

Master Thesis

The Association of Cardiovascular Risk Factors and Depression of an adult Population in Austria: Implications from the “BioPersMed” Study for Nursing Research and Practice

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List of abbreviations

BDI-II	Beck Depression Inventory-II
BMI	Body Mass Index
BP	Blood Pressure
CESD	Centre for Epidemiological Studies Depression Scale
CVD	Cardiovascular Disease
DALY	Disability adjusted life years
DSM	Diagnostic and Statistical Manual of Mental Disorders
GCP	Good Clinical Practice
HADS	Hospital Anxiety and Depression Scale
ICD	International Classification of Diseases
PHQ	Patient Health Questionnaire
PROM	Patient reported outcome measure
PYLL	Potential Years of Life Lost
SCORE	Systematic Coronary Risk Evaluation
SD	Standard Deviation
USPSTF	United States Preventive Services Task Force
WHO	World Health Organization
WHO ISH	World Health Organization/ International Society of Hypertension

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Abstract

Introduction: Cardiovascular disease (CVD), which is substantially preventable, and depression often coincide and are considered major health issues with the most common causes of disability. Depression has been recognized as a cardiovascular risk factor. There are differences in prevalence of CVD risk factors and CVD care and prevention in Europe. Therefore, it is vital to identify where the focus of CVD prevention should be placed, to implement specific country-based programs to reduce the CVD burden, especially for people with depression. It is assumed that there is no study in Austria that has examined the association between depression and cardiovascular risk factors. The aim of this study is to investigate the association between common cardiovascular risk factors hypertension, body mass index (BMI), and smoking with the severity of depression in an adult Austrian population. The second aim was to identify sex-related differences.

Method: This current thesis is a cross-sectional study examining the baseline data of the population from the K-Project/BioPersMed (The Biomarkers of Personalized Medicine) project in Graz, Austria. The initial non-probability recruitment started in the City of Graz between 2011 and 2015, resulting in a study population of 1,022 adult men and women who lived in the greater Graz area. Three CVD risk factors were examined for this paper and assessed by trained doctors and nurses at baseline: self-reported diagnosis of hypertension, self-reported smoking status, and BMI (kg/m^2) by measuring the height and weight of each participant. The PHQ-9 (Patient Health Questionnaire) was analyzed by recording the total score value into three groups. Descriptive statistics, statistical correlation analysis, and an ordinal regression analysis was performed.

Results: 977 participants were included in the data analysis, with a mean age of 57.3 years, and more than half of the participants (56%) were female. Results show a significant association between hypertension and the severity of depression ($p < 0.01$) and between males and all three cardiovascular risk factors, and between females and overweight. People with hypertension and elevated BMI, adjusted for age, sex, diagnosis of depression, and smoking were more likely to fall into a higher level of

depression (BMI: increase of 0.033 in the log odds, $p < 0.5$; hypertension: increase of 0.339 in the log odds, $p < 0.01$). Moreover, men were more likely to fall into a lower level of depression than women (decrease of 0.435 in the log odds, $p < 0.5$).

Conclusion: This is the first cross-sectional study to examine the association between cardiovascular risk factors and the severity of depression in an adult Austrian population. Further research where causality can be applied and longitudinal analyses in a larger sample size where generalizability is given are recommended to thoroughly examine and confirm these findings. The importance of nurses in CVD prevention is evident; therefore, a focus should be on enhancing resources, programs, and tools to support nursing CVD interventions by serving an agenda for nursing researchers, funding agencies, and politics with orientation and priorities in cardiovascular nursing. The results are an indication for CVD prevention programs in Austria to incorporate specific screening (CVD and Depression) and management on cardiovascular risk factors in their protocols and readapt them according to depression severity.

Keywords: cardiovascular risk factors, depression, PHQ-9, hypertension, BMI, smoking

Zusammenfassung

Einleitung: Herz-Kreislauf-Erkrankungen (HKE), die im Wesentlichen vermeidbar sind, und Depressionen treten oft gleichzeitig auf und gelten als schwerwiegende Gesundheitsprobleme mit den häufigsten Ursachen für Invalidität. Depression wurde als kardiovaskulärer Risikofaktor anerkannt. Es gibt unterschiedliche Prävalenzen von kardiovaskulären Risikofaktoren und deren Behandlung und Prävention in Europa. Daher ist es wichtig zu erkennen, wo der Schwerpunkt der Prävention von HKE liegen sollte, um länderspezifische Programme zur Reduzierung der Belastung von HKE, insbesondere für Menschen mit Depressionen, umzusetzen. Es wird davon ausgegangen, dass es in Österreich keine Studie gibt, die den Zusammenhang zwischen Depression und kardiovaskulären Risikofaktoren untersucht hat. Ziel dieser Studie ist es, den Zusammenhang zwischen den typischen kardiovaskulären Risikofaktoren Hypertonie, Body-Mass-Index (BMI) und Rauchen mit dem Schweregrad einer Depression bei einer erwachsenen österreichischen Bevölkerung zu untersuchen. Das zweite Ziel war es, geschlechtsbezogene Unterschiede zu identifizieren.

Methode: Die vorliegende Arbeit ist eine Querschnittsstudie, die die Basisdaten der Population aus dem K-Projekt/BioPersMed (The Biomarkers of Personalized Medicine) Projekt in Graz, Österreich untersucht. Die erste nicht-wahrscheinliche Rekrutierung begann in der Stadt Graz zwischen den Jahren 2011 und 2015 und führte zu einer Studienpopulation von 1.022 erwachsenen Männern und Frauen, die im Großraum Graz lebten. Drei Risikofaktoren von HKE wurden für diese Arbeit untersucht und zur ersten Erhebung von geschulten Ärzten und Ärzt*innen und Pflegepersonal bewertet: selbstberichtete Diagnose von Bluthochdruck, selbstberichteter Raucherstatus und BMI (kg/m^2) durch die Messungen von Größe und Gewicht jedes Teilnehmers. Der PHQ-9 (Patient Health Questionnaire) wurde analysiert, indem der Gesamtscore-Wert in drei Gruppen umkodiert wurde. Deskriptive Statistik, statistische Korrelationsanalyse und eine ordinale Regressionsanalyse wurden durchgeführt.

Ergebnisse: In die Datenanalyse wurden 977 Teilnehmer mit einem Durchschnittsalter von 57,3 Jahren eingeschlossen und mehr als die Hälfte der TeilnehmerInnen (56%) waren weiblich. Die Ergebnisse zeigten einen signifikanten Zusammenhang zwischen Bluthochdruck und dem Schweregrad der Depression ($p < 0,01$), sowie bei allen drei kardiovaskulären Risikofaktoren für Männer und Übergewicht für Frauen. Menschen mit Bluthochdruck und erhöhtem BMI, angepasst an Alter, Geschlecht, Diagnose einer Depression und Rauchen, neigten mit höherer Wahrscheinlichkeit in eine höhere Depressionsstufe zu fallen (BMI: ein Anstieg der „Log Odds“ um 0,033, $p < 0,01$; Hypertonie: Anstieg der „Log Odds“ um 0,339, $p < 0,5$). Darüber hinaus neigten Männer weniger häufiger in eine höhere Depressionsstufe zu fallen als Frauen (Senkung der „Log Odds“ von 0,435, $p < 0,5$).

Schlussfolgerung: Dies ist die erste Querschnittsstudie, die den Zusammenhang zwischen kardiovaskulären Risikofaktoren und dem Schweregrad einer Depression bei einer erwachsenen österreichischen Bevölkerung, untersucht. Weitere Untersuchungen, bei denen Kausalität nachgewiesen werden kann, und Längsschnittanalysen in einer größeren Stichprobengröße, bei denen Generalisierbarkeit gegeben ist, werden empfohlen, um diese Ergebnisse gänzlich zu untersuchen und zu bestätigen. Die Wichtigkeit von Krankenpflegepersonen bei der Prävention von HKE ist feststehend, daher sollte ein Schwerpunkt auf die Verbesserung von Ressourcen, Programmen und Instrumenten zur Unterstützung der Interventionen von HKE in der Pflege gelegt werden. Des Weiteren sollte eine Agenda mit einer Orientierung und Prioritätensetzung in der kardiovaskulären Pflege für Pflegeforscher*innen, Förderagenturen und die Politik dienen. Die Ergebnisse liefern einen Hinweis darauf, dass Präventionsprogramme von HKE in Österreich Screening und Management von kardiovaskulären Risikofaktoren in den Protokollen aufnehmen und entsprechend dem Schweregrad einer Depression anpassen sollen.

Schlüsselwörter: kardiovaskuläre Risikofaktoren, Depression, PHQ-9, Bluthochdruck, BMI, Rauchen

1. Introduction

Cardiovascular diseases (CVD) are the principal worldwide causes of death; however, they relate primarily to mostly modifiable lifestyle factors and are therefore substantially preventable. Prevention through risk factor management reduces mortality and morbidity and considerably prevents other chronic diseases from developing (Jennings et al., 2016, p. 23; Jha et al., 2019). CVD and depression often occur simultaneously and are considered major health issues, with the most common causes of disability amongst adults in high-income countries (Hare et al., 2014).

1.1. Epidemiology of cardiovascular disease and depression

CVD remains the most common cause of all deaths across European countries, accounting for 47% in females and 39% in males. (Timmis et al., 2020). The proportion of deaths caused by CVD is found to be higher in Central and Eastern European countries compared to Northern, Southern, and Western countries. Within the European Union, the prevalence of CVD deaths ranges from 23% in France to 60% in Bulgaria among men and from 25% in Denmark to 70% in Bulgaria among women (Wilkins et al., 2017). In 2011, 437.000 Austrians had a documented CVD, accounting for around 19% of inpatients, with men having 1.3 times higher standard rate of being hospitalized (Griebler et al., 2014).

CVD, also known as heart disease, can arise with problems within the heart and blood vessels. *“It is referred to the following 4 entities: coronary artery disease (CAD) which is also referred to as coronary heart disease (CHD), cerebrovascular disease, peripheral artery disease (PAD), and aortic atherosclerosis (Olvera Lopez et al., 2021, p. 2)”*.

CVD counts for 37% of Potential Years of Life Lost (PYLLs), a measure of premature mortality for females and 34% PYLLs for males in Europe. Moreover, CVD has significant economic consequences, with a total global cost estimated to rise to 1,044 billion dollars by 2030. In Europe, the estimated yearly cost in 2016 was 210 Billion

Euros; health care expenditures varied among countries, with Austria spending more than 5,000 US dollars per capita (Timmis et al., 2020).

Depression is considered the third leading cause of morbidity and mortality-related disease in Europe, accounting for 3.8% of disability-adjusted life years (DALY) – (years of life lost due to premature mortality and the burden of disease). 6.5% of the adult Austrian population suffer from depression in their lifetime, with women affected more often at 6.8%, and men with 6.3%. The one-year prevalence is 9.8%, 11.5% for women, and 7.9% for men. People with depressive disorders have a 20 times higher risk of suicide, and over 50 percent of all suicides occur in the context of acute depressive disorders (Nowotny et al., 2019). People with depressive disorders or also named affective disorder, suffer from a variety of symptoms, with the main symptoms being a *“lowering of mood or inner emotional emptiness, loss of interest and pleasurable feelings, and reduced drive with fatigue and loss of energy”* (Nowotny et al., 2019, p.22) Other symptoms include insomnia, loss of appetite, somatic symptoms, cognitive impairment, and feelings of worthlessness, guilt, and hopelessness, which are often associated with suicidal thoughts. According to the severity level and episodes, the ICD-10 (International Classification of Diseases) divides depressive disorders into the categories light, medium, and heavy (Nowotny et al., 2019). Depression can be categorized into atypical or typical depression. Among atypical depression, the key symptoms can be increased appetite, weight gain, and excessive sleep. In contrast, typical depression is a broader category that consists of other features such as anxiety or melancholy (lengthy period of sadness) (Patel et al., 2018).

Depression often occurs simultaneously with other diseases (comorbidities), preceding the course of development or resulting as a consequence of disease, and has often been associated with cardiovascular diseases (Ivanovs et al., 2018; Nowotny et al., 2019). The presence of chronic conditions is well-known as a risk for depression (Read et al., 2017). Depression is common in CVD patients, with one in five patients suffering from a major depressive disorder (Hare et al., 2014; Jha et al., 2019). Additionally, patients with depression have a 30% greater risk of coronary heart disease and a 36% greater risk of CVD mortality (Polanka et al., 2018).

1.2. Cardiovascular risk factors and depression

Cardiovascular risk factors have been identified, leading to an essential accomplishment of cardiovascular medicine to develop lifestyle and therapeutic strategies for the prevention of cardiovascular disease and its progression. According to the global INTERHEART study, nine major risk factors and health behaviors have been recognized: blood pressure, blood cholesterol, obesity, diabetes, smoking, alcohol, nutrition, physical activity, psychological factors. These risk factors account for more than 90% of the population's risk of acute myocardial infarction (Timmis et al., 2020). Hypertension, overweight, obesity, and smoking are common cardiovascular risk factors and increase the risk of having a more unsatisfactory outcome (decreased life quality, morbidity, or mortality) in cardiac patients (Berg et al., 2018; Griebler et al., 2014).

As a physical cardiovascular risk factor, hypertension accounts for one in four adults across Europe having an elevated blood pressure (BP), with an age-standardized prevalence of 21% in Austria, leading to 10.4 million deaths worldwide in 2017 (Timmis et al., 2020). Diagnosis of hypertension should be based on at least two BP measurements per visit and at least two visits. However, cut-off values differ for office or out-of-office (ambulatory or home) BP monitoring. The office BP levels can be defined and classified into categories ranging from optimal BP to Grade 3 Hypertension. The BP category is determined by the highest level of BP, whether systolic or diastolic. Hypertension is defined by a systolic BP \geq 140 mmHg or diastolic BP \geq 90 mmHg (Jennings et al., 2016, p.144).

As physical and behavioral cardiovascular risk factors, the worldwide prevalence of obesity, defined by a body mass index (BMI) of over 30 kg/m², nearly tripled between 1975 and 2016, with an estimated 650 million adults with obesity (Griebler et al., 2014; Timmis et al., 2020). In Europe, one in five adults is a person with obesity (Timmis et al., 2020). The BMI is calculated of weight for height and is commonly used as an index to classify underweight, overweight, and obesity in adults. The WHO classification is based on the association between BMI and mortality (Table 1) (WHO, 1998).

Table 1: The BMI classifications adopted from the WHO 1998 report.

Classifications	BMI (kg/m ²)
Underweight	<18.5
Normal weight	18.5-24.9
Overweight	25-29.9
Obese class 1	30-34.9
Obese class 2	35 -39.9
Obese class 3	40

Established by the World Health Organization - "Report of a WHO consultation on obesity. Obesity Preventing and Managing a Global Epidemic."(WHO, 1998)

According to literature, a BMI of ≥ 25 kg/m² is considered an increased risk and a BMI of ≥ 30 kg/m² is a high risk for CVD (Jennings et al., 2016, p.83). The BMI classification, according to (WHO, 1998) is independent of age. However, for older adults, due to changes in body composition and a reduction of body height, the validity of the BMI as a measure of overweight and obesity is reduced (Volkert et al., 2019).

As a behavioral cardiovascular risk factor, cigarette smoking has been shown to be prevalent in adults across European countries, with 20% and 25% being current smokers, which has been linked to CVD, causing roughly 6 million avoidable deaths per year (Timmis et al., 2020).

Depression has been identified as a cardiovascular risk factor in healthy subjects as well as associated with major cardiac events such as a myocardial infarction (Ceccarini et al., 2014; Jha et al., 2019). Screening for depression with standardized methods is recommended as a risk modifier of cardiovascular risk prediction and should be a part of overall cardiovascular risk assessment (Jennings et al., 2016; Jha et al., 2019). Cardiovascular risk factors, including depression, have been identified to have differences in prevalence between women and men. Therefore, women are two to three times more likely to develop depression during their lifetime (Garcia et al., 2016).

1.3. Sex differences in cardiovascular risk factors and depression

The lifetime prevalence of depressive disorders is generally twice as likely to be diagnosed in women. However, for depressed men and women, there is a similar increased risk of CVD and cardiovascular mortality. Furthermore, psychosocial stress also increases the cardiovascular risk in both sexes, whereas work stress possibly is more evident in men than women. Caregiving stress is associated with a high CVD risk in women (Griebler et al., 2014). The prevalence of hypertension increases significantly in postmenopausal women, which is a strong predictor of cardiovascular events in later life (Garcia et al., 2016; Griebler et al., 2014).

Moreover, the impact of obesity is more dominant in women in developing CVD, with an increased relative risk of 64% in women, opposed to 46% in men. For smoking, women had a 25% increased risk compared with men for a CVD event happening. Over the past years, an understanding of different approaches to prevent CVD, focusing on recognizing lifetime risk between men and women, has developed and evolved. The first evidence-based guidelines from the American Heart Association focused on primary prevention of CVD for women were published in 2007 (Garcia et al., 2016). The recommendations of CVD prevention (such as not smoking, being active, avoiding being overweight, and having blood pressure and blood cholesterol checked) for men are similar (Mosca et al., 2011). However, there is a growing appreciation that there may be gender differences in the magnitude of the relative and absolute potential benefits and risks of preventive interventions. Women can reduce their risk of a coronary event by more than 80% by not smoking, eating a healthy diet, drinking a moderate amount of alcohol, exercising vigorously 30 minutes a day, and maintaining a weight under 25kg/m². These are all crucial lifestyle modifications in CVD Prevention, which have to be highlighted and implemented (Garcia et al., 2016).

1.4. Cardiovascular disease prevention

Primary CVD prevention has evolved due to research and adapted strategies over the past decades. The European Society of Cardiology (ESC) Handbook of Preventive Cardiology (Jennings et al., 2016) presents the theoretical framework of this thesis. The

Handbook should assist healthcare workers in a feasible and accessible way to deliver the necessary skills and training for CVD prevention practice. The contents for the following subtitles have been abstracted from the ESC Handbook to serve as a guideline (Jennings et al., 2016).

“Cardiovascular disease (CVD) prevention is defined as a coordinated set of actions, at the population level or targeted at an individual, that are aimed at eliminating or minimizing the impact of CVDs and their related disabilities (Hobbs et al., 2016, p.321).

A person`s total CVD risk determines preventive interventions. People tend towards having more than one cardiovascular risk factor, which may interact multiplicatively. The total CVD risk of a person is defined by a combination of several cardiovascular risk factors, which can be estimated considering significant factors such as blood pressure, age, gender, and lipid levels. A major advantage of prevention arises by attending to all risk factors rather than by the level of an individual risk factor (Jennings et al., 2016, p.5). Therefore, a balance between biological, physiological, and social factors influences cardiovascular health. Having a balance between biological factors, for instance, by managing blood pressure or weight, and psychological factors such as emotions and feelings can also be seen as a protective approach. Therefore, psychological and social factors, playing a huge role in cardiovascular health, have to be assessed and managed when implementing CVD prevention (Jennings et al., 2016, p. 157).

1.4.1. Importance of cardiovascular disease prevention

A focus on primary prevention of CVD is necessary to reduce CVD mortality and the overall CVD burden (Garcia et al., 2016). Certain psychosocial factors contribute to a higher risk of developing a CVD as also negatively contributing to the clinical course and prognosis in patients with CVD. Psychosocial factors include acute stress, low socioeconomic status, social isolation, low social support, chronic work stress, anxiety, severe psychiatric disorders, financial barriers, unhealthy lifestyle, hostility, and depression (Jennings et al., 2016, p.158-159). Depressive disorders increase morbidity and mortality and decrease the quality of life (Nowotny et al., 2019). Consequently,

assessing and managing psychosocial risk factors can have a beneficial effect on distress, quality of life, and functional status (Jennings et al., 2016, p. 157). Additionally, depression is a predictor of poor future physical health and leads to negative cardiac risk behavior, including unhealthy eating habits, smoking, and medication non-adherence (Berg et al., 2018; Niles & O'Donovan, 2019).

Hypertension requires preventive care as well. With preventative treatment and management of elevated blood pressure, where lifestyle measurements and pharmacotherapy are necessary, cardiovascular events can be significantly avoided (Timmis et al., 2020). In 2016, the Global BMI Mortality Collaboration reported that for BMI ≥ 25.0 kg/m², every 5 kg/m² increase is associated with a 33% increase in mortality among people living in Europe and an increased BMI for all-cause mortality consistent across all regions worldwide (Timmis et al., 2020). People with obesity can benefit significantly from reducing their cardiovascular risk by losing 10% of their body weight and changing from unhealthy eating patterns to a cardioprotective diet (Jennings et al., 2016, p.55). Tobacco use has been described as the “single largest avoidable health risk” for CVD. Smoking status and tobacco dependence should continuously be assessed when talking to patients for the first time (Jennings et al., 2016, p. 45). The overall health benefits of quitting smoking are immediate; moreover, a primary cause of CVD is present earlier in smokers compared to never smokers. Smoking is considered a significant factor for total CVD risk. People identified as having a high cardiovascular risk with major factors gain the most from risk factor management due to the higher consequences of onset CVD. Therefore, assessing people with a high cardiovascular risk is a fundamental approach for CVD prevention (Jennings et al., 2016, p. 10).

1.4.2. Assessment of cardiovascular disease risk

Risk assessment and estimating total risk for CVD should be considered at every person or patient contact, as it remains a crucial part of all current guidelines. There are several systems available to assess total cardiovascular risk, such as the Framingham Risk Score, SCORE (Systematic Coronary Risk Evaluation), ASSIGN,

World Health Organization/ International Society of Hypertension (WHO ISH) model, the Reynolds score, and many more (Jennings et al., 2016, p.9-10).

SCORE is used for apparently healthy people and is the recommended European risk estimation system with versions for high- and low risk countries. SCORE estimates the 10-year risk of a first fatal atherosclerotic event, whether heart attack, aneurysm of the aorta, or other with different risk factor combinations on the following risk factors such as gender, age in years, cholesterol, systolic blood pressure, and smoking. However, several factors are known to alter CVD risk but which are not included in SCORE should be taken into consideration, such as central obesity, diabetes, and pre-diabetes, increased fibrinogen, etc. (Jennings et al., 2016, p.9-10).

SCORE 2 was recently developed to predict the 10-year risk of first-onset CVD in individuals without previous CVD or diabetes aged 40–69 years in Europe. Furthermore, risk regions were determined based on standardized cardiovascular disease mortality rates. Countries were grouped into four risk regions, and Austria is considered as a moderate-risk region. Countries like France, Spain, and the United Kingdom are regarded as low-risk regions, whereas Bulgaria, Georgia, and Lithuania are very high-risk countries. SCORE 2 enhances the identification of individuals at higher risk of developing CVD across Europe (Hageman et al., 2021).

1.4.3. Assessment of depression risk

Routine systematic screenings in primary care settings are necessary for early and accurate detection of depression, as depression is often unrecognized or incorrectly diagnosed, especially in non-psychiatric medical settings. Furthermore, routine screenings require minimal time and resources in the hospital and ambulatory care (Jha et al., 2019)

Psychological risk factors can be assessed by asking a ‘single-item’ screening question such as “Do you feel down, depressed, or hopeless?” or by administering validated patient-reported outcome measure (PROM) questionnaires during a consultation. PROM questionnaires for screening depression are the Hospital Anxiety and Depression Scale (HADS), Beck Depression Inventory-2 (BDI-II), Centre for

Epidemiological Studies Depression Scale (CEDDS) or the Patient Health Questionnaire (PHQ) (Ceccarini et al., 2014; Jennings et al., 2016, p.159-162).

The PHQ is a screening instrument that enables a valid and time-saving diagnosis of depression in combination with medical consultation. This questionnaire aims to improve the diagnosis and treatment of mental disorders within and outside primary medicine. PHQ can be used in its complete or short form as a diagnostic instrument in clinical practice and for research questions. The original American version of the PHQ is based on the diagnostic criteria of the DSM-IV3 (Diagnostic and Statistical Manual of Mental Disorders). It can be used both for initial diagnosis as well as for assessing the course of psychological disorders (Löwe et al., 2002). The PHQ-9 comprehensively assesses each of the nine domains that define depression (DSM-IV3) and can establish not only a provisional depressive disorder diagnosis but can rate symptom severity to determine appropriate treatment (Ceccarini et al., 2014; Jha et al., 2019). Patients usually complete the PHQ-9 in more or less than five minutes without assistance (Ceccarini et al., 2014). The PHQ-9 has also been identified as a significant, reliable, and validated screening tool for cardiac patients, which should be integrated into cardiovascular rehabilitation programs and generally in cardiology practices (Ceccarini et al., 2014; Hare et al., 2014; Jha et al., 2019). The PHQ-9 is also a frequently used tool for screening for depression in primary care (Levis et al., 2019).

The USPSTF (United State Preventive Services Task Force) recommends that screening should be implemented with adequate systems in place, referring to health settings and clinical staff, ensuring that patients are screened appropriately. Furthermore, the USPSTF recommends screening in all adults regardless of risk factors. However, depression is linked to increased risk for women, women during pregnancy, undereducated or unemployed people, people with chronic diseases, disability or poor health status, chronic sleep disorder, other mental disorders, or family history of psychiatric disorders. These are all factors that should be kept in mind; however, they cannot distinguish patients with depression from those without depression. Therefore, a pragmatic approach includes screening all adults who have

not been screened previously and using clinical judgment (US Preventive Services Task Force, 2016).

1.4.4. Global care pathway for cardiovascular disease prevention

The ESC prevention handbook has presented a global care pathway identifying stages to follow when a person presents for cardiovascular risk assessment. These stages can be applied in any health care setting, whereas it should be noted that acute events most likely occur in a hospital setting. Firstly, patients should be assessed for cardiovascular risk, then categorized for risk, and later preventive initiatives should be set within an interdisciplinary structure. The prevention strategies should be targeted to provide care at the accessibility of individuals, meaning setting realistic goals. The first step is knowing which people require a comprehensive assessment of all risk factors then learning how to assess CVD risk. The last step is categorizing CVD risk (very high, high, moderate, and low risk), targeting the correct interventions, identifying the setting, and implementing overall effective prevention. The outcomes of the preventive interventions should be measured and annually followed to reassess the health outcome (Jennings et al., 2016, p. 183-186). The prevention programs such as lifestyle initiatives must incorporate screening and treatment of depression in cardiac patients (Berg et al., 2018).

1.4.5. Integrating depression in the global care pathway

Symptoms of depression have been associated with cardiovascular risk factors signifying that depressive people were more likely to be current smokers or people with obesity (Berg et al., 2018). Evidence has also shown that obesity and smoking are comparable with depression as a risk factor for predicting diseases such as heart conditions and stroke (Niles & O'Donovan, 2019). Moreover, being overweight has been identified as a strong predictor of atypical major depression (Patel et al., 2018). In Addition, obesity has similarly been associated with a significant increase in lifetime diagnosis of major depression in the United States (Simon et al., 2006) and, according to a meta-analysis, increased the risk of depression (Luppino et al., 2010). A study revealed a significant interaction between current tobacco use, hypertension, BMI, and lifetime depressive disorder predicting incident CVD (Polanka et al., 2018).

Systematic screening for depression has been emphasized in settings such as primary care, in which simultaneously CVD primary prevention should occur (Ivanovs et al., 2018). Therefore, the knowledge of depression status may be helpful in determining the effect of primary cardiac prevention (Polanka et al., 2018). Depression requires prevention, detection, and management, no matter the causal relation between CVD and depression (Hare et al., 2014) and in general, according to guidelines, depression, as well as any other psychosocial factor, should be assessed in the clinical cardiology practice (Ceccarini et al., 2014). It can be recommended to implement a two-stage approach for assessing depression; this can be done by including questions on the psychosocial state or administering a questionnaire in their initial interview. Then, if positive for depression or complication occurs, patients should be referred to a qualified health professional such as a psychologist/psychotherapist/psychiatrist to pursue a deeper evaluation (Ceccarini et al., 2014). Depression, however, is often under-recognized (Jha et al., 2019) and greater attention should be given to cardiovascular risk factors and depression, especially in primary settings (Niles & O'Donovan, 2019).

1.5. Aspects of cardiovascular disease prevention and depression

There are complex interactions between psychosocial factors (low educational level, low socioeconomic status, stress at work and family life, depression, anxiety, and social isolation) and adverse lifestyle habits (smoking, high consumption of alcohol, and unhealthy eating habits), where professional support is needed to make lifestyle modifications. Initiation of behavioral change can be enhanced by effective communication and counseling skills by health professionals. The following sections focus on strategies for supporting and sustaining lifestyle changes such as smoking cessation, weight management, and blood pressure management (Jennings et al., 2016). In Austria, prevention programs for CVD have been established, with about half of the programs being workshops or training, followed by consulting and coaching and just consulting (Griebler et al., 2014).

1.5.1. Managing blood pressure

When treating hypertension, drug administration for BP is strongly evident and should be initiated. The goal of systolic BP should be below 140 mmHg in most cases. This

goal can change depending on age, comorbidities such as diabetes, setting of measurement (ambulatory or at home), time of measurement (during exercise or in quiet), etc. (Williams et al., 2018). BP medication should be taken responsively and according to plan. Additionally, treatment strategies on lifestyle changes should be made, such as salt restriction. People with hypertension should be scheduled for regular follow-up visits in primary care. During their visits, BP (office and out of office) is measured, and their cardiovascular risk profile and, if necessary further recommendations on lifestyle changes. When prescribing antihypertensive medication for the first time, it is vital to evaluate the effect on BP and to assess the possible side effects. The assessment should be performed at two – to four-week intervals, and once the optimal blood pressure has been attained, a visit interval of a few months can be sufficient (Jennings et al., 2016, p. 119-128). The insurance system offers two hypertension disease management programs in Austria, where the aim is to transfer necessary information to help manage BP (Griebler et al., 2014).

1.5.2. Diet and weight: major lifestyle challenges

A comprehensive assessment of dietary habits is vital when targeting advice and strategies. The key element of changing unhealthy eating patterns is reducing calorie intake and altering the balance of food groups in one`s diet, and switching unhealthy for healthy options, for instance, by following a cardioprotective diet (such as the Mediterranean diet). A cardioprotective diet recommends a high consumption of fruit and vegetables, fish consumption, fish oils, reduced sodium intake, whole grains, increased fibre intake, minimal or no sugar consumption, and a reduction in alcohol intake. If a patient presents with a weight problem or is a person with obesity, strategies should also be set for weight loss. Firstly, while assessing the person, it is vital to find out the degree of motivation to lose weight, which in the end impacts the course of success.

Furthermore, self-monitoring by, for instance, writing a diary about food intake, regular exercise, weight, and mood can record the progress, help identify patterns and highlight new problems. Behavioral goals and a plan of changing habits should be set with rewards (for instance, by engaging family members and planning special occasions).

Rewards lead to motivation to change lifestyle habits (Jennings et al., 2016). Austria offers a wide range of programs from health organizations and health insurances for nutritional advice, healthy eating and cooking programs for people with obesity, children and schools, kindergartens, companies, and other settings (Griebler et al., 2014).

1.5.3. Treatment of tobacco dependence

The challenge of stimulating a quit attempt by patients for health professionals is usually the fact that many patients have been smoking for years and have made many attempts to stop in the past (Jennings et al., 2016, p. 51). However, the overall benefits of smoking cessation are immediate (Siu, 2015). Priorities in smoking cessation, reported by Jennings et al. (2016) and Siu (2015), can be performed by following these steps: a comprehensive assessment, asking about smoking status when meeting for the first time, advising them to cease, assessing the level of dependency and establishing a strategy by organizing counselling and pharmacological support to aid quitting. Then reassess with a follow-up program. When counselling, it is essential to assess the motivation of quitting (Siu, 2015). For health professionals, it is crucial to express empathy when using motivational interviews, as tobacco dependence is often physical, mental, and social. It can be helpful by exploring the advantages and disadvantages of quitting to the patient's primary principles and life goals. Weight gain is common after stopping smoking; a targeted dietary and physical support program during smoking cessation may minimize weight gain (Jennings et al., 2016, p. 51). Programs and workshops given in schools, societies, communities, or companies for smoking cessation are offered in all states by different insurances with different set priorities (Griebler et al., 2014).

1.5.4. Managing psychological factors and depression

Interventions to manage psychological factors impact the course of clinical CVD, especially in patients who want to reach their behavioral goals. These interventions should be tailored based on the patient's individual risk consultation and treatment preference. To help reduce psychosocial stress and support the patient coping with illness, interventions such as supportive caregiver-patient interaction (establishing behavioral strategies, effective communicative strategies, assurance of a concrete

plan), enhancing social support, for instance by involving family members or spouses, promoting physical exercise, counselling on psychosocial risk factors, stress management training, psychotherapy, and work reorganization can be achieved. Medication for depression is administered in clinically significant depression and anxiety and can help improve symptoms (Jennings et al., 2016p. 162-166). Antidepressants can be a highly effective therapy for major depression in adults (Montgomery & Kasper, 2007).

In Austria, in addition to health promotion and prevention initiatives with a general focus on mental health, there are several programs for all ages that specifically focus on the prevention of depression, such as „Alliance against Depression“ with education, information, and training at various levels, web-portals (<https://psychische-hilfe.wien.gv.at/site/>) for education on the treatment and recognition of depression (Nowotny et al., 2019).

1.6. The role of nurses in cardiovascular disease prevention and depression

A multidisciplinary approach is highly recommended in patients with a CVD risk, which combines professionals such as physicians, nurses, dieticians, physical activity experts, social workers, and psychiatrists to establish appropriate interventions for in and out-patients. Establishing “integrated care” when patients are discharged from a hospital or ambulatory setting can be done with structured cooperation of physicians, nurses, and psychotherapists/psychiatrists to uphold continuous care and improve overall satisfaction (Jennings et al., 2016, p. 163). Counselling on psychosocial risk factors can and should be performed by trained nurses, where principles of behavioral therapy are used to solve individual problems (obesity, smoking habits, high BP levels). Behavioral therapy by nurses includes exploring barriers to behavior change and assessing for cognitive impairment because complex information cannot always be adequately processed. Moreover, conducting motivational interviews, designing a lifestyle-modification plan, addressing global self-efficacy, setting goals, and monitoring progress with frequent monitoring and feedback (Jennings et al., 2016, p. 35-42, 164).

As the largest group of healthcare workers (by promoting health and well-being), the importance and the critical role of nurses in CVD prevention has been reported in various publications (Berra et al., 2019; Commodore-Mensah et al., 2019). The nurses' responsibilities for health literacy, health promotion, prevention, advice on health and patient education, psychosocial care are established as key elements of the laws for Austrian nurses (RIS, 2018b).

According to the standards of practice of the American Nurses Association, a registered nurse is obligated to assess psychosocial and emotional factors and should identify psychosocial barriers to be able to make appropriate adaptations. Furthermore, nurses must have competencies to provide health teaching (empowerment and health literacy), which address topics such as healthy lifestyle, risk reduction behaviors, and preventive self-care (American Nurses Association, 2010). Daily psychosocial support through therapeutic communication and relationships are also defined competencies for nurses in Austria. These nursing competencies are explicitly recognized for empowering patients by assuring that patients receive all information and consequently decide over their own goals to live healthier. "*Empowerment is a term for the development process of every person, which enables them to regulate their own matters independently* (Petek et al., 2011, p. 25)." Nurses have an important role and position to screen for psychosocial risk factors (Halcomb et al., 2019) and cardiovascular risk (Jennings et al., 2016).

A heart failure nurse plays an essential part in a successful disease management program for CVD patients and is highly recommended by the Austrian Society of Cardiology. Patient education, evaluation of cardiovascular symptoms, and treatment effects for assessing educational and psychosocial needs are all components of the Austrian heart failure nursing training program (Moertl et al., 2017). Moreover, in Austria, there are further education and training programs in psychiatric health care for nurses (BMSGPK, 2020). In the United Kingdom, mental health nurses have been integrated; they can deliver effective interventions, such as cognitive and behavioral therapy, with positive outcomes for patients, such as improved depression, compliance in medication adherence, and cognitive impairment (Curran & Brooker, 2007).

Overall, nurses are in a unique position to support patients with CVD risk by establishing and maintaining a trustworthy relationship, providing emotional support, patient-centered communication, and professional guidance in coping with depression (Hobbs et al., 2016).

1.7. Research gap

Recent evidence (Timmis et al., 2020) reported differences in the prevalence of CVD risk factors in countries of Europe and the availability of cardiovascular care. Furthermore, psychological factors are currently not recorded in the recent prevalence study for European countries from the ESC, although they are well established as contributors to CVD risk. It is therefore vital to identify where the focus should be based in CVD prevention, to implement specific country-based programs to reduce the overall CVD burden (Timmis et al., 2020), especially for people with depression (Hare et al., 2014; Jha et al., 2019; Patel et al., 2018; Polanka et al., 2018). Local data are crucially important for the management of patients with CVD risk factors to enable targeted medical and nursing education, policy, and program development (Timmis et al., 2020). To conclude, it is assumed that there is no study in Austria has examined the association between depression and cardiovascular risk factors for smoking, BMI, and hypertension.

1.8. Objectives

This study aims to examine the association between cardiovascular risk factors as hypertension, BMI, and smoking with the severity of depression in an adult Austrian population. The second aim is to identify the association and rates of depression and cardiovascular risk factors between men and women.

Consequently, this resulted in the following research questions:

What is the association between cardiovascular risk factors (*hypertension, BMI, smoking*) and Depression in an adult Austrian population?

What is the association and difference between cardiovascular risk factors (*hypertension, BMI, smoking*) and depression in men and women in an adult Austrian population?

The following **hypotheses** have been established:

There is no difference between the diagnosis of depression and the PHQ-9 depressive disorder.

There is a difference between hypertension for men and women

There is a difference between BMI for men and women.

There is a difference between smoking for men and women.

Women with at least one cardiovascular risk factor have a higher level of depression than men.

People with a higher BMI have a higher level of depression than people who smoke or have hypertension.

People with at least one cardiovascular risk factor, such as high BMI, smoking, or hypertension, have a higher level of depression.

2. Method

Data from the cross-sectional survey has been analysed to answer the research question and hypothesis. Cross-sectional studies are carried out at a one-time point or over a short period of time. They are conducted to investigate associations between risk factors and the outcome of interest (Levin, 2006). To describe the method with all the essential components, subtitles have been established and are hereafter presented. First, the design is presented, following with ethical aspects, eligibility criteria, recruitment of participants and setting, data sources and measurements, and to conclude the process of statistical analyses (Petrie & Sabin, 2019).

2.1. Study design

The Biomarkers of Personalized Medicine (BioPersMed) project is designed as a single-center, prospective, observational study with a baseline screening and regular two years-follow-ups (Colantonio et al., 2015; Colantonio, 2014). The study was conducted with the primary purpose of evaluating the predictive value of various biomarkers reflecting different pathways of cardiovascular and metabolic disease development. Also, to assess extensive scale screening tools for improving cardiovascular and metabolic risk stratification, early diagnosis, prediction of clinical outcomes, and long-term clinical monitoring of patients at cardiovascular risk. This current thesis examined the baseline data of the cohort study population from the BioPersMed project.

2.2. Ethical aspects

The use for this thesis of the registered data of the BioPersMed cohort was permitted by the steering committee and a written declaration of consent was obtained by the project leaders. Ethical approval for the BioPersMed cohort study has been granted by the Ethics Committee of the Medical University of Graz, Austria and is renewed every year (EC Nr.24-224 ex 11/12). The BioPersMed study is conducted in compliance with Good Clinical Practice Guidelines Procedures (GCP) (Grimes et al., 2005) and complies with the Declaration of Helsinki (World Medical Association, 2013) and the Austrian laws (RIS, 2018a). Each participant received informed written consent at the

visit prior to the examination with an in-depth explanation of the study. All participants had been thoroughly checked for in- and exclusion criteria at baseline examination to avoid screening failures.

2.3. Eligibility criteria

Participants without a diagnosed cardiovascular disease at the time but with at least one classical cardiovascular disease risk factor and at the age of 45 or older were eligible to participate in the BioPersMed study. The age of 45 or older was defined from a cardiac standpoint, as the risk of CVD slowly increases at the age of 40 (Perk et al., 2012). The classical and potential cardiovascular risk factors for eligibility aside from age and gender, as the European Guidelines (Perk et al., 2012) have established, were smoking, elevated total cholesterol levels, arterial hypertension, obesity, diabetes, social environment, diabetes mellitus type 1 or 2, low HDL cholesterol, increases triglyceride levels, elevated fibrinogen, apolipoprotein B, lipoprotein a, family hypercholesterinaemia, increased sensitivity CRP, preclinical evidence of atherosclerosis and chronic kidney disease. Participants unable to perform function tests appropriately, such as the ergometer, were excluded, and pregnancy and serious mental health problems were considered exclusion criteria.

2.4. Recruitment of participants and setting

The initial recruitment started in the City of Graz (Styria, Austria) with the baseline data collection between 2011 and 2015, resulting in a study population of 1,022 adult men and women who lived in the greater Graz area at the time. Convenience sampling was used as the recruitment method with an established recruitment network, consisting of general practitioners, peripheral hospitals, and through the outpatient clinics of the Department of Cardiology and Endocrinology and Diabetics at the university hospital in Graz. The BioPersMed cohort is located at the Medical University of Graz in a clinical outpatient research centre and biobank. Participants were invited here for their examinations and face-to-face interviews.

2.5. Data collection/measurements

The research staff consisted of health professionals, including doctors and nurses with GCP, who were trained similarly prior to working with the participants. The interviews and examinations were conducted in a systematic way, all following the established study protocol.

According to the introduction, three CVD risk factors were examined for this thesis and were assessed at baseline: hypertension, smoking status, and BMI. The research staff obtained information such as hypertension and smoking status on the day of their visit from self-reported data during the interview.

Smoking status was assessed by asking the participants if they have been actively smoking on a regular basis. Participants were defined as a smoker if they had not quit for longer than six months. If they had smoked in the past, they were defined as ex-smokers. Hypertension was identified by self-reported data with the question if they had been diagnosed with hypertension by a doctor or a health professional. Furthermore, participants were asked if they received antihypertensive medication daily or weekly to determine if they had an unknown diagnosis of hypertension. Weight was obtained with a calibrated body scale (Pharo Soehnle Art.-Nr. 63746) and height with a tape measure for each participant to calculate the BMI. Secondary diagnoses were collected as self-reported data. Subjective physical and mental health were assessed by asking the participants: "If you had to rate your physical/mental health, how would you currently rate it from 1 - 5?" with values of one being very poor and five being very good.

Fifteen questionnaires were given to each participant at their visit to fill in independently in a separate area, where they were not observed by the study staff. Prior to filling in the questionnaire, each participant received information on the process. The "Patient Health Questionnaire (PHQ)" was also distributed to each participant to fill out. By using the nine items questionnaire, also referred to as the "PHQ-9", the total scale value "depressive disorder" can be calculated. Each of the nine questions has four response categories with a point value: 0 = "Not at all," 1 = "On individual days," 2 = "On more than half of the days," and 3 = "Almost every day." The sum of the point values over the nine

items can resemble a "depressive disorder" and varies, therefore between 0 and 27. A point value below 5 corresponds to the absence of a depressive disorder, and a point value between 5 and 10 corresponds to people with a mild degree of depression. For people with major depression, a score of 10 and higher are to be expected. The PHQ was translated into a German version (PHQ-D) with permission from the authors of the original version. The translation was done according to "state of the art criteria," and the German version PHQ-D was carried out on a sample of outpatients in clinics and showed good validity in the diagnosis of mental disorders. With scores over 10, the screening instrument had a sensitivity of 88% and specificity of 88% for major depression in primary care settings (Löwe et al., 2002). The German version was used for this sample, which can be found in the Appendix Nr. 1.

2.6. Statistical analysis

Of all the participants (N=1022), 11 people did not fill out the PHQ-9 questionnaire or did not receive the questionnaire, and additional 14 questionnaires had missing items. Twenty people were under the age of 45 and therefore excluded in the data analysis, to adhere to the study protocol of inclusion criteria. Participants who had not completed the PHQ-9 questionnaire were also excluded; 977 participants were included in the data analysis.

Descriptive statistic of the sample was used to describe age, sex, secondary diagnosis, physical/mental health, and cardiovascular risk factors. For the description of the sample, all unknown diagnoses were included. However, in the further analyses, they were excluded. The unknown values for participants only accounted for hypertension and secondary diagnosis. All other variables in the data analysis had no missing data.

The PHQ-9 questionnaire was analysed according to the German version manual handbook by recoding the total score value into a categorical, ordinal variable with three groups: Score 0 – 4 = no depression (coded 1), 5 - 9 = mild depression (coded 2), 10 - 27= major depression (coded 3). To analyse the mean, standard deviation (SD), maximum and minimum, and the correlation between age and the PHQ-9, the total score of the PHQ-9 was used as a metric variable.

As for the analyses of cardiovascular risk factors: smoking was recoded as a dichotomy (smokers/ex-smokers and non-smokers) variable with smoking being the reference category. Hypertension was also coded as a dichotomous variable, with the diagnosis of hypertension being the reference category. BMI was coded as a dichotomy dummy variable ($<25\text{kg/m}^2/\geq 25\text{kg/m}^2$), with $\geq 25\text{kg/m}^2$ being the reference category as the cardiovascular risk factor, with the reason described in the introduction. BMI was also used as a metric variable, with mean and SD described.

The chi-square test was used as the statistical test to measure the association between two categorical, independent variables. The chi-square test shapes the degree of freedom and can investigate the relationship when two factors have only two categories. Therefore, it can assess whether there is a trend in proportion with the characteristics over the categories of the second factor (Petrie & Sabin, 2019). A chi-square test was used to compare the relation between each cardiovascular risk factor (dichotomy variable) and the severity of depression (ordinal variable), also split for sex.

Different statistical correlation analyses were performed to describe the relationship between the variables. Correlation coefficients are used to assess the strength and direction of the linear relationships between pairs of variables and are quantified with a number, which varies between -1 and $+1$. Zero means there is no correlation, where 1 indicates a perfect correlation. A negative correlation means that the variables are inversely related, meaning as the value of one variable increases, the value of the other increases as well (Akoglu, 2018; Mukaka, 2012). As for a positive number, the variables are directly related and can be interpreted that if one variable increases, the value of the other increases as well (Mukaka, 2012). Spearman's rank correlation coefficient (r_s) is appropriate when one or both variables are ordinal and is robust when extreme values are present (Mukaka, 2012; Petrie & Sabin, 2019). The Spearman's rank correlation coefficient was used to analyse the relationship between the severity of PHQ-9 as an ordinal variable and age in years as a metric variable. This test was also used for the association between secondary diagnosis/mental health and physical health with the severity of depression of PHQ-9.

Phi coefficient test (ϕ) is a statistical measure of an association's strength between two categorical, dichotomous variables. Therefore, variables can be presented in a 2×2 contingency table (Allen, 2017, p. 290). The Phi coefficient was used when comparing the PHQ-9 depressive disorder (no depression/mild depression and depression) and the diagnosis of depression. Furthermore, this test was used to compare each cardiovascular risk factor and sex, both dichotomy variables.

For this thesis, the interpretation of the correlations had been applied from Mukaka (2012) as seen in Table 2.

Table 2: Correlation interpretation by Mukaka (2012)

Size of Correlation	Interpretation
± 0.90 to 1.00	Very high positive/negative correlation
± 0.70 to 0.90	High positive/negative correlation
± 0.50 to 0.70	Moderate positive/negative correlation
± 0.30 to 0.50	Low positive/negative correlation
± 0.00 to 0.30	Negligible correlation

An ordinal regression analysis was performed to analyse the relation of the three selected cardiovascular risk factors, diagnosis depression, sex, and age on the severity of depression according to PHQ-9. Ordinal regression is an extension of logistic regression, where the dependent variable is categorical and ordinal with more than two categories (Petrie & Sabin, 2019). The explanatory variables for levels of depression were the presence of smoking, BMI, hypertension, diagnosis depression, and sex. Sex, smoking, and hypertension were all used as dichotomy variables. As the covariables, participants' age and BMI were set as the measured covariates to describe the relation. The other cardiovascular risk factors, depression, smoking, and hypertension were coded "0" if they were present and "1" if not present. For sex, "1" was coded for men and "2" for women's age. The logit transformation was used to test the probability (Petrie & Sabin, 2019). The estimates of parameters explain the relationship between the independent variables and the dependent variable. The threshold coefficient was

interpreted as the predicted change in log odds of being in a higher category on the dependent variable per unit increase on the independent variable. Generally, this indicates that as the scores increase on an independent variable, there is an increased probability of falling into a higher level on the dependent variable (Adejumo & Adetunji, 2013).

The Model Fitting Information contains the likelihood ratio chi-square test to verify whether there is a significant improvement in the fit of the Final model relative to the Intercept only model. The “Goodness of Fit” table contains the Pearson chi-square test, which exhibits if the model is a good fit for the data. Non-significant is an indicator that the model fits the overall data well. The “Test of Parallel lines” analyses if the regression coefficients are the same for all categories. If the assumption of parallelism is rejected, it is recommended to use multinomial regression, which estimates separate coefficients for each category (Adejumo & Adetunji, 2013; Petrie & Sabin, 2019).

The regression model representative if the test of Parallel lines indicated non-significance with a p-value over 0.05, a Model of Information test with a p-value below 0.05, and the Pearson chi-square test, if the model is a good fit for the data, with a non-significant p-value over 0.05 (Adejumo & Adetunji, 2013; Petrie & Sabin, 2019). The Confidence Interval was set at 95% (Petrie & Sabin, 2019).

The probability distribution was obtained by the two-tailed p-value. “The p-value is the probability of obtaining the results, or something more extreme if the null hypothesis is true (Petrie & Sabin, 2019)”. The smaller the p-value, the greater the evidence against the null hypothesis; therefore, the p-value less than 0.05 was chosen as the significance level for the data analyses. To test the hypothesis, the null hypothesis (H₀) would therefore be rejected with no association between the two variables at the 0.05 level (Petrie & Sabin, 2019).

An electronic database (OpenClinica; www.openclinica.com) was used for the data entry. All analyses were conducted using SPSS version 26.

3. Results

The results are divided into the following categories: a description of the sample, depression with associations to the covariables, description of the cardiovascular risk factors and differences in men and women, the associations between the cardiovascular risk factors and the severity of depression, and to conclude a regression analysis.

3.1. Sample

977 participants were included in the data analysis. The mean age was 57.3 years with a standard deviation (SD) of 8.2, with 20.1% being over the age of 65 years old. More than half of the participants (56%) were female. Demographics and clinical profiles are presented in Table 3 for all respondents. The three most common secondary diagnoses were thyroid disease (24.3%), migraine (14.6%), and depression (9.5%). Of the nine secondary diagnoses, 14% had two diagnoses, and 5.3% have at least three diagnoses. 16.2% were smokers, and 83.8% were non-smokers (35.3% were ex-smokers). The mean BMI kg/m² for all respondents was 27.4, with a SD of 4.4. According to the WHO BMI classification, 58.9% were overweight or people with obesity (Table 3).

Table 3: Characteristics of the sample

N=977		N	%
Age Categories	45-49	206	21
	50-54	203	20,8
	55-59	205	21
	60-64	167	17,1
	>65	196	20,1
Sex	Male	430	44
	Female	547	56
Smoker	Smoker	158	16,2
	Ex-Smoker	345	35,3
	No Smoker	474	48,5
Hypertension	Yes	394	40,3
	No	575	58,9
	Unknown	8	0,8
BMI-WHO- Classification	Underweight	6	0,6
	Normal Weight	395	40,4
	Overweight	382	39,1
	Obesity Class 1	144	14,7
	Obesity Class 2	43	4,4
	Obesity Class 3	7	0,7
Migraine	Yes	143	14,6
	No	830	85
	Unknown	4	0,4
Thyroid disease	Yes	237	24,3
	No	730	74,7
	Unknown	10	1
Self-reported Diagnosis Depression	Yes	93	9,5
	No	883	90,4
	Unknown	1	0,1
Secondary Diagnosis	No Secondary Diagnoses	431	45,5
	1 Secondary Diagnosis	328	34,6
	2 Secondary Diagnoses	137	14,5
	≥ 3 Secondary Diagnoses	52	5,5

3.2. Depression

According to the cut-off scores of the PHQ-9, 639 participants (65.4%) had no depressive disorder, 27.5% (n=269) had a mild depressive disorder, and 7.1% (n= 69) had depressive disorder (Figure 1). The rate of a diagnosed self-reported depression was 9.5% (N=976), and 9.3% of all respondents took a daily antidepressant medication (Table 3). The mean total of the PHQ-9 scale was 4.1, with a SD of 3.5 for all respondents, with a minimum score of 0 and a maximum score of 23.

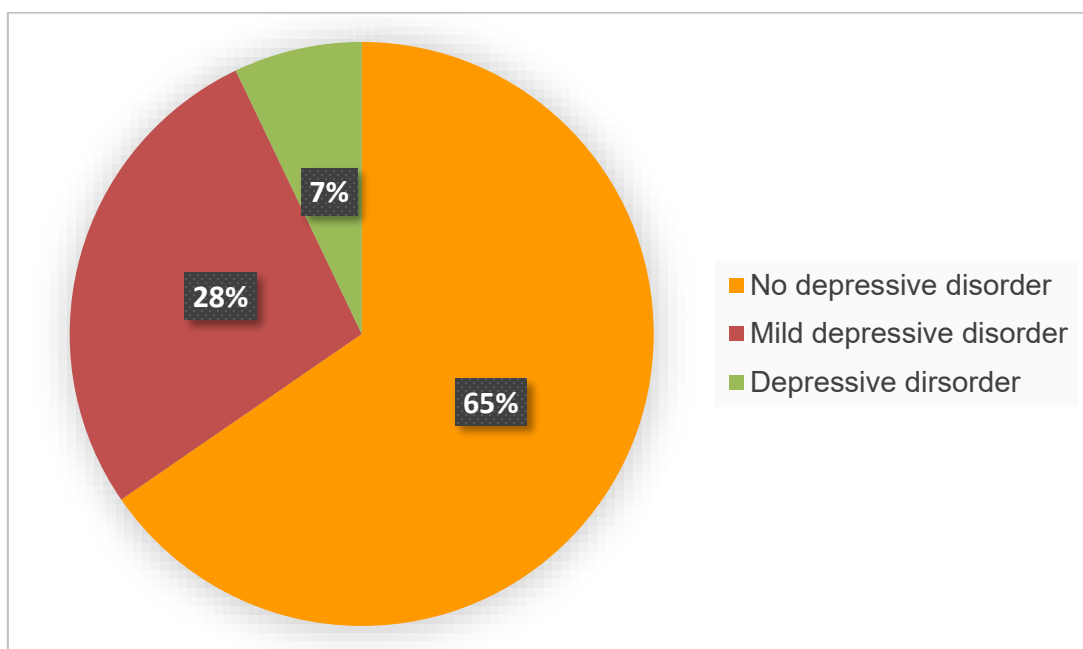


Figure 1: Percent of people in the three depression categories according to the PHQ-9, (N=977)

According to the PHQ-9 7.1% (n=69) had a depressive disorder and 9.5% (n=93) had a self-reported diagnosed depression for all respondents (N=977). Thus, there is a 2.4% difference in the diagnosis of depression and the assessed depression according to the PHQ-9. There was a statistically significant difference between the severity of depression PHQ-9 and the diagnosis of depression ($p < 0.01$). When comparing the PHQ-9 depressive disorder (no depression/mild depression and Depression) and the diagnosis of depression, there was a moderate positive association of [$\phi=0.346$, $p < 0.01$].

3.2.1. Age and PHQ-9

Age was evenly distributed, as seen in Table 3 for categories age 45 until 65. According to Figure 2, there is no linear association between age in years and the total score of PHQ-9. There was no significant correlation ($r_s = 0,104$, $p = 0.052$) between age in years and the severity of depression using the PHQ-9.

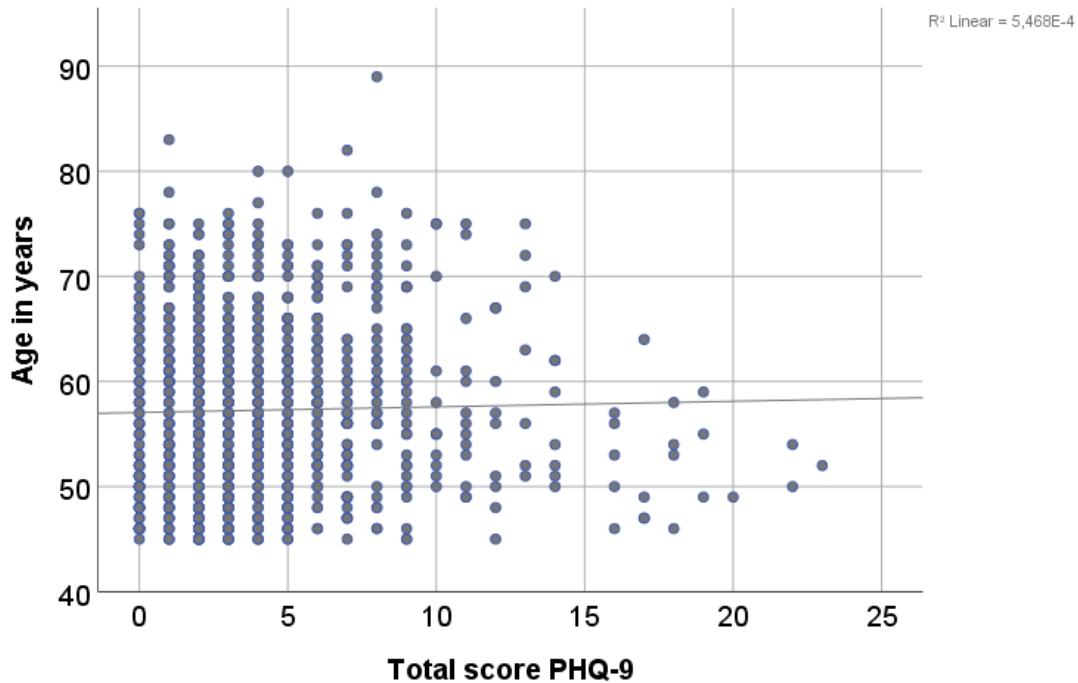


Figure 2: Scatter diagram for age and total PHQ-9 score, (N=977)

3.2.2. PHQ-9 in men and women

According to the cut-offs of PHQ-9, 5,1% of women had a depressive disorder, whereas only 1,9% of the men. 11,3% of the men and 16,3% of the women had a mild depressive disorder (Figure 3). The mean PHQ-9 score was 4.5 with a SD of 3.8 for women, with a maximum score of 23, and 3.7 with SD of 3.2 for men with a maximum score of 19.

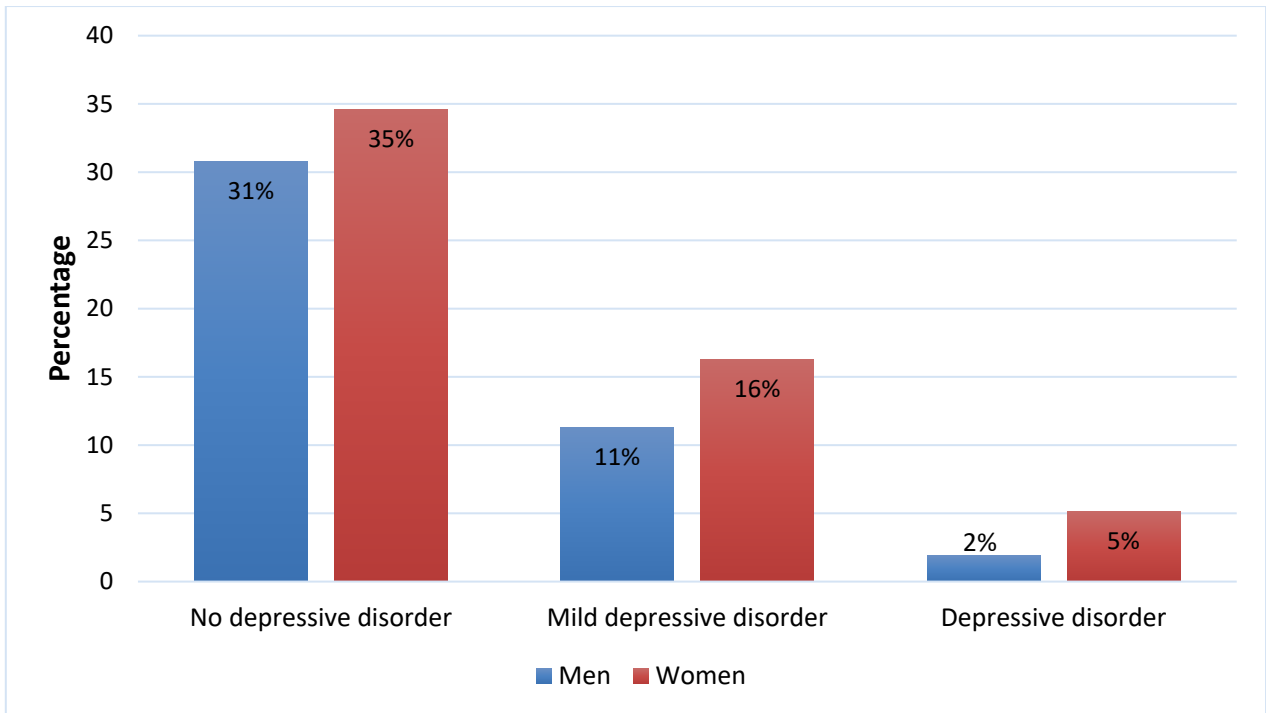


Figure 3: Severity of depression according to PHQ-9 for men and women in %, (N=977)

There was a statistically significant difference between sex and the severity of depression [$\chi^2(2) = 11,144$ $p=0.004$].

3.2.3. Physical/mental condition and PHQ-9

Many participants rate their physical condition and mental condition as good or very good, 2.9% and 3.7% as poor. 29.1% rate their physical condition as fair, 14.2% rate their mental condition as fair. (Figure 4 and 5)

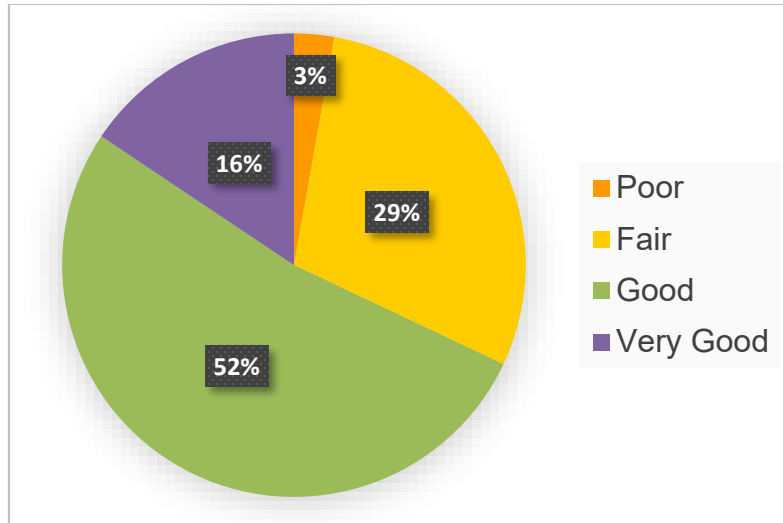


Figure 4: Self-rated physical condition in %, (N=977)

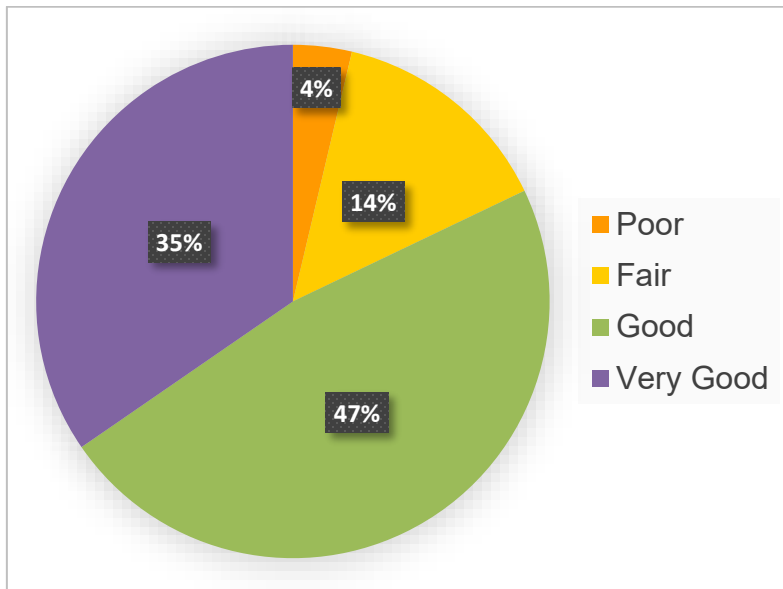


Figure 5: Self-rated mental condition in %, (N=977)

The physical condition had a significant negative low correlation with the severity of PHQ-9, which means the higher the score of physical condition (1= poor and 4= very good), the lower the severity of depression (1= no depression, 3=depression) [$r_s = -0,274$, $P < 0, 01$]. Furthermore, there was a significant low correlation between mental condition and the severity of depression. The higher the score of mental condition (1= poor and 4= very good), the lower the severity of depression [$r_s = -0,360$ $p < 0, 01$].

3.2.4. Secondary diagnoses and PHQ-9

Of nine secondary diagnoses, 45.5% had no secondary diagnosis, as seen in Table 3. 24,3% of the participants had thyroid disease, and 1.9% a chronic obstructive pulmonary disease (COPD), as seen in Figure 6.

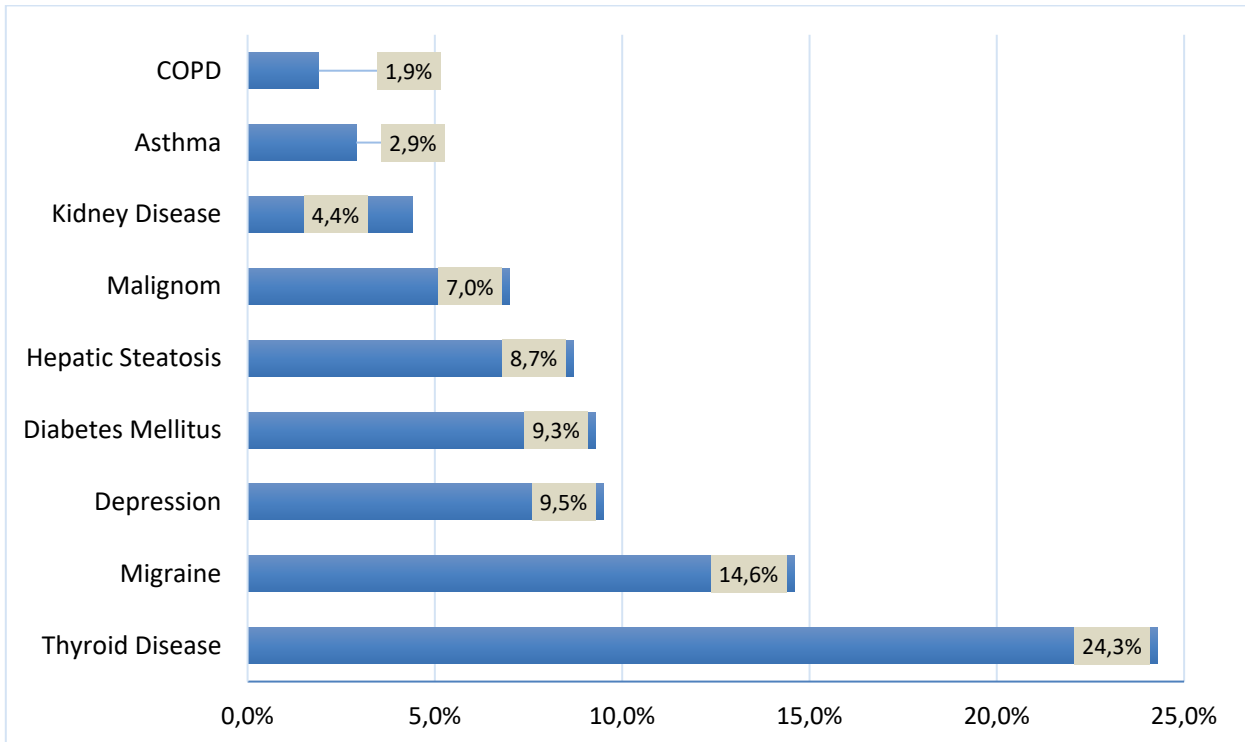


Figure 6: Secondary diagnosis in % for the respondents with a known diagnosis

5.5% of the participants had at least three of the nine secondary diagnoses, as seen in Table 3. There was a significant positive low correlation [$r_s = 0,224$, $p < 0.01$] between the amount of secondary diagnosis and the severity of PHQ-9. Therefore, as the number of secondary diagnoses increases (“1” = no secondary diagnosis, “4” = ≥ 3 secondary diagnosis), the higher the severity of depression according to PHQ-9.

3.3. Cardiovascular risk factors

3.6% of the participants (N=969) had all three selected cardiovascular risk factors, as shown in Table 4. 36.9% (n=358) had at least two cardiovascular risk factors. 26.7% of the participants were overweight and had hypertension.

Table 4: Distribution of cardiovascular risk factors in %, (N=969)

Cardiovascular risk factors			N	%
BMI ≥25kg/m ²	Hypertension	Smoker	35	3,6
		No Smoker	259	26,7
	No Hypertension	Smoker	45	4,6
		No Smoker	229	23,6
BMI <25kg/m ²	Hypertension	Smoker	19	2
		No Smoker	81	8,4
	No Hypertension	Smoker	55	5,7
		No Smoker	246	25,4

In the following subtitles, the relation between sex and the three cardiovascular risk factors are presented.

3.3.1. Hypertension in men and women

21% (n= 199) of the sample were men with hypertension, 20% (n=195) were women with hypertension, as shown in Figure 7.

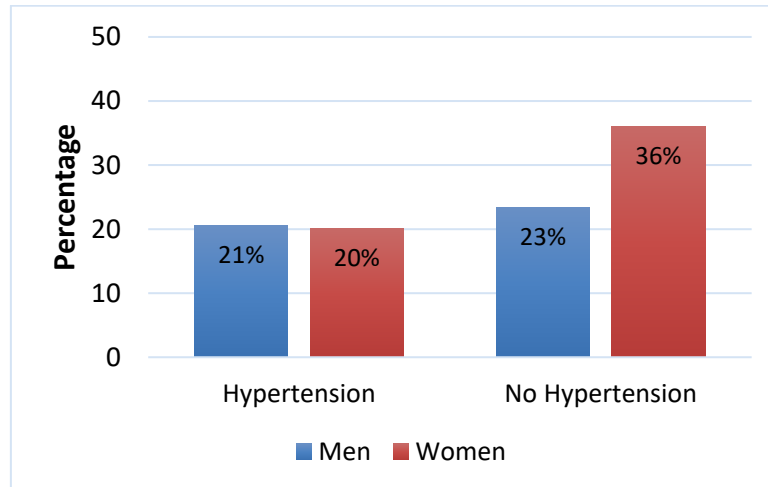


Figure 7: People with hypertension/ no hypertension between men and women in %, (N=969)

Sex and Hypertension had a negative low significant relationship [$\phi = -0,111$ with $p < 0.01$], indicating that the variables are inversely related.

3.3.2. Overweight in men and women

33% (N=320) of the men were overweight, whereas 26% (N= 256) of the women were overweight, as shown in Figure 8.

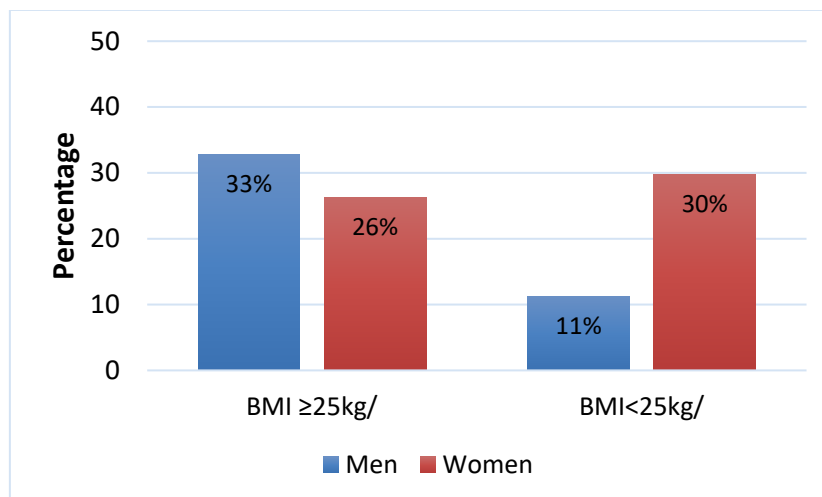


Figure 8: People for overweight/ no overweight between men and women %, (N=977)

Sex and overweight had a positive low significant association [$\phi = 0.279$, $p < 0.01$].

3.3.3. Smoking in men and women

7% (n=66) were male smokers and 9% (n=92) were female smokers in all respondents, as shown in Figure 9.

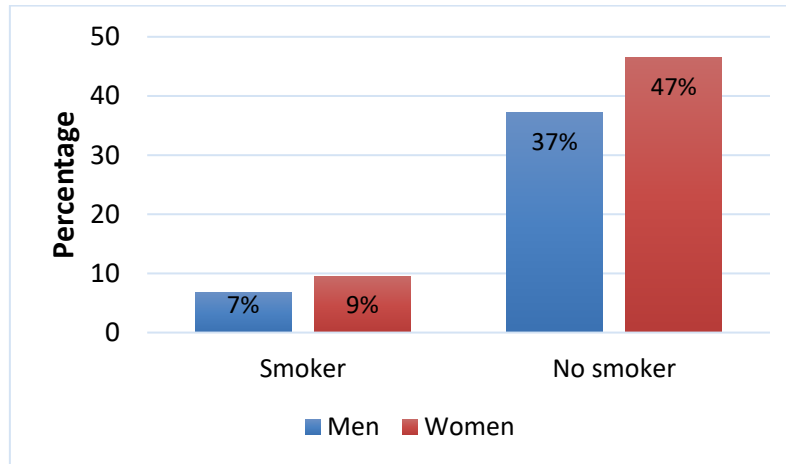


Figure 9: Smokers and no-smokers between men and women in %, (N=977)

Sex and smoking had a negative negligible non-significant relationship [$\phi = -0,020$ with $p = 0.536$].

3.4. Cardiovascular risk factors and depression

In the following chapters, associations of cardiovascular risk factors and depression according to the severity of depression are presented. Furthermore, a regression model was used to identify the relation of cardiovascular risk factors, age, sex, and diagnosis of depression as the independent variables to the severity of depression.

3.4.1. Cardiovascular risk factors and severity of depression

The cardiovascular risk factors according to PHQ-9 cut-offs are presented in Figure 1 for all respondents, with the percentage according to the three categories of depression for each cardiovascular risk factor. From people with depression (n= 69) 69.6% were overweight and people with a mild depression (n=269) 62.1% were overweight. According to the means for BMI kg/m^2 : The mean for no depression was 26.1 kg/m^2 with a SD of 4.1, mild depression was 26.7 kg/m^2 with a SD of 4.7, and for major

depression, it was 28 kg/m² with a SD of 5.4. For people with hypertension, 38.2% had a depression (n=68) and 50% a mild depression (n=266). 24.6% of the smokers had depression (n=69) and 17.1% had mild depression (n=269).

Results show a significant association between hypertension and the severity of depression (p<0.01). There was no statistically significant association between the severity of depression and smoking or BMI risk.

Table 5: Cardiovascular risk factors and severity of depression

Cardiovascular risk factors		No Depression		Mild Depression		Depression		N		p
		N	(%)	N	(%)	N	(%)	N	(%)	
BMI**	≥25kg/m ²	361	56,5	167	62,1	48	69,6	576	59	0.052
	<25kg/m ²	278	43,5	102	37,9	21	30,4	401	41	
Hypertension*	Yes	235	37	133	50	26	38,2	394	40,7	0.001
	No	400	63	133	50	42	61,8	575	59,3	
Smoking Status**	Yes	95	14,9	46	17,1	17	24,6	158	16,2	0.099
	No	544	85,1	223	82,9	52	75,4	819	83,8	

N=968*, N=977**

3.4.2. Cardiovascular risk factors and severity of depression between sex

12.5% of women with overweight (N=256) had depression, 9.7% of women with hypertension (N=195) had depression and 10.9% of women smokers (N=92) had depression. 5% of men with overweight (N=320) had depression, 3.5% of men with hypertension (N=199) had depression and 10.6% of men smokers (N=66) had depression. There was a statistically significant relationship between men and all cardiovascular risk factors, as shown in Table 7. There was a statistically significant relationship between women and overweight, but not for smoking or hypertension (Table 6).

Table 6: Cardiovascular risk factors and severity of depression in women

Cardiovascular risk factors in women	No Depression		Mild Depression		Depression		N	p
	N	(%)	N	(%)	N	(%)		
BMI $\geq 25\text{kg/m}^2$ *	148	57.8	76	29.7	32	12.5	256	0.027
Hypertension **	112	63	64	32.8	19	9.7	195	0.233
Smokers *	53	57.6	29	31.5	10	10.9	92	0.636

N=968*, N=977**

Table 7: Cardiovascular risk factors and severity of depression in men

Cardiovascular risk factors in men	No Depression		Mild Depression		Depression		N	p
	N	(%)	N	(%)	N	(%)		
BMI $\geq 25\text{kg/m}^2$	213	66.6	91	28.4	16	5	320	0.029
Hypertension	123	61.8	69	34.7	7	3.5	199	0.000
Smokers	42	63.6	17	25.8	7	10.6	66	0.027

N=968*, N=977**

3.4.3. Association between cardiovascular risk factors and the severity of depression

For the regression analysis, the dependent variable was the severity of depression according to the PHQ-9. The independent variables were gender, age, self-reported diagnosis of depression as for the three cardiovascular risk factors hypertension, BMI, and smoking. For the Model Fitting Information analyses, we can read a significant improvement in the fit of the Final model over the null model [$\chi^2(6) = 122,164$, $p < 0.01$]. The “Goodness of Fit” table containing the Pearson chi-square test, with a non-significance p-value [$\chi^2(1886) = 1836,413$, $p = 0.789$], was an indicator that the model fits the overall data well. Furthermore, the test of Parallel lines indicated non-significance; therefore, the results of the assumptions can be interpreted as satisfied ($p = 0.66$). In Table 8, the regression coefficients, parameter estimates and significance tests for each independent variable in the model are listed.

Table 8: Ordinal Regression for cardiovascular risk factors on the severity of depression

Variables	Estimates	Standard Errors	Sig.	95% Confidence Interval (CI)	
				Upper Bound	Lower Bound
BMI kg/m ²	,033	,016	,045	,001	,065
Age in years	,003	,009	,761	-,015	,020
Smoker	,211	,187	,261	-,156	,577
Men	-,435	,145	,003	-,719	-,151
Hypertension	,339	,156	,030	,033	,645
Diagnosis Depression	2,138	,227	,000	1,694	2,582

Dependent Variable: Severity of Depression according to PHQ-9, (N=977)

For every one-unit increase of BMI kg/m², there was a significant predicted probability increase of 0.033 in the log odds of being in a higher level of depression with a CI: (0.001-0.065). Hypertension was a significant positive probability predictor of falling into a higher level of depression with a difference of 0.339 in the log odds with a CI: (0.033 -0.645). The variable sex was a significant negative predictor of falling into a higher level of depression, indicating a difference of 0.435 in log odds with a CI: (-0.719- -0.151). On average, the log odds of falling into a higher level of depression for men was 0.435 less than for women. The diagnosis of depression was a significant positive predictor of falling into a higher level of depression of 2.138 in the log odds. Smoking and age were non-significant predictors for falling into a higher level of depression with a p-value above 0.05. According to this regression model, women with hypertension and higher BMI and a diagnosis for depression were significant predictors to fall into a higher level of depression.

4. Discussion

The overall aim of this thesis was to examine the association between selected cardiovascular risk factors (*hypertension, BMI, smoking*) and depression for an adult population in Austria. Reported in the results is a significant association between hypertension and the severity of depression in the sample. Moreover, hypertension was a significant predictor for falling into a higher depression level, adjusted for age, gender, diagnosis of depression, BMI, and smoking status. A person with an elevated BMI was likewise more likely to fall into a higher level of depression. The second aim of this thesis was to examine the association between men and women and identify sex-related differences. There was a significant association between all three cardiovascular risk factors for men and, a significant relationship was found for women with a high BMI and depression.

Moreover, as seen in the regression analysis, women were more likely to fall into a higher level of depression than men. Three of the presumptions were proven to be false, and four were true. Smoking status had no association between men and women, and therefore, the assumption is that there is no difference between sex and smoking for this sample. The difference between a diagnosis of depression and depression according to PHQ-9, the presumption there was no difference had to be rejected, resulting in a distinction between diagnosis of depression and the PHQ rated depression. Furthermore, the presumption of a high BMI being the single significant predictor of depression was false. According to the analysis, hypertension was likewise a significant predictor for depression, adjusted for age, sex, diagnosis of depression.

4.1. Hypertension and depression

The rate of hypertension was 40% in this sample, which is relatively high. In comparison to the prevalence for European countries, it was nearly 25%. In our results, hypertension was significantly associated with the severity of depression. The p-value indicated that these two variables are not independent of each other. Furthermore, as seen in the regression analyses, hypertension was significantly more likely to appear in a higher level of depression. Several published studies have reported that depression

is prevalent in people with hypertension (Maatouk et al., 2016; Rantanen et al., 2018; Scalco et al., 2005). Rantanen et al. (2018) main finding was that previously diagnosed people with hypertension had a higher risk for depressive symptoms than people unaware of their hypertension. This finding can be due to factors such as mental distress and the number of health care visits a person with a known diagnosis of hypertension has.

Moreover, depressive symptoms were associated with people with hypertension even without comorbidities (Rantanen et al., 2018). This finding implies that knowing one's diagnosis for hypertension may negatively influence depressive symptoms. In our sample, the participants were assessed for the diagnosis of depression, therefore knowing their condition, which may, according to Rantanen et al. (2018), influence depressive symptoms.

Another cross-sectional analysis found that older adults with symptoms of depression had significantly increased odds of having a diagnosis of hypertension (Maatouk et al., 2016). Furthermore, a literature review (Scalco et al., 2005) describes that higher blood pressure levels and incidents of hypertension increased the prevalence of depression. However, Patel et al. (2018) explain that hypertension was not a predicted risk factor for atypical major depressive disorder compared to no major depressive disorder in a prospective longitudinal study. Contrary to a cohort study by Polanka et al. (2018), hypertension was significantly a stronger predictor of incident CVD in people with a lifetime depressive disorder than in those without hypertension.

Depression is reported by Scalco et al. (2005) to impair the management and prognosis of hypertension. The relationship between depression and hypertension may be pathologically explained by the hyperreactivity sympathetic nervous system and genetic influences as underlying mechanisms. Moreover, antidepressants may interfere with BP management of patients, with side effects causing blood pressure changes (Scalco et al., 2005). In summary, the relationship between depression and hypertension is a complex concern, overall indicating our sample's results, a relationship between depression and hypertension. Moreover, depressive symptoms

have been common in patients with hypertension (Polanka et al., 2018; Rantanen et al., 2018; Scalco et al., 2005).

4.2. Overweight and depression

The findings of this study suggest that elevated BMI was associated with a higher incidence of having a higher level of depression which refines compelling evidence by Patel et al. (2018), where people with obesity had a greater chance of future atypical depression. A meta-analysis of 15 prospective studies also revealed that baseline obesity is associated with a greater chance of later depression (Luppino et al., 2010). On the other hand, Luppino et al. (2010) also added the result that depression was found to be a predictor of developing obesity.

According to a cross-sectional survey, obesity (BMI of $\geq 30\text{kg/m}^2$) was associated with a significant increase in a lifetime diagnosis of major depression, with an approximately 25% increase in the likelihood of mood and anxiety disorders (Simon et al., 2006). Simon et al. (2006) suggests that a variation across demographic groups, such as social or cultural factors (religion, socioeconomic status, nationality) may moderate or mediate the association between obesity and mood disorder. Social or cultural factors were not analysed in this sample, which may have influenced the results.

There was no significant association between BMI $\geq 25\text{kg/m}^2$ and depression for all respondents in this sample. Results showed a significant difference in the severity of depression only in men. A cross-sectional survey from Simon et al. (2006) found that the association between obesity and depression did not vary significantly between men and women.

Unlike the results in this sample, a cross-sectional study from Berg et al. (2018) identified a significant relationship between depression and obesity for both men and women. Berg et al. (2018) used a self-reported BMI of $\geq 30\text{kg/m}^2$ and a different screening tool for depression, the HADS. The meta-analyses by Luppino et al. (2019) had nevertheless shown that the association between depression and obesity was more substantial than the association between depression and being overweight. In general, this may suggest that a higher cut-off of BMI kg/m^2 may have led to a

significant association between obesity (BMI of $\geq 30\text{kg/m}^2$) and depression. However, in this study, a BMI of $\geq 25\text{kg/m}^2$ cut-off was set in our study due to the guidelines demonstrating an increased risk of CVD with this value (Jennings et al., 2016). The biological mechanisms of the association between obesity and depression remain unclear. However, system inflammation may be an underlying cause. Therefore the etiology of depression has been linked to cardiovascular risk factors such as hypertension and smoking since they both promote inflammation (Patel et al., 2018).

4.3. Smoking and depression

The regression analysis had shown that active smoking was no predictor for a higher level of depression. No association was found between depression and smoking in the sample. According to a literature review, most studies report an association between a baseline depression and onset smokers as well as for smoking history (smoking in the past and now) (Fluharty et al., 2016). A cross-sectional study had also found a significant association between current smoking and depression in cardiovascular patients (Berg et al., 2018). Patel et al. (2018) found that current smoking did not predict major depression. Their cohort study further discovered that only former tobacco consumption predicted depression (Patel et al., 2018). The review by Fluharty et al. (2016) found overall inconsistent findings regarding whether smoking leads to depression or vice versa or if there is a bidirectional relationship between the two. To be noted is the fact that there are different assessments for evaluating smoking categories, such as smoking onset, smoking status, smoking volume, and tobacco dependency (Fluharty et al., 2016). In our study, the smoking status was assessed by self-report. Smoking as a cardiovascular risk factor has no safe level of consumption; even low tobacco use is harmful, therefore indicating that a comprehensive assessment by asking patients about their smoking status is necessary (Jennings et al., 2016).

4.4. Sex differences in depression and cardiovascular risk factors

According to the literature, there is a difference between cardiovascular risk factors between men and women, which can also be seen in the results of this study (Garcia et al., 2016; Griebler et al., 2014). Risk factor differences between sexes may also be

explained that although more women die from CVD than men, it is suggested that women are dying at an older age from CVD, particularly up until menopause (Timmis et al., 2020).

For smoking, no significant sex-related difference was found in this study. However, according to reviews and cross-sectional studies, there are fewer adult women smokers (Dorner et al., 2020; Garcia et al., 2016; Griebler et al., 2014; Timmis et al., 2020). There was a significant relationship between smoking and the severity of depression for men; this did not account for female smokers in this sample. A systematic literature review found two studies reporting that depression was associated with smoking behaviors for men, while only one study reported this for women (Fluharty et al., 2016).

A BMI of 25kg/m² and over was more prevalent amongst men in this sample, with 33% being overweight. The obesity prevalence was consistently higher among women; however, it has changed in recent years in many European countries. In Austria, for some years now, the obesity rate among men has risen sharply, overtaking that among women (Großschädl & Stronegger, 2019). The prevalence of obesity for men was higher in high-income countries in Europe, also according to Timmis et al. (2020). This trend can be seen in the United States of America; therefore, the prevalence of obesity has increased over the past years for men, with no significant difference in the prevalence between men and women (Fryar et al., 2020).

In our sample, there was a significant association between BMI with the severity of depression split for men and women, which could not be seen when analysing the association between all respondents. Rantanen et al. (2018) describe depressive symptoms as being strongly associated with female gender and obesity.

Moreover, there was a significant relationship between hypertension and sex, therefore confirming the hypothesis of a difference between hypertension for men and women. The rate for hypertension was higher for men in this sample. The prevalence for men with hypertension is higher in European countries (Timmis et al., 2020); however, according to trend analysis, there was no difference between hypertension and sex in

Austria (Großschädl et al., 2015). According to Garcia et al. (2016), women develop hypertension later in life; therefore, hypertension is more prevalent in older women. In subgroup analysis, only men with hypertension were found to be significantly associated with the severity of depression.

According to the regression model, women were more likely to have a higher level of depression than men. Women, adjusted for age, diagnosis of depression, smoking, and hypertension, were more likely to fall into a higher level of depression. Therefore, confirming the hypothesis that women with at least one cardiovascular risk factor having a higher level of depression than men. Depression, as demonstrated by literature, is more common for women (Nowotny et al., 2019). In this sample, the prevalence of depression according to the PHQ-9 was double as high for women than for men, with 9,1% and 4,4%. A significant association between sex and depression according to the PHQ-9 was found, confirming the hypothesis of a difference between sex and depression. According to the regression analysis, women, adjusted with the covariables, were more likely to fall into a higher level of depression. Corresponding to Albert (2015) depression is linked to hormonal changes in women, particularly during puberty, prior to menstruation, following pregnancy, and at perimenopause, suggesting that hormonal fluctuations may trigger a higher occurrence of depression in women.

4.5. Influencing factors of depression

Age was the only covariable that had no significant association with depression. Our sample was evenly distributed. Depression is common in middle-aged people, between the ages of 45 and 59, for both men and women (Nowotny et al., 2019; US Preventive Services Task Force, 2016). Furthermore, in the regression model, age was not a predictor for a higher level of depression. In general, these results suggest that a depressive disorder was not operating as a substitute for age, which can be seen in another recent regression model. Polanka et al. (2018) found that age had no significant influence when analyzing associations between obesity, hypertension, and smoking with depression. Another cross-sectional study examined the association between obesity and mood disorders and found no significant variation across age groups (Simon et al., 2006).

A secondary diagnosis had a significant correlation with the severity of depression in our sample. Chronic diseases have been linked to an increased risk for depression (Nowotny et al., 2019; US Preventive Services Task Force, 2016). Furthermore, a systematic literature review found evidence that the risk of depression was twice as high for people with multimorbidity compared to those without multimorbidity. There was a 45% greater chance of having a depressive disorder with each additional chronic physical disease compared to no chronic physical condition. Moreover, a significant association between the number of chronic conditions and depressive symptoms was reported (Read et al., 2017).

Subjective physical and mental health had a significant relationship with depression in this sample. According to Niles and O'Donovan (2019) poorer physical (for instance, back pain or headache problems) and mental health (for example, anxiety or sleeping problems) may lead to a higher level of depression. Depression has been identified as a strong predictor for poor future physical health, and physical symptoms (trouble with pain or eyesight) have been described to worsen symptoms of depression (Niles & O'Donovan, 2019). In general, an increased risk of depression is demonstrated for people with a physical illness, especially with a chronic course. The explanation may be that each serious physical condition is a stressful life event promoting a provocative challenge, where individual alterations and coping strategies are needed (Nowotny et al., 2019). Mental health and mental disorders have also been described to influence depression, with more mental disorders having more negative consequences for depression symptoms (Nowotny et al., 2019; US Preventive Services Task Force, 2016).

4.6. Differences in self-reported depression diagnosis and measured depression according to the PHQ-9

The hypothesis of no difference between self-reported depression diagnosis and depression according to the PHQ-9 had to be rejected as there was a significant difference in the diagnosis of depression and the PHQ-9 depressive disorder. In this sample, the total rate of depression according to the PHQ-9 was 7.1% for all

respondents. There was a difference of prevalence between screening for depression with a cut-off score of and above ten and a self-reported diagnosis of depression. More people had a diagnosis of depression than those being positively screened for depression (PHQ-9), with a discrepancy of 2.4%. Also noteworthy is the prevalence of antidepressants and a diagnosis of depression, being nearly similar with 9,3% and 9,5%. This finding may conclude that people diagnosed with depression and a daily antidepressant therapy could have shown fewer depressive symptoms (Montgomery & Kasper, 2007). The one-year prevalence of depression in Austria of 9.8%, according to the Depression Report, is also similar to our results for the self-reported diagnosis of depression with 9.5% (Nowotny et al., 2019).

Contrary to this, the PHQ-9 has been shown not to exclude participants already diagnosed as having or being treated for depression (Levis et al., 2019). The research from Levis et al. (2019) finds agreement with the regression analysis results of this study. Therefore, people with depression were significantly more likely to be in a higher level of depression according to the PHQ-9, adjusted with the other explanatory variables.

The PHQ-9, as the screening tool for depression in this sample, with the cut-off score set at ten or above for a depressive disorder, was used according to the German manual (Löwe et al., 2002) and can be seen as the standard cut-off score for screening to identify possible major depression in most studies (Levis et al., 2019). Semi-structured interviews about psychosocial factors can also help diagnose depression while using the PHQ-9 to achieve better sensitivity and better outcomes of diagnosing depression (Jha et al., 2019; Levis et al., 2019). Furthermore, it is recommended to consider estimating depression across the full spectrum of PHQ-9 screening scores instead of having dichotomous cut-off variables. The combination of screening for specific characteristics generates individualized screening for possible major depression (Levis et al., 2019).

A recent study (Levis et al., 2019) developed a web-based tool ("The depressed Project") that health professionals can use to estimate the expected number of positive screening and screening that are true and false positives. This web-based tool can

enable the understanding of health professionals considering using the PHQ-9 to screen for depression. According to the web-based tool, the reported prevalence of our study with 7% and a cut-off score of ≥ 10 , 20 of 100 patients (20%) in this sample would screen positive for possible depression. Of the 20 people who would screen positive for depression, 6 (30%) would meet diagnostic criteria for major depression (true positives), and 14 (70%) would not meet diagnostic criteria for major depression (false positives). Of the 80 people who screen negative, 79 (99%) would be correctly ruled out (true negatives), and 1 (1%) would be missed as a major depressive case (false negatives) (Levis et al., 2019).

4.7. The focus of prevention for cardiovascular risk factors

The hypothesis that people with at least one cardiovascular risk factor having a higher level of depression could be confirmed. In summary, this study suggests that people with hypertension and elevated BMI, adjusted for age, sex, diagnosis of depression, and smoking, are more likely to have major depression than not having depression. This result is similarly consistent with another cross-sectional study in primary care settings suggesting that female gender and obesity are factors predisposing patients with hypertension to depression (Rantanen et al., 2018), only for smoking this could not be seen in the sample of this study. Rantanen et al. (2018) also underline the importance, while treating diagnosed hypertensive people, of considering depressive symptoms to promote good lifestyle habits and better management of hypertension.

The overall differences between the studies on the association of depression and cardiovascular risk factors are likely due to different measurements, cut-offs, and screening tools used to evaluate or assess depression and cardiovascular risk factors. Therefore, leading to the certain inconsistency of the results with other studies. However, there is a significant underlying association between certain cardiovascular risk factors and depression (Berg et al., 2018; Fluharty et al., 2016; Luppino et al., 2010; Maatouk et al., 2016; Simon et al., 2006), as seen in this sample. This awareness could lead to prevention, early detection and ultimately reduce the burden on all conditions (Luppino et al., 2010).

4.8. Limitations and strengths

Due to the natural cross-sectional design of the study, where only a “snapshot” of the situation can be formed, no causal inference can be made. This design concluded that the problem might provide conflicting results if another time frame had been chosen or may have differed across different sociodemographic groups. Furthermore, the findings of this sample do not indicate a specific mechanism or causal direction of cardiovascular risk factors and depression or vice versa (Levin, 2006). The estimated incidence or prevalence of the disease or the odds of a new event in a particular period cannot be calculated with the study design of this paper (Petrie & Sabin, 2019); therefore, the term rate was used to describe the sample. Many participants were recruited through the outpatient clinics of the Department of Cardiology, Endocrinology and Diabetics. A weakness in this study is that a non-probability method was used for recruitment. This recruitment method leads to a non-representative sample, especially for cross-sectional studies (Levin, 2006). The results can therefore not be generalized to the whole population.

Furthermore, no power calculation was performed to estimate the optimal sample size, which can be necessary to detect an important stimulating effect (Petrie & Sabin, 2019). Another weakness of this study is that data from the socioeconomic status had not been analysed, even though it is known that a lower socioeconomic status influences cardiovascular risk (Jennings et al., 2016) and depression (Nowotny et al., 2019; US Preventive Services Task Force, 2016). For this study, socioeconomic status had been evaluated at baseline screening. However, it was not entered into the database, which should be considered for future studies of this sample.

Furthermore, increased BMI and hypertension have been significantly associated (Großschädl et al., 2015) as CVD risk factors (Maatouk et al., 2016); therefore, potentially could have been a cofounder in relation to depression (Petrie & Sabin, 2019). A reporting bias may have occurred since self-reported measurements such as hypertension and other factors can be seen as unacceptable. Respondents tend to answer in the direction perceived of interest, and therefore may be smoking was seen as a negative behavior and not assessed correctly (Petrie & Sabin, 2019). Other CVD

risk factors (physical activity, alcohol, cholesterol) may have also been influential in the combined results of cardiovascular risk factors and depression (Berg et al., 2018; Polanka et al., 2018). Furthermore, the wide confidence intervals for the significant results in the regression analyses indicate that the estimates are imprecise (Petrie & Sabin, 2019). These are all limitations of this study that warrant consideration.

Despite these limitations, this study is the first to examine the association between cardiovascular risk factors and depression in an adult Austrian population and used a highly recognized screening tool for depression in cardiac research (Jha et al., 2019). Although self-reported smoking and hypertension are no gold standards, it has shown to be a representative method (Patel et al., 2018) Current BMI was directly measured from the participants, which is more precise than a self-report of height and weight (Polanka et al., 2018). Furthermore, the PHQ-9 screening tool for depression is supported by literature and exemplifies as a gold-standard instrument (Ceccarini et al., 2014) and has been highly recommended (Levis et al., 2019; US Preventive Services Task Force, 2016). The level of non-response can be an issue; however, there were only a few missing data for this sample, which can be seen as a significant strength. The results estimated the prevalence of an outcome, and many risk factors were assessed at one point in time, which can be helpful in public health planning.

Additionally, the design is beneficial when the purpose of the study is descriptive, for instance, in the form of a survey (Levin, 2006). In addition, a specifically adapted extensive electronic database (OpenClinica; www.openclinica.com) assured the quality of data entry and continuous data monitoring. Furthermore, due to the prospective design of the BioPersMed study, this data set is available for further longitudinal comparisons with follow-up visits in the future. Overall, the results of this study have possible theoretical, research, and clinical implications.

5. Implications for the global care pathway for cardiovascular risk factors

The possibility of early detection and management of cardiovascular risk factors to reduce the excess CVD risk in depressed people has already been emphasized in the literature, however not highlighting differences between men and women (Jha et al., 2019; Polanka et al., 2018). Therefore, this analysis underlines the importance of sex differences in the association between cardiovascular risk factors and depression. Further longitudinal research is needed, and sex differences should be added in conceptual frameworks and practical implications in settings where CVD primary prevention occurs. Gender-specific differences in depression such as symptom presentation, health behaviors, and coping strategies have been reported, where targeted interventions for men and women may be helpful (Nowotny et al., 2019). In total, longitudinal studies with a probability sample are needed to identify the trend of cardiovascular risk factors on depression and vice versa and generalize the results to the whole population. Clinical trials with an experimental design are also highly effective in assessing preventive measures as also whether exposure (hypertension) to a factor (depression) causes an effect (CVD disease) (Petrie & Sabin, 2019). A further recommendation for research is to examine the biological mechanisms of the association between people with obesity and depression, which until now remains unclear.

It is essential to understand better the effect of routine screening of depression for clinical outcomes of patients with CVD risk (Ceccarini et al., 2014; Jha et al., 2019). Clinical trials are necessary to determine whether depression screening should be implemented as part of routine care (Levis et al., 2019). However, several guidelines have emphasized screening for depression in a cardiac setting, which may have overall benefits on the individual's health outcomes (Ceccarini et al., 2014; Jha et al., 2019). The general recommendation is to screen for depression in adults independent of age, where people may have depression but may not have been identified yet (Levis et al., 2019; US Preventive Services Task Force, 2016). Furthermore, sociodemographic

status should be evaluated due to the possible influence on depression and cardiovascular risks (Nowotny et al., 2019; Timmis et al., 2020). Due to the overall benefits and fundamental approaches of screening for depression in CVD patients (Hare et al., 2014; Ivanovs et al., 2018; Jha et al., 2019), screening for depression has been adapted into the global care pathway (Figure 10).

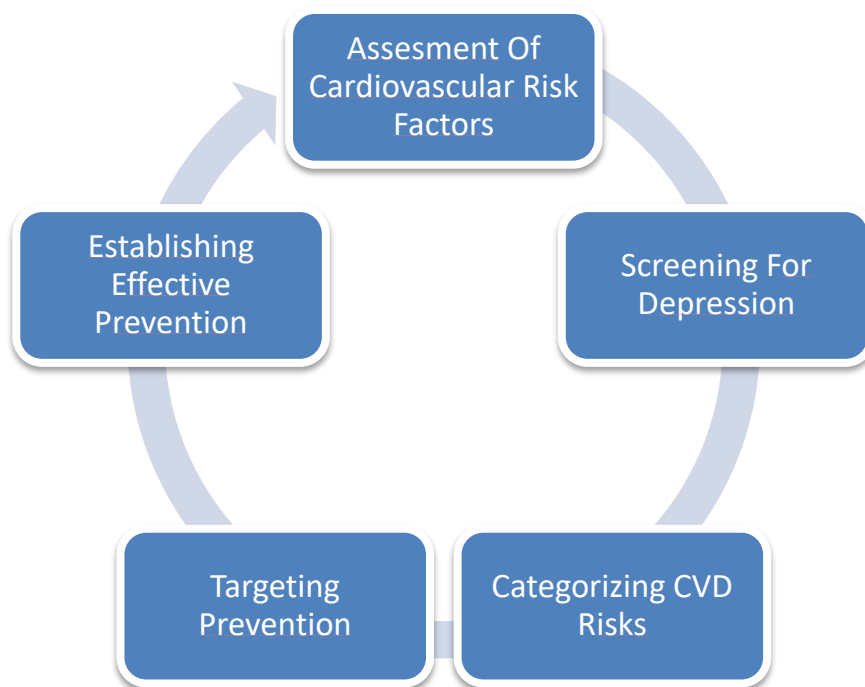


Figure 10: The cycle of global care pathway for CVD prevention adapted by the ESC prevention Handbook by (Jennings et al., 2016)

Nurses are well known as the largest group of healthcare professionals with the necessary education and skills to address primary and secondary prevention of CVD (Berra et al., 2019). People presenting themselves to a health care environment should be assessed for cardiovascular risk by identifying cardiovascular risk factors, such as smoking status, weight status, diet habits, blood pressure levels, blood lipid levels, blood glucose levels, etc. Further risk assessment tools such as the SCORE for European Countries can be used to estimate their cardiovascular risk (Jennings et al., 2016).

Screening for depression can initially be done in a clinical interview or consultation, with questions on the psychological and social state, or by administering a short screening tool like the PHQ-2 (with only two questions). As the largest healthcare group, nurses are often the first to initially assess and screen for depression (Halcomb et al., 2019). If positive, further screening is necessary and should be implemented (Ceccarini et al., 2014; Jha et al., 2019). A more robust method may be administering a validated PROM questionnaire with a standardized consultation or semi-structured diagnostic interview (Jennings et al., 2016, p. 159; Levis et al., 2019).

The overall cardiovascular risk should then be categorized on how high of a risk this person is confronted (Jennings et al., 2016, p. 183). Depression can also be categorized into levels of severity (Levis et al., 2019). Subsequently, when targeting the prevention, people who screened positive for depression should be referred to health professionals such as a psychologist or psychiatrist to follow a precise evaluation and, if necessary, start a specific psychological therapy (Ceccarini et al., 2014). Nursing interventions for people with depression such as cognitive therapy, behavioral therapy, case management, nurse-based telehealth have been reported to significantly decrease depressive symptoms and increase patient satisfaction (Halcomb et al., 2019).

Various cardiovascular risk factors require specific interventions while identifying the appropriate setting. For instance, a program in lifestyle changes such as maintaining a healthy diet, sustaining a healthy weight, managing blood pressure can be implemented (Jennings et al., 2016). A prevention CVD strategy for people, with depression, without depression or depressive symptoms, should be effectively established (Ceccarini et al., 2014; Hare et al., 2014; Jennings et al., 2016; Jha et al., 2019; Nowotny et al., 2019). Caregivers, like nurses, play an essential role in establishing behavioral strategies to help their patients and family members to achieve healthy lifestyle changes. A necessary factor of the global care pathway is evaluating the outcome of the prior targeted prevention intervention by measuring the effects annually (Jennings et al., 2016). Especially people who are undergoing a behavioral

change require follow-up and feedback. Therefore, the derived recommendation is to begin the cycle (Figure 10) to ensure the best health outcome.

Specialized nurses, such as heart failure or mental health nurses, should be implemented in primary care and hospital settings; they play a vital role in the success of optimal care by performing specific and necessary interventions for individuals with depression and cardiovascular diseases (Curran & Brooker, 2007; Moertl et al., 2017). There is, however, a necessity to further develop programs (for instance, behavioral therapy) and resources (such as patient education materials) to support and enhance the impact of nurses and nursing in CVD (Berra et al., 2019). Moreover, among nurses, there are global tools listed for managing cardiovascular diseases such as relevant fact sheets, evidence-based treatment protocols, systems for monitoring, protocols for health education and counselling on healthy behaviors, CVD advocacy toolkit. There is a need to provide nurses globally with these tools to educate patients and populations regarding risk factors for CVD (Commodore-Mensah et al., 2019). In Europe, cardiovascular nursing research has developed over the past decade, however, with Switzerland being the only German speaking country participating in developing an agenda providing researchers, funding agencies, and politics with orientation and priorities for cardiovascular nursing. Austria needs to provide a plan like the Swiss agenda to develop an action plan and promote nursing research projects in cardiovascular nursing (Händler-Schuster et al., 2014).

Most programs in Austria focus on nutrition and exercise, while significantly fewer are engaged in the reduction of obesity, the reduction of stress or smoking habits, and hypertension. Furthermore, there are no overall cardiovascular risk prevention programs, including all three investigated factors, and barely any prevention programs estimating a total cardiovascular risk (only eight of the 114 programs explicitly focus on cardiovascular diseases). Overall cardiovascular risk prevention programs would be necessary, considering people tend towards having more than one cardiovascular risk factor, which may interact multiplicatively and lead to a higher risk of CVD. Moreover, there are scarcely any nationwide programs for cardiovascular disease prevention in Austria (Griebler et al., 2014).

6. Conclusion

In conclusion, this report is the first cross-sectional study to examine the association between cardiovascular risk factors and the severity of depression in an adult Austrian population. Finding significant associations between hypertension for all respondents, between all three cardiovascular risk factors for men, and overweight for women. The results also found a possibility for higher levels of depression in women, hypertension, and elevated BMI. However, due to the limitation of this paper, results should be interpreted carefully. Therefore, further research where causality can be applied and longitudinal analyses in a larger sample size where generalizability is given are needed to examine these findings and confirm the hypothesis. The importance of nurses in CVD prevention is evident; therefore, a focus should be laid on enhancing resources, programs, and tools to support nursing CVD interventions.

Furthermore, a plan for nursing researchers, funding agencies, and politics with orientation and priorities in cardiovascular nursing in Austria should be provided. There are few established nationwide CVD prevention programs in Austria. There is an indication for CVD prevention programs in Austria to incorporate specific screening and management on cardiovascular risk factors in their protocols and readapt them according to depression severity.

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Appendix Nr. 1

In den nächsten Fragen geht es um Ihr Befinden. Bitte Beantworten Sie jede Frage, so gut Sie können.

Wie oft fühlten Sie sich im Verlauf der letzten 2 Wochen durch die folgenden Beschwerden beeinträchtigt?

	Überhaupt nicht	An einzelnen Tagen	An mehr als der Hälfte der Tage	Beinahe jeden Tag
Wenig Interesse oder Freude an Ihrer Tätigkeit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Niedergeschlagenheit, Schweremut oder Hoffnungslosigkeit	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Schwierigkeiten, ein- oder durchzuschlafen, oder vermehrter Schlaf	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Müdigkeit oder das Gefühl, keine Energie zu haben	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Verminderter Appetit oder übermäßiges Bedürfnis zu essen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Schlechte Meinung von sich selbst; Gefühl, ein Versager zu sein oder die Familie enttäuscht zu haben	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Schwierigkeiten, sich auf etwas zu konzentrieren, z.B. beim Zeitungslesen oder Fernsehen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Waren Ihre Bewegungen oder Sprache so verlangsamt, dass es auch anderen aufgefallen würde? Oder waren Sie im Gegenteil „zappelig“ oder ruhelos und hatten dadurch einen stärkeren Bewegungsdrang als sonst?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gedanken, dass Sie lieber tot wären oder sich Leid zufügen möchten?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>