.

Poor health behaviors (smoking, excess alcohol intake, physical inactivity), obesity, and poor adherence to CV medications have been shown to increase the risk of CVD (Cohen et al. 2015; Dhar and Barton 2016). Furthermore, stress experienced by depressive people predisposes them to autonomic nervous system dysfunction and hypothalamus-pituitary-adrenal axis deregulation, which can lead to raised BP, elevated resting heart rate, left ventricular hypertrophy, coronary vasoconstriction, and ventricular arrhythmias (Dhar and Barton 2016). Also, inflammatory processes, platelet activation and endothelial dysfunction are speculated to explain the relationship of CVD and depression (Cohen et al. 2015) (Figure 2).

Women have a twofold lifetime risk of depression compared to men (Seedat et al. 2009). Furthermore, young women have higher rates of depression than young men (R. C. Kessler et al. 2005; Mallik et al. 2006). Women also have poorer prognosis after acute MI than men (Champney et al. 2009). Depressive symptoms predicted the risk of CHD events and mortality among healthy women in the large Nurses' Health Study (Whang et al. 2009) and in The Women's Health Initiative Observational Study (Wassertheil-Smoller et al. 2004). In the EPIC-Norfolk Study (8,261 men and 11,388 women, aged 41-80 years), there was a 2.7-fold risk of dying due to CHD among participants with major depression compared to non-depressed individuals (Surtees et al. 2008). Also, a study from the Netherlands showed that major depression increased the risk of CHD events threefold (RR 3.00, 95% CI 1.51-5.93) among both sexes aged over 55 years compared to non-depressed participants (Bremmer et al. 2006).

Moreover, the risk of recurrent CHD is increased with depressive symptoms. In The Women's Ischemia Syndrome Evaluation Study participants with treated depression and current major depressive symptoms had a threefold risk of death and CVD events (multivariate-adjusted risk ratio, 3.1; 95% CI 1.5-6.3; P = .001) compared with those without depression (Rutledge et al. 2006).

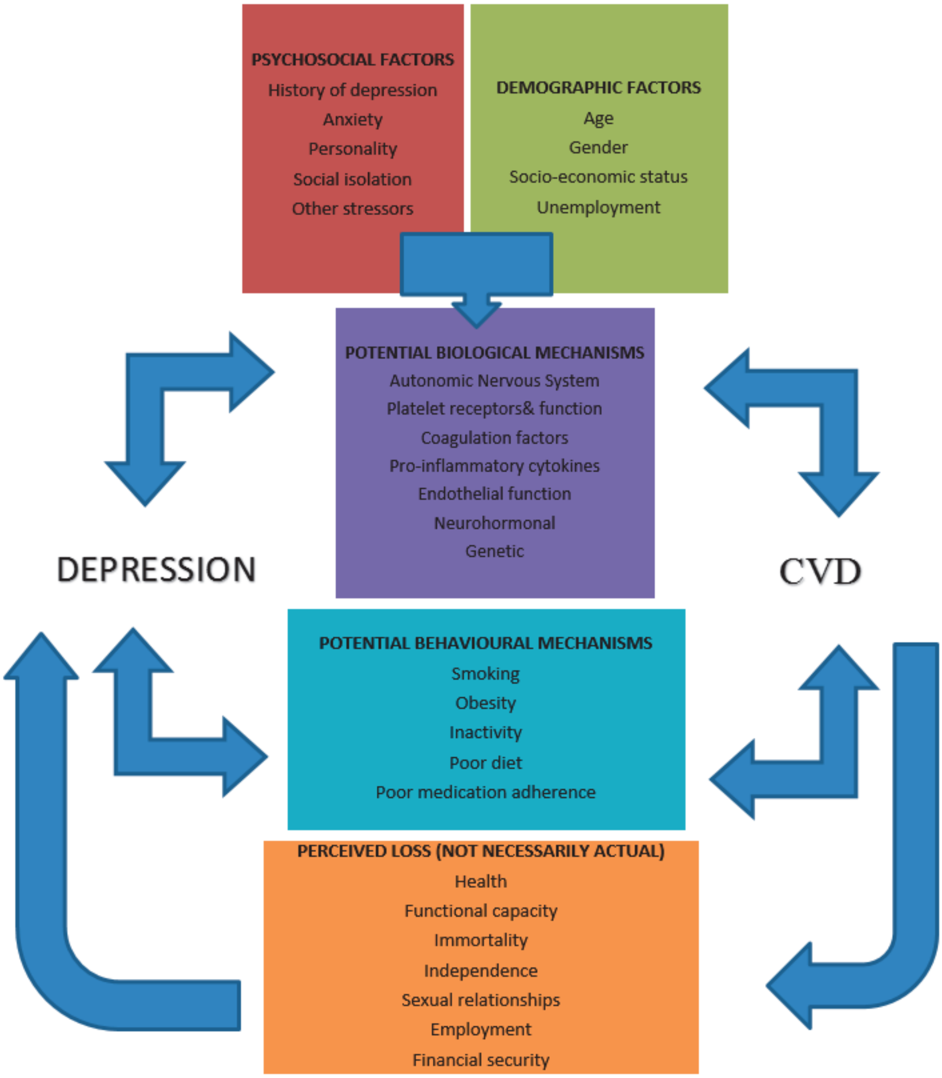

Figure 2. Potential factors that could explain the relationship between cardio-vascular disease (CVD) and depression. Modified from Hare et al., 2014.

2.2.2.1.4 Anxiety

Results linking CVD and anxiety are inconsistent, changing from anxiety being a protective mechanism to being a risk factor (Cohen et al. 2015). In a Finnish cohort study with 25,895 men and women, anxiety was linked to elevated risk of CHD only in women (Nabi et al. 2010). Also, panic disorder (Smoller et al. 2007) and general anxiety increased the risk of CHD death in studies focusing only in women (Denollet et al. 2009). Even though anxiety was more common among women than men, it was linked to five-year CHD mortality and incident CHD only in men in a Swedish longitudinal survey (Ringback and Rosén 2005).

Anxiety and depression are known to have an interrelationship with an estimation that 60% of depressive people also have an anxiety disorder (R. Kessler et al. 1996). Moreover, the presence of anxiety soon after an acute cardiac event predicted later development and persistence of depression in 137 discharged cardiac unit patients (Celano et al. 2011). Because of the overlapping symptomology and comorbidity also the possible mechanisms linking CVD and these two risk factors are similar. Like depression, anxiety associates with poor health behaviors (Cohen et al. 2015). Two pathophysiological mechanisms are proposed to explain the association between anxiety and CVD. First, excess activation of the autonomic nervous system and hypothalamus-pituitary-adrenal axis results in endothelial dysfunction leading to atherosclerosis. Second, anxiety starts a process by an emotional trigger where acute anxiety alters sympathovagal control, increasing the risk of sudden cardiac death. However, no study to date has yet shown that treating anxiety is useful for decreasing CVD risk (Cohen et al. 2015).

2.2.2.1.5 Hostility

Hostility is less strongly associated with incident CHD in women compared to men, but predicts CVD outcomes in women already affected by CHD (Low et al. 2010). In a meta-analysis, an increased risk for CHD events was especially apparent in men with hostility, anger and tendency to engage aggressively (Chida and Steptoe 2009). In a US study, hostility was an independent risk factor of recurrent CHD in postmenopausal women (Chaput et al. 2002).

2.2.2.1.6 Type D personality

In type D personality, D stands for “distressed”, and a person with this type of personality has negative feelings (negative affectivity) and avoids social contacts (social inhibition) (Perk et al. 2012). In a study among civil servants (n=10,308) in the United Kingdom (UK), negative affectivity increased the risk of incident CHD (HR=1.32, CI 1.09 to 1.60) (Nabi et al. 2008). CVD patients with type D personality have an over threefold risk for both CVD events and a poorer quality of life (O ’Dell et al. 2011). Furthermore, type D personality is linked to poor prognosis of CVD (Denollet, Schiffer, and Spek 2010).

2.2.2.2 Work-related factors

Work engagement is defined as “a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication and absorption” (Schaufeli et al. 2002). It is a positive psychological construct and a continuous state, which is not affected by any particular event, behavior, individual or object. Vigor is characterized by “high levels of energy and mental resilience while working, the willingness to invest effort in one’s work, and persistence even in the face of difficulties”. Dedication alludes to “a sense of significance, enthusiasm, inspiration, pride, and challenge”. Absorption is characterized by “being fully concentrated and deeply engrossed in one’s work, whereby time passes quickly and one has difficulties with detaching oneself from work” (Schaufeli et al. 2002). Thus, engaged workers are hardworking (vigor), involved (dedicated) and absorbed in their work. Importantly, evidence suggests that well-being at work positively affects employees’ health as described in the following paragraph.

Work engagement has been shown to have a positive relationship with self-rated health (SRH) among employed Finnish female breast cancer survivors and their reference group (Hakanen and Lindbohm 2008). Moreover, employees with a high level of work engagement seem to have lower levels of stress, anxiety and depression (Hakanen and Schaufeli 2012; Hakanen et al. 2008; Hallberg and Schaufeli 2006; K. Imamura et al. 2016; Schaufeli et al. 2008; Shimazu et al. 2012), which are known risk factors of CVD. Also, a positive association between life satisfaction and job performance with work engagement has been observed in a study among 776 Japanese employees (mean age 38 years, males 94%), whereas work engagement was negatively related to psychological distress and physical complaints (Shimazu and Schaufeli 2009). Nevertheless, the associations between work engagement and physical health (i.e. CVH) are a sparsely investigated area of research. Only in the longitudinal Study on Transitions in Employment, Ability and Motivation among 8,837 middle-aged (aged 45–64) employees from the Netherlands, was better mental and physical health associated with a higher work engagement score, with mental factors having a stronger impact on work engagement than physical health (Leijten et al. 2015). Work engagement also has a positive influence on work ability (Airila et al. 2012, 2014; Rongen et al. 2014). Airila et al. (2014) showed that baseline work ability predicted work ability after a 10-year follow-up, via work engagement. Work ability is the degree to which a worker, given his/her health, is physically and mentally able to cope with the demands at work (Ilmarinen 2006).

2.2.2.3 Self-rated health

Patient´s subjective assessment of his/her health status is a powerful health measure. SRH is linked to incident CVD and its mortality (Mavaddat et al. 2014). In an 11-year follow-up study among 20,941 men and women (aged 30-74 years) in the UK, poor SRH increased the risk of fatal and non-fatal CVD events almost fourfold compared to excellent SRH (HR 3.7, 95% CI 2.8-4.9). This association remained strong even after adjustment for behavioral, clinical, and socio-demographic risk factors (HR 3.3, 95% CI 2.4-4.4) (van der Linde et al. 2013). Similarly, in a Swedish Women's Lifestyle and Health Cohort Study (n=49,259 women aged 30-50 years) investigators found a strong association between poor SRH and incidence of fatal CHD/non-fatal MI (HR 3.9, 95% CI 2.4-6.3), but after adjustment for CV risk factors, the HR attenuated (HR 1.7, 95% CI 1.0- 2.9) (Kuper et al. 2006). Likewise, in a Finnish study (n=21,302, mean age 42 years) with 23 years of follow-up, CVD mortality and SRH were linked even after adjustments (SRH poor vs. good: men HR 1.7 (1-5-1.9) and women HR 1.6 (1.3-2.1)) (Heistaro et al. 2001). Also, all-cause mortality and SRH are strongly associated and in most studies male gender increases the association (Benjamins et al. 2004; Desalvo et al. 2005; Idler and Benyamini 1997). It has been speculated that the association of poor SRH with all-cause mortality may be driven by its association with CVD.

As a complement to traditional CVD risk factors, such as smoking status, hypertension, T2D, and cholesterol, current US guidelines recommend assessment of SRH status in patients with CVD (Rumsfeld et al. 2013). This single-item assessment has comparable predictive validity for mortality irrespective of wording and when compared to more-complex multi-item assessments (Desalvo et al. 2005; Idler and Benyamini 1997). SRH is considered useful as a comprehensive indicator of lifestyle-related diseases for individual health management (Jylhä 2009). Unlike laboratory data, SRH does not reflect a biological pathway to mortality risk. Instead, SRH is viewed as an integrated or synthesized summary of conditions that are met on the path of life (Jylhä 2009).

Several studies have linked good SRH and healthy lifestyle (Allen et al. 2015; Harrington et al. 2010; Kwaśniewska et al. 2007; Mood 2013; Yamada et al. 2012). In an Irish study (n= 10,364, age >18 years), four protective lifestyle factors (non-smoking, moderate alcohol consumption, regular PA and adequate consumption of fruits and vegetables) compared to having none of them was associated with a sevenfold likelihood of excellent/very good SRH (OR 6.8 95% CI 3.64–12.82) and a four times likelihood of having better mental health (OR 4.4 95% CI 2.34–8.22) (Harrington et al. 2010). Also, adequate exercise, nonsmoking, social support and vegetable consumption were related to better SRH in a Swedish longitudinal study (Mood 2013). Individual health behaviors are also related to SRH. Among 194,545

Australian adults (mean age 62 (+/- 11) years) the most physically active individuals were twice as likely to report excellent SRH (OR 2.22, 95% CI 2.20-2.47) than the least active individuals. Moreover, sitting time was inversely associated with SRH in this study (Rosenkranz et al. 2013). Also, adherence to dietary guidelines and lower intake of fat and saturated fat were associated with favorable SRH in an Australian study (Collins et al. 2008). Further, overweight and obesity have been shown to be associated with poorer SRH than individuals having normal weight (Harrington et al. 2010; Kwaśniewska et al. 2007; Tsai et al. 2010). In addition, the Behavioral Risk Factor Surveillance System study of 430,912 adults from the US reported that the more healthy the behaviors, the better the SRH, especially among adults already diagnosed with CVD or diabetes (Tsai et al. 2010).

2.2.2.4 Physical capability

Physical capability, the ability to perform the physical tasks of daily living, is based on objective measures of PA (Kuh et al. 2014). Measures such as grip strength, chair rise test, standing balance test, and six minutes' walking test, widely assess upper and lower extremity muscle strength and balance. Good muscle strength reduces all-cause (FitzGerald et al. 2004; Ortega et al. 2012; Sasaki et al. 2007) and CVD mortality (Rantanen et al. 2003), and decreases CVD risk in women independent of aerobic PA level (Drenowatz et al. 2015). In women, muscle-strengthening training has been associated with reduced total CVD risk, as well as lower body fat, TC and fasting glucose levels (Drenowatz et al. 2015). Likewise, the measures of physical capability have been associated with all-cause mortality (Cooper et al. 2010, 2014; Elbaz et al. n.d.) and the risk of stroke (McGinn et al. 2008). In young men, grip strength is the strongest measure to predict CHD later in life (Silventoinen et al. 2009) and is also linked to lower CVD mortality in middle-aged and elderly populations (Sasaki et al. 2007).

Importantly, individual CVD-related health behaviors have a positive relationship with physical capability. Among 487 elderly women (65-77 years of age), smoking was associated with slower chair rise and walking speed and lower grip strength. The effect of smoking was similar to 7-11 years of normal age-related decrease in physical functioning (Rapuri et al. 2007). In 2,394 British adults (aged 53 years), standing balance and chair rising time were lower among higher smokers, but not grip strength (Strand et al. 2011).

In a US study, individuals over 60 years of age were shown to have better physical performance (measured by gait speed and knee extensor power) when following the dietary recommendations (Xu et al. 2012). In an Italian nine-year follow-up study of 935 men and women over 65 years of age, a Mediterranean diet lowered the risk of declining physical function (studied with 4-meter walking speed, repeated chair rises and standing balance) (Milaneschi et al. 2011). The Hertfordshire Cohort Study in the UK (n=2,983) showed that consumption of fatty fish was associated with increased grip strength among adults aged 59-73 years (S. M. Robinson et al. 2008). In a Finnish study among 840 participants aged 32-72 years, higher BMI and lower hand grip strength predicted lower walking speed after 22 years of follow-up (Stenholm et al. 2007). The association between greater PA and better physical capability has been studied widely. PA level was positively related to chair rise and standing balance performance, but not to grip strength among British women aged 53 years (Cooper et al. 2011). In the same cohort at the age of 60-64 years, also grip strength was associated with increased level of PA in both sexes (Dodds et al. 2013). Moreover, a six-year follow-up study among middle-aged adults (n=10,209, aged 50-69 years) from the US and the UK found that PA was protective against loss of physical functioning irrespective of a participant being normal weight or overweight (Lang et al. 2007). In Iceland, among 4,573 participants (mean age 76 (+- 6) years) those physically active in midlife had better results after 25 years in physical function tests (gait speed on a 6-m walk, Timed Up and Go, and knee extension strength test) (Chang et al. 2013). Also, The Hertfordshire Cohort Study (n=717, mean age 68 years) demonstrated that customary PA (i.e. gardening) is associated with better grip strength and physical performance (studied with 3 m customary walking pace, 5 sit-stand chair rises time and timed one-legged balance) among women but not among men (Martin et al. 2008).

Only recently, have a few studies exploring the association of physical capability and CVD risk factors taken multiple CVD risk factors into account, but still focused on older populations. In the UK, among 3,222 participants aged 59-73 years it was shown that the more CVD risk factors (low PA, poor diet, obesity, smoking) the poorer was the physical function of the participant (measured with timed Up-and-Go Test, timed 3-m walk, chair rises, one-legged standing balance) (S. Robinson et al. 2013).

2.3 Women and cardiovascular health

Several population-based studies in Europe and in the US have revealed that among young and middle-aged women, CVD event incidence and mortality, especially related to CHD, have increased or plateaued during the past two decades (Ford and Capewell 2007; Lehto et al. 2007; Mannsverk et al. 2012; Statistics 2017; Towfighi et al. 2009; Wilmot et al. 2015) (Figure 3).

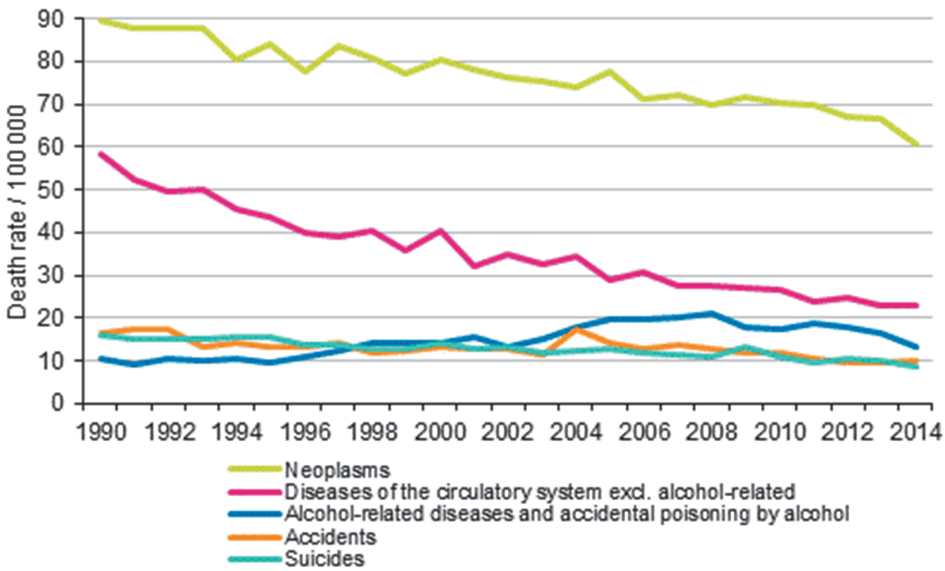

Figure 3. Age-standardized mortality of working-age women (aged 15 to 64) from different causes of death in 1990 to 2014. Source: *Official Statistics of Finland (OSF): Causes of death [e-publication]. ISSN=1799-5078. 2014, Appendix 3. Age-standardised mortality of working-age women (aged 15 to 64) from different causes of death in 1990 to 2014. Helsinki: Statistics Finland [referred: 2.8.2018]. Access method: http://www.stat.fi/til/ksyyt/2014/ksyyt_2014_2015-12-30_kuv_003_en.html*

The European CVD prevention guidelines indicate that there are gaps in the evidence of CVD prevention in women (Perk et al. 2012). One major concern is that studies still often lack sex-specific results, which makes it hard to draw conclusions among female populations (Blauwet et al. 2007; Mehta et al. 2016). Female-specific factors for CVD are pregnancy and menopause, while the classic risk factors of CVD remain the same in both sexes (Appelman et al. 2015). Gender differences are based on sociocultural practices (behaviors, environment, lifestyle), but sex differences are biological variances among women and men. Sex-unique gene expression and function explain the differences in hormones, which are associated with hypertension, diabetes, vascular and cardiac remodeling, and autonomic regulation (Garcia et al. 2016). Along with the genetic factors, anatomic and physiological factors, as well as the delays in symptom recognition and underutilization of diagnostic tests and treatments, are referred to in order to explain the sex difference in CVD (Stranges and Guallar 2012).

The lack of awareness of the CVD is a major issue. In 2012, half of US women did not know that heart disease is the leading killer among women (Mosca et al. 2013). This lack of awareness is pronounced among women of low socioeconomic status and women of color, both of which are also linked to higher CVD death rate in women (Benjamin et al. 2018).

In women, the symptoms of CVD can differ from those in men (McSweeney et al. 2003). Two out of three women had no previous symptoms before sudden death (Go et al. 2013). Compared to men, CVD develops at older ages among women and is associated with poorer outcome (Dey et al. 2009). In the US and in Finland, CVD outcomes like HF, CHD, MI, and stroke are more frequent in men than in women (Benjamin et al. 2018; Koponen et al. 2018). Menopause is the time of life when cardio-protective estrogen levels shrink, and women become more vulnerable to CVD (Barrett-Connor and Bush 1991; Grodstein et al. 2000). Middle-aged and older women have a poorer prognosis to survive the first year after their heart attack than men of the same age (Benjamin et al. 2018). Furthermore, women experience less chest pain and higher mortality in acute coronary syndrome than men, especially among young women (Canto et al. 2012). Chest discomfort is the most common symptom in heart attack in both sexes, but women are more likely to report also other symptoms (weakness, fatigue, nausea, dyspnea or chest-related symptoms in neck, jaw or back), which delays treatment and results in misdiagnosis (Canto et al. 2007; Eastwood et al. 2013; Mieres et al. 2011).

Moreover, the lack of referral of their physician is considered to influence the diagnosis and treatment plan of women (Ghisi et al. 2013; Mosca et al. 2005). Preventive treatment, like statins, aspirin and lifestyle counseling were received less by women than men with a similar risk profile (Abuful et al. 2005; Mosca et al. 2005). Also, medical treatment like antihypertensive medications and statins in women, is often less aggressive and results in less optimal effects than in men (Bird et al. 2007; Chou et al. 2007; Gu et al. 2008; Rathore et al. 2002). Sex differences also play a role in receiving more aggressive treatment, like an implantable cardioverter-defibrillator (Sahni and Fonarow 2014) or percutaneous coronary intervention (D'Onofrio et al. 2015; Go et al. 2013). Women with acute coronary syndrome are less likely to have cardiac catheterizations, fibrinolytic and bypass surgical procedures, resulting in poorer clinical outcomes and higher mortality and a lower health-related quality of life than men (Blomkalns et al. 2005).

2.3.1 Sex differences in traditional cardiovascular risk factors

In a large NHANES mortality follow-up study, among individuals who had none of the key risk factors of CVD (hypertension, elevated TC, smoking) compared to those with at least one risk factor, the risk for fatal CHD was 71% lower in females and 51% lower in males (Mensah et al. 2005). Nevertheless, an estimated 64% of all CHD deaths in females and 45% of male deaths could have been prevented if none of the risk factors existed (Mensah et al. 2005).

The comprehensive nationally representative health examination study of Fin-Health 2017, aims to investigate health, functional capacity, and welfare in the Finnish general population (Koponen et al. 2018). According to this study, Finnish men smoke more than women (daily smokers 16% vs 11%), have poorer diet patterns (use of daily fruits and vegetables, in men 10% vs 21% in women) and are more often overweight (BMI $\geq$ 25.0 kg/m^2 72% vs 64%). In addition, 58% of men vs 48% of women have hypertension or medication for it, and 15% of men vs 10% of women have T2D. In contrast, men have better TC levels (46% vs 40% reaching TC < 5.0 mmo/l) than women. In achieving aerobic PA recommendation the results were gender neutral (in men 50% vs 49% in women) (Koponen et al. 2018).

Dyslipidemia is the most common risk factor of CVD among women worldwide (Yusuf et al. 2004). Besides the poor adherence to prescribed cholesterol-lowering medication (only 45% using the products) (Mercado 2015), studies from the US show that women are less likely to get the prescription (Safford et al. 2015; Virani et al. 2015). Moreover, obesity is usually more common among women than men (Flegal et al. 2012) and increases the CVD risk more in women (64% vs 46%) (Wilson et al. 2002). Likewise, PA is linked with lower rates of CVD, but sedentary lifestyle is more prevalent among women than men and increases with age (Center for Health Statistics 2011).

Compared to men, smoking in women is linked to higher risk of CVDs, sudden cardiac death and hypertension (Huxley and Woodward 2011; Sandhu et al. 2012; Satcher 2001). Also, women smokers tend to have CVDs more prematurely than men (Grundtvig et al. 2009). As a sex-specific nuance, smoking along with oral contraceptives ensures a greater risk for acute MI, stroke and venous thromboembolism than smoking without oral contraceptives (Lidegaard 1999).

Diabetic women have a greater risk for CVD (Huxley et al. 2006) and CVD death (Barrett-Connor et al. 1991) than diabetic men and therefore need aggressive CVD prevention efforts due to the impaired endothelium-dependent vasodilation, worse atherogenic dyslipidemia and metabolic syndrome (Pradhan 2014; Steinberg et al. 2000). There are studies showing that even among pre-diabetic individuals women are prone to more adverse changes in CV risk (Donahue et al. 2007; Haffner, Miettinen, and Stern 1997).

In primary prevention, risk calculators can be used to evaluate overall risk for CVD. The Framingham Risk Score was the first developed for this purpose (D’Agostino et al. 2013), and while options have since multiplied, the FINRISKI calculator based on the FINRISKI Studies is the most precise in the Finnish population (Vartiainen et al. 2007). This calculator evaluates the risk of having CHD or stroke in the next decade and takes into account the main risk factors; sex, age, TC, HDL-C, smoking, BP, diabetes, and family risk (Vartiainen et al. 2007). A high risk (≥10%) has been evaluated in 2% and 17% in women ages 50-59 years and 60-69 years, respectively. In men the levels are 19% and 71%, respectively (Koponen et al. 2018).

2.4 The role of prevention in cardiovascular health

The experience from the fall of CHD in Finland and elsewhere speaks strongly in favor for change in living habits reflecting lowering of TC and BP values, and in the incidence of smoking (Ford et al. 2007; Jousilahti et al. 2016). CVD prevention efforts are increasingly important due to the ongoing trend of unhealthy behaviors such as sedentary lifestyle and adverse dietary habits, which have led to increased prevalence of obesity and T2D (Lehto et al. 2012; Yang et al. 2012). In a large study of the Women's Health Initiative, 83% of the US study population (n= 161,808 , aged 50-79 years) were "at high risk" or "at risk" for CVD (Hsia et al. 2010). Fortunately, adopting a healthy lifestyle would prevent at least 75% of CVDs and even 40% of cancers (Chomistek et al. 2015; Hu et al. 2000; Kelly 2010; K. Liu et al. 2012; Stampfer et al. 2000). In a study among young adults with over 30 years of follow-up, the incidences of CVD morbidity and mortality were rare in persons with favorable levels of BP, TC, BMI, glucose and nonsmoking compared to individuals with poor risk factor levels at young ages (Daviglus et al. 2004). These data make prevention efforts sensible.

Health promotion and CVD prevention require that three different aspects be acknowledged; (1) primordial prevention, (2) risk factor accumulation in childhood, and (3) balance between population-level approach and disease prevention in high-risk individuals (Lloyd-Jones et al. 2010). Prevention is typically divided into three; primordial, primary and secondary (Figure 4). Primordial prevention sets out to prevent risk factors occurring in the first place in the whole population. In primary prevention, the focus is on preventing the first occurrence of a clinical event in individuals at risk. In secondary prevention, the aim is to prevent a new clinical event in patients with the clinically manifest disease (Strasser 1978).

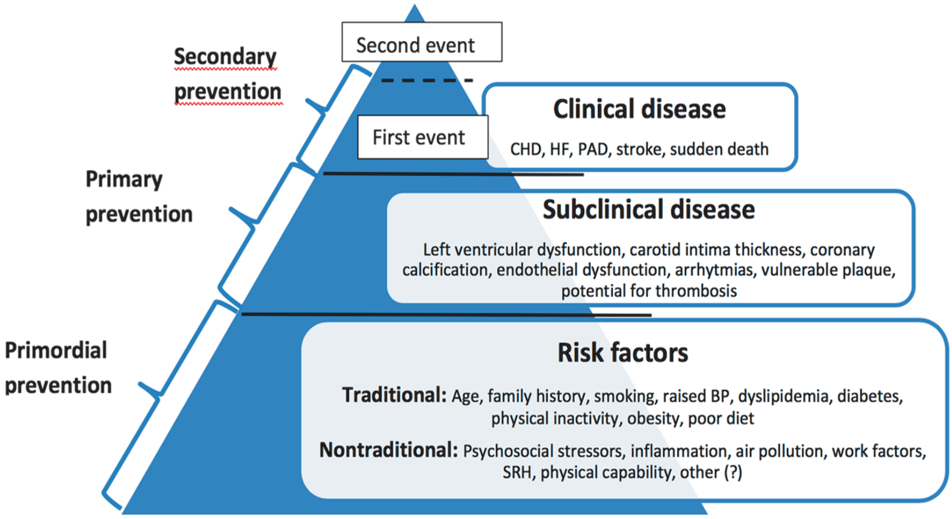

Figure 4. The levels of cardiovascular disease prevention. Modified from (B. Franklin and Cushman 2011). CHD; coronary heart disease, HF; heart failure, PAD; peripheral arterial disease, BP; blood pressure, SRH; self-rated health.

Most of the studies indicate that the present reductions in CHD mortality over the last decades are due to the preventive acts of primary and secondary prevention interventions in high-risk individuals (Ford et al. 2007). Population-level strategies are essential in the ongoing CVD battle, because the majority of CVD events occur with mild or average level of risk factors (Rose 1992; Stamler et al. 1993). Half of the reduction in expected CHD deaths were explained by evidence-based medical treatments for secondary prevention and half with the favorable population shift in risk factor levels (Ford et al. 2007). These findings, together with other similar ones (Bennett et al. 2006; Björck et al. 2009; Laatikainen et al. 2005; Unal et al. 2005), highlight the importance of primordial prevention in targeting the risk factor levels of the population and preserving CVH in healthy individuals as they age (Figure 5).

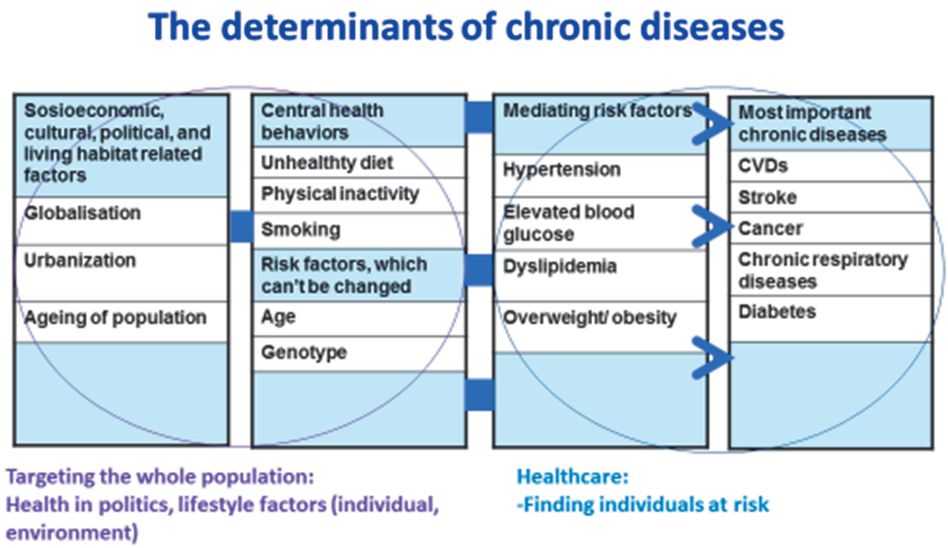

Figure 5. The determinants of chronic diseases. Modified from (Le Galès-Camus 2005).

2.5 Ideal cardiovascular health

In 2010, the AHA created a concept of the ideal CVH defined by the absence of clinically manifest CVD together with the presence of both ideal health behaviors (nonsmoking, normal BMI, PA at target levels, healthy diet) and ideal health factors (untreated TC <5.17 mmol/l (<200mg/dL), untreated SBP <120 mm Hg and DBP <80 mm Hg, fasting plasma glucose <5.6mmol/l (<100 mg/dL)) (Lloyd-Jones et al. 2010) (Table 2). This metric also labeled as “Life´s Simple 7”, is a means to assess the CVH of the population and aims to the goal: “By 2020, to improve the CVH of all Americans by 20% while reducing deaths from CVDs and stroke by 20%” (Lloyd-Jones et al. 2010). Positive language is adopted for the concept since health is a broader and positive construct than just the absence of clinical disease. In addition, increased longevity, disease-free survival, and improved quality of life, together with reduced healthcare costs, are the construct’s main goals (Lloyd-Jones et al. 2010). The concept of an ideal CVH tries to create a positive atmosphere for clinicians and patients by providing goals and targets which are possible to reach with a healthy lifestyle.

Table 2. Definition of adult ideal cardiovascular health by the American Heart Association

Goal/Metric (>20 years)	**Ideal Cardiovascular Health Definition**
Current smoking	Never or quit >12 months ago
Body mass index	<25 kg/m^2
Physical activity	≥150 min per week moderate intensity or ≥75 min per week vigorous intensity or combination (≥150 min per week moderate + vigorous intensity)
Healthy diet score	4–5 Components Fruits and vegetables: ≥450 g per day Fish: ≥two 100 g servings per week (preferably oily fish) Fiber-rich whole grains: ≥three 30 g servings per day Sodium: <1500 mg per day Sugar-sweetened beverages: ≤450 kcal per week
Total cholesterol	<5.17 mmol/l (<200 mg/dL) (untreated values)
Blood pressure	<120/<80 mm Hg (untreated values)
Fasting plasma glucose	<5.6 mmol/l (<100 mg/dL) (untreated values)

Modified from Lloyd-Jones et al. 2010.

2.5.1 The prevalence of ideal cardiovascular health

Since the launch of the concept in 2010 many studies have adopted the ideal CVH to review the population's CVH. It seems that ideal CVH is quite hard to achieve. Folsom et al (2011) presented results showing that among 12,744 US middle-aged people the prevalence of ideal CVH was 0.1% (Folsom et al. 2011). Similar findings were presented by Yang et al (2012) with a studied 1.2% ideal CVH prevalence among the US population. According to the National Center for Health Statistics, National Health and Nutrition Examination Survey 2011 to 2012, 0% of US adults have all seven ideal CVH metrics, but 17% have over 5, and 4% reach 6 metrics. Most US adults (65%) have 2, 3, or 4 criteria of ideal CVH, with 20% of adults within each of these categories. Fifteen percent achieve only 1 of the 7 criteria and 3% have none of them (Benjamin et al. 2018). A greater number of ideal CVH metrics is related to younger age and female sex. For example, 21% of females had ≥5 metrics at the ideal level compared to 13% of males (Benjamin et al. 2018). Furthermore, several social risk factors (low family income, low education level, minority race, and single-living status) were related to poorer CVH in the US (Caleyachetty et al. 2015).

In a large Chinese study with 91,698 people 18-98 years of age, the prevalence of ideal CVH was 0.1%, but increased to 9% if ≥5 CVH metrics were taken into account (Wu et al. 2012). In a Spanish adult population (≥18 years, n= 11,408), 16%

had ≥5 CVH metrics at the ideal level (Graciani et al. 2013). Meanwhile, in Bosnia/Herzegovina among 4,170 adults (mean age 50.2 years, 54 % women), 10% had ≥ 5 CVH metrics at the ideal level (Janković et al. 2014b). Overall, when the ideal level was set at 5-7 ideal CVH metrics, the prevalence of ideal CVH of the US studies varied from 5-35%. And in non-US studies (including Korea, China, Spain, India, Iran, Bosnia/Herzegovina, and Ecuador) the prevalence for ≥5 ideal CVH metrics was 9-43% (Younus et al. 2016) (Table 3). However, when the level of ideal CVH was upgraded to 6-7 CVH metrics, the prevalence decreased to 0.5-12% in the US, and in the non-US populations to 0.3-12% (Younus et al. 2016). In Finland, only 9% of women and 3% of men aged 25–74 years have ≥5 ideal health metrics (Peltonen et al. 2014).

Smoking was the best and diet the poorest achieved CVH metric, despite the native origin (Younus et al. 2016). According to the 2013-2014 NHANES data, 77% of adults met the criteria of ideal smoking (Benjamin et al. 2018). The AHA recommendations follow a DASH (Dietary Approaches to Stop Hypertension)-type eating plan, which consists of consumption of fruit, vegetables, fish, fiber-rich whole grains and reduction of sodium and sugar-sweetened beverages (Lloyd-Jones et al. 2010). The prevalence of an ideal healthy diet was only 0.4% (Benjamin et al. 2018). The trend is that more US adults over time are meeting the smoking metric, whereas fewer are meeting the BMI and glucose metrics, while the prevalence of healthy diet has stayed stable and minuscule during the time of the follow-up (Benjamin et al. 2018).

Table 3. Prevalence of ideal number of CVH factors in US and non-US studies.

Prevalence of Ideal Number of CVH Factors in US studies and Non-US studies

US studies

Reference, year	Folsom et al,[8] 2011	Artero et al,[12] 2012	Yang et al,[13] 2012[b]	Dong et al,[15] 2012	Xanthakis et al,[17] 2014	Saleem et al,[18] 2015	Ford et al,[19] 2012[c]	Djoussé et al,[23] 2015	Robbins et al,[27] 2015	Bambs et al,[28] 2011[d]	Kulshreshtha et al,[29] 2013	Shay et al,[33] 2012[de]	Kim et al,[37] 2013	Ogunmoroti et al,[38] 2015
Study date	1987-1989	1987-1999	1988-1994	1993-2001	1995-1998	1997-2007	1999-2002	2000-2004	2002-2003	2003	2003-2007	2003-2008	2009-2011	2014
Total population (N)	12,744	11,993	15,305	2981	2680	3121	7622	4132	1731	1933	22,914	14,515	4754	9364
Prevalence of CVH factors (%)														
0	2.5	4	1	2	1	2	2	2	5	8	3	3	1	0
1	14.5	13	8	17	8	13	8	25	17	21	19	14	7	2
2	25	22	19	32	21	27	20	33	24	27	31.5	25	21	10
3	27	23	26	30	30	28	27	23.5	23	24	26.5	25	27	23
4	19	20	24	14	22	19	22	12	18	12	14	21	23	31
5	9	14	15	4	13	9	14	4	10	5	5	10	14	23
6 or 7	3	5	7	1	5	2	7	0.5	3	3	1	3	8	12

Non-US studies

Reference, year	Kim et al,[40] 2013	Wu et al,[43] 2012	Gupta et al,[46] 2015	Graciani et al,[47] 2013	Lee et al,[48] 2013	Wu et al,[49] 2013	Moghaddam et al,[50] 2014[d]	Zeng et al,[51] 2013	Bi et al,[53] 2015	Janković et al,[52] 2014	Del Brutto et al,[54] 2013
Study date	1993	2006-2007	2006-2010	2008-2010	2009	2009-2011	2009-2011	2009-2012	2010	2010	2012
Region/country	Korea	China	India	Spain	Korea	China	Iran	China	China	B/H	Ecuador
Total population (N)	12,538	91,698	6198	11,408	5898	1,012,418	4865	9962	96,121	4020	616
Prevalence of CVH factors (%)											
0	0.04	2.5	1	4	0.4	1	1	2	0.3	3	0.3
1	1	11.5	8	14	3.5	4	12	9	3	14	7
2	5	25	22	23	12	9	20	17	10	26	25
3	18	31	29	24	22	23	29	22	23	28	31
4	34	21	25	20	26	22	22	23	31	19	23
5	31	8	12	12	22	26	16	21	23	8	9
6 or 7	12	1	3	4	14	15	0.3	6	10	2	4

[a]B/H = Bosnia/Herzegovina; CVH = cardiovascular health.
[b]NHANES 1988-1994.
[c]NHANES 1999-2002.
[d]Approximate values obtained from Figure 1 of the respective publications.
[e]NHANES 2003-2008.

Modified from (Younus et al. 2016)

2.5.2 Association of ideal cardiovascular health with all-cause and cardiovascular mortality, and cardiovascular events

The concept of ideal CVH is strongly associated with reduced all-cause and CVD-related mortality in a diverse range of racial and ethnic groups and in both sexes (Artero et al. 2012; Dong et al. 2012; Ford et al. 2012; Kim et al. 2013; Y. Liu et al. 2014; Yang et al. 2012) (Table 4). Yang et al (2012) showed a stepwise inverse association with ideal CVH and the risk of death according to NHANES data of 1988 to 2006 (44,959 US adults, ≥20 years). There was a 59% (HR 0.41 95% CI, 0.28–0.61), 78% (HR 0.22 95% CI, 0.11–0.41) and 74% (HR 0.26 95% CI, 0.11–0.58) reduction in all-cause mortality, CVD, and CHD mortality, respectively with ≥6 ideal CVH metrics compared to 0 metrics (Yang et al. 2012). Hypertension, smoking and unhealthy diet were the most attributable metrics to the CVD mortality explaining 41% (95% CI, 25%–55%), 14% (95% CI, 5%–22%), and 13% (95% CI, 4%–29%), respectively, of the CVD mortality (Yang et al. 2012). In a US middle-aged cohort with 5-7 ideal CVH metrics, the risk of CVD death was 63% (HR 0.37; 95% CI, 0.15-0.95) lower compared to those with only 0-2 ideal CVH metrics (Artero et al. 2012). An inverse linear relationship between ideal CVH metrics and mortality was also found in a meta-analysis of 6 studies with over 140,000 participants in the US, China and Korea. For each additional ideal CVH metric a person had an 11% decline in the risk of all-cause mortality, and a 19% reduction in the CVD mortality was noticed (Aneni et al. 2017). Also, Guo et al. (2017) in their meta-analysis involving 193,126 people from 13 prospective studies done in the US, Korea, China and the UK, showed that subjects having the highest number of ideal CVH metrics had 46% lower risk for all-cause mortality, 70% lower risk for CV mortality, 78% lower risk of overall CVD, and 67% lower risk of stroke (Guo and Zhang 2017). In a 22-year follow-up study among middle-aged women, total mortality was lowered by 60% and nine years more were gained for life expectancy, when ideal health factors (nonsmoking, TC <5.17mmol/l, BP <120/80 mm Hg, and no diabetes) were present (Stamler et al. 1999).

Folsom et al (2011) showed 89% (HR 0.11, 95% CI 0.07-0.17) lower incidence of CVD (including stroke, HF, MI, and fatal CHD) with 6-7 metrics of ideal CVH compared with meeting only 0-1 of the ideal CVH metrics in a middle-aged US cohort with a follow-up of 18.7 years (Folsom et al. 2011) (Table 4). Among the EPIC-Norfolk cohort (10,043 individuals) in the UK, the HR for CVD was 0.07 (95% CI 0.02-0.23) (defined as either CHD or stroke) when comparing those in the healthiest group (CVH score 12-14) to those in the unhealthiest group (CVH score 0-2) (Lachman et al. 2016). Thus, the lower incident CVD is associated with ideal CVH in many studies (Dong et al. 2012; Folsom et al. 2011; Lachman et al.

2016; Miao et al. 2015; Ommerborn et al. 2016; Wu et al. 2012). Ideal health behaviors and ideal health factors are each independently associated with lower CVD risk in a stepwise fashion (Folsom et al. 2011).

Ideal CVH metrics also protect against incident stroke (Dong et al. 2012; Kulshreshtha et al. 2013; Lachman et al. 2016; Miao et al. 2015) (Table 4). According to the large Chinese Kailuan study cohort of 91,598 individuals, the risk of stroke was 70% lower with the highest ideal CVH score category compared to the lowest score category (Miao et al. 2015). Similar observations were made in the US in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) Study (22,914 individuals) and in the UK with the EPIC-Norfolk study cohort (10,043 individuals), with HRs 0.34 (95% CI 0.08-1.52) and 0.16 (95% CI 0.02-1.37) for stroke, respectively (Kulshreshtha et al. 2013; Lachman et al. 2016). In addition, better CVH is protective against incident HF (Folsom et al. 2015), and venous thromboembolism (Olson et al. 2015). Also, having more ideal CVH metrics is associated with lower levels of subclinical atherosclerosis (Alman et al. 2014; Oikonen et al. 2013; Robbins et al. 2015; Saleem et al. 2015).

Table 4. Characteristics of prospective studies of ideal CVH metrics with all-cause and cardiovascular mortality, and cardiovascular events.

Author/year	Country	Subjects (% males)	No. of Events	Baseline Age, y	Quantity	Events/Number, HR (95% CI)
Artero et al, 2012	US	14,572 (62.3)	305 (all death); 70 (CV death)	46+-9.9	No. of ideal CVH metrics, 5-7 vs 0-2	0.77 (0.53-1.12) all death; 0.37 (0.15-0.95) CV death
Dong et al, 2012	US	2,981 (36.3)	1,123 (all death); 435 (CV death); 722 (CVD); 208 (stroke)	69.0	No. of ideal CVH metrics, 5-7 vs 0-1	0.59 (0.43-0.81) all death; 0.48 (0.29-0.80) CV death; 0.41 (0.26-0.63) CVD; 0.43 (0.21-0.91) stroke
Folsom et al, 2011	US	12,744 (?)	3063 (CVD)	54.0	No. of ideal CVH metrics, 6-7 vs 0	0.11 (00.7-0.17) CVD
Ford et al, 2012	US	7,622 (62.5)	439 (all death); 90 (CV death)	43.0	No. of ideal CVH metrics, 6-7 vs 0	0.21 (0.07-0.59) all death; 0.10 (0.02-0.47) CV death
Kim et al, 2013	Korea	12,538 (100)	1,054 (all death); 171 (CV death)	47.5	No. of ideal CVH metrics, 6-7 vs 0-2	0.42 (0.31-0.59) all death; 0.10 (0.03-0.29) CV death
Kulshreshtha et al, 2013	US	22,914 (42)	432 (stroke)	65.0	No. of ideal CVH metrics, 6-7 vs 0	0.34 (0.08-1.52) stroke
Lachman et al, 2015	UK	10,043 (44.1)	1,175 (CVD); 171 (stroke)	57.0	Ideal CVH score, 12-14 vs 0-2	0.07 (0.02-0.23) CVD; 0.16 (0.02-1.37) stroke
Liu et al, 2014	China	95,429 (79.8)	1,564 (all death); 458 (CV death)	51.5	No. of ideal CVH metrics, 5-7 vs 0-1	0.69 (0.54-0.89) all death; 0.58 (0.37-0.92) CV death
Miao et al, 2015	China	91,598 (79.5)	3,276 (CVD); 2,579 (stroke)	51.6 +-12.4	Ideal CVH score, 10-14 vs 0-4	0.29 (0.24-0.35) CVD; 0.30 (0.24-0.37) stroke
Wu et al, 2012	China	91,698 (79.4)	1,811 (CVD)	51.5	No. of ideal CVH metrics, 6-7 vs 0	0.21 (0.09-0.50) male; 0.04 (0.00-0.42) female; 0.18 (0.08-0.40) overall
Yang et al, 2012	US	13,312 (?)	2,673 (all death); 1,085 (CV death)	46.8	No. of ideal CVH metrics, 6-7 vs 0-1	0.41 (0.28-0.61) all death; 0.22 (0.11-0.41) CV death
Zhang et al, 2013	China	91, 698 (79.4)	1,486 (stroke)	51.5	No. of ideal CVH metrics, 6-7 vs 0	0.28 (0.12-0.66) male; 0.14 (0.02-1.03) female; 0.24 (0.11-0.54) overall

Modified from (Guo and Zhang 2017).

2.5.3 *Association of ideal cardiovascular health with the risk of non-cardiovascular disease outcomes*

In 2013, a US study found that persons with 6-7 ideal CVH metrics had a 51% lower risk of cancer compared to persons with 0 metrics (Rasmussen-Torvik et al. 2013). The risk for incident diabetes was 90% lower with ≥4 ideal CVH metrics than with 0-3 metrics among American Indians (Fretts et al. 2014). Also, poor health behaviors in women have a positive association with incident diabetes (Hu et al. 2001). Furthermore, better CVH is associated with better cognitive performance and function (Crichton et al. 2014; Thacker et al. 2014), as well as with higher levels of optimism (Hernandez et al. 2015).

Better CVH has been shown to predict better physical functioning (Dhamoon et al. 2015), lower incidence of end-stage renal disease (Han et al. 2016; Muntner et al. 2013), less pneumonia and chronic obstructive pulmonary disease (Fan et al. 2017), as well as longer leukocyte telomere length (Gebreab et al. 2017). Moreover, lower healthcare costs later in life are associated with ideal CVH (Willis et al. 2015). A recent US study compared the groups having 0-2 ideal CVH metrics with the group having 6-7 ideal CVH metrics and reported over 2000 US dollars lower annual healthcare costs with a favorable CVH profile compared to the poor CVH profile (Osondu et al. 2017).

3 AIMS OF THE STUDY

The aim of this thesis is to evaluate the associations between the AHA's concept of ideal CVH and non-traditional risk factors of CVD among the Finnish working-aged female population. The aims in detail are the following:

1) To investigate the association of psychosocial risk factors with the AHA's ideal CVH concept. Do the psychosocial risk factors have an effect on reaching ideal CVH?

2) To assess the relationships between ideal CVH, psychosocial risk factors and work engagement. Is both physical and mental health important to work engagement?

3) To study the relationship of SRH and ideal CVH. Does the sum of ideal CVH, as an indicator of lifestyle and CVD risk, associate with general SRH among working-aged women?

4) To examine the associations of ideal CVH, physical capability, leisure-time physical activity (LTPA) and the recommended level of aerobic PA. Is better aerobic PA related to other ideal CVH metrics or better physical capability? Are better physical capability or LTPA associated with the sum of AHA's ideal CVH metrics?

4 MATERIALS AND METHODS

4.1 Study population

The study population consisted of individuals participating in a longitudinal PORTAAT (PORi To Aid Against Threats) survey in the years 2014-2015. The study was carried out among employees of the city of Pori (83,497 inhabitants in 2014) in South-Western Finland. The study population comprised workers from 10 out of 30 work units, which were selected by the chief of the municipal welfare unit of Pori. The selected work units were as follows; the unit of social services and healthcare (1926 women employees in 2014), unit of day-care centers (116), unit of libraries (60), occupational health care of Satakunta (38), Sinfonietta of Pori (14), museum of Satakunta (17), museum of art (11), the Centre of culture (6), unit of traffic warden (10), and the school of art (3). The main selection criterion was that the work unit had not been involved in any other health- promoting program than routine occupational health care during the past 10 years. The idea was to get several different occupational and socioeconomic groups represented in the study. Invitation and study information letters were sent to the employees as an email attachment by the managers of the work units. Information events about the study were also organized for employees, where potential study individuals were informed about the flow of the study and about the current knowledge of CVH. The selected work units had altogether 2570 employees, of which 836 (104/369 males, 732/2201 females) responded to the e-mail invitation. Participation rate of the study was 33%. Respondents were invited to an appointment with the study nurse.

There were no exclusion criteria. We analyzed data of the 732 female employees (mean age 48±10 years) working in libraries (n=22), museums (n=33), technical management (n=80), social services (=196), and health care units (n=401). Due to the common lack of women-focused studies of CVH and because the number of men (n=104) was so limited in the study population, we decided to study only women in this thesis.

4.2 Methods

4.2.1 Physical examination and questionnaires

All participants were evaluated by a study nurse. In the first appointment, the nurse gathered written informed consent to participate in the study. Laboratory tests (TC, HDL-C, and TG, B-HbA1c) were taken after an overnight fast of at least 8 hours. The questionnaire on psychosocial risk factors (described in detail in the following section) was filled in, and the participant was given the rest of the study questionnaires to be completed at home. Through the self-administered questionnaires information was gathered about diseases diagnosed by a physician, years of education, marital status (cohabiting or not), and quality of sleep (good or not good). Alcohol consumption was assessed with the 3-item Alcohol Use Disorders Identification Test (AUDIT-C) with a cutoff of 5 for harmful drinking (Bush et al. 1998). Smoking was assessed with a questionnaire containing information about non-smoking, smoking cessation and number of current cigarettes smoked daily. Dietary habits were obtained with a non-quantitative food frequency questionnaire. The questionnaire allowed us to study the consumption of fruits, vegetables, white meat, fish and whole grain products. The use of unsaturated dietary fats was estimated based on the consumption of fat-free milk products, cheeses, red meat, sausages and chips. The frequency of diet product consumption was assessed with a response scale as follows; daily, 3-6 times a week, twice a month, more seldom, or never. The medical records and the previous disease history were obtained from the health care units used by the participant. Furthermore, work-related factors, SRH and PA were assessed with questionnaires, which are described in detail later.

At the second appointment, the study nurse measured height, weight, BMI and waist circumference of the participants. Height and weight were measured with the subjects in standing position without shoes and outer garments. Weight was measured to the nearest 0.1kg with calibrated scales and height to the nearest 0.5cm with a wall-mounted stadiometer. BMI was calculated as weight (kg) divided by the square of height (m^2). BP was measured with an automatic validated BP monitor with subjects in a sitting posture, after resting at least 5 minutes. Among the subjects whose arm circumference was >32 cm, a larger cuff was used. Two readings taken at intervals of at least 2 minutes were measured, and the mean of these readings was used in the analysis. The subjects were instructed to perform Home BP measurements (duplicate measurement twice a day) for a week if the mean reading of twice measured BP was over 140/90 mm Hg. Hypertension was defined as the use of medication for hypertension or the mean reading of home BP measures ≥135/85 mm Hg (Parati et al. 2008). The results of the questionnaires and laboratory tests were checked. Study subjects were given personal recommendations for adopting a healthy lifestyle and if any medical problem needed further examination, the study subject was guided to the occupational healthcare.

The participants performed the physical capability tests with the physiotherapist students. Six minute walking test, grip strength, chair rise test and standing balance tests were performed (described in detail later). All participants received guidance for PA.

4.2.1.1 *Psychosocial risk factors*

At the clinic, the study nurse assessed psychosocial risk factors by core questions suggested by the European 2012 guidelines on CVD prevention in clinical practice (Perk et al. 2012) (Table 5):

Table 5. The core questions of psychosocial risk factors.

Work and family stress	Do you have enough control over how to meet the demands at work?
	Is your reward appropriate for your effort?
	Do you have serious problems with your spouse?
Social isolation	Are you living alone?
	Do you lack a close confidant?
Depression	Do you feel down, depressed and hopeless?
	Have you lost interest and pleasure in life?
Anxiety	Do you frequently feel nervous, anxious, or on edge?
	Are you frequently unable to stop or control worrying?
Hostility	Do you frequently feel angry over little things?
	Do you often feel annoyed about habits other people have?
Type D personality	In general, do you often feel anxious, irritable, or depressed?
	Do you avoid sharing your thoughts and feelings with other people?

Modified from Perk et al. 2012.

Low job demand-control, low effort-reward imbalance and/or a ´yes´ answer to one or more items was an indication of a likely psychosocial risk factor.

4.2.1.2 *Work-related measures*

Work engagement was measured with the 9-item Utrecht Work Engagement Scale (UWES-9) (Schaufeli et al. 2006) (Table 6). UWES-9 consists of three subscales; vigor, dedication, and absorption, which were scored on a 7-point Likert scale ranging from 0 (never) to 6 (daily). The mean subscale score was computed by adding the scores on the particular scale and dividing the sum by the number of items in the subscale involved. A similar procedure was followed for the total score. The higher each item was rated the higher the overall work engagement. The Finnish values of the general population for total work engagement are <1.44 (very low), 1.44-3.43 (low), 3.44-4.53 (moderate), 4.54-5.30 (high) and 5.31-6.00 (very high) (Hakanen 2009).

Table 6. The 9-item Utrecht Work Engagement Scale (UWES-9) (Schaufeli et al. 2006).

UWES-9		Vigor	Dedication	Absorption
1.	At my work, I feel bursting with energy	V1		
2.	At my job, I feel strong and vigorous	V1		
3.	When I get up in the morning, I feel like going to work	V1		
4.	I am enthusiastic about my job		D1	
5.	My job inspires me		D1	
6.	I am proud of the work that I do		D1	
7.	I feel happy when I am working intensely			A1
8.	I am immersed in my work			A1
9.	I get carried away when I am working			A1

Modified from Schaufeli et al 2006.

We assessed the worker´s ability to participate in work with the question "what is your current work ability compared to your lifetime best?". This first item of the widely used Work Ability Index (Ilmarinen 2006) is named Work Ability Score (WAS) and has a 0–10 response scale, where 0 represents "completely unable to work" and 10 "work ability at its best". Similar reference values for WAS were used as for the Work Ability Index; poor (0–5 points), moderate (6-7), good (8-9), excellent (10) (Gould et al. 2000).

Questions were asked as regards length of time working in the current occupation (in years), occupational status, working hours per week, and the role of shift work in current work using self-administered questionnaires. The participant's financial situation was assessed with the question "I have to spare expenditures" (yes or no).

4.2.1.3 Self-rated health

SRH was assessed with the question: "How satisfied are you with your health?". The response scale ranged in the Likert scale from 1 (very dissatisfied) to 5 (very satisfied). This assessment method is based on the World Health Organization's Quality of Life questionnaire (WHOQOL-BREF) (Harper and Power 2017). Due to the low rate of very dissatisfied persons (9/725, 1.2%), we combined the very dissatisfied and dissatisfied groups as poor, and used four categories (poor, fair, good and excellent) to evaluate SRH.

4.2.1.4 Leisure-time physical activity

Regular weekly PA was assessed with a self-administered questionnaire with the following six items; 1. No regular PA, 2. Light aerobic type PA (e.g. slow walking), 3. Moderate aerobic type PA (e.g. brisk walking), 4. Vigorous aerobic type PA (e.g. running), 5. Resistance type of training (e.g. gym training), 6. PA related to balance (e.g. dance or games). Participants were instructed to report all weekly physical activities that lasted longer than 10 minutes. Each item included a question about the frequency and duration of PA.

The AHA categories of PA level (ideal, intermediate, poor) were assessed by the questionnaire's items of moderate and vigorous intensity aerobic type PA (items 3 and 4). The ideal level of PA was defined as engaging in ≥75 minutes per week of vigorous intensity activities, or ≥150 minutes per week of moderate intensity activities, or a combination of moderate and vigorous intensity activities. The intermediate PA was an activity level, where the subject was active in moderate or vigorous intensity activities (0-149 minutes per week), but did not reach the recommended level of aerobic PA. Poor PA meant no reported activity in moderate or vigorous intensity activities (0 minutes per week) (Lloyd-Jones et al. 2010).

In order to measure also muscle-strengthening activities, the items 5 (resistance training) and 6 (balance-related PA) of the questionnaire were combined with aerobic type training. To assess the LTPA, a single metabolic equivalent (MET, 1 MET = 3.5 ml of O^2/kg/min or 1 kcal/kg/h) value was defined based on a previous study (Ainsworth et al. 2011). Weekly mean intensity of PA was expressed with time-weighted average intensity in MET values (TWA-MET), which was calculated on the basis of information about the frequency, duration, and intensity (MET) of PA reported in each item. TWA-MET was calculated with a previously described equation (Determination of metabolic rate 2004; Wasenius et al. 2013, 2014). The advantage of TWA-MET over, for example, volume units (e.g. MET-hours) is that it is expressed per unit of time and therefore it is more comparable between individuals (Wasenius et al. 2014).

4.2.1.5 Physical capability

Physical capability measures were conducted by trained physiotherapist students with four objective measures: grip strength, chair rise test, standing balance test, and six minutes' walking test (Cooper et al. 2014; Kuh et al. 2014).

The grip strength was evaluated with a handgrip dynamometer, which was calibrated before the tests. Two measures were taken from both hands and the best result was used in the analyses. Between the measures there was a 30-60 second rest. The measurements were done in sitting position, back against the chair and upper arm next to the body with elbow at a 90 degree angle and wrist in a straight position (Viitasalo et al. 1985). A physiotherapist encouraged subjects for a maximal squeeze for 3-5 seconds. Test-retest correlation coefficient of more than 0.95 has been shown for handgrip strength (Bohannon and Schaubert 2005).

The chair rise time (Guralnik et al. 1994) was determined by stopwatch as the time in seconds to rise from a chair to a complete standing position 10 times as quickly as possible. The subject sat on a chair with arms crossed to the chest, back in contact with the chair and feet (with shoes on) flat on the floor. The test started when the subjects back detached from the chair's back rest. The test was finished when the subject stood up for the tenth time and the time was marked with one decimal. The test-retest reliability of the sit-to-stand test has been reported as good to very good in most populations and settings (Bohannon 2011).

The standing balance time was measured with a stopwatch as the time to maintain a stance as the subject stood eyes-closed on one leg (without shoes), hands on hips and the other leg bent at a 45 degree angle. The test started when the subject lifted her leg from the floor and stopped when the subject could no longer retain the stance (maximal 60 seconds).

The six minutes' walking test was performed with the subject walking as fast as she could in six minutes on a flat indoor surface with shoes on. Running was not allowed. The subject was given a signal when the test started and after each minute thereafter. She was informed when the remaining time was 15 seconds and was eventually told to stop after six minutes (Guyatt et al. 1985).

A physical capability composite score was obtained by combining the results of the physical capability measures. Each measure was standardized with a mean of 0 and a SD of 1, and then the mean of the scores was calculated from the measurements.

4.2.2 Laboratory measurements

Laboratory tests were determined in blood samples which were obtained after at least eight hours of fasting. TC, HDL-C, and TG were measured enzymatically (Architect c4000/c8000). Friedewald formula was used to calculate LDL-C (Friedewald et al. 1972). Glucose tolerance was measured with glycated hemoglobin (B-HbA1c) which was analyzed using the High Performance Liquid Cromatography method, HPLC, (Tosoh HLC-723G7 (G7)).

4.2.3 Assessing the ideal cardiovascular health metrics

The AHA's ideal CVH metrics were used to evaluate the CVH status of the participants (Lloyd-Jones et al. 2010) (See Table 2).

4.2.3.1 Ideal health factors

The ideal level of BP was defined as untreated SBP <120 mmHg and DBP <80 mmHg. AHA's ideal target of < 120/80 mm Hg follows the steps of the Seventh Joint National Committee of the National High Blood Pressure Education Program (Chobanian et al. 2003). The ideal level of untreated TC was defined as <5.17 mmol/l (<200 mg/dL). The AHA metrics uses fasting plasma glucose <5.6 mmol/l (<100 mg/dL) to determine normoglycemia; however, we used B-HbA1c because of its property of giving an indication of glycemia over several preceding weeks rather than at a single time point (Selvin et al. 2007). Normoglycemia was defined as HbA1c <6.0% (<42 mmol/mol) (International Expert Committee 2009).

4.2.3.2 Ideal health behaviors

Smoking status was assessed by a questionnaire. Ideal smoking status was defined as having never smoked or having quit smoking >12 months earlier. Ideal BMI was classified as <25.0 kg/m^2. Information on diet was collected with a food-frequency questionnaire. A dietary score of 4–5 was set as ideal and required daily consumption of fruits, vegetables, whole grains, unsaturated dietary fats, and white meat (poultry, fish) at least three times a week (one point for each dietary component). PA was assessed with the above-mentioned self-report questionnaire. The ideal level of PA was defined as engaging in ≥75 minutes per week of vigorous intensity activities, or ≥150 minutes per week of moderate intensity activities, or a combination of ≥150 minutes per week of moderate and vigorous intensity activities.

4.2.3.3 The categories of ideal cardiovascular health

The seven ideal CVH metrics were grouped into three categories of ideal CVH metrics (0-2, 3-4 and 5-7). This classification is based on the previous research of AHA's CVH ideals, where this classification is used to describe poor (0-2 ideal CVH metrics), intermediate (3-4) and ideal (5-7) levels of CVH (Artero et al. 2012; España-Romero et al. 2013; Gaye et al. 2016; Willis et al. 2015).

4.2.4 Statistical analyses

The data are presented as means with SDs or as counts with percentages. All analyses were performed using STATA 14.0 (StataCorp LP, College Station, TX). In each statistical analysis $p < 0.05$ was considered statistically significant.

The associations of the ideal CVH metrics with psychosocial risk factors (study I), work engagement (study II), self-rated health (study III), and physical activity and capability (study IV) were analyzed, as follows. Statistical significance for the hypotheses of linearity was evaluated using Cochran-Armitage test for trend and analysis of variance with an appropriate contrast. Adjusted hypotheses of linearity (orthogonal polynomial) were evaluated using generalized linear models (e.g. analysis of co-variance and logistic models) with appropriate distribution and link function. In study I and II, the models included age and years of education as covariates. In study III, adjustments were made for age, years of education, cohabiting, alcohol consumption and number of chronic diseases. In study IV, the models included age, years of education and the number of comorbidities as covariates. In the case of violation of the assumptions (e.g. non-normality), a bootstrap-type method was used (10,000 replications) to estimate the standard error. The normality of the variables was tested using the Shapiro-Wilk W test.

In addition, multivariate linear regression analysis was used to identify the appropriate predictors of continuous work engagement (study II) using the standardized regression coefficient Beta (β). The Beta value is a measure of how strongly each predictor variable influences the criterion (dependent) variable. The Beta is measured in units of SD. Cohen's standard for Beta values above 0.10, 0.30 and 0.50 represent small, moderate and large relationships, respectively (Cohen 1988).

A multivariate logistic regression model was used to investigate factors related to good or excellent SRH (study III).

4.2.5 Ethical issues

The study protocol and consent forms were reviewed and approved by the Ethics Committee of the Hospital District of Southwest Finland. All participants signed a written informed consent to participate in the project and subsequent medical research.

5 RESULTS

5.1 Characteristics of the participants

We evaluated 732 female employees with a mean age of 48 (SD 10) years. The characteristics of the participants are presented in Table 7.

Table 7. A general overview of the characteristics of the study subjects

Variables	
Age, mean (SD)	48.0 (9.8)
Years of education, mean (SD)	13.9 (2.7)
AUDIT-C, mean (SD)	2.9 (1.7)
Height (cm), mean (SD)	165.0 (5.9)
Weight (kg), mean (SD)	72.9 (14.1)
Waist circumference (cm), mean (SD)	87.7 (12.4)
Sum of the total 7 ideal CVH metrics, mean (SD)	3.6 (1.3)
Smokers, n (%)	97 (13.3)
Body mass index (kg/ m^2), mean (SD)	26.8 (4.9)
Healthy diet, n (%)	258 (35.2)
Sum of diet components (0-5), mean (SD)	2.0 (1.7)
Physical activity at goal, n (%)	290 (39.6)
Blood pressure systolic (mmHg), mean (SD)	131.3 (17.0)
Blood pressure diastolic (mmHg), mean (SD)	85.8 (10.6)
Total cholesterol (mmol/l), mean (SD)	5.3 (0.9)
Triglycerides	1.1 (0.6)
LDL-C	3.0 (0.8)
HDL-C	1.8 (0.5)
HbA1c (%), mean (SD)	5.5 (0.5)
Sum of the total 6 psychosocial risk factors, mean (SD)	1.5 (1.5)
Work ability score, (NRS 0-10), mean (SD)	8.2 (1.2)
Work engagement, (0-6) mean (SD)	
Total	4.8 (0.9)
Vigor	4.8 (1.0)
Dedication	4.9 (1.0)
Absorption	4.7 (1.1)
Self-rated health (1-5), mean (SD)	3.7 (0.9)
Physical capability tests	
Grip strength (kg), mean (SD)	33.0 (6.2)
Standing balance (0-60s), mean (SD)	26.7 (22.2)
Chair rise time for 10 reps (s), mean (SD)	20.5 (4.2)
Walking distance in six minutes (m), mean (SD)	625.7 (70.2)
Time weighted average intensity (MET), mean (SD)	4053.6 (1462.2)

SD; standard deviation, AUDIT-C; Alcohol Use Disorders Identification Test, CVH; cardiovascular health, LDL-C; low-density lipoprotein cholesterol, HDL-C; high-density lipoprotein cholesterol, HbA1c; glycated hemoglobin, NRS; numeric rating scale, MET; metabolic equivalent

5.2 Ideal cardiovascular health

The prevalence of ideal CVH was 1.2% (9/732). There were 183 (25.0%) women having 5-7 ideal CVH metrics, 385 (52.6%) having 3-4, and 164 (22.4%) having only 0-2 ideal CVH metrics. The distribution of the sum of components of ideal CVH is shown in Figure 6. Nonsmoking (86.7%) and normoglycemia (92.5%) were the CVH metrics with the highest ideal prevalence, whereas untreated BP <120/80 mmHg (18.9%) was the most infrequent (Figure 6).

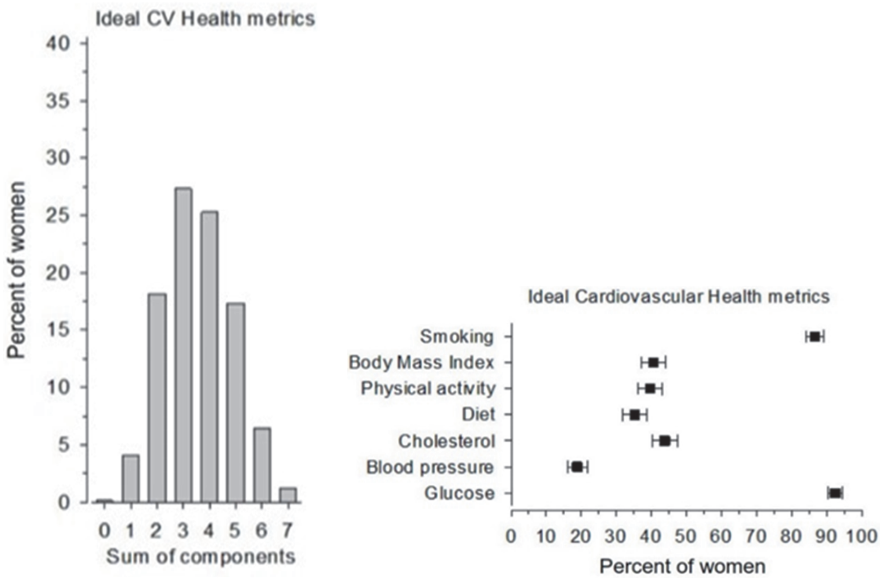

Figure 6. The distribution of the sum of components of ideal CVH metrics and their prevalence individually. *(Modified from the Study I: Veromaa V, et al.* Ideal cardiovascular health and psychosocial risk factors among Finnish female municipal workers. *Scand J Public Health*. 2017 Feb;45 pp. 50-56. Copyright © 2017, © SAGE Publications. *https://doi.org/10.1177/1403494816677661*).

Table 8 shows the characteristics of the participants with 0-2, 3-4 or 5-7 CVH metrics at ideal level. Participants with more ideal CVH metrics were more likely to be younger, more highly educated and financially more satisfied. Also, they were more likely to be cohabiting and had better quality of sleep. Furthermore, the prevalence of diabetes and hypertension was lower with increasing levels of CVH metrics (Table 8).

Table 8. Characteristics of study subjects according to the sum of ideal cardiovascular health metrics.

Variables	**Sum of ideal cardiovascular health metrics**			
	0-2 n=164	3-4 n=385	5-7 n=183	P-value for linearity
Age, mean (SD)	52 (8)	48 (10)	44 (10)	<0.001
Years of education, mean (SD)	13.4 (2.7)	13.9 (2.7)	14.5 (2.6)	<0.001
Financial satisfaction, n (%)	85 (52)	240 (62)	130 (71)	<0.001
Marital status, cohabiting, n (%)	116 (71)	296 (77)	153 (84)	0.005
Good quality of sleep, n (%)	101 (64)	280 (73)	135 (74)	0.037
AUDIT-C, mean (SD)	3.02 (1.81)	2.90 (1.68)	2.79 (1.75)	0.25
Comorbidities diagnosed previously, n (%)				
Diabetes mellitus	15 (9)	10 (3)	2 (1)	<0.001
Hypertension	38 (23)	62 (16)	15 (8)	<0.001
Coronary heart disease	1 (1)	1 (1)	0 (0)	0.46
Depression	4 (2)	10 (3)	2 (1)	0.44
Asthma	7 (4)	25 (6)	8 (4)	0.78
Cancer	1 (1)	5 (1)	5 (3)	0.27
Musculoskeletal disorders	27 (16)	57 (15)	31 (17)	0.81
Gastrointestinal disorders	15 (9)	27 (7)	9 (5)	0.16
Thyroidal disorders	19 (12)	39 (10)	7 (4)	0.023

SD; standard deviation, AUDIT-C; Alcohol Use Disorders Identification Test. *(Study I: Veromaa V, et al.* Ideal cardiovascular health and psychosocial risk factors among Finnish female municipal workers. *Scand J Public Health*. 2017 Feb;45 pp. 50-56. Copyright © 2017, © SAGE Publications. *https://doi.org/10.1177/1403494816677661*).

5.3 Ideal cardiovascular health and psychosocial risk factors (I)

There were 272 (37.2%) women who had none of the assessed psychosocial risk factors. One psychosocial risk factor was reported by 166 (22.7%), 2-3 by 205 (28.0%), and 4-6 by 89 (12.2%). Of the 272 women with none of the psychosocial risk factors, 84 (30.9%) had 5–7 CVH metrics, 136 (50.0%) had 3–4 metrics, and 52 (19.1%) had 0–2 metrics at ideal level. Anxiety (31.3%), work and family stress (30.7%) and type D personality (26.1%) were the most prevalent of the psychosocial risk factors. The prevalence of hostility (20.8%), depressive symptoms (18.7%) and social isolation (17.3%) were the most infrequent (Figure 7).

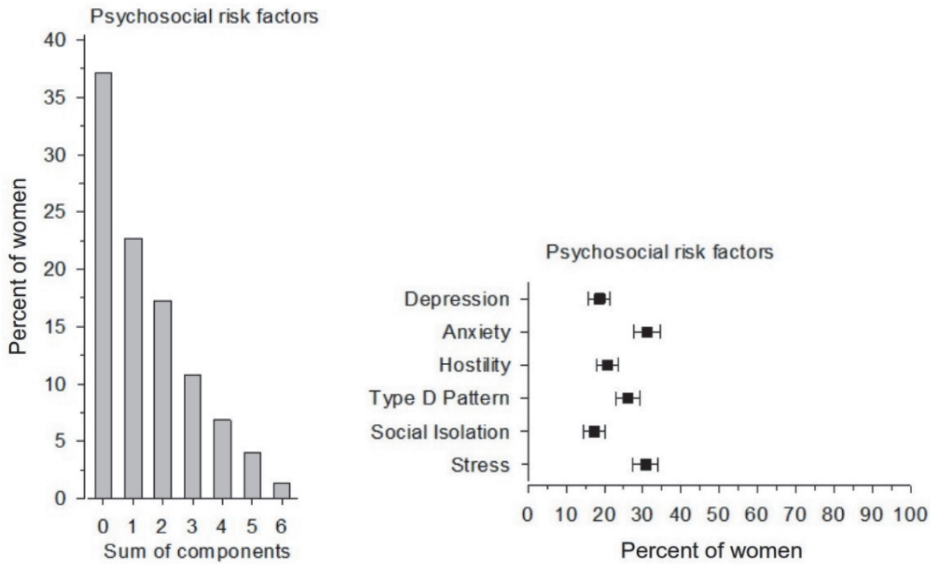

Figure 7. The distribution of the sum of components of psychosocial risk factors and their prevalence individually. *(Modified from the Study I: Veromaa V, et al.* Ideal cardiovascular health and psychosocial risk factors among Finnish female municipal workers. *Scand J Public Health*. 2017 Feb;45 pp. 50-56. Copyright © 2017, © SAGE Publications. *https://doi.org/10.1177/1403494816677661*).

Of the psychosocial risk factors, the prevalence of depressive symptoms and social isolation decreased linearly along with the sum of ideal CVH metrics. After adjustment for age and years of education, the association was statistically significant with depressive symptoms and type D personality, but slightly attenuated with social isolation. Even among the 183 women with 5–7 ideal CVH metrics, 54.1% had at least one psychosocial risk factor (Table 9, Figure 8).

Table 9. Prevalence of psychosocial risk factors by the sum of ideal cardiovascular health metrics.

	Sum of ideal CV health metrics			**P-value for linearity**	
Psychosocial risk factors	0-2 n=164	3-4 n=385	5-7 n=183	Crude	Ad-justed*
Any psychosocial risk factor, n (%)	112 (68)	249 (65)	99 (54)	0.009	0.033
Depressive symptoms, n (%)	44 (27)	74 (19)	19 (10)	<0.001	<0.001
Anxiety, n (%)	53 (32)	126 (33)	49 (27)	0.32	0.31
Hostility, n (%)	33 (20)	85 (22)	34 (19)	0.80	0.97
Type D personality, n (%)	45 (27)	111 (29)	35 (19)	0.12	0.049
Social isolation, n (%)	36 (22)	70 (18)	21 (11)	0.013	0.059
Stress, n (%)	58 (35)	113 (29)	54 (30)	0.21	0.13

* Adjusted for age and years of education. *(Study I: Veromaa V, et al.* Ideal cardiovascular health and psychosocial risk factors among Finnish female municipal workers. *Scand J Public Health*. 2017 Feb;45 pp. 50-56. Copyright © 2017, © SAGE Publications. *https://doi.org/10.1177/1403494816677661*).

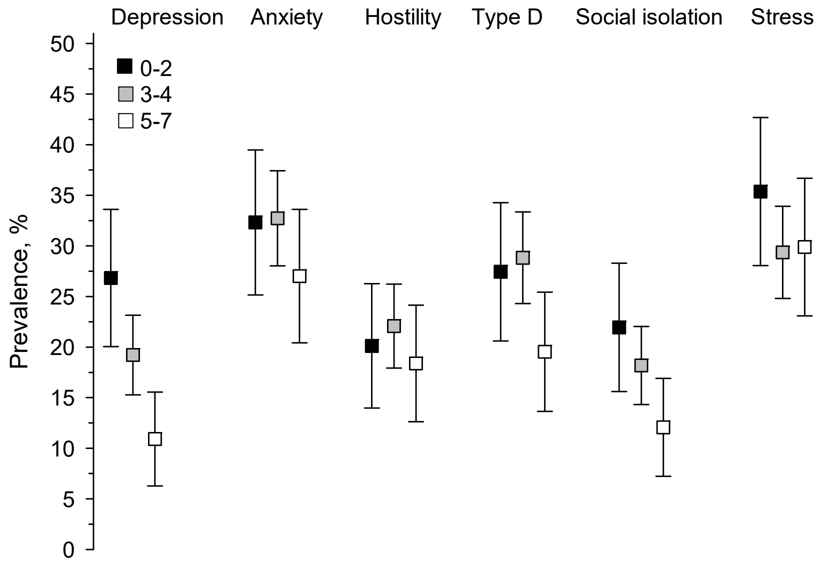

Figure 8. Prevalence of psychosocial risk factors by the sum of ideal cardiovascular health metrics.

5.4 Ideal cardiovascular health, psychosocial risk factors and work engagement (II)

In study II we evaluated 726 female employees, who had completed the work engagement (UWES-9) questionnaire. In Table 10, the characteristics of the study subjects are presented according to the categories of Finnish mean levels of work engagement. The sum of ideal CVH metrics was linearly associated with work engagement driven by the positive relationship of healthy diet and PA. Financial situation, good quality of sleep, and WAS were associated positively with work engagement. The prevalence of any psychosocial risk factor decreased linearly with work engagement (Table 10).

Table 10. Characteristics of the study subjects according to the level of total work engagement.

Variables	Total work engagement				P-value*	
	Low (≤3.43) n=59	Moderate (3.44-4.53) n=151	High (4.54-5.30) n=276	Very high (>5.30) n=240	Crude	Adjusted **
Age, mean (SD)	47 (11)	48 (9)	47 (10)	49 (9)	0.53	..
Education years, mean (SD)	14.0 (2.5)	14.0 (2.6)	14.0 (2.7)	13.7 (2.8)	0.28	..
Financial satisfaction, n (%)	27 (46)	85 (56)	175 (63)	167 (70)	<0.001	<0.001
Marital status, cohabiting, n (%)	43 (73)	111 (74)	231 (84)	180 (75)	0.59	0.55
Good quality of sleep, n (%)	36 (61)	103 (68)	196 (71)	181 (75)	0.019	0.016
AUDIT-C, mean (SD)	2.9 (2.0)	2.9 (1.7)	3.1 (1.6)	2.7 (1.8)	0.55	0.59
Working hours, hours/ week, mean (SD)	41.1 (4.0)	41.2 (3.6)	41.4 (3.9)	41.9 (4.2)	0.12	0.16
Shift work, n (%)	20 (34)	55 (36)	85 (31)	71 (30)	0.20	0.12
WAS, (NRS), mean (SD)	7.2 (1.7)	7.6 (1.4)	8.2 (1.0)	8.8 (0.9)	<0.001	<0.001
Sum of ideal cardiovascular health metrics, n (%)					0.076	0.023
Unfavorable (0-2)	11 (19)	39 (26)	59 (21)	49 (20)		
Intermediate (3-4)	37 (63)	80 (53)	148 (54)	120 (50)		
Favorable (5-7)	11 (19)	32 (21)	69 (25)	71 (30)		
Ideal cardiovascular health metrics, n (%)						
Nonsmoking	48 (82)	142 (94)	237 (86)	208 (87)	0.58	0.34
Body mass index <25.0 kg/m^2	30 (51)	63 (42)	117 (42)	87 (36)	0.050	0.070
Physical activity at goal	21 (36)	48 (32)	110 (40)	111 (46)	0.008	0.006
Healthy diet	16 (27)	45 (30)	90 (33)	107 (45)	<0.001	0.001
Untreated blood pressure <120/80mmHg	12 (20)	23 (15)	52 (19)	50 (21)	0.39	0.22
Untreated total cholesterol <5.17mmol/l	26 (44)	61 (40)	121 (44)	111 (46)	0.39	0.23
Untreated HbA1c <6.0% (<42 mmol/mol)	54 (92)	139 (92)	263 (95)	215 (90)	0.43	0.58
Any psychosocial risk factor, n (%)	50 (85)	107 (71)	169 (61)	134 (56)	<0.001	<0.001
Depressive symptoms	25 (42)	38 (25)	46 (17)	28 (12)	<0.001	<0.001
Anxiety	31 (53)	57 (38)	83 (30)	57 (24)	<0.001	<0.001
Hostility	23 (39)	34 (23)	57 (21)	38 (16)	<0.001	<0.001
Type D personality	30 (51)	48 (32)	67 (24)	46 (19)	<0.001	<0.001
Social isolation	15 (25)	35 (23)	36 (13)	41 (17)	0.047	0.049
Stress	32 (54)	56 (37)	85 (31)	52 (22)	<0.001	<0.001

SD; standard deviation, WAS; work ability score, NRS; numeric rating scale, HbA1c; glycated hemoglobin. * P for linearity ** Adjusted for age and years of education. *(Modified from Study II: Veromaa V, et al. Physical and mental health factors associated with work engagement among Finnish female municipal employees: a cross-sectional study. BMJ Open. 2017 Oct 5;7:e017303). Copyright © Article authors, 2017. http://dx.doi.org/10.1136/bmjopen-2017-017303).*

Figure 9 shows that in subjects without psychosocial risk factors, total work engagement was high and stable (p-value for linearity 0.14) across the range of the sum of ideal CVH metrics. The presence of even one psychosocial risk factor had a negative relationship with work engagement. Linearity between the presence of at least one psychosocial risk factor and work engagement was significant (p <0.001) across the categories of the sum of ideal CVH metrics. The interaction between the presence of psychosocial risk factors and the sum of ideal CVH metrics was not significant (p = 0.79).

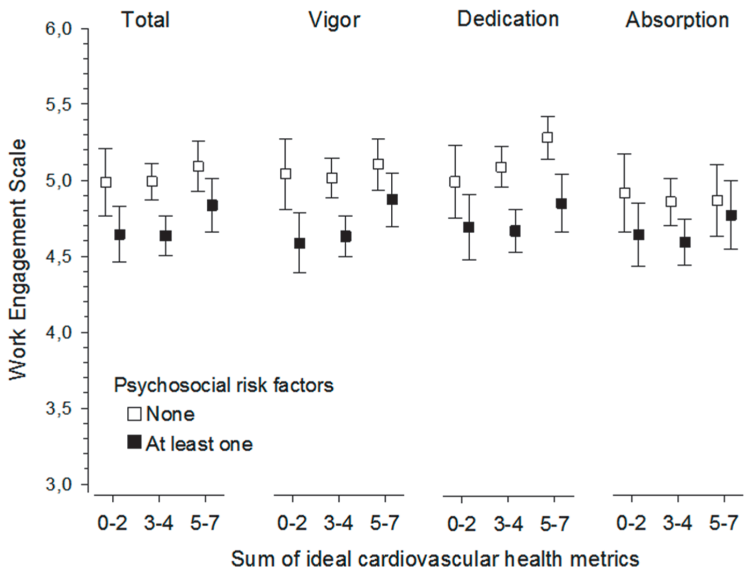

Figure 9. Work engagement and its subscales according to the sum of ideal cardiovascular health metrics and the prevalence of psychosocial risk factors among the female employees. Adjusted for age and years of education. *(Study II: Veromaa V, et al. Physical and mental health factors associated with work engagement among Finnish female municipal employees: a cross-sectional study. BMJ Open. 2017 Oct 5;7:e017303). Copyright © Article authors, 2017. http://dx.doi.org/10.1136/bmjopen-2017-017303).*

In the multivariate linear regression analysis, WAS had a strong positive relationship with work engagement, while age, financial situation, and TC level had a small positive association. BMI, depressive symptoms, hostility, and stress had a small negative influence on work engagement (Figure 10).

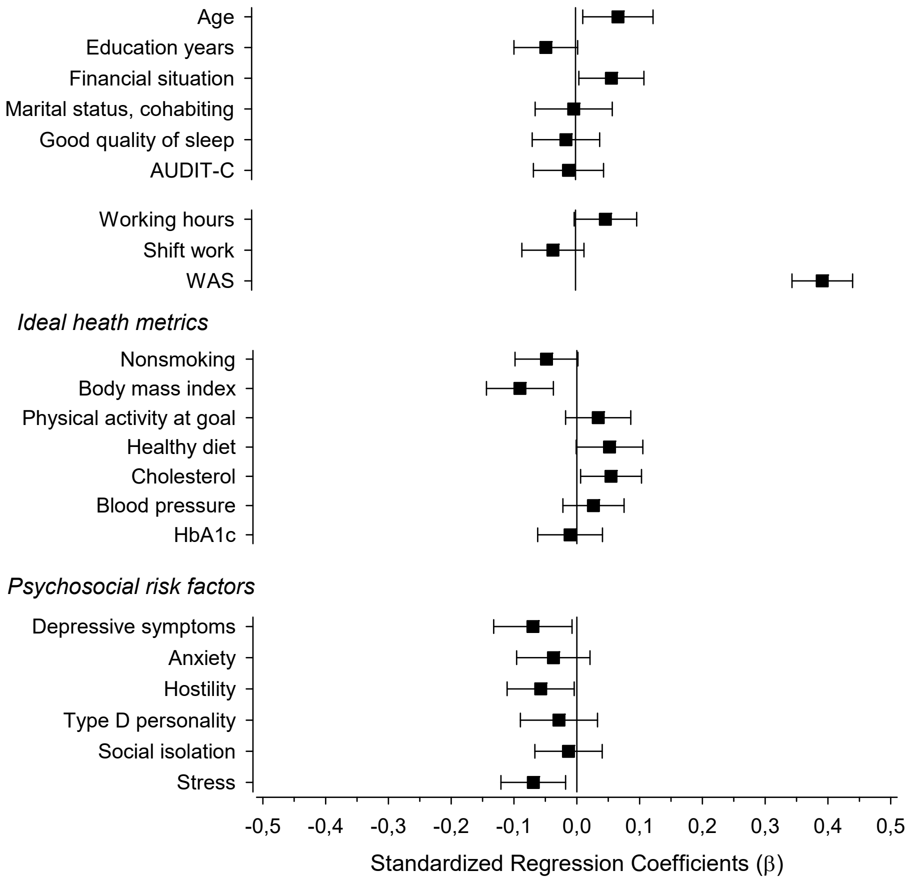

Figure 10. Predictors of continuous work engagement (β-values with 95% confidence intervals) using multivariate regression. *(Study II: Veromaa V, et al.* Physical and mental health factors associated with work engagement among Finnish female municipal employees: a cross-sectional study. *BMJ Open*. 2017 Oct 5;7:e017303). Copyright © Article authors, 2017. *http://dx.doi.org/10.1136/bmjopen-2017-017303*).

5.5 Ideal cardiovascular health and self-rated health (III)

The SRH question was reliably answered by 725 (99%) of the participants. Table 11 shows the characteristics of the subjects according to categories of SRH. Poor or fair health was reported by 209 (28.8%), and good or excellent health by 516 (71.2%) of the subjects. WAS, financial satisfaction, good quality of sleep, lower BMI, healthy diet, lower DBP and HbA1c were associated with better SRH. Presence of any chronic disease, especially diabetes, hypertension, CHD, musculoskeletal disorders and depression, had a negative relationship with SRH (Table 11).

Table 11. Characteristics of the study subjects according to categories of SRH

	Self-Rated Health				
	Poor n=95 (13.1%)	Fair n=114 (15.7%)	Good n= 405 (55.9%)	Excellent n=111 (15.3%)	P- for linearity
Age, mean, (SD)	48.9 (9.3)	48.4 (9.5)	47.8 (10.0)	47.3 (10.3)	0.20
Education years, mean (SD)	13.8 (2.6)	13.9 (2.6)	13.9 (2.8)	14.1 (2.5)	0.46
WAS, (NRS), mean (SD)	6.9 (1.8)	7.9 (1.1)	8.4 (0.9)	8.9 (1.0)	<0.001
AUDIT-C, mean (SD)	2.6 (2.1)	2.9 (1.6)	3.0 (1.6)	2.7 (1.8)	0.50
Financial satisfaction, n (%)	50 (52.6)	61 (53.5)	256 (63.2)	86 (77.5)	<0.001
Good quality of sleep, n (%)	42 (44.2)	72 (63.2)	303 (74.8)	98 (88.3)	<0.001
Cohabiting, n (%)	76 (80.0)	88 (77.2)	322 (79.5)	78 (70.3)	0.20
Body mass index (kg/m^2), mean (SD)	29.0 (5.8)	28.1 (5.0)	26.3 (4.4)	24.8 (4.2)	<0.001
Diet score, mean (SD)	1.7 (1.1)	1.8 (1.2)	2.1 (1.1)	2.2 (1.0)	<0.001
Total cholesterol (mmol/l), mean (SD)	5.4 (0.9)	5.3 (1.1)	5.3 (0.9)	5.1 (0.8)	0.084
Systolic BP (mmHg), mean (SD)	133 (16)	133 (18)	131 (17)	131 (16)	0.17
Diastolic BP (mmHg), mean (SD)	88 (10)	87 (10)	85 (11)	85 (11)	0.007
HbA1c (%), mean (SD)	5.6 (0.5)	5.5 (0.5)	5.4 (0.5)	5.4 (0.3)	0.001
Sum of ideal cardiovascular health metrics, n (%)					<0.001
Poor (0-2)	33 (34.7)	31 (27.2)	81 (20.0)	12 (10.8)	
Intermediate (3-4)	51 (53.7)	65 (57.0)	213 (52.6)	56 (50.5)	
Ideal (5-7)	11 (11.6)	18 (15.8)	111 (27.4)	43 (38.7)	
Comorbidities diagnosed previously, n (%)	77 (81.1)	77 (67.5)	248 (61.2)	38 (34.2)	<0.001
Diabetes mellitus	8 (8.4)	5 (4.4)	13 (3.2)	1 (0.9)	0.033
Hypertension	25 (26.3)	24 (21.1)	58 (14.3)	8 (7.2)	0.001
Coronary heart disease	2 (2.1)	0 (0.0)	0 (0.0)	0 (0.0)	0.004
Asthma	6 (6.3)	5 (4.4)	27 (6.7)	2 (1.8)	0.23
Cancer	0 (0.0)	2 (1.8)	6 (1.5)	3 (2.7)	0.47
Musculoskeletal disorders	30 (31.6)	26 (22.8)	54 (13.3)	5 (4.5)	<0.001
Depression	6 (6.3)	4 (3.5)	6 (1.5)	0 (0.0)	0.008

SD; standard deviation, WAS; work ability score, NRS; numeric rating scale, AUDIT-C; Alcohol Use Disorders Identification Test, BP; blood pressure, HbA1c; glycated hemoglobin. *(Study III: Veromaa V, et al. Self-rated health as an indicator of ideal cardiovascular health among working-aged women. Scand J Prim Health Care. 2017 Dec;35:322-328. Copyright © The Authors, 2017. https://doi.org/10.1080/02813432.2017.1397299)*

Figure 11 shows the distribution of categories of SRH according to the sum of ideal CVH metrics. Most of the subjects with 0-3 of the 7 CVH metrics at ideal level were dissatisfied with their health (Figure 11).

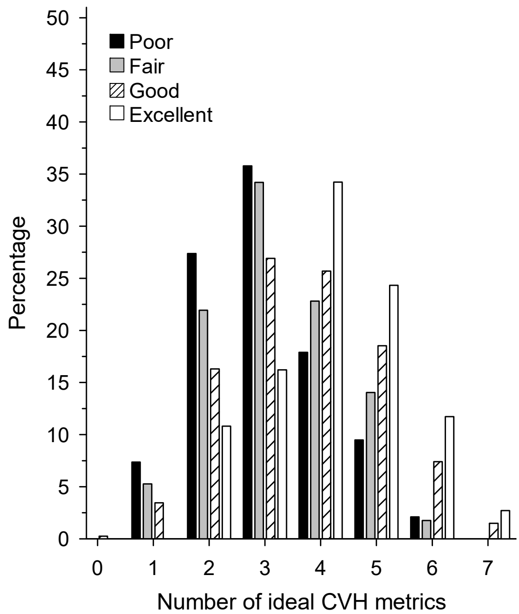

Figure 11. The distribution of categories of self-rated health according to the sum of ideal CVH metrics. *(Study III: Veromaa V, et al. Self-rated health as an indicator of ideal cardiovascular health among working-aged women. Scand J Prim Health Care*. 2017 Dec;35:322-328. Copyright © The Authors, 2017. *https://doi.org/10.1080/02813432.2017.1397299*)

When SRH was evaluated in the poor (0-2 ideal CVH metrics), intermediate (3-4), and ideal (5-7) levels of CVH, a linear decrease in SRH was observed among the subjects with poor and a linear increase in ideal level of CVH. The prevalence of 3-4 health metrics was quite stable across the categories of SRH (Figure 12).

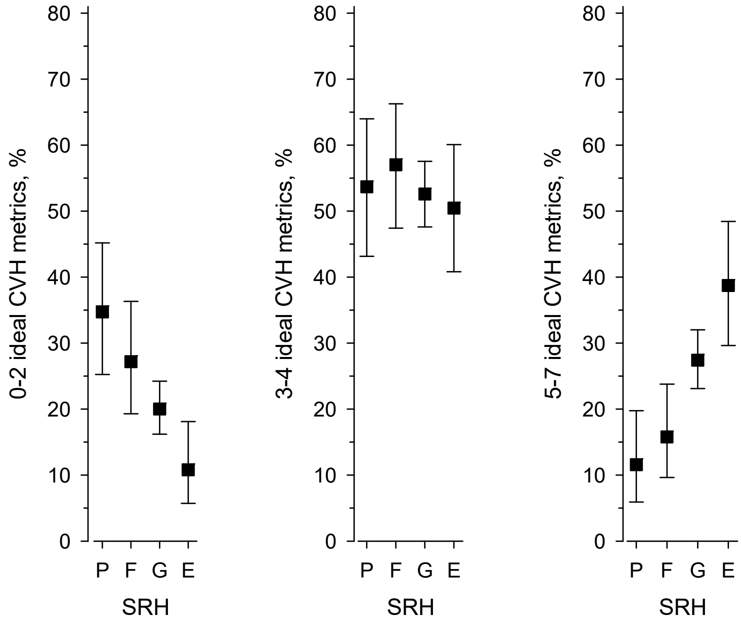

Figure 12. The prevalence of ideal cardiovascular health metrics in self-rated health categories [Poor (P), Fair (F), Good (G), Excellent (E)]. *(Study III: Veromaa V, et al. Self-rated health as an indicator of ideal cardiovascular health among working-aged women. Scand J Prim Health Care. 2017 Dec;35:322-328. Copyright © The Authors, 2017. https://doi.org/10.1080/02813432.2017.1397299)*

Participants satisfied with their health were more likely to have ideal health behaviors and ideal health factors than participants who were dissatisfied with their health. Only ideal BP and glucose levels were not related to SRH in the fully adjusted model (Table 12).

Table 12. Ideal cardiovascular health metrics according to categories of self-rated health

	Self-Rated Health				P- for linearity	
	Poor n=95 (13.1%)	Fair n=114 (15.7%)	Good n= 405 (55.9%)	Excellent n=111 (15.3%)	Crude	Ad-justed*
Health behaviors, n (%)						
Nonsmoking	79 (83.2)	94 (82.5)	358 (88.4)	103 (92.8)	0.011	0.007
Body mass index <25.0 kg/m^2	24 (25.3)	30 (26.3)	177 (43.7)	66 (59.5)	<0.001	<0.001
Physical activity at goal	29 (30.5)	35 (30.7)	163 (40.2)	63 (56.8)	<0.001	<0.001
Healthy diet	25 (26.3)	35 (30.7)	154 (38.0)	44 (39.6)	0.014	0.001
Health factors, n (%)						
Untreated TC <5.17 mmol/l	33 (34.7)	54 (47.4)	177 (43.7)	55 (49.5)	0.088	0.038
Untreated BP <120/80 mmHg	12 (12.6)	18 (15.8)	83 (20.5)	24 (21.6)	0.045	0.24
Untreated HbA1c <6.0%	84 (88.4)	103 (90.4)	374 (92.3)	109 (98.2)	0.009	0.15

BMI; body-mass index, TC; total cholesterol, BP; blood pressure, HbA1c; glycated hemoglobin.
* Adjusted for age, years of education, cohabiting, alcohol consumption and number of chronic diseases *(Study III: Veromaa V, et al. Self-rated health as an indicator of ideal cardiovascular health among working-aged women. Scand J Prim Health Care. 2017 Dec;35:322-328. Copyright © The Authors, 2017. https://doi.org/10.1080/02813432.2017.1397299)*

In multivariate analysis, good/excellent SRH was associated with nonsmoking [odds ratio (OR) 2.00 (95 % CI 1.22 to 3.30)], normal BMI [OR 2.45 (95% CI 1.66 to 3.61)], PA at goal [OR 1.51 (95 % CI 1.05 to 2.17)], and healthy diet [OR 1.52 (95 % CI 1.05 to 2.22)] when adjusted for age, years of education, cohabiting, alcohol consumption and number of chronic diseases (Figure 13).

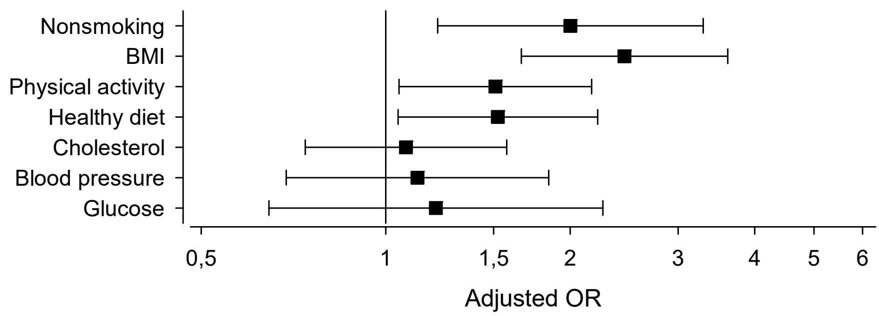

Figure 13. Ideal cardiovascular health metrics as predictors of good/excellent self-rated health. (*Study III: Veromaa V, et al. Self-rated health as an indicator of ideal cardiovascular health among working-aged women. Scand J Prim Health Care. 2017 Dec;35:322-328. Copyright © The Authors, 2017. https://doi.org/10.1080/02813432.2017.1397299*)

5.6 Ideal cardiovascular health and recommended level of aerobic physical activity (IV)

Table 13 shows the characteristics of the study subjects according to categories of AHA's definition of PA. Of the 732 study subjects, 60.4% (442) did not fulfill the ideal criteria of PA. Younger age, lower BMI, financial satisfaction, higher WAS, healthy diet, higher HDL-C, lower TGs, and lower DBP were associated with higher PA. Although low in numbers, the prevalence of depression was higher in the poor PA group. Other comorbidities showed no impact on PA (Table 13).

Table 13. The characteristics of the study subjects according to categories of aerobic physical activity

	Physical activity			
	Poor N=59	Intermediate N=383	Ideal N=290	P for linearity
Age, mean (SD)	50 (9)	48 (10)	47 (10)	0.013
Education years, mean (SD)	13.1 (2.5)	14.0 (2.8)	14.0 (2.6)	0.074
Cohabiting, n (%)	40 (68)	295 (77)	230 (79)	0.094
Body mass index (kg/m^2), mean (SD)	28.2 (5.6)	27.3 (5.1)	25.8 (4.3)	<0.001
AUDIT-C, mean (SD)	2.6 (1.7)	2.9 (1.7)	3.0 (1.8)	0.086
Financial satisfaction, n (%)	28 (47)	231 (60)	196 (68)	0.002
Good quality of sleep, n (%)	39 (66)	270 (72)	207 (71)	0.61
WAS (NRS), mean (SD)	7.8 (1.6)	8.1 (1.2)	8.4 (1.2)	<0.001
Diet score, mean (SD)	1.3 (1.1)	1.9 (1.1)	2.2 (1.1)	<0.001
Plasma lipids (mmol/l), mean (SD)				
Total cholesterol	5.3 (0.9)	5.3 (1.0)	5.3 (0.9)	0.54
HDL-cholesterol	1.7 (0.4)	1.8 (0.5)	1.8 (0.4)	0.017
LDL-cholesterol	3.1 (0.8)	3.1 (0.8)	3.0 (0.8)	0.38
Triglycerides	1.3 (0.6)	1.1 (0.6)	1.0 (0.6)	0.003
HbA1c (%), mean (SD)	5.5 (0.3)	5.5 (0.6)	5.4 (0.4)	0.20
Systolic BP (mmHg), mean (SD)	132 (17)	131 (18)	131 (16)	0.76
Diastolic BP (mmHg), mean (SD)	88 (11)	86 (10)	85 (11)	0.046
Comorbidities, n (%)				0.21
Diabetes mellitus	2 (3)	17 (4)	8 (3)	0.42
Hypertension	12 (20)	54 (14)	49 (17)	0.91
Asthma	3 (5)	24 (6)	13 (4)	0.49
Musculoskeletal disorders	8 (14)	62 (16)	46 (16)	0.82
Depression	3 (5)	10 (3)	3 (1)	0.045

SD; standard deviation, AUDIT-C; Alcohol Use Disorders Identification Test, WAS; work ability score, NRS; numeric rating scale, HDL; high density lipoprotein, LDL; low density lipoprotein, HbA1c; glycated hemoglobin, BP; blood pressure.

Subjects fulfilling the ideal PA criteria were more likely to have also other ideal health behaviors than subjects who were less active. Ideal health factors were not related to PA. BP <120/80 mmHg was reached only by 20 % of those with the ideal PA level (Table 14).

Table 14. Ideal CVH metrics according to categories of aerobic physical activity

Health metric, n (%)	Physical activity			P for linearity	
	Poor N=59	Intermediate N=383	Ideal N=290	Crude	Adjusted*
Health behaviors					
Nonsmoking	42 (71)	332 (87)	261 (90)	<0.001	0.003
Body mass index <25.0 kg/m^2	16 (27)	142 (37)	139 (48)	<0.001	0.002
Healthy diet	10 (17)	123 (32)	125 (43)	<0.001	<0.001
Health factors					
Total cholesterol <5.17 mmol/l	25 (42)	168 (44)	128 (44)	0.84	0.41
Blood pressure <120/80 mmHg	8 (14)	72 (19)	58 (20)	0.32	0.76
Glucose HbA1c <6.0 %	55 (93)	351 (92)	271 (93)	0.59	0.91

HbA1c; glycated hemoglobin. *Adjusted for age, education years and number of comorbidities.

Figure 14 displays the sum of other ideal CVH metrics in categories of PA. Most of the subjects with 4-6 of the total 7 CVH metrics at ideal level had also ideal PA, when adjusted for age, years of education and number of comorbidities. Still, 54 % of those with ideal PA level had only 1–3 additional ideal CVH metrics (Figure 14).

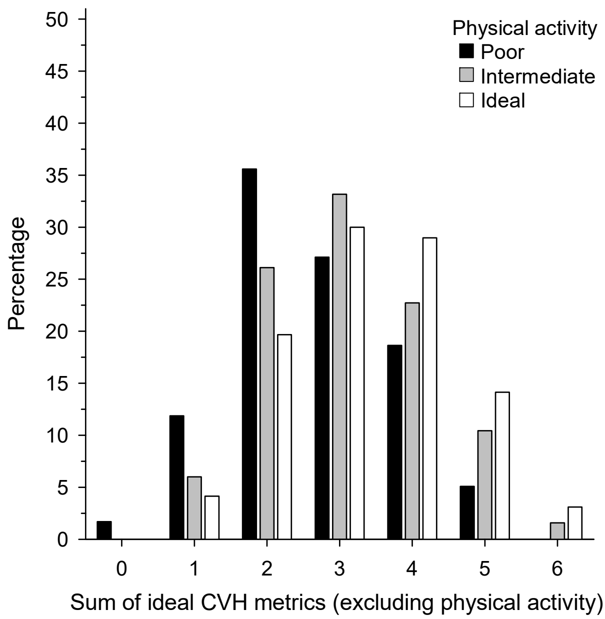

Figure 14. The distribution of categories of aerobic physical activity according to the sum of ideal cardiovascular health metrics (excluding physical activity).

5.7 Ideal cardiovascular health, physical capability and leisure-time physical activity (IV)

All measures of physical capability, except handgrip strength, increased linearly with the categories of PA even after adjustments for age, years of education and number of comorbidities. When also muscle-strengthening and balance activities were taken into account in LTPA, the difference was 3.9 times greater in the ideal than in the poor category of PA. Only in the ideal PA group did the combined score of physical capability reach the mean level of the objective tests of our subjects (Table 15).

Table 15. Physical capability and leisure-time physical activity according to categories of aerobic physical activity

Mean (SD)	**Physical activity**			**P for linearity**	
	Poor N=59	Intermediate N=383	Ideal N=290	Crude	Adjusted*
LTPA, (TWA-MET)	1252 (1097)	3860 (1038)	4844 (1215)	<0.001	<0.001
Physical capability					
Six minutes walking test (m)	571 (84)	617 (68)	648 (61)	<0.001	<0.001
Chair rise test x10 (s)	22 (4)	21 (4)	20 (4)	<0.001	<0.001
Handgrip strength (kg)	33 (5)	34 (6)	34 (6)	0.075	0.16
Standing balance test (s)	19 (19)	25 (22)	31 (23)	<0.001	0.002
Physical Capability Composite Score	-0,23 (0,48)	-0,03 (0,48)	0,09 (0,45)	<0.001	0.001

SD; standard deviation, LTPA; leisure-time physical activity, TWA-MET; time-weighted average metabolic equivalent, m; meters, s; seconds, kg; kilograms. *Adjusted for age, years of education and number of comorbidities.

A linear association of LTPA and combined physical capability was seen with increasing number of ideal CVH metrics. After reaching four ideal CVH metrics both LTPA and physical capability reached the mean scores of the measures (Figure 15).

In multivariate analysis, LTPA was associated with nonsmoking [OR 1.46 (95 % CI 1.16 to 1.83)], normal BMI [OR 1.33 (95% CI 1.13 to 1.56)], healthy diet [OR 1.32 (95 % CI 1.13 to 1.56)], and ideal BP [OR 1.24 (95 % CI 1.01 to 1.51)], when adjusted for age, years of education, cohabiting, alcohol consumption and number of chronic diseases. Furthermore, physical capability was associated with nonsmoking [OR 1.67 (95 % CI 1.01 to 2.76)], and normal BMI [OR 2.08 (95% CI 1.46 to 2.95)] (Figure 15).

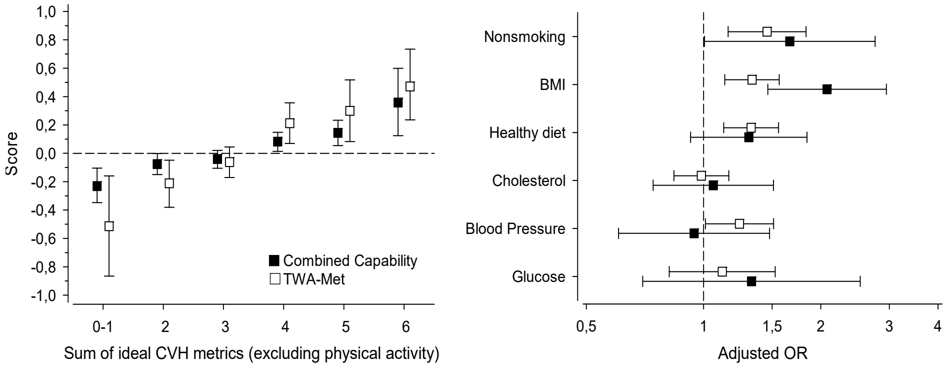

Figure 15. Physical capability (combined score of capability, black square) and leisure-time physical activity (TWA-MET, white square) according to the sum of ideal CVH metrics excluding physical activity (left figure). Ideal cardiovascular health metrics as predictors of leisure-time physical activity (white square) and physical capability (black square) (right figure). BMI; body-mass index, OR; odds-ratio. Linear trends for both $p < 0.001$ (even adjusted). Spearman correlation between TWA-Met and combined score 0.23 (95%: 0.16 to 0.30) $p<0.001$.

6 DISCUSSION

The main results of the study are presented in Figure 16. All 7 ideal CVH metrics were achieved only by 1.2% of the subjects, while 25.0% fulfilled 5-7 of the ideal CVH metrics. Psychosocial risk factors had a negative relationship, while work engagement had a positive relationship with the sum of ideal CVH metrics. The presence of even one psychosocial risk factor had potential to associate negatively with work engagement regardless of the sum of ideal CVH metrics. Our study also revealed the sum of ideal CVH metrics to positively associate with good self-rated health driven by favorable health behaviors (nonsmoking, normal body mass index, healthy diet and physical activity). Moreover, physical capability was related to the sum of ideal CVH metrics, as well as the categories of recommended level of aerobic physical activity.

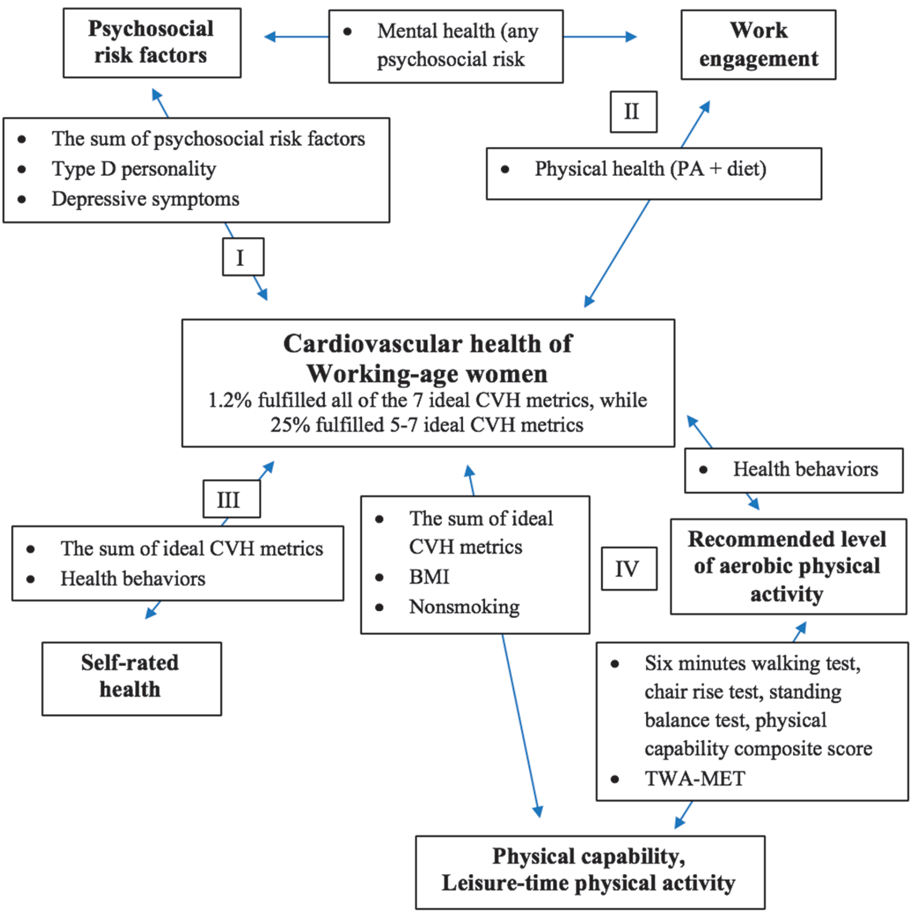

Figure 16. The main findings of this thesis. The roman numerals (I-IV) refer to the original publications. *PA; physical activity, CVH; cardiovascular health, BMI; body mass index.*

6.1 Study population

The participants of this thesis study were from the PORTAAT (PORi To Aid Against Threats) study. This study of CVD and psychosocial risk factors in working adults was a longitudinal study conducted with employees of the city of Pori in the years of 2014 and 2015. This thesis is based on the 2014 cross-sectional data of the study. The aim was to get around 1,000 participants in the study representing many occupational and socioeconomic groups. Due to the common lack of women-focused studies of CVH and because the number of men was so limited in the study population (104/369 males), we decided to focus only on women in this thesis. Even though the participation rate for female employees was only 33.3% (732/2,201 females), the work units involved in the study (library, museums, technical management, social services and health care units) highlight the typical gender distribution of women in municipal work units in Finland. In 2014, 78.1% (5138/6582) of Pori's employees were women (Personnel report of the city of Pori. 2014). Similarly, the mean age and the educational level of the participants were comparable with municipal employees of Pori in 2014. The gender distribution of municipal employees gives us an opportunity to generalize our results to Finnish female employees. Our study population involving relatively young females with typical family and household commitments might potentially increase the risk of psychosocial risk factors and decrease the time available for being physically active compared to those not active in working life. On the other hand, those individuals outside working life due to potential diseases or psychosocial risk factors are not involved in our study, thus limiting the generalization of our results to the general population. However, the working population is the cornerstone of society and as they are still young, our study population consists of potential future CVD patients, if the CVH ideal metrics are minimal. Therefore, for primordial and primary prevention they form an important focus group.

No exclusion criteria were used in the study, but the chief of the municipal welfare unit of Pori chose ten work units that had not participated in any health-promoting program in the last decade. The aim was to get as many participants as possible to the study, given the resources available. No power analysis was done, because this was an epidemiological study and no intervention was included.

6.2 Methods

6.2.1 Assessing the ideal cardiovascular health

The methods of BP, plasma TC and glucose measurements are well standardized. However, the AHA metrics uses fasting plasma glucose <5.6 mmol/l (<100 mg/dL) to determine normoglycemia, but we used B-HbA1c because of its property of giving an indication of glycemia over several preceding weeks rather than at a single time point (Selvin et al. 2007). Normoglycemia was defined as HbA1c <6.0% (<42 mmol/mol) (International Expert Committee 2009).

Of the health behavior methods, BMI measurement is well standardized. In a primary care setting the affordability and usability of self-reported measurements of smoking status, PA and diet are the main reasons for using self-reported questionnaires, even though they may pose a potential limitation. The AHA defines an ideal diet as consumption of fruits and vegetables (≥450 g per day), fish (≥two 100 g servings per week, preferably oily fish), fiber-rich whole grains (≥1.1 g of fiber per 10 g of carbohydrate) (≥three 30 g servings per day), sodium (<1500 mg per day), and sugar-sweetened beverages (≤450 kcal per week). In addition, for secondary metrics AHA uses nuts, legumes, and seeds (≥4 servings per week), processed meats (≤2 servings per week), and saturated fat (<7% of total energy intake). In our study, dietary habits were obtained from a food frequency questionnaire, which did not allow us to get quantitative amounts of the above-mentioned products or their intake measurements. However, the frequency of diet product consumption (fruits, vegetables, white meat, fish and whole grain products) was assessed with a response scale as follows; daily, 3-6 times a week, twice a month, more seldom, or never. The use of unsaturated dietary fats was estimated on the basis of the consumption of fat-free milk products, cheeses, red meat, sausages and chips. A dietary score of 4–5 was set as ideal and required daily consumption of fruits, vegetables, whole grains, unsaturated dietary fats, and white meat (poultry, fish) at least three times a week (one point for each dietary component).

6.2.2 Psychosocial risk factors

The psychosocial risk factors were assessed by core questions suggested by the European 2012 guidelines on CVD prevention in clinical practice (Perk et al. 2012). These questions are not validated, and they only indicate a likely psychosocial risk factor. Answering ´yes´ to one of these questions does not imply that the person actually has a risk factor; e.g. not all people living alone are socially isolated. In order to diagnose a disease (e.g. depression) the use of longer and validated questionnaires, together with the doctor-patient relationship, are suggested. However, giving an affirmative answer to either one of the two core questions on depression used in the present study, has been shown to be as effective as using longer screening instruments (Whooley 2016).

6.2.3 Work-related factors

The 9-item Utrecht Work Engagement Scale (UWES-9) was used to assess work engagement (Schaufeli et al. 2006). This scale is a validated instrument and even has its own Finnish reference values (Hakanen 2009). Also, the single-item question of Work Ability Score (WAS) is derived from the validated Work Ability Index (Ilmarinen 2006). WAS has a strong association with the Work Ability Index and is trustworthy in evaluating work ability (El Fassi et al. 2013).

6.2.4 Self-rated health

The single-item question on self-reported health and its response scale are premised on the World Health Organization's Quality of Life questionnaire (WHOQOL-BREF) (Harper and Power 2017). Even though the wording and scale of the one-item assessment of SRH vary across surveys, it has shown to be reliable and valid (Idler and Benyamini 1997; Lundbergls and Manderbacka 1996).

6.2.5 Leisure-time physical activity and physical capability

PA was assessed with a self-administered questionnaire with six items based on the type, intensity, frequency and duration of PA. From the questionnaire the level of aerobic PA and LTPA were calculated. Participants were instructed to report all weekly physical activities that lasted longer than 10 minutes. This assessment method sets a limitation, because PA measured objectively with an accelerometer has been found to be much lower than self-reported PA (Troiano et al. 2008).

Trained physiotherapist students conducted the physical capability measures. The four objective measures: grip strength, chair rise test, standing balance test, and six minutes' walking test comprise the concept of physical capability (Cooper et al. 2014; Kuh et al. 2014). The concept is not validated, but widely used as a mixed combination among older individuals to evaluate physical performance. Each of the tests is also individually validated for younger adults. In Finland, the chair rise test and grip strength were studied in the FinHealth 2017 study with the mean results presented for each 10-year age group from the age of 30 years (Koponen et al. 2018). Also, the six minutes' walking test and standing balance time were evaluated in a previous Finnish population-based Health 2011 Study with the mean scores presented in the age groups of 30-44, 45-54 and 55-64 years (Koskinen et al. 2012).

6.3 Results

6.3.1 Prevalence of ideal cardiovascular health in women

Of our 732 study subjects (age from 19 to 66 years, mean age 48 ± 10 years) only 1.2% reached all seven ideal CVH metrics, while 25% had 5-7 CVH metrics at ideal level. Moreover, 52.6% of the women had 3-4 ideal CVH metrics, and 22.4% had 0-2 ideal CVH metrics. Although the prevalence of ideal CVH metrics is strongly dependent on the age of the population studied, our results are quite comparable to those reported in the US and in Europe (Kim et al. 2013; Yang et al. 2012). In a Spanish study, 19% of adult women (≥18 years) had 5-7 ideal CVH metrics (Graciani et al. 2013). Overall, in a recent systematic review article including studies from the years 2010 to 2015, the prevalence of ideal CVH (defined as 5-7 ideal CVH metrics) was 5-35% among US studies. In studies conducted in Korea, China, Spain, India, Iran, Bosnia/Herzegovina, and Ecuador, a prevalence of 9-43% was reported (Younus et al. 2016). The low prevalence of ideal CVH is unfortunate, since with ideal CVH (5-7 ideal metrics) the risk of CVD death was 63% (HR 0.37; 95% CI, 0.15-0.95) lower compared to those with poor ideal CVH (0-2 CVH metrics) (Artero et al. 2012). Also, the ideal CVH is related to lower all-cause mortality, and lower incidence of CVDs (Folsom et al. 2011; Guo and Zhang 2017). Moreover, a better understanding of ideal CVH is important since the concept is becoming more commonly used as a metric to guide population-wide progress in improving CVH in many countries.

Female sex and lower age are associated with better ideal CVH metrics. For example, in the US, 21% of females had ≥5 metrics at ideal levels compared to 13% of males (Benjamin et al. 2018). The same phenomenon was seen in a Finnish study in 2007, where 9% of women and 3% of men aged 25–74 years had ≥5 ideal health metrics (Peltonen et al. 2014). Our study population's better scoring on the ideal CVH is most likely explained by the younger study population and by the selection bias with only female employees included in the study. Also, the low participation rate of the study sets a potential bias and it might be speculated that only apparently healthy individuals participated. Low education level and low socioeconomic status have been shown to associate with lower ideal CVH scores (Caleyachetty et al. 2015; Janković et al. 2014a; Olsen et al. 2014). Also, in the present study, the prevalence of ideal levels of CVH metrics increased linearly with the years of education and financial satisfaction. Our study subjects were all working-aged women with permanent jobs, and thus, their CVH may be better than in subjects outside the active work force even despite the fact that the education system in Finland is proven to be excellent and everyone goes through a 9-year compulsory education.

In 2012, Huffman et al (2012) estimated, according to the trends from NHANES data from 1988 to 2008, that the CVH of the US population will improve by only 6% between 2010 and 2020, which is nowhere near the goal of a 20% increase (Huffman et al. 2012). The prevalence of obesity and hyperglycemia are offsetting the good influence of the declining prevalence of smoking, high cholesterol, and high BP (in males) (Huffman et al. 2012). In a US study nonsmoking and normal BMI in young adulthood were the most protective metrics against the loss of an ideal CVH profile through middle age (Gooding et al. 2015). Willis et al. have estimated that individuals in midlife with 5–7 ideal CVH metrics exhibited 25% lower median annual non-CVD costs and 75% lower median CVD costs in old age than those with 0–2 ideal CVH metrics (Willis et al. 2015).

In the present study, normoglycemia (93%) was the most frequent ideal CVH metric. Despite the fact that we used an even more strict cut off point of HbA1c, <6.0% (<42 mmol/mol), this finding is in line with the FinHealth 2017 Study (Koponen et al. 2018). In Finland, the mean prevalence of T2D (diagnosed by a physician, HbA1c ≥ 6.5% (<48 mmol/mol), fasting glucose ≥ 7.0 mmol/l) in adult women is 10%, but in an age group of 30-60 years the prevalence is only 4.1% (Koponen et al. 2018). For the first time in decades, no increase in the prevalence was seen from 2011 to 2017, which reflects a positive development. This plateaued phase is important, because women with T2D are linked with more adverse changes in CV risk compared to men, even in the pre-diabetic phase (Donahue et al. 2007; Haffner et al. 1997).

In our study, nonsmoking had the second highest ideal prevalence of 87% among our participants. According to a recent systematic review including 29 studies from the US, Italy, Finland, China, Luxembourg, Korea, India, Spain, Iran, Bosnia/Herzegovina and Ecuador, ideal smoking status has been the easiest to fulfill with a prevalence ranging from 29 to 98%, with only 4 studies reporting prevalence for ideal smoking status of less than 50% (Younus et al. 2016). Similarly to our results, in 2017, 11% of Finnish women over 30 years were smoking daily and 5% occasionally. Furthermore, 3% of adult women were exposed to secondhand smoke for at least an hour a day (Koponen et al. 2018). There was a favorable trend, since the prevalence of daily smokers decreased from 18% in 2011 to 13% in 2017 among working-age women (30-64 years). This is gratifying, because smoking has been proved to be a more potent risk factor of CVD among women than men (Huxley and Woodward 2011).

The decrease in TC level is one of the major reasons for the decrease in CHD levels in Finland (Jousilahti et al. 2016). Importantly, every 1.0 mmol/l reduction in the main carrier of cholesterol (LDL-C) decreases the risk of CVD mortality by 20-25% (Cholesterol Treatment Trialists' (CTT) Collaborators et al. 2012). A small positive shift towards lower cholesterol levels was seen in the FinHealth 2017 Study from 2011 to 2017. Still, 60% of adult Finnish women have a TC over the recommended level of 5.0 mmol/l, and 53% have LDL-C over the limit of 3.0 mmol/l (Koponen et al. 2018), which well reflects the ideal level of TC (< 5.17 mmol/l) reached by 44% of our study subjects. Overall, the worldwide decrease in cholesterol levels in recent years appears to be caused by a greater use of cholesterol-lowering medications rather than changes in dietary patterns (Ford and Capewell 2013).

Furthermore, obesity (BMI ≥30kg/m^2) is one of the key public health problems with increasing prevalence. This is seen also in our study, while the prevalence of normal weight individuals was 41%, which is a slightly better result than the 36% of adult women from the recent FinHealth 2017 Study. Unfortunately, among working-age women the prevalence of obese individuals rose from 22% in 2011 to 26% in 2017. The mean BMI was 27.5 kg/m^2 among women (Koponen et al. 2018), quite similar to our subjects' 26.8 kg/m^2 (SD 4.9). BMI is strongly related to risk factors of CVD and CVD outcomes (Emerging Risk Factors Collaboration et al. 2011). Also, the recommended level of aerobic PA was achieved only by 39% of our subjects, but by nearly 55% among working-age women in the FinHealth 2017 Study (Koponen et al. 2018). According to a recent survey, leisure-time PA has increased, but occupational PA and commuting PA has decreased in recent decades in Finland (Borodulin et al. 2016).

Ideal diet seems to be the hardest ideal health metric to achieve worldwide (Younus et al. 2016). The prevalence of ideal diet ranged from 0% to 39% in the US studies, while non-US studies reported a 2-76% range in the prevalence of ideal diet. However, only four studies reported a prevalence of over 35%, while 14 reported a prevalence of ideal diet of less than 10% (Younus et al. 2016). Surprisingly, in our study population the prevalence of ideal diet was high (35.5%) compared to other worldwide studies (Younus et al. 2016). However, during the national follow-up from 2011 to 2017, the consumption of fruits and vegetables, as well as the use of plant-based oils, decreased among working-age Finnish women (Koponen et al.

2018). The difference is mostly due to different diet habit measurements. The food-frequency questionnaire used in our study is not appropriate to calculate quantities or intakes of consumed food products. The estimation of five different nutrition categories (fruits and vegetables, fish, fiber-rich whole grains, sodium, and sugar-sweetened beverages) by their frequency of consumption potentially over- or underestimates the real use of these products. Furthermore, compared to other ideal CVH metrics the healthy diet defined by AHA is hard to measure and reach, because four out of five categories have to be achieved to make it ideal. Partially, the difference could be explained by Finnish workplace lunch canteens, which serve home-cooked meals (used by nearly half of employees (Koponen et al. 2018)) and that the invasion of fast-food companies has been slower in Finland than in the US.

Untreated BP <120/80 mmHg was the most infrequently achieved ideal CVH metric in our study subjects with a prevalence of only 19%. Currently, in Finland, every other adult woman has either hypertension (≥140 SBP or DBP ≥ 90 mmHg) or treatment for it and the prevalence rises steeply with age. Among Finnish working-age women the mean levels of BP were 127 mmHg SBP and 79 mmHg DBP in 2017 (Koponen et al. 2018), while in this study the BP means were even higher (131/86 mmHg). Compared to other Europe countries these numbers are high (Zhou et al. 2017) and hypertension remains relatively common in Finland. AHA defines ideal BP as low as <120/80 mmHg, whereas in the FinHealth 2017 Study the lowest category of BP was set at <130/85 mmHg, which still only 44% of adult women achieved (Koponen et al. 2018). Thus, BP levels are the subject of a constant global debate as to what is the optimal BP level. The AHA and the American College of Cardiology recently lowered the BP treatment target to as low as 130/80 mm Hg and recommended the definition of hypertension to be SBP ≥130 mm Hg or a DBP ≥80 mm Hg (Whelton et al. 2018). This is partially based on the findings of 25% lower relative risk of fatal and nonfatal major CVD events and death from any cause in an intensive treatment group (goal SBP < 120mmHg), the SPRINT Study (SPRINT Research Group et al. 2015). However, the changing guidelines represent a 14% increase in the prevalence of hypertension in the US (46% versus 32%) (Muntner et al. 2018). In the European hypertension guidelines published in August 2018, hypertension is defined as office SBP values ≥140 mmHg and/or DBP values ≥90 mmHg (Williams et al. 2018).

To conclude, ideal CVH seems to be a good concept to evaluate and to follow the changes in CVH of different populations worldwide, while taking into account all traditional risk factors of CVD. However, the concept seems to set quite unrealistic goals for BP and diet to be achieved for the time being. This implies that primordial prevention should be started already in childhood, and that policy makers, healthcare systems, food industries, and civil society are responsible for creating a healthy environment in which populations can make healthy choices easily.

6.3.2 Ideal cardiovascular health and psychosocial risk factors (I)

In this study, we demonstrated that the presence of psychosocial risk factors associates negatively with the sum of ideal CVH metrics. Especially depressive symptoms and type D personality decreased the sum of ideal CVH metrics linearly. Also, social isolation showed the same trend, but was not statistically significant after adjustments for age and years of education. Almost two out of three of our study subjects had at least one of the six psychosocial risk factors, with anxiety and stress being the most frequent and the presence of social isolation being the least prevalent. Importantly, women without any psychosocial risk factors (37%) had a 31% prevalence for ideal CVH (defined as 5-7 ideal CVH metrics), while the prevalence was 22% for those having even one psychosocial risk factor.

Previously, only one Chinese study has investigated the relationship between ideal CVH together with multiple psychosocial risk factors (stress, anxiety and depression). Zeng et al (2013) found in their 9,962 middle-age population (mean age 47.1 years, 44% females) a negative correlation between psychosocial risk factors (the 21-item Depression Anxiety Stress Scales was used) and ideal CVH after adjusting for sex, age, education and occupation in multivariable regression analyses (Zeng et al. 2013). Nevertheless, only the associations of ideal CVH and depressive symptoms have been studied on a larger scale. In a French Paris Prospective Study III (n=9,417, mean age 59.6 years, females 39%), a high level of depressive symptoms (using antidepressants or scoring ≥7 on the 13-item Questionnaire of Depression 2nd version) was estimated to lead to 30% decreased likelihood of ideal CVH (5-7 ideal CVH metrics) (Gaye et al. 2016). Also, a US study (n=5,110, 20% females) turned the hypothesis around and showed a 36% decreased odds for depressive symptoms (assessed with 10-item Center for Epidemiologic Studies) with ideal CVH compared with the 0-2 ideal CVH group (España-Romero et al. 2013). Furthermore, Kronish et al (2012) (n=20,093, 56% females) showed depressive symptom severity to correlate with lower scores on ideal CVH (Kronish et al. 2012). In these previous studies there has been a stronger correlation between depressive symptoms and health behaviors than biological factors (like BP, blood glucose or cholesterol levels) (España-Romero et al. 2013; Gaye et al. 2016; Kronish et al. 2012).

Similarly to the previous studies, our study found a negative association with depressive symptoms and ideal CVH, even though we evaluated the association only by the sum of ideal CVH metrics. Given the fact that depression is proved to strongly predict both incident and recurrent CHD among women, the results are not surprising (Low et al. 2010). However, the link already existing between the risk factors of CVD and just two symptoms of depression gives an opportunity to intervene before one or the other changes into clinically manifest disease. Also, the proved link between depression and poor health behaviors and non-adherence to medications possibly largely explains the association (Cohen et al. 2015). Given the nature of our study, the potential biological mechanisms (autonomic nervous system, platelet function, coagulation factors, pro-inflammatory cytokines, endothelial function, neurohormonal, and genetic) for the relationship between depressive symptoms and CVD could not be investigated. Partially, the comorbidity between depression and other psychosocial risk factors (especially with anxiety, social isolation and type D personality) could also be a potential mechanism in this association. The prevalence of depressive symptoms was 19% among our subjects. The nationally representative FinHealth 2017 Study asked the same two depression core questions as we did with results indicating the same prevalence as ours (Koponen et al. 2018). Among working-age women, 23% had felt themselves down, depressed and hopeless for at least two weeks in the previous 12 months, and 20% had lost interest and pleasure in life for at least two weeks in the same time period. Both questions were answered positively by 14% of women (Koponen et al. 2018). In the same study, women had more depressive symptoms than men (12% prevalence in men with core questions) and the unfortunate trend of increasing depressive symptoms was prevalent from 2011 to 2017 (6-item version of Beck Depression Inventory (BDI-6): men from 6% to 9%, and women from 9% to 13%) (Koponen et al. 2018). Only 2% of the women in our study had previously diagnosed depression compared to the prevalence of 8% reported in the FinHealth 2017 Study, but it is noteworthy that we evaluated subjects active in working life. Depression is one of the most disabling single conditions (Wittchen et al. 2011) and, thus, depressive subjects may have dropped out of working life or may have ignored the invitation to the study. The fact that the depressive symptoms are becoming more common indicates that we need to focus more precisely on promoting early recognition and treatment of depression.

No previous studies were found reporting the associations between ideal CVH and hostility, type D personality, or social isolation. In our study, type D personality associated negatively with the sum of ideal CVH metrics. This finding is supported by the fact that type D personality is linked to incident (Nabi et al. 2008) and recurrent CVD (O 'Dell et al. 2011), as well as to a poorer outcome of CVDs (Denollet et al. 2010) in previous studies. Furthermore, the association is probably explained by the shared pathophysiology of depression and this personality trait. The core questions asked for depression inquire about patients' mood and experience of anhedonia in the previous two weeks, while for type D personality the questions are: 'In general, do you often feel anxious, irritable or depressed' and 'Do you avoid sharing your thoughts and feelings with other people?'. The questions are quite similar and show features of depression in this particular personality type. Thus, D means "distressed", and negative feelings (negative affectivity) and avoiding social contacts (social inhibition) are the main features of this personality type (Perk et al. 2012). The prevalence of type D personality was 26% in our study population, which is comparable to a study of 3,678 subjects among whom the prevalence of type D personality was 21% in the general population, 28% in CHD patients, and 53% in hypertensive subjects (Denollet 2005). In the light of this study, there might be a link between our findings of BP being the most infrequent ideal CVH metric and the quite high prevalence of type D personality. Also, other psychosocial risk factors, anger, depressive symptoms, and stress, have been shown to associate with increasing BP levels (C. Ford et al. 2016).

Furthermore, a linearly decreasing association was found between social isolation and ideal CVH, even though it was not statistically significant after adjustments (p=0.059). To add credit to this finding there was also a statistically significant linearly increasing association between the sum of ideal CVH metrics and cohabiting (p=0.005). Social isolation has been suggested to associate with as much as 50% increased risk of CVD events (Cohen et al. 2015), but the evidence is mixed and also null findings of the association have been published (Kuper et al. 2006; Low et al. 2010). The Women's Lifestyle and Health Cohort Study included 49,259 women from Sweden (aged 30–50 years) and it found that social support at work and at home did not affect CHD risk. We are dealing worldwide with a major change in living circumstances with the number of single-households rising, which could affect population health in a way that we have not even considered. Thus, the 16% of 30-60-year-old women living on their own in Finland, which is similar to our 17% prevalence of social isolation, does not mean that they are necessarily lonely and at risk of CVD. More worrying is the fact that according to the FinHealth 2017 Study, 9% of adult women had no close confidant, and 8% felt themselves lonely constantly or frequently (Koponen et al. 2018). Researchers using the NHANES data showed that severe loneliness almost doubled the CHD risk in women but not in men, even after adjustments for age, race, education, income, marital status, hypertension, T2D, TC, PA, smoking, alcohol use, SBP and DBP, BMI, and depressive symptoms (Thurston and Kubzansky 2009). In order to recognize social isolation, the core questions used in our study might be more appropriate than asking about a person´s cohabiting status.

Our findings demonstrate new information about psychosocial risk factors studied in a “package”. We showed that psychosocial factors are common and over a half of those with ideal CVH still had at least one psychosocial risk factor. The studies with ideal CVH and psychosocial risk factors are scarce, and every study has used a different assessment tool for the evaluation of psychosocial risk factors, so comparison of the studies is challenging. While psychosocial risk factors have been shown to contribute to the development and adverse outcome of CHD, more longitudinal research is needed in this inspiring study field aiming at primordial and primary prevention of CVDs.

6.3.3 Ideal cardiovascular health, psychosocial risk factors and work-related factors (II)

This study demonstrates that physical health is positively associated with work well-being driven by the positive relationship of a healthy diet and PA with work engagement. However, even just one of the measured psychosocial risk factors had a negative association with the level of work engagement regardless of the sum of ideal CVH metrics.

Our study represents new information, since no studies on ideal CVH's relationship with work engagement or work ability were found with a literature search by November 2018. Only Leijten et al. have previously linked higher work engagement with better physical health (Leijten et al. 2015), which is in line with our findings. Furthermore, they showed that during the one-year follow-up a higher physical load at the workplace and higher psychological job demands were related to poorer physical health, and that higher psychological job demands and lower support were related to poorer mental health after adjustments for age, gender, educational level, all work-related factors, work engagement, all interaction terms, and baseline health. However, their study population involved nearly 9,000 45-64-year-old Dutch employees, whose physical and mental health were studied only with twelve self-reported questions, whereas the ideal CVH metrics take into account several objective measures of physical health. Therefore, our study is the first to report an association between physical health and ideal CVH. Work plays a relevant role in society, and relationship between work well-being and health are important, whether the associations are bidirectional or not. Thus, organizations need engaged employees rather than just "healthy" employees to survive in today's rapidly changing work environment.

Our finding that psychosocial risk factors have a negative association with work engagement is similar to previous studies reporting that employees with better work engagement have lower levels of stress, anxiety and depression (Hakanen and Schaufeli 2012; Hakanen et al. 2008; Hallberg and Schaufeli 2006; K. Imamura et al. 2016; Schaufeli et al. 2008; Shimazu et al. 2012).In particular, vigor, characterized by energy, mental resilience, the willingness to invest one's effort and persistence (Schaufeli et al. 2002), was linked to decreased depression and anxiety in a Norwegian two-year follow-up study of 3,475 employees (mean age 42 years) (Innstrand et al. 2012). Likewise, better work engagement negatively predicted depressive symptoms and increased life satisfaction among Finnish dentists (n=3,255) in a seven-year prospective study (Hakanen and Schaufeli 2012). Due to technological developments, the nature of work in developed countries has become less physical but more demanding mentally and emotionally, as work pace and stress have increased (Baumann et al. 2010). These changes in daily working life may contribute to adverse health effects, including mental health problems and body weight gain (Baumann et al. 2010). However, work can also contribute in a positive way to mental health, providing psychological development, social contacts, a purpose in life and an increase in self-esteem and quality of life (Baumann et al. 2010). In addition, the concept of work engagement represents more equivalently mental health than the concept of ideal CVH referring to physical health, so that the associations between mental health and work engagement may partially be explained by a common source bias.

Compared to Finnish reference values (Hakanen 2009), work engagement in our subjects was high and stable. It is unclear, however, which lifestyle-related efforts could increase work engagement. Enhancing PA and fruit intake did not improve work engagement in a work-place health promotion program (Strijk et al. 2013), even though these were the ideal CVH metrics associated with work engagement in the present study. Our finding of an association between quality of sleep and work engagement has also been established by Hallberg et al. (Hallberg and Schaufeli 2006), who showed that poor sleep hygiene decreases work engagement. Even though physical health is rarely studied with work engagement, psychological studies have shown many potential factors that increase work engagement, such as social support, innovativeness, appreciation (Bakker et al. 2007), and job control (Mauno et al. 2007). Likewise, job resources (autonomy, supervisory coaching, performance feedback) and personal resources (optimism, self-efficacy, self-esteem) have been found to best predict work engagement (Bakker et al. 2008). Engaged employees often experience positive emotions, which might reflect personal accomplishments, psychological well-being and mental resources linked to work engagement (Kanste 2011).

Similarly, Airila et al (2014) also demonstrated that better job resources (supervisory relations, interpersonal relations, task resources) and self-esteem were related to increased work engagement and work ability (Airila et al. 2014). In our study subjects, WAS was strongly associated with higher work engagement (7.2 vs 8.8). This supports previous studies showing that work engagement has a positive influence on working ability (Airila et al. 2012, 2014; Rongen et al. 2014). It seems that work engagement is more dependent on mental aspects, whereas work ability also involves the subject's physical condition. Our result still has to be interpreted with caution, because the relationship can also be bidirectional.

At an organizational level, occupational and primary health care should actively seek for psychosocial risk factors, but also focus on enhancing a healthy lifestyle, i.e. factors proven to have a positive relationship with work engagement. Thus, the use of the ideal CVH concept could be of practical use in this matter. To increase work engagement at an individual level it seems that the simplest rule is to eat healthily, exercise at a moderate-to-vigorous level, focus on social life and embrace a positive attitude.

6.3.4 Ideal cardiovascular health and self-rated health (III)

This study demonstrates that the sum of ideal CVH metrics is positively associated with good SRH. This connection is driven by the positive relationship of health behaviors (nonsmoking, normal BMI, healthy diet and PA).

To the best of our knowledge, only two studies have evaluated the relationship between SRH and ideal CVH with results being similar to ours. In the US among 7,115 individuals from the NHANES study from 2001 to 2010 those with ideal CVH were 71% less likely to rate their general health status as fair/poor than those with poor ideal CVH (Allen et al. 2015). In this study also higher quality of life, and fewer physically and mentally unhealthy days each month were associated with better ideal CVH. Moreover, a study population of 10,687 participants (45-64 years) from south-east Poland had a graded association with better ideal CVH and higher SRH. Among participants rating SRH ≥ 7 on a scale of 1-10 were more likely to have PA at goal, normal weight, and normal BP and glucose compared to participants with lower ratings of SRH (Manczuk et al. 2017).

As with our results, health behaviors' positive associations with SRH are confirmed in many previous studies (Allen et al. 2015; Harrington et al. 2010; Kwaśniewska et al. 2007; Mood 2013; Yamada et al. 2012). In a Polish study of 1,222 people (52% female, aged 20-64 years) non-smoking, regular fruit and vegetable intake, healthy weight, and adequate PA were positively associated with SRH. In those achieving only 3, 2, 1, or 0 of the studied health behaviours, poor/fair SRH was almost three (OR = 2.89; 95% CI: 1.5-5.56), four (OR = 3.61; 95% CI: 1.88-6.93), six (OR = 5.93; 95% CI: 2.88-12.21) and seven times (OR = 6.67; 95% CI: 1.97-22.51) as high as in those with all four health behaviours at target level (Kwaśniewska et al. 2007). Thus, according to the US Behavioral Risk Factor Surveillance System study of over 400,000 adults the more healthy the behaviors the better the SRH (Tsai et al. 2010).

Also, we observed that individually all of the ideal CVH behaviours were linked to better SRH, while health factors were not. In previous studies, smoking (Harrington et al. 2010; Kwaśniewska et al. 2007; Mood 2013; Tsai et al. 2010) and overweight (Kwaśniewska et al. 2007; Tsai et al. 2010) have been linked negatively to poor SRH. Furthermore, poor dietary habits (Harrington et al. 2010; Kwaśniewska et al. 2007; Mood 2013; Tsai et al. 2010) associate negatively, whereas PA (Harrington et al. 2010; Kwaśniewska et al. 2007; Mood 2013;

Rosenkranz et al. 2013; Tsai et al. 2010) associates positively with SRH. Our results add new information about how strongly each CVH metric predicts SRH in working-aged women. In a multivariate analysis, nonsmokers rated their health as twice as good as current smokers, while BMI was the most potent indicator to predict self-reported well-being. Thus, these two metrics also predicted the continuity of ideal CVH to middle age (Gooding et al. 2015).

According to our study, 29% reported ill health (poor/fair SRH). The majority of them reached only 0-3 of the 7 ideal health metrics. These subjects also had more diagnosed diseases and cardiovascular risk factors, as well as poorer quality of sleep, diet, and PA level than subjects rating their health as good or excellent. Thus, health care providers should pay increased attention with a holistic approach to those reporting poor SRH, taking into consideration the physiological, psychological, and social factors, as well as health education. In the case of primary and occupational health care it is worth noting that among employees reporting ill-health in our study population, the average WAS (scale 0-10) was only 7, whereas with excellent SRH the WAS score was 9. Good SRH has also been reported to predict return to work after long-term sickness (Momsen et al. 2017).

Lifestyle-related diseases are increasing (Chestnov 2014) and adoption of unhealthy habits and people living longer are potential explanations. However, the mechanism of why healthy habits are associated with better SRH is still unclear (Allen et al. 2015; Harrington et al. 2010; Kwaśniewska et al. 2007; Mood 2013; Rosenkranz et al. 2013; Tsai et al. 2010; Yamada et al. 2012). Smokers or obese individuals reporting poor SRH may reflect an increased awareness due to intense public health messaging about these CVD risk factors. The same phenomenon applies to the rest of the ideal health behaviors, while those neglecting PA and healthy diet may (partly rightly) blame their poor health on these poor behaviors. Reporting poor SRH has been speculated to depict hidden symptoms, risk factors or diseases, which could develop into future health outcomes (Jylhä 2009; Mavaddat et al. 2014). Furthermore, it is thought that SRH captures aspects of health that more guided questionnaires cannot (Jylhä 2009). The ideal CVH, as an indicator of lifestyle and CVD risk, is linked to optimism (Hernandez et al. 2015), which is also suggested to explain SRH, in that optimistic people would rate their health as better than pessimistic people (Benyamini et al. 2000). Another potential alternative explanation of the association between ideal CVH and SRH may be confounded by depression. Yet, the associations Manczuk et al (2017) observed were independent of the depression score, psychotropic medication or past self-reported psychiatric diagnoses (Manczuk et al. 2017). Moreover, other psychosocial risk factors like stress and anxiety may also be confounders or mediators of SRH due to the physiologic consequences of adapting to repeated stress (Mc Ewen 2000). These psychosocial factors are also risk factors for CVD and can often be real barriers for lifestyle changes. Regretfully, we did not evaluate the associations between SRH and psychosocial risk factors in this study.

For the clinical practitioner, valuable information about health and well-being from the patient's point of view can be obtained by simply asking "How satisfied are you with your health?". This one-item SRH can be used as a substitute for time-consuming health-related quality of life questionnaires in the hectic office of the primary care physician. Our results provide evidence that one-item SRH, as a simple, quick and inexpensive method, helps to recognize persons at risk of poor health. Finding reasons for low subjectively experienced health could lead to targeted risk factor interventions and could be the key for attaining better health behaviors with favorable CVH outcomes later. Also, targeting resources to those experiencing ill health, over those reporting good/excellent SRH with a probable healthy lifestyle, could save the time and effort of clinicians and reduce the costs of healthcare. The potential of SRH lies in the rational clinical decision- making, cost-effective targeting of healthcare resources and better surveillance of the disease burden (Rumsfeld et al. 2013).

6.3.5 Leisure-time physical activity, physical capability and ideal cardiovascular health (IV)

The findings of this study demonstrate a positive, linear association between both the LTPA and the physical capability with the sum of ideal CVH metrics. Furthermore, our study showed an accumulation of ideal health behaviors in those reaching the recommended level of aerobic PA. Also, LTPA and the measures of physical capability (except handgrip strength) did associate with the categories of the recommended aerobic PA level.

Our results give new information within the working-age population, since no previous study has estimated the association between physical capability and ideal CVH within this age group. In an Italian nine-year longitudinal study with a mean age of the subjects of 74 years at baseline, an association between better ideal CVH and better physical capability was reported. Physical capability was assessed by Short Physical Performance Battery, an objective assessment with three physical performance tests: 4-meter walking speed, repeated chair stands, and standing balance. The study showed a 69% ($p<0.001$) lower risk of poor physical function, when the lowest category of ideal CVH score was compared to the highest category, with health behavior more meaningful than health factors (Jin et al. 2017). Moreover, in the Atherosclerosis Risk in Communities Study, the relationship between midlife CVH status and physical functioning according to the SPPB 25 years later was evaluated. Nearly 6,000 US individuals were found to have greater physical performance later in life with a higher ideal CVH score in midlife, when the baseline mean age of the study population was 54.2 years (Windham et al. 2017). Also, smoking (Rapuri et al. 2007; Strand et al. 2011), healthy diet (Milaneschi et al. 2011; S. M. Robinson et al. 2008; Xu et al. 2012), BMI (Stenholm et al. 2007) and PA (Chang et al. 2013; Cooper et al. 2011; Dodds et al. 2013; Lang et al. 2007) have been found to associate individually with physical capability. However, the focus just on older people (Jin et al. 2017; S. Robinson et al. 2013; Sternfeld et al. 2017; Windham et al. 2017) or on only a single health behavior has influenced earlier results of the relationships between physical capability and CVD risk factors. Interestingly, the physical capability seems to distinguish differences in CVH already in mid-life. It is suggested that the physical capability measures could be influenced by general health status, ageing or subclinical disease (Cooper et al. 2011). Our study population, however, was quite young (48±10 years), healthy, and active in working life.

Our finding of the dominant association of the health behaviors with increasing level of aerobic PA can be explained by the tendency of health behaviors to accumulate (Conry et al. 2011) more than health factors. Furthermore, the health behaviors influence the health factors, which are typically seen as markers of hidden health risks. For example, a strong dose-response association between exercise intensity and TG and HDL-C have been reported (Bassuk and Manson 2005), consistent with our results. This finding points to the metabolic syndrome and is not seen in the analysis of TC. Moreover, even a great improvement in the AHA metric is not shown, until it reaches the ideal level. For example, a SBP of 130 mmHg is better than 160 mmHg, but both are still categorized as non-ideal, according to AHA. This potentially explains why the ideal level of the most common CVD risk factor in Finland, BP, was alarmingly low among the subjects. In our study, only the lower DBP associated with the level of aerobic PA, even though previous studies have shown an association between BP and PA (Pescatello et al. 2004; Whelton et al. 2002). Also, the used level of HbA1c was so frequent that greater differences could be obtained with a single time-point fasting glucose compared to HbA1c.

Concerning the clinical perspective, the most important finding in the present study is the accumulation of unfavorable health behaviors together with higher rates of depression and lower work ability among the subjects with poor level of aerobic PA. One possible intervention focus could be the diet, since only a few reached the ideal level of diet with the poor level of aerobic PA. In addition, actively screening for depression in those who report poor aerobic PA habits should be one of the priorities of occupational health care . More than half of those with even the recommended level of aerobic PA had only 1–3 of the other 6 ideal CVH metrics, so the recommended level of aerobic PA is inadequate on its own to guarantee better ideal CVH. Thus, we can speculate that the goals for ideal health factors may be too strict for real life, or is the recommended level of aerobic PA too low? Thus, the recommendations of PA are only the minimum recommendations for providing health benefit and aim to motivate people to start a physically active lifestyle.

Moreover, our study subjects with the recommended level of aerobic PA also scored best on the LTPA, as well as on the measures of objective physical capability (except grip strength). For example, reaching 30 seconds in eyes-closed one-legged stance could categorize working middle-aged women into those reaching the recommended level of aerobic PA, when focusing on other health behaviors would be more important for CVH than increasing the quantity of PA. For the clinician, this quick test could provide more information in the evaluation of the level of PA, especially since it is known that objectively measured PA is far from the self-reported PA (Troiano et al. 2008). In line with our results, the association of better physical capability with a greater level of aerobic PA in midlife has been shown previously (Cooper et al. 2011; Lang et al. 2007). In addition, in a study where health behaviors in early midlife were associated with faster walking speed and chair stands among women, PA was the only factor to be associated with physical capability individually, when women were studied again at the age of 56-68 years (Sternfeld et al. 2017). Importantly, slower walking speed and fewer chair stands predicted incident ischemic stroke in women with the same magnitude as known risk factors like hypertension, while grip strength did not (McGinn et al. 2008). The physical capability measures used mainly measured lower body strength (except grip strength), and as PA typically enforces that domain the relationship is not surprising.

To conclude, physical capability measures could be used to evaluate the level of self-reported aerobic PA, as well as the level of ideal CVH, in female employees already in middle age. This might help clinicians to select the more vulnerable patients for CVD into more targeted prevention programs. Nevertheless, the possible bidirectional association should be kept in mind.

6.4 Strengths and limitations

Our study has several limitations. Due to the cross-sectional nature of the study, it is impossible to draw conclusions about causality with the results. Thus, the association between studied non-traditional CVH risk factors and ideal CVH may be bidirectional. The participation rate for the study was only 33%, because it is likely that every invited employee did not notice or open the invitation to the study sent by e-mail. In general, mail surveys seem to reach about a 20% higher response rate than e-mail surveys (Shih and Fan 2009). However, the mean age of 48 years and the mean education level of the study participants were comparable to the means of the entire personnel of the studied city of Pori. Furthermore, a possible healthy worker effect (Li and Sung 1999) can emerge, as subjects outside the workforce were not studied. This causes bias in the generalizability of the results. Also, self-reporting of ideal CVH metrics (diet, PA and smoking status) may be unreliable, and may be influenced by social desirability, but with the use of validated questionnaires and standardized procedures we tried to overcome this bias. We assessed psychosocial risk factors (used in studies I and II) with core questions, which can be used as a preliminary assessment within a clinical interview (Perk et al. 2012). Nevertheless, giving an affirmative answer to either one of the two core questions on depression used in the present study, has been shown to be as effective as using longer screening instruments (Whooley 2016).

The strengths of our study are that the wide-ranging data come from a representative sample of the Finnish women working in municipal work units, which enables us to find women-focused nuances of CVD prevention. Moreover, we could take into account many factors at work and during leisure time, which enabled us to analyze the associations of non-traditional CVH risk factors with ideal CVH metrics with good precision. As a strength, we can also report that we did not have any exclusion criteria, and as such, our study subjects resemble typical patients seen in primary care with all their health issues. Also, all anthropologic measurements were carried out by trained medical staff and objective indicators of physical health were used.

6.5 Future research prospectives

Longitudinal study designs are needed to draw conclusions about the causality of psychosocial risk factors, work engagement, SRH, LTPA, physical capability and ideal CVH. Also, larger data sets with individuals from different work sectors (e.g. municipal, private, self-employed, entrepreneurs) and from outside the work force need to be studied on a larger scale to be able to generalize the results over the general population. Since the ideal CVH concept depends on positive psychology, it would be interesting to study also the associations with positive psychosocial factors affecting the concept rather than focusing on just the risk factors. Also, the use of validated questionnaires able to detect clinically meaningful psychosocial distress is a necessity in further evaluation of ideal CVH. The relationship of work-related factors and CVH is an interesting study field that is sparsely explored for the time being. Future studies could focus on the relationships of work engagement, job and personal resources affecting physical health markers. Moreover, the association of SRH with ideal CVH implies that also the quality of life could be related to the concept. Furthermore, future studies could also focus on individual ideal CVH metrics (e.g. PA, BP) evaluated as continuous variables, since the AHA´s ideal metrics are defined as dichotomous variables potentially explaining the lack of associations between the metrics and many of the studied variables. In addition, the ideal CVH of Finnish people would be well worth following in the long term, since primordial prevention might be the solution to stem the rising tide of obesity, diabetes and CVD.

7 CONCLUSIONS

On the basis of this study, the following conclusions can be drawn:

1. Psychosocial risk factors have a strong relationship with the ideal CVH metrics in Finnish women in municipal work units. Even among women with 5–7 ideal CVH metrics, over 50% have at least one psychosocial risk factor.

2. The sum of ideal CVH metrics have a positive relationship with work engagement. However, the presence of even one psychosocial risk factor has potential to associate negatively with work engagement regardless of the sum of ideal CVH metrics.

3. The sum of ideal CVH metrics is positively associated with good SRH driven by favorable health behaviors (nonsmoking, maintaining normal BMI, healthy diet and PA).

4. Physical capability and LTPA are associated with the sum of ideal CVH metrics, as well as the categories of recommended level of aerobic PA. Health behaviors (nonsmoking, BMI, healthy diet) are more frequent with the recommended level of aerobic PA than health factors (TC, BP, blood glucose).

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APPENDICES

Kyselykaavakkeiden tarkoituksena on kerätä tietoja voinnistasi ja tottumuksistasi. Tiedot käsitellään luottamuksellisesti ja kaikilla tietojasi käsittelevillä tutkijoilla on salassapitovelvollisuus.
Vastaa rastittamalla seuraavista kysymyksistä Sinun tilannettasi kuvaava ruutu tai kirjoita vastaus viivalle. Palauta kaavakkeet tullessasi tutkimushoitajan vastaanotolle.

Onko Sinulla lääkärin toteamia sairauksia? □ Ei □ Kyllä, mitä:

____

____

____

Käytätkö säännöllisesti jotain lääkitystä? □ En □ Kyllä, minkä nimisiä:

____

____

____

Onko Sinulla lapsia?
□ Ei □ On, alle 18-vuotiaita _____kpl □ On, yli 18-vuotiaita _____kpl

Mikä on nykyinen elämäntilanteesi?

0 Asun yksin 1 Parisuhde 2 Yksinhuoltaja 3 Eronnut 4 Leski 5 Muu

Miten luonnehtisit taloutesi tulojen ja menojen yhteyttä tällä hetkellä?
0 Rahat riittävät hyvin tarpeisiimme ja jää ylikin
1 Rahat riittävät sopivasti tarpeisiimme
2 Joudumme tinkimään kulutuksessa jonkin verran
3 Joudumme tinkimään paljon kulutuksesta, mutta tulemme tuloillamme toimeen
4 Joudumme tinkimään kaikesta kulutuksesta emmekä tule toimeen omilla tuloillamme

TYÖ- JA AMMATTIKYSELY

Mikä on ammattinimikkeesi? ____

Mikä seuraavista kuvaa parhaiten nykyistä työaikamuotoasi?

1 Päivätyö 2 Kaksivuorotyö 3 Kolmivuorotyö 4 Osa-aikatyö
5 Säännöllinen iltatyö 6 Säännöllinen yötyö

Mikä on peruskoulutuksesi?

0 Ei loppuun suoritettua koulutusta　1 Kansakoulu

2 Peruskoulu tai keskikoulu　3 Lukio

Mikä on ammatillinen koulutuksesi?

1 Ammatillinen kurssi　2 Ammatillinen koulu/oppisopimuskoulutus

3 Ammatillinen opisto　4 Ammattikorkeakoulu tai alempi korkeakoulututkinto

5 Yliopisto tai korkeakoulu　0 Ei mikään edellä mainituista

Kuinka usein koet työssäsi seuraavien väittämien kaltaisia tuntemuksia tai ajatuksia?

Rastita se vaihtoehto (0-6), joka parhaiten kuvaa kokemuksiasi.

	En koskaan	**Muutaman kerran vuodessa**	**Kerran kuussa**	**Muutaman kerran kuussa**	**Kerran viikossa**	**Muutaman kerran viikossa**	**Joka päivä**
Tunnen olevani täynnä energiaa, kun teen työtäni.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Tunnen itseni vahvaksi ja tarmokkaaksi työssäni.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Olen innostunut työstäni.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Työni inspiroi minua.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Aamulla herättyäni minusta tuntuu hyvältä lähteä töihin.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Tunnen tyydytystä, kun olen syventynyt työhöni.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Olen ylpeä työstäni.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Olen täysin uppoutunut työhöni.	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Kun työskentelen, työ vie minut mukanaan.	**0**	**1**	**2**	**3**	**4**	**5**	**6**

Oletetaan, että työkykysi on parhaimmillaan saanut 10 pistettä. Minkä pistemäärän antaisit nykyiselle työkyvyllesi asteikolla 0-10? Ympyröi sopivin numero.

0 1 2 3 4 5 6 7 8 9 10

työkyvytön työkyky parhaimmillaan

Työviikkojeni pituus viimeisen 2 kk:n aikana keskimäärin sisältäen kotona tehdyn työn.

1 alle 40 tuntia viikossa 2 40–44 h viikossa 3 45–50 h viikossa 4 yli 50 h viikossa

PSYKOSOSIAALISET RISKITEKIJÄT

Avainkysymykset psykososiaalisten riskitekijöiden arvioimiseksi;

Osion jatkokysely tehdään, jos vastaus yhteenkin avainkysymykseen on ”kyllä”.

Riskitekijä	Avainkysymys	Jatkokysely
Työ- ja vapaa-ajan stressi	• Tuntuvatko työsi vaatimukset hallitsemattomilta? • Tuntuvatko työstäsi saamasi hyödyt riittämättömiltä työpanokseesi nähden? • Onko sinulla vaikeita ongelmia parisuhteessasi?	Bergen Burnout Indicator (BBI)
Sosiaalinen eristyneisyys	• Asutko yksin? • Puuttuuko sinulta läheinen ystävä?	ENRICHD Social Support Instrument
Depressio	• Tunnetko itsesi alakuloiseksi, masentuneeksi tai toivottomaksi? • Oletko menettänyt mielenkiintosi tai ilosi elämään?	Major Depression Inventory (MDI)
Ahdistuneisuus	• Tunnetko olevasi usein hermostunut, ahdistunut tai ”kireä”? • Onko sinun vaikea lopettaa tai hallita huolestumistasi asioista?	Generalized Anxiety Disorder, 7-item scale (GAD-7)
Vihamielisyys	• Suututko usein pikkuasioista? • Harmittavatko toisten ihmisten tavat sinua usein?	Cynical Hostility Test (CH)
Tyypin D persoonallisuus	• Oletko usein huolestunut, ärtynyt tai masentunut? • Vältätkö jakamasta ajatuksiasi ja tunteitasi	DS 14

LIIKUNTA JA HARRASTUKSET

Kuinka usein harrastat vapaa-ajan liikuntaa vähintään puoli tuntia kerrallaan niin, että ainakin lievästi hengästyt ja hikoilet?

1 Päivittäin **2** 4-6 kertaa viikossa **3** 2-3 kertaa viikossa **4** Kerran viikossa
5 2-3 kertaa kuukaudessa **6** Muutaman kerran vuodessa tai harvemmin

Kuinka kauan kävelet tai pyöräilet työmatkoillasi? (laske yhteen meno- ja paluumatkaan käytetty aika)

1 Kuljen työmatkani kokonaan moottoriajoneuvolla
2 Alle 15 minuuttia päivässä 3 15-29 minuuttia päivässä
4 30-59 minuuttia päivässä 5 1-2 tuntia päivässä 6 Yli 2 tuntia päivässä

Kuinka paljon kaiken kaikkiaan liikut viikoittain? Laske yhteen kaikki säännöllinen liikunta, joka kestää vähintään 10 minuuttia kerrallaan. Voit valita useamman vaihtoehdon.

□ Ei juuri mitään säännöllistä liikuntaa joka viikko

□ Rauhallista kestävyysliikuntaa (ei hikoilua tai hengästymistä, esim. rauhallinen kävely)
_____ päivänä viikossa, yhteensä _____ tuntia _____ minuuttia viikossa

□ Reipasta kestävyysliikuntaa (jonkin verran hikoilua tai hengästymistä, esim. reipas kävely)
_____ päivänä viikossa, yhteensä _____ tuntia _____ minuuttia viikossa

□ Rasittavaa kestävyysliikuntaa (voimakasta hikoilua tai hengästymistä, esim. juoksu)
_____ päivänä viikossa, yhteensä _____ tuntia _____ minuuttia viikossa

□ Lihaskuntoharjoittelua (esim. kuntopiiri tai kuntosaliharjoittelu)
_____ päivänä viikossa, yhteensä _____ tuntia _____ minuuttia viikossa

□ Tasapainoa edellyttävää liikuntaa (esim. tanssi, pelit)
_____ päivänä viikossa, yhteensä _____ tuntia _____ minuuttia viikossa

Jos et harrasta liikuntaa, mikä on mielestäsi suurin syy liikkumattomuuteesi?

0 En ole koskaan harrastanut liikuntaa
1 Minulla on huonoja kokemuksia liikunnan harrastamisesta
2 En ole löytänyt itselleni sopivaa liikuntalajia
3 Muu. Mikä?____

RAVINTO

Kuinka usein syöt seuraavia ruokia tai juot seuraavia juomia? Rastita sopiva ruutu.

	Joka päivä	**3-6 päivänä viikossa**	**Muutaman kerran kuukaudessa**	**Harvemmin**	**En koskaan**
Tummaa leipää	**4**	**3**	**2**	**1**	**0**
Vaaleaa leipää					
Makeita leivonnaisia, keksejä					
Perunalastuja tai vastaavia					
Makeisia					
Tuoreita hedelmiä					
Tuoreita vihanneksia tai kasviksia					
Marjoja					
Juustoja					
Rasvattomia tai 1% maitotuotteita					
Muita maitotuotteita					
Makkaraa					
Punaista lihaa (sika, nauta, lammas)					
Valkoista lihaa (kana, kalkkuna)					
Kalaa					
Kananmunia					

ELÄMÄNLAATU

Arvioi elämääsi kahden viime viikon aikana. Rastita se vaihtoehto (5-1), joka parhaiten kuvaa tilannettasi.

	Erittäin hyväksi	Hyväksi	Ei hyväksi eikä huonoksi	Huonoksi	Erittäin huonoksi
Millaiseksi arvioit elämänlaatusi?	**5**	**4**	**3**	**2**	**1**

	Erittäin tyytyväinen	Melko tyytyväinen	Ei tyytyväinen eikä tyytymätön	Melko tyytymätön	Erittäin tyytymätön
Kuinka tyytyväinen olet terveyteesi?	**5**	**4**	**3**	**2**	**1**
Kuinka tyytyväinen olet kykyysi selviytyä päivittäisistä toiminnoistasi?	**5**	**4**	**3**	**2**	**1**
Kuinka tyytyväinen olet itseesi?	**5**	**4**	**3**	**2**	**1**
Kuinka tyytyväinen olet ihmissuhteisiisi?	**5**	**4**	**3**	**2**	**1**
Kuinka tyytyväinen olet asuinalueesi olosuhteisiin?	**5**	**4**	**3**	**2**	**1**

	Täysin riittävästi	Lähes riittävästi	Kohtuullisesti	Vähän	Ei lainkaan
Onko Sinulla riittävästi tarmoa arkipäivän elämääsi varten?	**5**	**4**	**3**	**2**	**1**
Onko Sinulla tarpeeksi rahaa tarpeisiisi nähden?	**5**	**4**	**3**	**2**	**1**

ALKOHOLINKÄYTTÖ

Kuinka usein juot olutta, viiniä tai muita alkoholijuomia?

0 En koskaan **1** Noin kerran kuussa tai harvemmin **2** 2–4 kertaa kuussa

3 2–3 kertaa viikossa **4** 4 kertaa viikossa tai useammin

Kuinka monta annosta alkoholia yleensä olet ottanut niinä päivinä, jolloin käytät alkoholia? Yksi annos on pullo (33 cl) keskiolutta tai siideriä; lasi (12 cl) mietoa viiniä; pieni lasi (8 cl) väkevää viiniä; ravintola-annos (4 cl) väkeviä.

0 1–2 annosta **1** 3–4 annosta **2** 5–6 annosta **3** 7–9 annosta **4** 10 tai enemmän

Kuinka usein olet juonut kerralla kuusi tai useampia annoksia?

0 En koskaan **1** Harvemmin kuin kerran kuussa **2** Kerran kuussa

3 Kerran viikossa **4** Päivittäin tai lähes päivittäin

TUPAKOINTI

0 En ole koskaan tupakoinut säännöllisesti

1 Olen lopettanut tupakoinnin vuonna __________

2 Tupakoin nykyisin _______ savuketta päivässä

Kuinka monta tuntia päivässä olet tiloissa, joissa joudut hengittämään muiden aiheuttamaa tupakansavua? _______ tuntia

Jos tupakoit nykyisin, kuinka pian herättyäsi poltat ensimmäisen savukkeen?

1 yli 1 tuntia **2** 31–60 minuuttia **3** 6–30 minuuttia **4** alle 6 minuuttia

UNI

Millaiseksi arvioisit unen laadun kaiken kaikkiaan viimeisen kuukauden ajalta?

1 erittäin hyvä **2** melko hyvä **3** melko huono **4** erittäin huono

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