A cross-sectional survey on the relationship between physical activity and symptoms of depression in Norwegian university students

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Master's thesis in Interdisciplinary Health Research

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Spring 2022

Sammendrag

Formål: Formål med studien er å undersøke assosiasjonen mellom grad av fysisk aktivitet (FA) og psykiske plager blant norske universitetsstudenter, samt om livsstilsfaktorer, som BMI, alkoholrelaterte problemer og søvnvarighet er av betydning.

Teoretisk forankring: Studien er basert på litteratur som beskriver biologiske og psykososiale mekanismer og faktorer som potensielt kan påvirke forholdet mellom FA og psykiske plager.

Metode: Data er innhentet fra Studentenes Helse- og Trivselsundersøkelse fra 2018 (SHoT2018), en nasjonal helseundersøkelse for høyere utdanning i Norge, der 50 054 studenter i alderen 18-35 år deltok. Psykologiske plager ble vurdert med Hopkins Symptom Checklist-25: HSCL-25 (1-4, 4 verst helse), hvor ≥2.0 = psykiske plager. FA ble kategorisert som følger: over/under moderat til hard fysisk aktivitet (MVPA)150 minutter pr uke (MVPA150) og over/under 300 minutter (MVPA300). Deskriptive analyser og statistiske tester (Pearsons khikvadrattest, toveis ANOVA og logistisk regresjon) ble utført.

Resultater: Det var 31.6% av kvinnene og 15.6% av mennene som skåret HSCL-25 ≥2.0 (psykiske plager). 82.1% kvinner og 76.8% menn nådde ikke FA anbefalingene på MVPA150. Det var en signifikant sammenheng mellom FA nivå og psykiske plager for begge kjønn (p<.001). Kvinner og menn i gruppa under MVPA150 hadde større sannsynlighet for å skåre HSCL ≥2 (OR=1.69 for kvinner og OR=2.07 for menn). For gruppa over MVPA300 var resultatene tilsvarende: OR=1.61 og OR=2.03. Justering for alder og livsstilsfaktorer ga ubetydelig endring av OR ide justerte analysene.

Konklusjon: Resultatene i denne studien må tolkes med forsiktighet på grunn av lav svarprosent i SHoT2018. Likevel er det bekymringsfullt at en stor andel av norske universitetsstudenter ikke fyller anbefalingene for fysisk aktivitet og at mange rapporterer psykiske plager. Siden lav grad fysisk aktivitet og psykiske plager henger sammen, er det grunn til å øke fokus på oppfordring og tilrettelegging for at studenter skal være fysisk aktive.

Abstract

Purpose: The purpose of the study was to investigate the association between level of physical activity (PA) and psychological distress among Norwegian university students and whether lifestyle factors, such as BMI, alcohol-related problems and sleep duration are essential.

Literature framework: This thesis is based on a literature framework of the biological and psychosocial mechanisms underlying the relationship between PA level and psychological distress, and the factors that may influence it.

Method: This thesis employed data from the *students' health and well-being survey* from 2018 (SHoT2018), a national health survey for higher education in Norway, in which 50,054 students aged 18-35 years participated. Psychological distress was assessed with Hopkins Symptom Checklist-25: HSCL-25 (1-4, 4 worst health), where ≥2.0 = psychological distress. PA was categorized as follows: above/below moderate to vigorous PA (MVPA) and above/below 300 minutes (MVPA300). Descriptive analyses and statistical tests (Pearson's chi-square test, two-way ANOVA, and logistic regression) were performed.

Results: Of the total sample, 31.6% were women and 15.6% men scored HSCL-25 ≥2.0 (psychological distress). 82.1% females and 76.8% males did not achieve the recommended PA level of MVPA150. There was a significant association between FA level and psychological distress for both genders (p <.001). Females and males in the group below MVPA150 were more likely to score HSCL ≥2.0 (OR = 1.69 for women and OR = 2.07 for men). For the group above MVPA300, the results were similar: OR = 1.61 and OR = 2.03. Adjustment for age and lifestyle factors resulted in an insignificant change in OR in all analyzes.

Conclusion: The results of this study must be interpreted with caution due to the low response rate in SHoT2018. Nevertheless, it is worrying that a large proportion of Norwegian university students do not meet the recommendations for physical activity and that many report mental illness. Since low levels of physical activity and mental illness are linked, there is reason to increase the focus on encouragement and facilitation for students to be physically active.

Acknowledgements

This thesis is the final product of a master's degree that has given me many opportunities and taught me a lot. Not merely have I understood the pros and cons of the scientific world. I have also had the chance to really think about the importance of my field of studies and, more practically, how I can utilize the knowledge I have gotten from taking a master's degree in interdisciplinary health research to make a difference in public health. I find that important and even more – useful.

Hanne Solveig Dagfinrud, I would like to use this opportunity to express my gratitude for lending me a helping hand with this master thesis. Your devotion to this study has impressed me on numerous occasions. Your experience and true knowledge have provided me with comments, discussions and remarks that have been essential for bringing me to this goal.

I would also like to thank Børge Sivertsen for being incredibly helpful, providing me guidance, and giving me the opportunity to work with this study. Finally, I would like to thank my family for their encouragement and support throughout this process.

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List of abbreviations

AUDIT   Alcohol Use Disorders Identification Test

BMI   Body Mass Index

CBT   Cognitive Behavioural Therapy

DSM-IV   Diagnostic and Statistical Manual of Mental Disorders - 5

ECT   Electroconvulsive Treatment

ESEMeD   European Study of the Epidemiology of Mental Disorders

GDPR   General Data Protection Regulation

HSCL-25   The Hopkins Symptom Checklist-25

HPA axis   Hypothalamic Pituitary Adrenal

MVPA   Moderate to Vigorous Physical Activity

NIPH   Norwegian Institute of Public Health

NSD   Norwegian Centre for Research Data

PA   Physical Activity

RCT   Randomized Controlled Trial

REK   The Regional Committee for Medical and Health Research Ethics

SHoT   Students' Health and Well-being study

SSRI   Selective Serotonin Reuptake Inhibitors

TSD   Services for Sensitive Data

WHO   World Health Organization

CHAPTER ONE

Introduction

Chapter 1
INTRODUCTION

1.0 Introduction

Understanding the association between physical activity (PA) and mental health problems among university students is essential due to two significant public health issues; low PA levels and depression. A better understanding of the relationship between symptoms of depression and PA may facilitate prevention of development of depression. The World Health Organization (WHO) predicts that by 2030 depression and anxiety will be the leading cause of mortality and burden of disease globally[1]. Hence, the present study focuses on the association between different levels of PA and depression, one of the most common mental health problems in Norway[2]. In this thesis, mental health was measured with a frequently used instrument focusing on anxiety and depression, in the following also referred to as *psychological distress*.

Worldwide, several studies show that the number of people who engage in regular PA is too few, regardless of overwhelming evidence that demonstrates extensive health benefits of engaging in PA. More than one in four adults worldwide fails to achieve the recommended levels of PA (i.e., engaging in 150 minutes or preferably 300 minutes of moderate to vigorous PA (MVPA) per week)[3]. The Global Burden of Disease study has underlined that mental health problems are one of the significant causes of disability globally and consider depression the most crippling disorder[4]. Furthermore, mental health problems do not only cause immediate individual consequences, but it also puts a burden on the economy in society. The economic consequences are disastrous, where Norwegian authorities estimate the annual costs of mental health problems in Norway to be roughly 60-70 billion NOK (5-6 billion EUR)[5]. As a result of these enormous consequences for both the individual and the society, mental health problems are classed as a top priority in the coming years in public health by the national authorities[6].

The number of studies with focus on mental health problems (i.e., psychological distress) in university students is surprisingly scarce even if the transition from adolescence to young adulthood is a crucial transitional period. Most mental health disorders appear in early adulthood and late adolescence[7], and some studies have reported that around 12-50% of university students fulfil the criteria for at least one common mental health disorder[8,9]. A

Norwegian study[10] from 2020 on students' health and well-being study (SHoT study) calls attention to the high prevalence of psychological distress among university students from 2010 to 2018. This study also calls attention to the disturbingly high percentage of young adults failing to meet the recommended levels of weekly PA, despite the current media-focus and strong evidence on the beneficial effects of even a tiny increase in PA from inactivity. Both student welfare organizations and educational institutions try to facilitate and encourage students to participate in outdoor activities, physical exercise and different types of sports, but the current results imply that increased efforts are justified[10].

Moreover, a Norwegian study on the SHoT survey data from 2014 found that students reporting severe psychological distress have about four times the risk of encountering low academic self-efficacy compared to those who report moderate level of psychological distress[11]. A situation where anxiety contributes to motor restlessness, worries, not accomplishing things or unfounded fear, combined with avoidance behaviour and procrastination may explain why students develop problems when participating in study situations and learning. This may, in turn, contribute to loneliness, avoidance, and isolation, leading to poorer social- and academic inclusion with both staff and fellow students at the university[11]. Thus, academic performance is related to psychological distress which can cause students to drop out of school[11,12].

Furthermore, several known risk factors can lead to psychological distress (i.e., depression): poor economy, substance and alcohol use, reduced cognition, physical morbidity, stress, sleep problems, gender, age, and sedentary behaviour[13]. These factors have been linked to mental well-being and physical activity in young adulthood[13]. Determinants of psychological distress tend to be unevenly distributed between social groups, and social and economic circumstances may be expected to provide different opportunities in life[14,15].

A better insight into the associations between psychological distress and a modifiable factor like physical activity may be an important tool in reducing disease burden in the large group of university students.

CHAPTER TWO

Theoretical background

Chapter 2
THEORETICAL BACKGROUND

2.1 Mental health

WHO definition of mental health is organized around a eudaimonic and hedonic perspective[16], in which a fundamental role is appointed to a person's productivity and well-being. A eudaimonic perspective considers well-being to consist of more than only happiness, proposing that even though people report being happy does not necessarily mean that they are psychologically well[17], and the hedonic perspective focuses on happiness, defining well-being in terms of pain avoidance and pleasure attainment[18]. While regarding well-being as a desirable goal for most, its inclusion in the definition of mental health raises concerns. Well-being includes psychological, emotional, and social well-being, and involves positive feelings (i.e., satisfaction and happiness), positive functioning (i.e., social integration, coherence, and actualization), and positive attitudes towards others and own responsibilities[19]. A perspective of mental health influenced by eudaimonic and hedonic traditions[20] risks leaving out most adolescents and young adults, where many are somewhat shy, those who fight against inequalities and injustice, as well as minorities and migrants experiencing discrimination and rejection[20].

WHO's definition[16], while representing an important progress with respect to moving away from the conceptualization of mental health as a state of absence of mental illness, raises multiple concerns and leaves room to potential misunderstandings when it identifies positive functioning and positive feelings as fundamental factors for mental health[17]. In truth, regarding well-being as a fundamental aspect of mental health is hard to reconcile with the numerous challenging everyday situations in which well-being might even be harmful[21,22]: The majority would judge someone to be mentally unhealthy when they experience a state of well-being while killing numerous persons during actions of war and would regard a person to be mentally healthy when feeling desperate after being fired from his/her job when occupational opportunities are few. Also, people with sound mental health experience a wide range of emotions, such as anger, sadness, or unhappiness, which is part of a fully lived life for a human being[17]. Nevertheless, mental health has been conceptualized as a purely positive affect, defined by sense of mastery over the environment and feelings of happiness[17,21,22].

Also, well-being and positive mental health are resources for development and growth at an individual level and at state levels. The WHO collaborative cross-national study[23]: '*The Health Behaviour in School-aged Children' (HBSC)*, conducted between 1982 to 2008, conceded of researchers from Norway, Denmark, Sweden, Finland, England, Wales, Scotland, Netherlands, Hungary, Belgium, Israel, Switzerland, and Australia. This cross-national survey looked at smoking and a range of important health-related behaviours in the context of young people's lifestyles. It found that most young people perceive their health as good, are satisfied with their lives, and did not regularly suffer from health complaints such as irritability, headaches or feeling low. Nonetheless, many young people report their health as poor or fair and experience several recurring health complaints[24]. Also, HBSC provides evidence of inequalities in well-being and mental health regarding gender, family structure, socioeconomic status, geography, and migrant status[23]. Further, following the eudaimonic tradition[17], the concept of positive functioning, in terms of working productively and fruitfully, is a matter of concern. It implies that a person in a physical condition, at any age, or even political position is prevented from being productive during work and is not, by definition, in good health[17].

Moreover, evidence found during the past two decades shows that disadvantaged social circumstances are associated with increased health risks[25,26]. As a consequence, inequalities in health are rooted in contemporary international policy development. The WHO Commission on Social Determinants of Health argues that the large majority of health inequalities withing and between countries are avoidable[27], nonetheless they remain experienced by young people across North America and Europe. Little attention has been paid to inequalities related to gender, age, and socioeconomic status among this group.

Thus, the definition of mental health is influenced by its environment, where the significance of the mental health of university students is emphasized by research implying that mental disorders obstruct with university attendance[28] and decrease the likelihood of successful university completion[28,29].

For many, young adulthood is characterized by the development of personal relationships, the pursuit of better educational opportunities and employment prospects, and for some, parenthood. Despite the fact that all these circumstances offer opportunities for growth, they might also result in stress that precipitates the recurrence or onset of mental health problems[30].

Mental health problems include bipolar disorder, schizophrenia, depression and other psychoses, developmental disorders such as autism, and dementia[31].

In an American National epidemiologic study, mental health problems were shown to be as prevalent among university students as same-aged non-students[32], and mental health problems seem to be increasing in severity and number among university students[30,32]. Even if university students are often viewed as a privileged population[30], they still are prone to suffer from mental health problems. Mental health among university students represents a rising concern due to the increased number of students suffering from psychological distress, in particular depression[32]. Still, it could also be considered an opportunity, due to the large number of people who could be reached during an essential phase of life[30,32]. The university years represent a developmentally challenging transition to adulthood, and untreated psychological distress, in particular depression, might have significant implications for academic success[29], productivity[33], social relationships[34], and substance abuse[35].

2.1.1 Depression

According to a review on studies of genetic association related to depression, depression is the leading cause of disability, with a lifetime prevalence of 19% among adults[36] and thus a severe public health issue[37]. Psychological, neuroscience, and medical texts, along with art and literature in most cultures, give articulate interpretations and descriptions of the observed underlying pathophysiology of depression. Fundamental to the definition is a disordered effect, meaning it is without a clear order, and is defined as the behavioural and objective expression of internal mood states with consequent observable motor components such as expressive features of facial movements[37]. Depression is a complicated term because it is used in daily language with its own culturally applicable meanings. However, the term also refers to the heterogeneous manifestation of the medical disorders captured by the term major depression[38].

Depression, also known as *major depressive disorder* or *clinical depression*, is one of the most damaging mental health disorders[39]. Of all diseases, depression is solely exceeded by ischemic heart disease, lower respiratory infections, HIV/AIDS, perinatal conditions, diarrheal diseases, and cerebrovascular disease in the context of disability during a person's lifetime, which is partly due to the recurrence and chronicity of depression[37,39,40]. Depressive

disorders can affect both mental and physical health, and in turn create a considerable burden on health systems, decreasing quality of life and increasing the likelihood of premature mortality[40,41]. Depression occurs typically early in life and is a highly recurrent disease, where nearly three-fourths experience a second episode later in life[36]. The associated years of life lived with disability due to depression and loss in productivity have consequences on society[36].

It was first in 1980 that the diagnosis of depression was introduced in Diagnostic and Statistical Manual of Mental Disorders (DSM), as an affective/mood disorder distinguished by loss of pleasure or interest and low mood and energy[42]. Symptoms of depression include irritable or depressed mood, change in appetite or weight, decreased pleasure or interest, change in activity, the feeling of worthlessness/guilt, lack of concentration, loss of energy or fatigue, suicidality and change in sleep patterns[43]. In accordance with the commonly used DSM-IV criteria, there must be at least five out of nine symptoms present almost every day to set a diagnosis. The educational, social, or occupational function must also be afflicted. Depression is a mental disorder subordinate to mood disorders and ranges in severity from mild, temporary episodes to severe, permanent depression[44].

Major depressive disorder is the more severe form of depression, which is not the same as depression caused by the death of a loved one or an injury, such as the loss of a limb. People with major depressive disorders tend to receive inadequate treatment, risk developing cardiovascular disease, and increase mortality and morbidity[45]. Furthermore, people with symptoms of depression are more likely to be on sick leave than others, and their productivity is incapacitated by the inability to concentrate and organise work and low efficiency[36]. The degree and severity of depression are related to work performance and absenteeism, where the more severe forms of depression cause the worst outcomes[36].

The concepts of affect, emotion, mood, and feeling are frequently used interchangeably in the literature. However, affect is generally an umbrella term representing concepts that include feelings, emotions, and mood[46]. Depressive disorders should be distinguished from depressive moods because some people meet the definition of the clinical problem, while others only can show symptoms of depression due to normal fluctuation in mood. Showing symptoms of depression does not mean that a person suffers from a major depressive disorder[45,46]. On the contrary, showing symptoms of depression, only indicates that a person has a depressive mood and that the emotions fluctuate. When one meets the criteria of a clinical depression,

which is diagnosed by clinicians by the help of DSM-5[47], one should seek help from medical and psychological professionals[46].

2.1.2 Disease mechanisms

Depression is a multifaceted disorder with multiple causes and has been associated with the risk to develop serious medical disorders. For instance, depression increases the risk of stroke by 1.8-fold[48], the risk for cardiovascular disorders by 1.5-2-fold[49], Alzheimer's Disease by 2.1-fold[50], diabetes by 60%[51], cancer by 1.3-1.8-fold[52], and epilepsy by 4-6-fold[53]. Numerous biological mechanisms with a plausible role in clinical depression disorder's pathophysiology have been identified, and these mechanisms might have a role both in the progression and ethology of the disorder.

Despite several studies attempting to clarify the pathophysiology of depression, it still remains elusive, in which is a major factor for the slow-paced development of drugs against this disease. Most theories on the pathogenesis of depression are based on measurements of indirect markers, neuro-imaging techniques, and post-mortem studies. For decades, depression pharmacotherapy and a consequent explanation for the underlying pathology, focused on the brain's level of monoamine neurotransmitters following the accidental discovery of iproniazid and imipramine as antidepressants[54,55].

Several functional and structural studies have reported abnormalities in the areas of the brain in which are responsible for the regulation of mood, executive functions, and reward response[54,55]. Neuro-imaging and post-mortem studies have shown morphological changes which was indicated by reductions in grey-matter volume and glial density in the hippocampus and prefrontal cortex, areas that have received greater focus in animal research on depression[55]. The decline in hippocampal function, is believed to have a repressive effect on the hypothalamic-pituitary-adrenal (HPA) axis, could potentially be responsible for the hypercortisolaemia seen in depression[54,56]. The HPA axis is a neuroendocrine mechanism that adjust the effects of stressors by regulating several physiological processes, such as the autonomic nervous system, and immune responses[56].

The mesolimbic dopamine system that is composed of the ventral tegmental area (VTA) and the nucleus accumbent (NAc) are also believed to play a part in the pathogenesis of depression. These areas of the brain mediate the reward response to pleasurable stimuli such

as sex, drugs, and food. Thus, lack of pleasure in depressed patients can feasible be explained as dysfunction in this brain reward circuit[56].

Hyperactivity of the HPA axis and chronic stress (causing chronic hypercortisolaemia) have been hypothesized to play a significant role in the incidence of depression and even in recurrence after full remission. Structural abnormalities in the brain have been registered in patients with increased levels of corticosteroids. One of the structures in the brain affected is the amygdala, in which is a part of the brain that is involved primarily in regulating emotional reactivity and to some degree stress response[57,58]. Another area in the brain shown to decrease in size with chronic administration of corticosteroids is the hippocampus, in which is the part of the brain that is believed to exert a repressing signal to the HPA axis[59].

There is a lack of complete understanding on how behavioural stress causes depression. Yet, chronic stress has shown to alter the expression of genes regulating antioxidant systems like catalase, superoxide dismutase (SODs), glutathione reductase, glutathione peroxidase, and NADPH oxidase[60]. Furthermore, animal studies have uncovered that treatment with glucocorticoids cause an increase in the level reactive oxygen species (ROS) in the brains of animals, while also downregulate several antioxidant enzymes and introducing depression-like behaviour[60].

There currently exists a compelling argument that in order for depression to surface there needs to be a complex interaction between genes and the environment that alters an individual response to stressful situations in life. Not a single gene polymorphism seems responsible for causing depression, there has been suggested that genetic factors make certain individuals susceptible to depression by increasing their vulnerability to stressful environmental factors[61].

2.1.3 Prevalence, age, and gender distribution

2.1.3.1 Prevalence of mental health problems

In the adult Norwegian population, around one-third has suffered from mental health problems, and estimates predict that around 16 to 22% of the adult population will most likely suffer from a mental disorder over the course of 12 months[62]. Even if the knowledge about the prevalence of depression is limited, several international studies have shown that depression is more prevalent among young adults than among older adults. In the European Study of the Epidemiology of Mental Disorders (ESEMeD), found that the 12-month prevalence of mental

disorders was more than double among people between 18 and 24 years compared to 65 years or older[63]. An important finding in the ESEMeD study was that from early adolescence, the prevalence of psychological distress is around twice as high among females as males[63]. Females were at a higher risk of psychological distress, and they were more likely to have a mental disorder (OR = 1.79) and mood disorder (OR = 2.04) than males[63]. Further, a Finnish comparison study conducted in 2002, which consisted of 330 participants (aged 18 to 64 years), also found that psychological distress is more prevalent in females than males[64].

Furthermore, an analysis done by the Norwegian Labour and Welfare Administration (NAV) shows that the proportion of disabled people between 18 and 29 years has doubled since 2013 due to mental disorders[65]. At the beginning of 2021, over 20000 mentally disabled people were in this age group in Norway. Statistics from NAV show that the proportion of mentally disabled people in Norway is increasing steadily and is now over 10%, which is an increase of 3.8% from 2018[65]. Even though there has been an increasing concern about mental health, in particular depression, in certain groups such as the elderly or adolescents, the problem of depression among university students has gotten relatively scant attention, despite evidence of an increasing number of Norwegian university students suffering from psychological distress[10,66]. Moreover, several factors seem to affect the prevalence of depression, such as the population studied, diagnostic tool, sociodemographic factors (i.e., age, gender), and sampling used[67].

2.1.3.2 Age and gender distribution

For a long time, depression has been deemed predominantly a disease that affects females, but more attention has been given to males[68]. Many studies show that females undergo depression more often than males[69]. For instance, a systematic review, on 30 studies examining whether PA is a protective factor against the onset of depression[70], reported that gender might modify PA's effect on depression. In contrast, a meta-study[71] on 49 prospective studies (N = 266 939) suggested that the potential protective association of PA is similar for men and women. However, depression is also a common problem among males and increasing among young males[72]. The differences in females' and males' portrayals of depressive symptoms include, for instance, that females are more likely to emphasise sadness, guilt, internalising symptoms, and shame. In contrast, males can be more prone to expressed physical symptoms such as

anger, externalising, and chest pain[73]. Moreover, young males have been found to talk about emotional distress more often than older males[73].

The onset of the gender gap has been found to begin early during their adolescence, where females are significantly more at risk than males. The rates of depression have become more common among girls in early adolescence, in contrast to boys, where the prevalence is somewhat higher in childhood[7,69,74]. The exceptions for gender differences are bipolar disorder and obsessive-compulsive disorder, which have similar prevalence among females and males. Nevertheless, even for these disorders, males and females differ in disease course and presentation. Further, subclinical depression symptoms are also more common in females[75]. Despite differences between genders in prevalence rates for depressive disorders, there seem to be no apparent differences by gender in treatment[75].

There have been presented several explanations to explain the gap between the genders. A theoretical model explains the predominance of depression in adolescent girls, and it is based on the idea of correlated consequences[76]. This model describes girls as more vulnerable to depression due to the combination of transition difficulties and a more affiliated style in social relations, which is set off by adverse events in life. A problematic transition includes anxious temperament, low coping skills and insecure parental attachments. Which in turn might affect anxiety levels and combine with affiliative needs, which is affected by hormonal changes in puberty and gender socialisation[76]. Simultaneously this may lead to depression-provoking stress vulnerability, including low attachment security, high anxiety, high affiliated focus, and low instrumentality, in which can be triggered by adverse events in life and thus cause depression[76].

Understanding the cultural and biological foundation of differences between genders in affective disorders could be a helpful window into mechanisms of illness in both females and males[77]. Gender differences in brain function and structure are abundant and waver across development[78,79]. Some gender differences that promote reproductive success probably increase females' vulnerability to mental health problems. For instance, females' adaptive behavioural differences in terms of parenthood seem to encompass superior social capacity and cognition for attunement with others, which is essential for children's social and cognitive development[80]. Despite that, these gender differences are arguably some reasons why females experience more severity of separation, rejection, criticism, and critical features of mental health problems[81].

Moreover, it is crucial to recognize that gender differences in coping styles and behaviours are not absolute, merely more common in one gender than the other. For the most part, the extent of these gender differences is minor. Even though environmental influences contribute to gender differences in risk for mental health problems and human behaviour, it is tricky to disentangle to what degree gender-specific cultural stereotypes are based on biologically determined gender-specific traits[82]. Further, gender differences in cultural expectations and life experiences might, in turn, modify gene expression and contribute to the development of gender differences in physiology and brain throughout the lifespan[83].

Furthermore, the most reproducible finding is the higher prevalence among females in the epidemiology of major depressive disorders[84]. The differences between genders regarding functional consequences, treatment response, or symptoms are inconsistent. However, some differences in symptoms exist, such as negative symptoms, which are more common among older individuals. Whereas reverse vegetative symptoms (i.e., characteristics of atypical depression: oversleeping and overeating) are more common among younger individuals[81]. In major depressive disorder, the onset might occur later, and longer episodes and fewer total episodes are more common[84]. The data on specific effects of ageing and the long-term course of untreated major depressive disorder is inadequate. However, the data available indicate that inadequately treated or untreated individuals with major depressive disorder seem to encounter more recurrences as time goes by. Furthermore, they endure more frequent and more prolonged episodes, which appear to be more challenging to treat with each following episode[81,83,84].

2.1.4 Risk factors

In the last decade, increased emphasis has been given to investigate stress risk factors and well-being consequences among university students[85,86]. University students' mental health is an essential public health topic as healthy students will be in the future the healthier workers. Attending university has the potential to become a satisfying and positive experience in the students' life, but empirical evidence from studies in Portugal, Australia, Korea, United States of America, and Norway show that being a student might be a stressful experience[85,87,88,89,90].

Never before have there been as many Norwegian university students as there were in 2021, based on the most recent figures from the annual statistics "*students in higher education*"[91]. The number of Norwegian students has increased by on average 2% each year in the last

decade, but from 2019 to 2020 this percentage increased by 3.5%[92]. We are seeing unprecedented levels of Norwegian university student enrolment, and more students are finishing their degree. Nevertheless, statistics in Norway (SSB) show that three of ten students have not finished their degree eight years after starting[93].

2.1.4.1 Gender and social position

Even if the prevalence of mental health problems is similar between females and males; the prevalence of depression differs by gender[94]. Females have a longer life expectancy than males, and the morbidity rates are higher among males than females[95]. The cause to why it exists differences between gender involve psychological, social, and biological factors, and these factors should be addressed together to give a comprehensive answer[96].

Further, it is more common that males have jobs with higher income and status, which means more economic resources and might result in better food, living conditions, and more significant opportunities to seek care[97]. Females who enter the workforce might get a double burden if they also take care of domestic tasks, which might cause poor health and increased stress[97]. A further example is that females and males might engage in different health behaviours[97]. It can be challenging to study differences between the genders, especially with the risk of preserving traditional gender roles. Thus, it is crucial to consider that differences also occur within the groups of females and males and that situations can change over time[97].

Having a low social position might be a risk factor in the development of internalising difficulties. The notion that the combination of social differences has harmful effects on mental health has been studied by several. Independently, gender and having a low position in society might contribute to developing difficulties of internalisation. However, the concept that the combination of social factors has adverse effects on mental health has been contemplated by multiple researchers. The idea of double jeopardy was brought up in 1970[98], as follows "*several sources of social disadvantage interact to produce especially problematic outcomes*".

Double jeopardy has gotten mixed support in earlier research, which might be due to different measures and definitions of depression and social position and different effects in various stages in life[99]. Moreover, it has been found that boys are more affected by symptoms of depression when it comes to household poverty than girls[99]. Whereas adults having low

socioeconomic status in childhood might be associated with more severe depression among females than males[100]. However, there is inconsistency in gender patterns regarding social position, which might be due to different measures of poor mental health[101].

There is an agreement that differences between genders have a multifactorial aetiology[102]. Theories emphasise how certain vulnerability factors appear at critical developmental periods in adolescence and produce differences between the genders. For instance, during the pubertal transition, the merging of neurodevelopmental and hormonal changes varies between the genders, which might influence the differences found in depression. Researchers have, for the most part, ignored the development of depression in adulthood when examining and theorising about the differences between genders, in contrast to their broad focus on the gender differences in adolescence[102]. For instance, little is known about stress levels for males compared with females across adulthood and specifically among university students[102]. When looking at differences in depression between the genders, it is essential to consider the relevance of various life transitions[102].

2.1.4.2 Distress and eustress

In a paper from 2010, Stallman[85] introduced two different types of stress: *distress* and *eustress*. Distress is harmful to students' well-being as it exposes them to a higher risk of behavioural (i.e., eating disorders), suicidal ideation, psychological (i.e., anxiety and depression), and physical health problems (i.e., headaches, ulcers, and high blood pressure). In contrast, eustress is positive stress which promotes feelings of focus, energy, fulfilment, and excitement[85,86], and it is essential for student success and motivation at university[93,103,104]. Further, several researchers have found that high-stress levels were linked to low-grade average, reduced academic performance, and higher dropout and low rates of graduation[105,106,107].

Also, the university context can be inherently stressful. And while a certain amount of stress (eustress) is necessary and beneficial for learning, motivation, and attention, excess stress (distress) negatively impacts student' physical- and mental health, learning, self-efficacy, academic success, and persistence[85,86]. Understanding the causes and nature of students' stress is a precondition in creating supportive learning environments ideal for university students[105,106,107,108].

2.1.4.3 Potential stressors for university students

Several stressors are unique when young people attend university. These stressors include experiencing challenging academics, having significant financial burdens, being away from home and family, and living with new people. An American correlation study found several risk factors for developing psychological distress among 348 university students[108]. Risk factors include academic failure, lack of opportunities for leisure, unhealthy lifestyle, lack of appropriate school support, having no close friends, family conflicts, bullying, exposure to discrimination and violence. The absence or presence of disadvantageous life events near the beginning of depression episodes does not seem to guide the selection of treatment or prognosis, even though stressful life events are well-recognised as a cause of major depressive episodes[47].

To further complicate these challenges, university students are reported to experience significantly higher emotional stress than previous students' generations[108,109]. There is an association between increased emotional stress and new surroundings. Further, there are risk factors that play a part in university adjustment, for instance some first-year students are adjusting to a whole new environment; for students in their second year or more, there are new challenges with new classes and heightened stress with more responsibility[108]. Several worldwide studies have shown that some students enter university with psychological and social disadvantages, often lacking the structure they had previously at home. This might result in the students not being able to cope with the stress, such as self-harm, isolation, withdrawal, and substance abuse[90,103,104,105,106,107,108].

Also, several academic stressors when attending university have been linked to a greater risk of distress and reduced academic achievement, such as higher workload, respecting deadlines, economic issues, and balancing university[86,110,111,112]. Moreover, several authors have extended and adopted original measures of stress, for instance, by adapting work-related stress measures to the university context[113,114]. These measurements were mainly designed for medical students[115] or stress measurements not explicitly developed for the academic context[113,114,115]. According to a German cross-sectional study[116], most of these measures lack a theoretical stress model, which might represent a significant limitation. Measurements based on a standard tested stress model might help the researchers capture the links between mental health among university students and stress and develop theory-based interventions[114].

2.1.5 Treatment of depression

There are different treatment options for depression, such as pharmacological treatment, psychotherapy, and exercise. Many pharmacological treatments were created based on the knowledge that depression happens due to a lack of signal substances such as serotonin. However, other therapy also focuses on the minds' impact[117]. Although effective treatments exist, most people with mental disorders never seek professional help. Among those who do, only half seem to benefit[118]. Moreover, general medical practitioners are often the primary care providers for depression; thus, treatment options can readily be prescribed in community healthcare settings[117].

Treatment for major depressive disorders during the first three months after diagnosis often consists of psychological interventions (talk therapies) and pharmacological interventions (medications including tricyclic antidepressants, selective serotonin reuptake inhibitors, and serotonin-norepinephrine reuptake inhibitors)[119]. The treatment plan for depression varies for each person due to different types of depression and how severe it is[119]. There are various treatments, such as psychotherapy[120], antidepressants[121], and exercise[117]. If this does not help, then brain stimulation techniques such as electroconvulsive therapy or transcranial magnetic stimulation might be an option. A considerable number of antidepressants and several types of psychotherapy have shown to be effective in treating major depression in adults[122].

Conventional treatment of depression with cognitive behavioural therapy and antidepressant medications can be effective in 60-80% of patients[123]. Even so, less than 25% of those suffering from mental health problems have access to effective treatment. However, antidepressant therapy has several undesirable side effects, such as a decrease in blood pressure, sedation, sexual or indigestion dysfunction, and an increase in weight. This often results in patients' poor compliance, which results in a break-up of medication with recurrence of symptoms of depression and increased suicidal risk[123].

2.1.5.1 Pharmacological treatment

The use of antidepressants is considerable in the Western world and is rising in several countries[124]. Several antidepressants exist, such as selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors, Tricyclic antidepressants, atypical antidepressants, and Monoamine oxidase inhibitors[124]. SSRIs are the most widely prescribed class of antidepressants and thus often used as a first-line treatment for depression[125].

Worldwide, psychiatrists and general practitioners routinely use antidepressants to treat depression. Antidepressants for major depressive disorder, either alone or in combination with psychotherapy, are recommended by the American Psychiatric Association, the UK National Institute for Health and Care Excellence, the Norwegian Directorate of Health, as well as guidelines[126,127,128,129,130].

The prescription of antidepressants medications has increased over the last 20 years to a large extent due to the development of a new type of antidepressant medication SSRIs and other newer medications[131]. The prescription of antidepressant medication in Norway has increased[132]. It continues to increase the most, from around 290.000 users outside the institution in 2004 to around 350.000 users in 2017. If we go back to 1990, we see that the use of antidepressants has increased fivefold up until 2017[132]. However, getting a good overview of the statistics of antidepressant medications in Norway is challenging because of the limitations in how it is registered[132].

While antidepressants continue to be the backbone of treatment for major depressive disorder, adherence rates remain low in part of patients' concerns about possible dependency and side effects. Besides, surveys have demonstrated patients' preference for psychological interventions over treatment with antidepressants[131]. Thus, psychological therapies can offer an additional or alternative treatment for major depressive disorder[131].

2.1.5.2 Psychotherapy

Psychotherapy is often the first form of treatment recommended for depression. Supportive therapy, cognitive behavioural therapy (CTB), and interpersonal therapy are three common types of psychotherapy to treat a major depressive disorder[133]. The Royal Australian and New Zealand College of Psychiatrists defines *structured psychotherapy* as "the treatment of mental or emotional illness by using defined (often manualized) psychological techniques, pre-planned with clear goals and employed within a specific timeframe."[134]. Patients must be seen by their treatment provider on at least a monthly basis, either in a small group or individually[134]. Interpersonal therapy and CBT are considered structured psychotherapies, whereas supportive therapy is not[134].

Supportive therapy, also called nondirective supportive therapy, is typically an unstructured therapy that relies on the therapists' basic interpersonal skills, for instance, empathic listening,

reflection, and encouragement. *Supportive therapy* has been defined as a psychological treatment where therapists do not engage in any therapeutic strategy other than offering support and active listening, focusing on the patients' concerns and problems[135]. This form of therapy focuses more on current problems than long-term difficulties[136], where the goal is to reduce the patients' level of discomfort and find coping mechanisms for their current circumstances[135,136].

CBT concentrates on helping the patients to be conscious of how certain negative automatic attitudes, thoughts, beliefs, and expectations contribute to feelings of anxiety and sadness[136]. Patients learn how these patterns of thinking, which might have been developed in the past to deal with painful or difficult experiences, can be changed and identified to reduce unhappiness[136].

Interpersonal therapy concentrates on resolving and identifying problems in maintaining and establishing satisfying relationships[136]. Problems of this kind might be, for instance, dealing with life changes, loss, increasing ease, and conflicts in social situations[136].

In a meta-analysis of 52 studies including 3623 participants, the authors concluded that combined treatment with psychotherapy and antidepressant medication is more efficient than treatment with antidepressant medications alone[137]. This difference was significant for major depression, obsessive-compulsive disorder (OCD), and panic disorder[137]. The superior effects of combined treatment remained significant at one to two-year follow up[137].

2.1.5.3 Exercise as treatment

Inactivity might lead to or cause symptoms of depression, which in turn might lead to further health problems[138]. For this reason, physical exercise has been proposed widely as an effective alternative treatment for depression. In a meta-analysis[139], which examined the effects of exercise on depressive symptoms in 58 randomized trials (N = 2982), demonstrated effect sizes from -0.80 to -1.1, indicating that participants in the exercise interventions had significantly lower depression scores than those receiving the control treatment[139]. To be included in this meta-analysis, the exercise group had to use a form of moderate to vigorous exercise (aerobic or resistance) as treatment condition and had to measure depression as a dependent variable, and the controls had to be a non-treatment or waiting-list control[139]. Further, a Cochrane review of 32 randomised controlled trials (RCTs) (N = 1858), in which

exercise was compared to standard treatment, no treatment or a placebo treatment in adults (aged 18 and over) with depression, found that exercise was moderately more effective than control interventions[140].

Various explanatory models on the mechanisms have been proposed to explain the benefits of frequent exercise on mood disorders. These models include increased serotonin synthesis, changes in core body temperature, and hippocampal cell proliferation[141,142] and lower levels of proinflammatory cytokines[143]. Concerning both treatment and prevention of mental health problems, PA and, in particular, activities outdoors have been suggested as advantageous. A recent systematic review of 36 RCTs and non-RCTs studies from around the world (N = 3933) on adults (aged 18 years and older) found that nature-based, outdoor exposure positively affects several emotional parameters related to stress relieving[144].

Moreover, physical exercise for lifestyle factors such as depression is recommended in Norway on "*green prescription*", introduced by the Minister of Health in 2003[145]. *Green prescription* is a term that includes measures to increase the physicians' and the patients' focus on treating lifestyle diseases without the use of medications. The green prescription is a «contract» between the physician and patient, indicating the type, frequency, and dosage of, for instance, physical activity[145]. However, an online questionnaire performed in Norway in 2005 showed that only 41% of the 134 general physicians who answered had never prescribed green prescription, which indicates that green prescription is not frequently used by physicians[146].

2.1.6 Self-reporting psychological distress

The prevalence of depression seems to be affected by various factors, such as diagnostic tools, population studied, sociodemographic factors (i.e., age, gender), and sampling used. Depression can be measured by use of different types of questionnaires, which measure self-reported symptoms of depression. The 25 item Hopkins Symptoms Check List (HSCL-25) is an example of such a questionnaire, a screening tool designed to detect symptoms of depression and anxiety[147], and is used to measure psychological distress.

The fundamental doctrine of the differences between gender in reporting depression severity is that females are more likely to report mild to moderate symptoms of depression[148]. In contrast, males report more severe depression[149]. Females tend to recognize more subtle

emotional changes than males[150], due to females having better social skills and overall, better at understanding their feelings[151]. Analogously, a small Chinese study (N = 23), which included participants between 18 to 60 years, found that females with depression reported more emotional experiences, notably negative emotional experiences than males [152]. Further, this Chinese study showed that females have more emotional experiences than males, which is notably significant in terms of negative emotional experiences[152]. Another study conducted in Sweden, included all citizens between 0 and 95 years (N = 3563), found that females reported consistently more mild to moderate depression across all age groups[153].

Also, the same Chinese study[152] found cognitive evidence that showed females having a deeper level of emotional information processing and more detailed emotional picture coding than males: thus, emotional images had a more significant effect on the cognition of females. In addition, females were found to have a higher level of an emotional experience than males: Such as, females' negative emotional experiences were significantly stronger than those of males. Females increased negative emotional experiences were likely an important reason why females suffer from long-term depression, are more vulnerable to relapse, and have a higher risk of suffering from severe depression episodes.

Further, several studies on the biological factors which influence gender differences in patients with depression have found no significant difference in risk of depression between postmenopausal females and males[154,155], indicating that the secretion levels of estrogen and androgen affect a persons' psychoactive state. Thus, different sex hormones are one crucial feature of gender differences: females primarily have estrogen, whilst males primarily have androgen. A review of epidemiological studies in 2001[156] reported that the substantial risk of female depression is related to the imbalance of female ovarian hormones progesterone and estrogen, where an increase in estrogen has been found to have a direct association with negative emotions[156].

Moreover, a perimenopausal depression model proposed by Gordon et al.[157] has shown that many factors cause female depression. Psychological pressure, female personality, genetic vulnerability factors, and physiological factors including Gamma-aminobutyric acid (GABA) disorder (GABA blocks certain nerve signals in the brain to reduce anxiety, fear, and stress[158]), imbalance in the HPA axis[159], and estrogen fluctuations. These social and psychological factors interacting with each other could result in depression[157]. The perimenopausal depression model[157] found that a consequence of the interaction between

these social and psychological factors is that females report milder to moderate depression more frequently, whilst mild to moderate depression is under-reported among males[157]. Further, based on a study of the general Danish population (N = 1224), the difference between the genders was only significant when minor depression was included because females are more prevalent in those presenting with less severe depression[160].

Furthermore, a Swedish study[153], previously mentioned in this thesis, suggested that the gender ratio among people with severe depression was not significant due to the prevalence of females decreasing along with the degree of depression. As a result, optimal cut-off points for depression are recommended to be higher for females[161]. However, studies using the Hopkins Symptom Checklist-25 to measure psychological distress have established clinical cut-offs of >1.85, which is defined as a valid cut-off value for predicting mental distress[162]. The HSCL-25 measures symptoms of depression and anxiety and consists of 25 items: 10 questions about anxiety symptoms and 15 questions about depression symptoms. It has consistently been shown in multiple populations that the total score highly correlates with severe emotional distress of unspecified diagnosis, and the depression score is correlated with major depression as defined by the DSM-5[47]. Moreover, the optimal cut-off for a student population is not examined as far as is known. In descriptive reports on the SHoT surveys[66] a cut-off at ≥2.0 has been employed, which is based on experience from welfare organisations that a certain symptom load is common among students[66].

2.2 Physical activity

As stated in the introduction, the proportion of people who engage in regular PA is low, even though there is staggering evidence showing extensive health benefits of PA. A study on Norwegian University students showed that most young adults failed to meet WHOs recommendations on PA[163]. PA is usually defined as overall PA, exercise, or combined with other types of PA. Research shows that increased PA prevents non-communicable diseases, such as cardiovascular disease and type 2 diabetes[164]. Besides, several studies have shown positive effects of PA on mental health problems, notably when it comes to psychological distress (i.e., depression)[165,166]. Moreover, several studies have shown that PA can cause multiple physiological changes and mechanisms. For instance, reducing the stress levels and acting as a safeguard on the stress response may shield against harmful health effects due to stress, which can, in turn, cause a positive impact on the mood[167,168]. Moreover, the plasma

levels of endorphins rise instantly after PA, which is why athletes may experience euphoria after exercising[169].

Furthermore, a systematic review[170] on 35 RCTs (N = 2498) indicated that clinical patients with moderate to severe depression who did exercises reported more significant reductions in symptoms of depression than other patients. PA has been linked to the functioning of numerous neurotransmitters in the brain, such as serotonin, noradrenaline, and dopamine, suggesting that PA acts similarly to the SSRI antidepressants[171]. Several studies suggest that PA may have a similar therapeutic effect on psychological distress as psychotherapy[164]. Additional factors that can help investigate the association between poor mental health and inactivity are other lifestyle factors, such as body mass index (BMI), alcohol-related problems, and sleep duration. In which have been linked to mental well-being and PA in young adulthood[164]. Therefore, they are essential to consider when examining the association between PA and psychological distress.

Further, mitochondria have a crucial role in maintaining cellular stability via modulation of calcium ions (Ca2+) levels, maintaining the regulation of apoptosis and levels of reactive oxygen species (ROS), and energy production via metabolism of proteins, lipids, and steroids[172]. Thus, mitochondrial dysfunction not only impairs neuronal communication and cellular resilience but hampers cells to meet energy requirements, which underpin psychotic disorders and mood disorders[173]. The exact pathophysiology of psychological distress (i.e., depression) is still puzzling, even though several theories have been proposed. Evidence shows that mitochondrial dysfunction in several brain regions is associated with depression[174].

A study done on rats[175] indicated that the anti-depressive actions of exercise may be due to a reversal of mitochondrial dysfunction. Also, several studies have shown that PA could increase antioxidant enzymes in the nervous tissue and improve mitochondrial function. For example, another study on rats[176] showed that physical exercise during the developmental period may protect against oxidative brain damage caused by exposure to chronic stress later in life. Hence, PA is essential to maintain mitochondrial function and biogenesis. Therefore, lengthy periods of inactivity are an essential factor in developing the pathophysiology of mental diseases[174].

2.2.1 Recommendations of physical activity

PA is a positive health measure and considered as a healthy behaviour and thus, forms an essential part of a healthy lifestyle. PA is a significant element in developed and developing countries' public health policy systems[177], it is also a recognised health promotion tool globally because it increases the health potential biologically and psychologically. Therefore, WHO distribute information concerning spending energy through PA, with a specific frequency and volume, which is the minimum for keeping and developing sound health[178]. The recommendation for adults (>18 years) is a minimum of 30 minutes (or preferably 60 minutes) of moderate to vigorous physical activity (MVPA) five days or more per week[179], which is estimated to be between a minimum of 150 minutes to preferably 300 minutes of weekly PA. Stepping up PA from 150 minutes to 300 minutes each week further lowers the risk of a wide range of diseases, such as diabetes and heart disease and reduces the risk of developing mental health problems such as depression[179].

People engaging in weekly MVPA above 150 minutes to 300 minutes have been found to be less likely to score above the cut-off score of ≥1.85 on the HSCL-25, compared to inactive people[180]. However, a Canadian longitudinal association study (N = 460) on the context of physical activity and mental health in early adulthood[181] observed a significant controlled direct effect for PA volume on the association between mental health and team sports, which indicated that there was no benefit from increasing PA volume. Moreover, contrary to educational programs and interventions promoting a sporty or active lifestyle, dissemination of a sedentary lifestyle (e.g., avoiding the effort of being physical active and living a comfortable life); is influenced by several factors connected to the development of modern society[182]. The development of urban areas and an increase in society's wealth seem to lead to increased sedentary behaviour[182].

2.2.2 Physical activity and sedentary behaviour

It is worth mentioning that one in five people globally is physically inactive[183]. Where globally, more than one-fourth of adults and four-fifths of the youth fail to achieve the recommended levels of PA[3]. In a Lancet paper form 2018[3], there was reported a global age-specific prevalence of inadequate PA of 27.5% (31.7% in females and 23.4% in males). The tendency shows that women are more inactive than men and that this trend increases with age.

Studies investigating students' PA frequency[184,185,186] have shown this, where around 80% of the students were insufficiently physically active according to the WHO's guidelines. A national cross-sectional survey conducted in the United States[187] (N = 54 377) supports these findings. They found that only 25% of Americans achieved the minimum recommended level of weekly PA (MVPA150). Moreover, a cross-sectional study (N = 14804)[188], on mental health and vigorous physical activity in American college students, found that poor mental health was less common among college students who exercised.

Changes in leisure-time PA and depression have been found to be related, where an inverse relationship have been found between depression and PA[189,190]. An American cross-sectional descriptive study (N = 4058)[191] found that depressed adults spend significantly less time in moderate and vigorous PA than non-depressed adults. After controlling for socio-demographic factors, females with self-reported less MVPA were at greater risk for depression[191]. Cross-sectional study on Australian adults[192] (N = 3796) showed that the time spent in front of the phone, TV or computer screen has increased systematically, combined with lack of PA, has an adverse impact on quality of life regarding health. In addition, globally, the fourth leading cause of death is lack of PA[193].

Even though there is much knowledge about PA's benefits regarding health outcomes[194], there is little knowledge about the relationship between different levels of PA, sedentary behaviour, and depression. Moreover, even though sedentary behaviour and PA might operate through varying behavioural mechanisms[195], influence disease risk independently and have different determinants, these behaviours are presumably correlated within individuals[196]. Therefore, they are better considered co-occurring behaviours instead of independent actions.

2.2.3 Health effects of physical activity

Health-related PA involves the components of PA related to health status, including musculoskeletal fitness, metabolism, cardiovascular fitness, and body composition. Further, several long-term prospective follow-up studies (mainly involving males but more recently females as well) have assessed the relative risk of death from specific diseases (i.e., cardiovascular disease) and any cause associated with physical inactivity[197,198,199,200,201]. Both females and males who reported increased levels of PA and fitness were found to have reductions in relative risk of death by 20-35%[202]. Further, some studies have shown even

more significant reductions in the risk of death from cardiovascular disease and any cause. For instance, being active or fit has been associated with a more than 50% reduction in risk[203].

There is existing evidence that the intensity of PA is linearly and inversely associated with mortality[204]. Studies have shown that average energy expenditure of around 1000 kcal (4200 kJ) per week is associated with a 20-30% decrease in all-cause mortality[204,205]. Thus, most fitness and health professionals and organizations advocate a minimum volume of exercise that expends 1000 kcal (4200 kJ) per week and acknowledge the added benefits of higher energy expenditures. Moreover, researchers have postulated that even lower levels of weekly energy expenditure might be associated with health benefits[205]. A volume of exercise that is about half of what is currently recommended might be sufficient[204] especially for people who are severely deconditioned, elderly, or frail[197]. If so, then people who have a sedentary lifestyle might be more likely to engage in PA and maintain an active lifestyle.

Moreover, routine PA has proven to improve body composition (e.g., through improved weight control and reduced abdominal adiposity)[206,207,208] enhance lipid lipoprotein profiles (e.g., through increased high-density lipoprotein [HDL], cholesterol levels, reduced triglyceride levels, and decreased low-density lipoprotein [LDL]-to-HDL ratios)[206,209,210], and reduce blood pressure[211,212]. Further, routine PA is also associated with improved psychological well-being (e.g., reduced anxiety, stress, and depression)[206,213]. Psychological well-being is crucial for the management and prevention of cardiovascular disease. However, it also has important implications for preventing and managing other chronic diseases such as osteoporosis, hypertension, diabetes, cancer, obesity, and depression[206].

2.3 Mental health and physical activity

2.3.1 Association between physical activity and mental health

PA is well recognised as a crucial factor for the management and prevention of mental health problems, including psychological distress such as anxiety and depression, as well as the promotion of mental health such as well-being[214,215]. A systematic review of 31 cross-sectional, prospective, or longitudinal studies (N = 71 981) from around the world found a positive association between PA and better outcomes for mental health (e.g., anxiety, well-being, and depression)[216]. In this systematic review PA was an explanatory variable for mental health[217], and PA was found to be positively associated with mental health[218,219].

Participants who had a decrease in mental health had a more significant reduction in PA[220]. The inactive people had higher anxiety and depression and worse well-being than participants who were moderately active and very active[221,222]. In contrast, sufficiently active participants reported significantly lower anxiety and depression and higher life satisfaction. Furthermore, the PA intensity was found to be necessary. Depression was found negatively correlated with moderate intensity but not vigorous intensity[223]. Also, vigorous PA was found to be better at predicting depressive symptoms than moderate PA[224].

2.3.2 Physical activity as a protective factor for mental health

In the modern world, a decrease in the overall PA can be seen due to changes in our lifestyle, which might be caused by less activity at home and work, and modern transportation means. In parallel, planned PA has slightly increased or been relatively stable[225]. Around 60% in 27 European countries answered in different surveys that they never or seldom play sports or exercise[226]. Despite that, other types of PA such as bicycling, gardening, and walking was far more common, with 65% engaging in such PA with some regularity or regularly[226].

The association between PA and depression has been of interest for a long time to researchers. Evidence from a North American cross-sectional study (N = 42) indicated that high levels of PA (exercise or overall) are associated with a lower prevalence of depression[227]. However, this does not explain whether depression is a result of low levels of PA or if low PA is due to depression status. A systematic review consisting of 30 studies from North American and Europe on prospective-based, longitudinal design, which examined relationships between PA and depression, have shown that higher levels of PA are associated with a lower risk of developing depression[228]. Nonetheless, the patients might have reduced their PA even further due to the onset of depression. A great example of long-term evidence on the association between PA and depression can be seen in the North American Alameda County study[229] (N = 8023) on adults aged 20 years and older. This study showed that there were not only low levels of PA associated with a greater risk of depression at follow-up, but the change in PA was also contributing to the risk of developing depression. Moreover, healthy people who had to discontinue their aerobic exercise showed an increase in fatigue and symptoms of depression in the following coming weeks[230].

Be that as it may, some oppose this way of looking at the association between PA and depression. A population-based longitudinal study (1991-2002) used data from the

Netherlands Twin register (N = 5952) suggested that common genetic factors led people in their leisure time to be more physically active and was a protective factor against developing depression[231]. This longitudinal study suggested that PA could still treat depression; however, it should be part of a therapeutic program where the PA is supervised[231].

2.3.3 Physical activity as treatment for mental health

If becoming or being physically active can diminish the risk of developing depression, people who are already depressed may benefit from PA, which several RCTs have outlined. Various Cochrane reviews have demonstrated that when compared to controlled conditions (for instance, social activity or waiting list), PA has a small to moderate impact on depression[232,233]. Another review utilized meta-analysis to demonstrate that the effect of PA on depression is indeed significant, as publication bias resulted in a miscalculation of the effect in previous reviews[234].

The effect of PA on depression, either compared to active treatment or a control group, has for the most part been reported as short-term effects, for instance, the effects measured directly after the end of the intervention period[234]. Research looking at long-term effects, measured at a minimum of six months or more after the intervention period ends, is insufficient. There has been proposed by systematic reviews that the effects are not long-term[235] or has a negligible effect when PA is compared to placebo or waiting list. Regardless of the evidence showing that PA, combined with other treatments alone, can be as effective as traditional treatments, physicians do not generally prescribe PA. Moreover, using PA as treatment and recovery for depression is nearly non-existent in the Norwegian health care system[236,237]. Both PA and preventative measures are often not recommended.

2.4 Aim

Due to the considerable consequences mental health problems have on economic, educational, and social outcomes, it is important to identify protective and risk factors for developing mental health problems in the student population. Even if the association between PA and mental health is well studied, less is known about the association between different levels of PA (MVPA150 and MVPA300) and psychological distress (i.e., depression). Further, most studies in this field have been conducted on undergraduate students, focusing on the transition

from adolescence to adulthood, and less is known about associations between different levels of PA and psychological distress in the whole student population. Expanding knowledge on these issues in university populations may be especially important, as the lack of PA in this population might represent an ongoing mounting risk for deterioration of health.

For this reason, the aim of this thesis was to investigate the association between different levels of PA and psychological distress (i.e., depression) among male and female university students. Further, to explore if any observed association can be partially explained by age or lifestyle factors, such as BMI, alcohol-related problems, and sleep duration.

2.4.1 Research question

Is there any association between psychological distress (i.e., depression) and levels of PA (MVPA150 and MVPA300) in a large cohort of Norwegian university students (18-35)? If so, can this be partially explained by age and lifestyle factors such as BMI, alcohol-related problems, and sleep duration?

The research question was answered by testing the following general hypothesis:

H0: Psychological distress is not associated with level of PA (MVPA150 and MVPA300) among Norwegian university students.

H1: Psychological distress is associated with level of PA (MVPA150 and MVPA300) among Norwegian university students.

The research question was also answered by testing the following variable-specific hypothesis:

H0: Age, BMI, alcohol-related problems, and sleep duration do not explain the association or influence on the relationship between do psychological distress and level of PA (MVPA150 and MVPA300).

H1: Age, BMI, alcohol-related problems, and sleep duration explain the association or influence on the relationship between do psychological distress and level of PA (MVPA150 and MVPA300).

CHAPTER THREE

Methodology

Chapter 3

METHODOLOGY

3.1 Study design

Quantitative research method[238] has been utilised in carrying out this cross-sectional study, analysing data derived from the Students' Health and Well-being Study (SHoT study) conducted in 2018[239]. A cross-sectional study is a type of research design in which one collects data from several different individuals at a single point in time[240]. In cross-sectional research, one observes variables without influencing them. Moreover, a cross-sectional is the best choice when the goal is to examine the prevalence of some outcome at a particular moment in time. Also, this type of study can be the best choice due to practical reasons: for instance, if the time or budget is limited. Cross-sectional studies are less time-consuming and cheaper than many other types of studies, and thus they allow the researcher to easily collect data that can be used as a basis for future research[240].

However, it is hard to establish cause-and-effect relationships because the data is collected only in a single timeframe. This type of study only measures the alleged cause and effect one-time[240]. Further, since cross-sectional studies only study a single moment in time, they cannot be used to establish long-term trends or analyse behaviour over some time. Also, the timing of the cross-sectional are being conducted might be unrepresentative of the group's behaviour as a whole[240].

3.2 SHoT2018 study

The SHoT study is a national student survey for higher education in Norway[241]. So far, the study has been conducted at a four-year interval and have been carried out three times (2010, 2014 and 2018). Both the scope and size of the SHoT studies have increased over time and is comprised of all fulltime university and college students aged 18-35 years in Norway. The aim of the survey was to monitor the student' physical and mental health, as well as psychosocial environment. The SHoT2018 survey was used in this current thesis. The survey data were collected electronically through an online platform. A total of 162,512 students fulfilled the inclusion criteria, of whom 50,054 (30.8%) students completed the online questionnaires[163].

The SHoT2018 study was a collaboration between all student welfare associations in Norway and the Norwegian Institute of Public Health (NIPH), and the dataset is administrated by

NIPH. All full-time Norwegian university students studying in both Norway and abroad were invited to participate in the survey. The dataset includes a broad spectrum of self-reported data covering information on physical and mental health, health-related behaviours, along with specific study-related information. The focus of this thesis is on the association between different levels of PA and symptoms of depression.

Table 3.0: Overview of the study included in the thesis

Material	Population age	Study description
SHoT-2018 Survey data Cross sectional N = 50 054	18-35	Norwegian University students' self-reported health and wellbeing

3.3 Cohort description

Norway is a social-democratic welfare state and has predominately public health services and generous universal public health insurance coverage. Eight universities offer higher education in Norway, nine specialised universities, 24 university colleges, and several private universities. Public education is free and consists of two semesters during an academic year, from August to December and from January to June. All students belonged to a student welfare association which accounts for services such as kindergartens, housing, some healthcare, and advisory services. In Norway, students who enrol in higher education do not have to apply for membership in a student welfare association because it is a part of the university.

3.4 Procedure

The SHoT2018 study was collected on Norwegian full-time students attending university between February 6th and April 5th, 2018. The data collection was a joint effort with the student welfare associations. The SHoT study is, as stated, a collaboration between NIPH and all student welfare associations in Norway and is a notable survey carried out on Norwegian university students. Both the planning and the implementation of the health survey were in close collaboration with the steering group for SHoT2018. The SHoT2018 survey consisted of 10 main topics with several sub-points asking more in-depth questions.

Students from 45 educational institutions participated in SHoT2018, where 162 512 students met the inclusion criteria. These students received an invitation by SMS and by email. During the two months the survey lasted, students who had not responded to the survey were sent up to three reminders (two by email and one by SMS). Also, student politicians ran offensive advertising and campaigns to increase participation. Several participating educational institutions set aside 45 minutes in lectures for adequate time to complete the online health survey. Electronically informed consent was signed after the participants had received a detailed description of the survey. All responses were collected electronically in the online platform Services for Sensitive Data (TSD) at the University of Oslo.

A total of 50 054 students completed the survey, which gave a response rate of 30.8%. To recruit students, there was advertised that a hundred random participants could win a gift card of 500 NOK, and the inclusion criteria were that one had to be a Norwegian citizen, a full-time student, and between 18-35 years.

3.5 Instruments

An overview of the main included instruments/variables in the SHoT2018 study is presented in Table 3.1, covering self-reported information on physical and mental health, and lifestyle factors. Of particular interest were instruments assessing the physical and mental health and instruments assessing lifestyle factors, such as BMI, alcohol-related problems, and sleep duration.

Table 3.1: Overview of the included instruments/variables in the thesis

Domain	Instruments and description
Mental health and well-being	**Psychological distress** was evaluated using The Hopkins Symptoms Checklist (HSCL-25)[242], acquired from the 90-item Symptom Checklist (SCL-90), which is a screening tool designed to uncover symptoms of depression and anxiety. It comprises a 15-item subscale for depression and a 10-item subscale for anxiety, with each item scored on a Likert scale from 1 (not at all) to 4 (extremely). The reference period is the past two weeks. **Alcohol-related problems**: The students' answers were assessed using the Alcohol Use Disorder Identification Test (AUDIT). The AUDIT consists of 10 items from three domains: consumption patterns (questions 1-3), dependence symptoms (questions 4-6), and harmful consequences of drinking (questions 7-10). The response options can be scored from 0 to 4 on each item. Then the scores are summarised from the 10 items, giving a total score ranging from 0 to 40. A total score of 6 or more for women and 8 or more for men are used to indicate risky drinking, and a total score above 11 and 13 indicate hazardous drinking. **Sleep duration:** the sleep variables were typical rise time, bedtime, wake after sleep onset, sleep onset latency was separately reported for weekdays and weekends. The students also indicated number of nights per week they experienced difficulties maintaining sleep, difficulties initiating sleep, snoring, early morning awakenings, daytime sleepiness, tiredness and breathing cessations during sleep. The students were asked additionally for how long they had suffered from these sleep problems. The information gathered from these questions was used as an operationalisation for insomnia disorder, according to the DSM-5 criteria.
Health behaviour	*Physical activity* (PA) was evaluated using three sets of questions, evaluating the average intensity, frequency, and duration and the average number of times PA each week. ➢ "If you do exercise as frequently as once or more times a week: How hard do you push yourself?" (I take it easy without breaking into a sweat or losing my breath, I push myself so hard that I lose my breath and break into a sweat, I push myself to near-exhaustion). ➢ "How long does each session last?" (Less than 15 min, 15-29 min, 30 min to 1 hour, more than 1 hour). ➢ "How frequently do you exercise?" (Never, less than once a week, once a week, 2-3 times per week, almost every day). ➢ The respondents were also asked if they considered themselves a 'top athlete,' in that case, what sport and how many hours per week they trained.
Other information	Various background and demographical factors were also evaluated, such as age, gender, height, and weight (BMI).

3.6 Variables

The instruments and variables used in this thesis (see table 3.1) are described more thoroughly below.

3.6.1 Dependent variable

3.6.1.1 Hopkin Symptom Checklist-25: HSCL-25

HSCL-25 is considered a good screening tool designed to uncover psychological distress (i.e., depression and anxiety)[102]. The Norwegian translation of HSCL-25 was used to measure psychological distress in the survey. HSCL-25 is a self-report measure based on a more extended checklist developed by Derogatis and colleagues[243]. HSCL-25 consists of 25 statements regarding symptoms the subjects have experienced in the past two weeks, including 10 items making a subscale of anxiety and 15 items providing a subscale for depression. Each statement has response options ranging from 1 (not bothered) to 4 (extremely bothered). Not bothered gives 1 point, while extremely bothered gives 4 points. The answers are summarised across all items, and the mean score is utilised to measure psychological distress.

Several cut-offs and factor structures have been proposed for the HSCL-25[244,245]. A uni-dimensional model is recommended after investigating the instrument factor structure in the SHoT data[246], and thus it has also been employed in the current study. A mean score of >1.85 is regarded as a valid cut-off value for predicting mental distress[162]. However, the optimal cut-off for a student population is not established as far as is known. In descriptive reports from the SHoT surveys[66], a cut-off at ≥2.0 has been employed. This practice is based on experience from welfare organisations that somewhat high symptoms loads are common among students[66]. In accordance with this, a cut-off on ≥2.0 for identifying moderate and higher levels of psychological distress was applied also in the current thesis. The HSCL-25 was split into two groups, those who scored low (below the cut-off score of ≥2.0) and high (above the cut-off score) on the HSCL-25. Appendix 1, Table 1 details the exact HSCL-25 questionnaire used in the SHoT2018 study.

3.6.2 Physical activity

PA was measured employing a three-item questionnaire, which assesses the mean time every exercise takes and the mean number of times the subjects exercise during a week[247]. The students who partook in the SHoT2018 study were presented with the following definition of exercise: "*With exercise, we mean that you, for example, go for a walk, swim, go skiing or take part in a sport*." The questions used were following:

Table 3.2: Physical activity: three-item questionnaire

Questions	Answer options
1) *If you do such exercise as frequently as once or more times a week: How hard do you push yourself?*	• *I take it easy without breaking into a sweat or losing my breath* • *I push myself so hard that I lose my breath and break into a sweat* • *I push myself to near-exhaustion.*
2) *How frequently do you exercise?*	• *Never* • *less than once a week, once a week* • *2-3 times per week* • *almost every day*
3) *How long does each session last?*	• *Less than 15 minutes* • *15-29 minutes* • *30 minutes to one hour* • *more than one hour.*

As a measure of PA, the variables duration, frequency and intensity are dichotomized by using two times per week as the cut-off value (inactivity = "never," "less than once a week," "once a week").

This three-item questionnaire has been employed in the large population-based Nord-Trøndelag Health Study (the HUNT studies). Former validation studies[247,248] have indicated a moderate correlation between the three-item questionnaire responses and measurement of

VO$_2$max during maximal PA on a treadmill (intensity r = 0.40, duration r = 0.31, and frequency r = 0.43), with ActiReg[249,250], an instrument that measures energy expenditure and PA.

Based on the WHO recommendation for duration, frequency and intensity of weekly PA[251], the two following dichotomous variables were created based on the students' responses to the three questions.

Table 3.3: physical activity levels

1) MVPA: 150 mins/week:	students answering both "*Almost every day*" on the frequency item, "*I push myself so hard that I lose my breath and break into a seat*" on the intensity item, and "*30 minutes or more*" or "*More than one hour*" on the duration item.
2) MVPA: 300 mins/week:	students answering both "*Almost every day*" on the frequency item, "*I push myself so hard that I lose my breath and break into a sweat*" on the intensity item, and "*More than one hour*" on the duration item.

Abbreviation: MVPA = moderate to vigorous physical activity

3.6.3 Body mass index

The participants reported height and weight. The body mass index (BMI) was calculated as weight in kilos divided by squared height in meters and split into four categories: underweight (BMI <18.5), normal weight (BMI 18.5-24.9), overweight (BMI 25.0-29.9), and obesity (BMI ≥30). Studies have shown that BMI levels correlate with future health risks and body fat, where a high BMI predicts future death and morbidity[252].

BMI is an adequate measure for screening obesity, but some clinical limitations should be considered. BMI is an alternate measure of body fatness because it measures excess weight rather than excess body fat. Keys et al.[253] pointed out that the BMI rather poorly represents a person's body fat percentage. Age, ethnicity, muscle mass, and gender might influence the

relationship between body fat and BMI. Furthermore, BMI does not distinguish between bone mass, excess fat or muscle, nor does it supply any indication of fat distribution. The failure of BMI to fully capture cardiometabolic risk is partially related to the fact that BMI in isolation is an insufficient biomarker of abdominal adiposity.

Waist circumference is a simple method to assess abdominal adiposity that is easy to apply and standardize clinically. It is strongly associated with cardiovascular[254,255] and with all-cause mortality[256,257] with or without adjustments for BMI[256,258]. However, the full strength of the association between waist circumference with mortality and morbidity is realized only after adjusting for BMI[256,259]. Hence, waist circumference enables a further improvement of the disadvantageous health risk characterized by BMI and should be included when stratifying obesity-related health risks.

3.6.4 Alcohol-related problems

In this thesis, a translated Norwegian version of the Alcohol Use Disorders Identification Test (AUDIT) was used to measure potential alcohol-related problems among the student population. AUDIT is a widely used instrument to detect individuals who have harmful or risky patterns of alcohol use and is developed by the WHO to identify risky or harmful alcohol use[260]. The 10-item AUDIT includes items for measuring the frequency, episodic heavy drinking frequency, and typical amount (items 1-3), alcohol dependence (items 4-6) and problems related to alcohol consumption (items 7-10)[261]. The AUDIT total score ranges from 0 to 40; a score of 8 or more is considered to indicate harmful or hazardous alcohol use. Appendix 1, Table 2 details the exact AUDIT questionnaire used in the SHoT2018 survey.

3.6.5 Sleep duration

The participants' Self-reported usual bedtime and rise time were indicated in hours and minutes and was calculated separately for weekends and weekdays. The difference between these two-time points calculated time in bed (TIB). Wake after sleep onset (WASO) and sleep-onset latency (SOL) were also indicated separately for weekends and weekdays in hours and minutes. Sleep duration was defined as TIB minus WASO and SOL[262].

For the purpose of this thesis, sleep duration was used as a categorical variable. Subjective need of sleep was reported in terms of hours and minutes, and sleep deficit was calculated separately for weekends and weekdays, subtracting total sleep duration from subjective sleep need. This has also been done on previously studies on the SHoT2018 data[262]. Also, the participants indicated the number of nights per week they experienced difficulties initiating sleep (DIS), early morning awakenings (EMA) and difficulties maintaining sleep (DMS), as well as tiredness and daytime sleepiness.

The participants who suffered from sleep problems were also asked about how long the problems had been present. Following three criteria were used in a study done on the SHoT2018 data[262] and in this thesis, as an operationalization for insomnia disorder, in line with the DSM-5 criteria: (a) the presence of either DIS, DMS or EMA for at least 3 nights per week; (b) the presence of daytime sleepiness and tiredness for at least 3 days per week; and (c) a duration of the sleep problems for at least 3 months. Appendix 1, Table 3 details the exact sleep questionnaires used in the SHoT2018 study, which consisted of one item of the depression subscale of the HSCL-25 based on the DSM-5 insomnia disorder.

3.7 Data access

The SHoT2018 survey data were collected electronically through a web-based platform in 2018. Guidelines for accessing the SHoT2018 data are found on NIPH's webpage[263]. An application was sent to NIPH, asking for access to the SHoT2018 data in August 2021. An approved application from the Regional Committee for Medical and Health Research Ethics (REK) is a pre-requirement to gain access to the survey data. This thesis received approval from REK (no. 269726) before sending an application to NIPH.

Furthermore, approval from the Norwegian Centre for Research Data (NSD) was a requirement due to the new general data protection regulation (GDPR) law in Europe. This law imposes obligations onto organizations anywhere, as long as they collect or target data related to people in the EU[264]. Moreover, the survey data is stored in Services for sensitive data (TSD)[265] to ensure information security. TSD is a platform for storing, collecting, sharing, and analyzing sensitive data complying with the Norwegian privacy regulation.

3.8 Statistical analyses

As the data for this thesis was collected from the SHoT2018 study[102], no power calculations were explicitly performed. Statistical analyses include parametric tests due to the data being normally distributed.

The analyses are divided into two parts. The first part involved the descriptive statistics, which presents the characteristics of the study population in this thesis. As the variables were categorical, they were examined using crosstabs. The number of participants is presented as frequencies (%) and the total number before and after listwise deletion. Demographic and clinical characteristics are presented as mean and standard deviation (SD) and frequencies and total number (Table 4.1). Age distribution is presented in Figure 1 as frequencies (%) and split into different age groups (ages [18-20], [21-22], [23-25], [26-28], and [29-35]). BMI distribution is presented in Figure 2 as frequencies (%) and split into underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), and obesity (≥30). A table of the included instruments and variables is presented in table 4.2. In the two levels, MVPA 150 and MVPA 300, PA among the genders is presented in Figure 3 as the number of students (n) and frequencies (%).

The second part of the analyses examined the association between psychological distress and levels of PA (MVPA 150 and MVPA 300). The difference between categorical variables in the student population was tested with chi-squared tests, and the distribution of categorical variables across the groups was tested with two-way ANOVA. Logistic regression models were run to examine the relationship between psychological distress (HSCL-25) and level of PA.

Pearson's chi-squared tests were used to examine differences in the prevalence of psychological distress by two different levels of PA stratified by gender. Models that are both crude and adjusted have been computed, where the adjusted models control the BMI, sociodemographic, AUDIT and sleep duration in one table. Estimated marginal means were computed to examine PA's two levels against the HSCL-25 average score and were adjusted for the lifestyle factors above.

To examine the research question, an Analysis of Variance (ANOVA) was conducted to determine if there were any statistically significant differences between the means of the

HSCL-25 and level of PA (MVPA150 and MVPA300). Also, if there were any statistically significant differences between HSCL-25, level of PA, age, BMI, alcohol-related problems, and sleep duration. The two-way ANOVA is appropriate when the research goals involve is to identify significant differences in a continuous variable between two or more discrete groups. Estimated marginal means (EMMs) was computed using the UNIANOVA procedure in SPSS (which provides analysis of variance and regression analysis) to examine changes in continuous outcomes (HSCL-5), adjusting for gender, age, BMI, alcohol-related problems, and sleep duration.

Psychological distress (HSCL-25) was split into 1 (the participants score above the cut-off value of ≥2.0 on the HSCL-25) and 0 (the participants score below the cut-off value of ≥2.0 on the HSCL-25). Since the dependent variable is discrete, the ordinary least squares regression can be used to fit a linear probability model. However, since the linear probability model is heteroskedastic and may predict probability values beyond the (0, 1) range, the logistic model was used to estimate the variables that might influence symptoms of depression. The logistic regression models have been computed to obtain effect-size estimates and are presented as odds ratios (ORs) with a 95 % confidence interval (95% CI). The overall model significance for the multinomial logistic regression was examined by the collective effect of the independent variable(s) using the $\chi 2$ omnibus test of model coefficients. Predicted probabilities of an event occurring will be determined by Exp(B), the odds ratio. The association of the two levels of PA (MVPA 150 and MVPA 300) and HSCL-25 stratified by gender, was also controlled for age, BMI, AUDIT, and sleep duration.

This thesis uses IBM SPSS Statistics 25 for Windows[266] for all statistical analytical analyses. The level of statistical significance was set at default to α=0.05.

Table 3.4 Overview of focus, exposures, outcomes, and analyses for the studies included in the thesis

Study	Exposure	Outcome	Design/analysis	Focus	n
SHoT-2018 study	Physical activity, BMI, alcohol-related problems, sleep duration	Self-reported symptoms of depression measured at 18-35 years of age	Pearson chi-squared test, logistic regression, and one-way ANOVA	Male and female students with depression	49 836

3.9 Missing Data

There were in total 50 054 students who participated in the SHoT2018 study. However, a small number of students did not answer every question concerning this thesis included variables. As a result, the sample included in this thesis is insignificantly smaller. Observations with missing data on the student's welfare organization membership, age and gender, students with gender other than male/female, and missing questions of the HSCL-25 and PA questionnaires were not included in this thesis (n = 324), resulting in a sample of 49 730 students (95.4% of the total number of participants of 50 054).

3.10 Ethical approval

The Regional Committee for Medical and Health Research Ethics (REK) in southeast Norway approved the research questions related to the SHoT2018 study (no. 269726). Informed consent was obtained in 2018 electronically after the participants received a detailed introduction to the SHoT2018 study, which stated that the survey data could be saved and used for research. Thus, informed consent was not necessary to obtain for this thesis.

CHAPTER FOUR

Results

Chapter 4

RESULTS

4.1 Descriptive statistics

4.1.1 Characteristics of study population

The data used in the current analyses was retrieved from the SHoT-2018 survey, which was one out of three surveys conducted on full-time Norwegian university students aged 18-35 years.

Of the 162 512 students who received an invitation to participate in the SHoT-2018 survey, 50 054 students completed the web-based survey, which resulted in a response rate of 30.8%. However, of the 50 054 students who responded, only 49 836 had answered the survey questions about PA and psychological distress. After the listwise deletion, the analyses in this thesis are based on 34 437 (69.2%) female and 15 399 (30.9%) male students, aged between 18 and 35 years. (Table 4.0).

Table 4.0: Distribution of study participants in this thesis

	Total answered		Included in analysis	
	n	%	n	%
	50 054		49 836	
Gender				
Female	34 587	69.09	34 437	69.10
Male	15 467	30.90	15 399	30.89

Almost all students submitted data on the included variables: HSCL-25, PA level (MVPA150 and MVPA300), age, BMI, alcohol-related problems, and sleep duration. However, there were some discrepancies in the number of participants answering each question about their mental and physical health.

Descriptive data of all the included variables in this thesis is presented in Table 4.1. Leaving out level of PA, among the total group 31.6% of the females and 15.6% of the males fell into the high HSCL-group. A higher percentage of the females showed indications of poor mental

health compared to the male students, which was the same when comparing the relationship between PA and the HSCL-25.

Table 4.1: Demographic and clinical characteristics of the of the participants in the SHoT2018 study.

	Females	Males	Total
HSCL-25 mean (SD)	1.82 (0.56)	1.53 (0.48)	1.76 (0.55)
HSCL-25 > 2, % (n)	31.6% (10 852)	15.6% (2396)	26.6% (13 248)
MVPA < 150 mins/wk, % (n)	82.1% (28 224)	76.7% (11 761)	80.4% (39 985)
MVPA ≥ 150 mins/wk, % (n)	17.9% (6172)	23.3% (3573)	19.6% (9745)
MVPA < 300 mins/wk, % (n)	91.0% (31 306)	83.2% (12 753)	88.6% (44 059)
MVPA ≥ 300 mins/wk, % (n)	9.0% (3090)	16.8% (2581)	11.4% (5671)
Age, mean (SD)	23.12 (3.3)	23.54 (3.3)	23.25 (3.3)
BMI, mean (SD)	24.0 (4.5)	24.5 (3.9)	24.5 (3.9)
AUDIT, mean (SD)	6.82 (4.5)	8.20 (5.1)	7.25 (4.7)
Sleep duration, mean (SD)	7:24 (1:26)	7:23 (1:26)	7:24 (1:26)

Abbreviation: HSCL-25 = 25 items Hopkins Symptoms Check List (cut-off value 2.0), MVPA = moderate to vigorous physical activity, <150 = below 150 ≥150 = above 150 minutes, ≥300 = above 300 minutes, AUDIT = Alcohol Use Disorders Identification Test, SD = standard deviation, n = number of participants, Sleep duration = measured in hours and minutes

The mean age was 23.2 years (SD = 3.3). Almost all students submitted data on their gender and age, only 897 (1.8%) did not answer the question about age. In line with previous studies on the SHoT-data[163,241], age was categorised into five groups: 18-20 years [17.9%, n = 8797], 21-22 years [31.4%, n = 15 419], 23-25 years [32.2%, n = 15 849], 26-28 years [11.6%, n = 5681], and 29-35 years [6.9%, n = 3411].

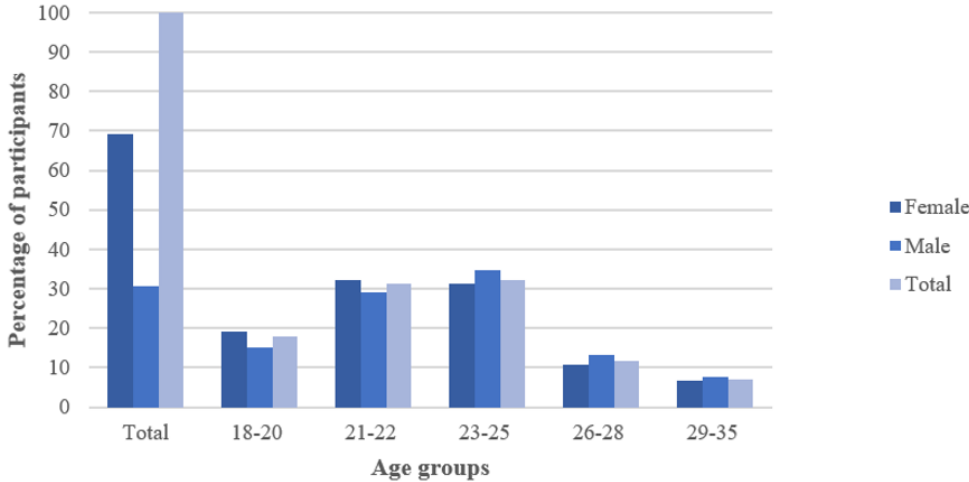The distribution of male and female participants in age-groups is presented in Figure 1.

Figure 1: Bar graph presenting the age distribution of the overall sample (N = 49 157), across gender. The age groups were split into five groups.

The mean BMI was 24.5 (SD = 3.9). The participants' BMI was classified into underweight, normal weight, overweight and obese[267] (BMI <18.5 [3.4%, n = 1663], BMI 18.5-24.9 [64.2%, n = 31 004], BMI 25.0-29.9 [23.5%, n = 11 343], and BMI ≥30 [8.8%, n = 4251]).

Figure 2 present the distribution of the participants in the different BMI groups, underweight, normal weight, overweight and obese.
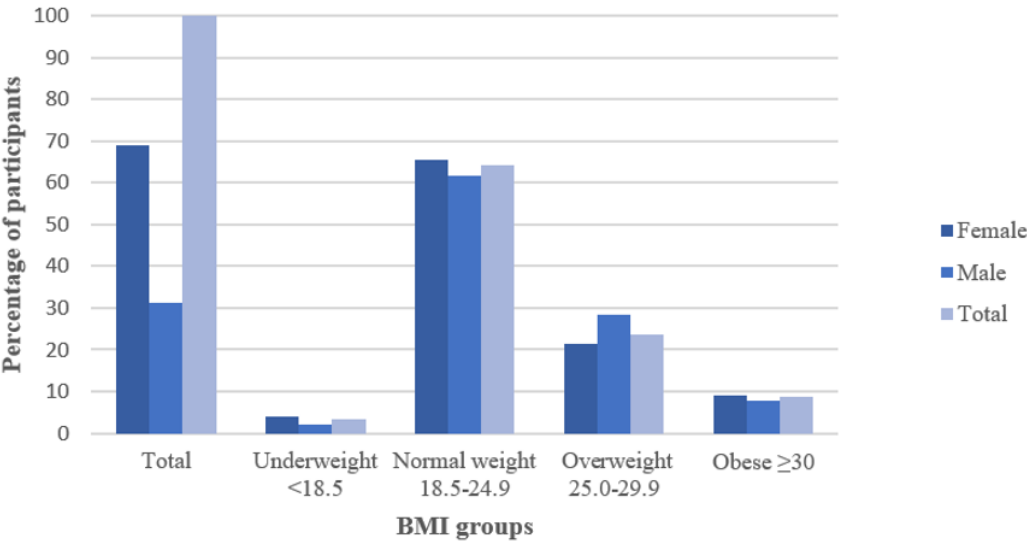
Figure 2: Bar graph presenting the BMI distribution of the overall sample (N = 48 261), across gender. The BMI was split into four groups: underweight, normal weight, overweight and obese.

Table 4.2 present the included instruments and variables in this thesis.

Table 4.2: The included instruments and variables in this thesis

	Variable	Instrument
Dependent	Psychological distress	Psychological distress was evaluated using The Hopkins Symptoms Checklist (HSCL-25), acquired from the 90-item Symptom Checklist (SCL-90), which is a screening tool designed to uncover symptoms of depression and anxiety. It comprises a 15-item subscale for depression and a 10-item subscale for anxiety, with each item scored on a Likert scale from 1 (not at all) to 4 (extremely). The reference period is the past two weeks.
Independent	Physical activity	Physical activity (PA) was evaluated by a three-item questionnaire, evaluating the average intensity, frequency, and duration and the average number of times PA each week. Two dichotomous variables were created based on the students' responses to the three-item questionnaire; MVPA150 and MVPA300.
Confounding	BMI	Was measures by dividing the participants weight with their heigh in meters squared.
	Alcohol-related problems	The students' answers were assessed using the Alcohol Use Disorder Identification Test (AUDIT). The AUDIT consists of 10 items from three domains: consumption patterns (questions 1-3), dependence symptoms (questions 4-6), and harmful consequences of drinking (questions 7-10). The response options can be scored from 0 to 4 on each item. Then the scores are summarised from the 10 items, giving a total score ranging from 0 to 40. A total score of 6 or more for women and 8 or more for men are used to indicate risky drinking, and a total score above 11 and 13 indicate hazardous drinking.
	Sleep duration	The sleep variables were typical rise time, bedtime, wake after sleep onset, sleep onset latency was separately reported for weekdays and weekends. The students also indicated number of nights per week they experienced difficulties maintaining sleep, difficulties initiating sleep, snoring, early morning awakenings, daytime sleepiness, tiredness and breathing cessations during sleep. The students were asked additionally for how long they had suffered from these sleep problems. The information gathered from these questions was used as an operationalisation for insomnia disorder, according to the DSM-5 criteria.

4.1.2 Level of physical activity

The proportion of male and female students reporting MVPA below and above the minimum recommendation of MVPA150 minutes and below or above the preferable recommendation of MVPA300 minutes is presented in Figure 3. For both genders, the percentage of Norwegian university students who fall into the respective 'below MVPA150' and 'below MVPA300' groups are higher (below MVPA150 [female = 82.1% and male = 76.8%], and below MVPA300 [females = 91% and males = 83.2%]) than the percentage of students who fall into the respective above MVPA150 and above MVPA300 (above MVPA150 [females = 17.9% and males = 23.2%], and above MVPA300 [females = 9.0% and males = 16.8%]).
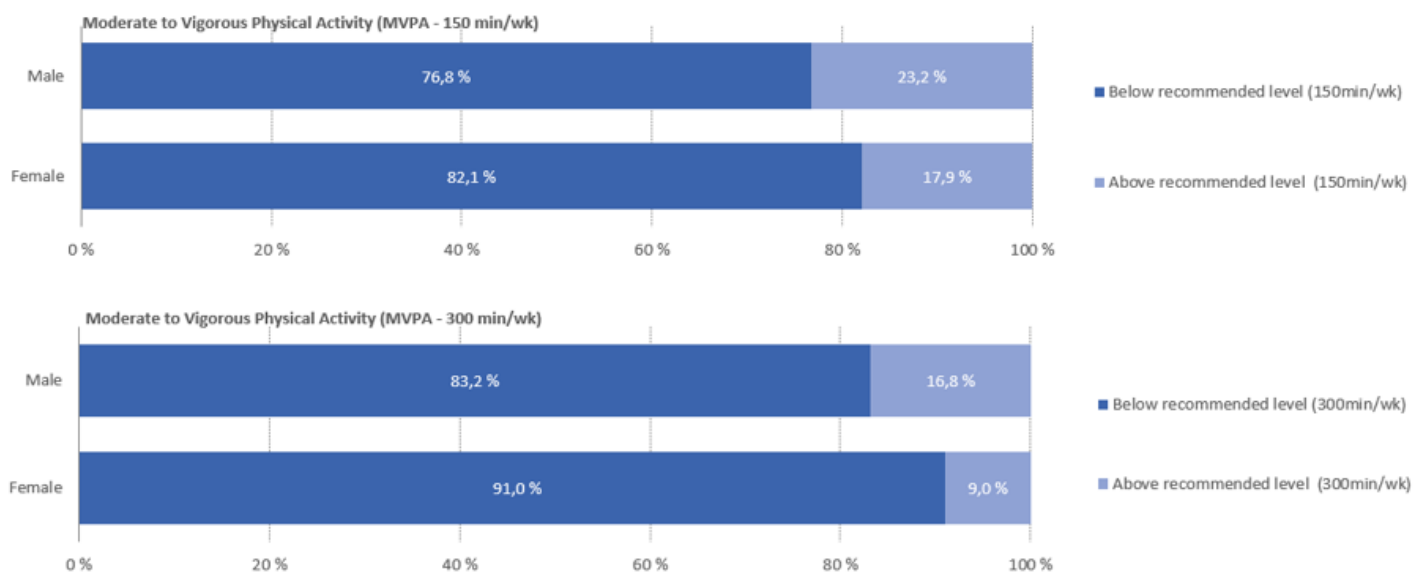
Figure 3: *Stacked bar graph showing the distribution of study participants who fall into the various PA levels, above and below moderate to vigorous physical activity (MVPA) of 150 minutes and 300 minutes per week, stratified by gender. Dark blue bars present the percentage of Norwegian university students who fell into the respective 'below MVPA150' and 'below MVPA300' groups, and light blue bars presents the percentage of students who fell into the respective 'above MVP150' and 'above MVPA300' groups.*

4.2 Distribution of females and male students with high vs low HSCL-scores in the MVPA 150 and 300 groups

Figures 4 and 5 present the prevalence of psychological distress by the different levels of PA (MVPA150 and MVPA300), stratified by gender. The total number of participants in figure 4 and 5 was 49 730. Participants who exercised less than recommended reported in general poorer mental health. Of the students in the below MVPA150 group (n = 39 985), 28.8% was classified into the high HSCL-group (poor mental health), whereas 17.9% of the above MVPA150 group (n = 9745) fell into the high HSCL-group. Of the students in the below MVPA300 group (n = 44 059), 27.9% fell into the high HSCL-group vs 16.7% % in the above MVPA group (n = 5671).

Of the male and female students in the below MVPA150 group, 33.5% of the female and 17.5% of the male students fell into the high HSCL-group, whereas 22.8% females and 9.5% males in the above MVPA150 group fell into the high HSCL-25 group.

In the below MVPA300 group, 32.4% females and 16.9% males fell into the high HSCL-group, whereas 22.9% females and 9.1% males of the above MVPA300 group fell into the high HSCL-group.
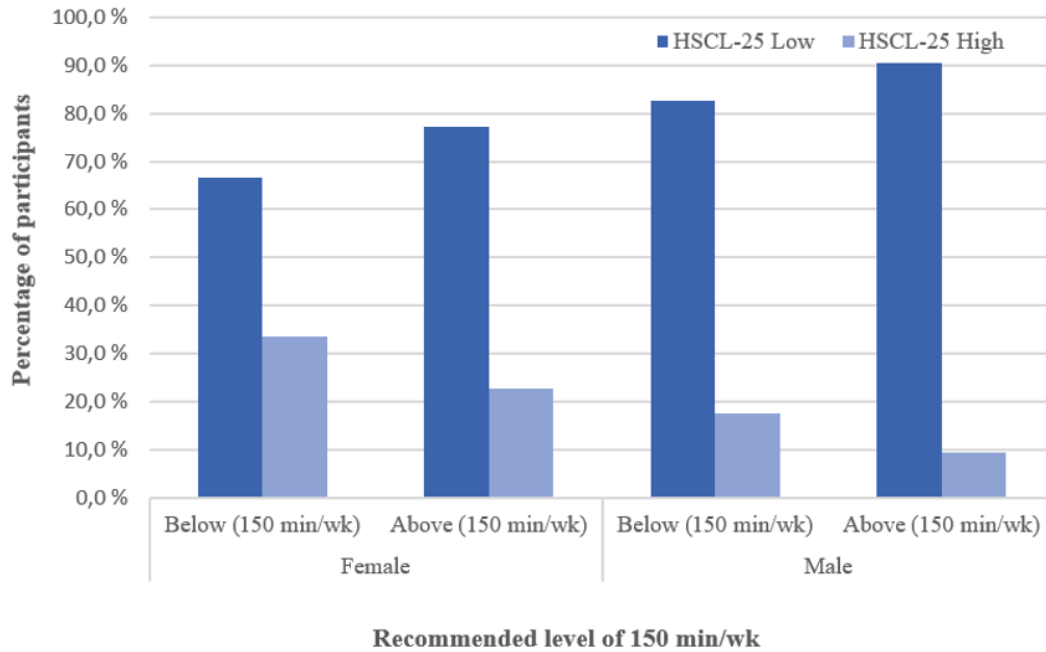
Figure 4: *Bar graph showing the percentage of Norwegian university students falling below and above the recommended level of moderate to vigorous physical activity (MVPA) of 150 minutes per week versus percentage of participants, for 49 730 students. Dark blue bars represent students with low score of psychological distress (HSCL-25), and light blue bars represent students with high scores on the HSCL-25. The cut-off score for the HSCL-25 was set to ≥2.0.*
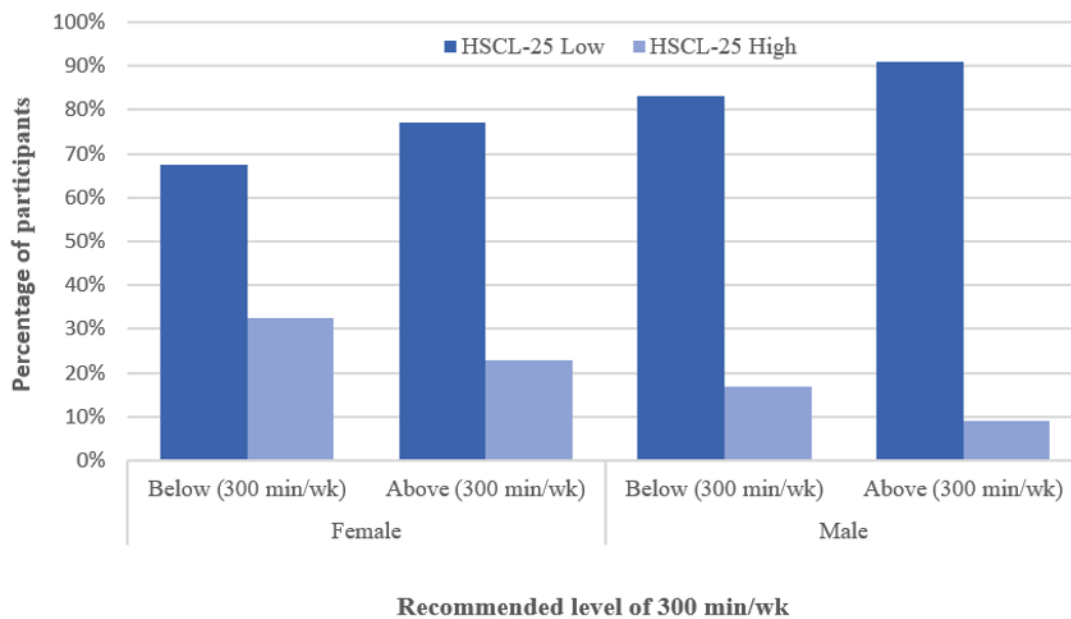

Figure 5: *Bar graph showing the percentage of Norwegian university students falling below and above the recommended level of moderate to vigorous physical activity (MVPA) of 300 minutes per week versus percentage of participants, for 49 730 students. Dark blue bars represent students with low score of psychological distress (HSCL-25), and light blue bars represent students with high scores on the HSCL-25. The cut-off score for the HSCL-25 was set to ≥2.0.*

4.3 The association between HSCL-25 and level of physical activity

A chi-squared test of independence was performed to examine the association between psychological distress (HSCL-25) and MVPA150, stratified by gender. The HSCL-25 variable was dichotomized in this analysis (low = < 2.0 and high = ≥2.0). There was a significant association between the two variables among the female students, X^2 (1, n = 34 396) = p < .001), as well as among the male students, X^2 (1, n = 15 334) = p < .001.

A chi-squared test of independence was also run to examine the association between HSCL-25 and MVPA300, stratified by gender. There was a significant association between the two variables among both female students, X^2 (1, n = 34 396) = p < .001 and male students, X^2 (1, n = 15 334) = p < .001.

Table 4.3: Frequencies and Chi-Square results for symptoms of depression and mode of PA (MVPA 150 and MVPA 300), by gender (N = 49 730)

| | | HSCL-25 | | | | | |
| | | Low level | | High level | | X^2 (df) | p-value |
	n (%)	n	%	n	%		
Female	**34 396**						
MVPA <150	28 224 (82.05)	18 777	66.5	9 447	33.5	268.864 (1)	<.001
MVPA ≥150	6 172 (17.95)	4 767	77.2	1 405	22.8		
MVPA <300	31 306 (91.02)	21 163	67.6	10 143	32.4	116.409 (1)	<.001
MVPA ≥300	3 090 (8.98)	2 381	77.1	709	22.9		
Male	**15 334**						
MVPA <150	11 761 (76.70)	9 704	82.5	2 057	17.5	133.105 (1)	<.001
MVPA ≥150	3 573 (23.30)	3 234	90.5	339	9.5		
MVPA <300	12 753 (83.17)	10 593	83.1	2 160	16.9	98.892 (1)	<.001
MVPA ≥300	2 581 (16.83)	2 345	90.9	236	9.1		

Abbreviation: n = number of participants, HSCL-25 = 25 items Hopkins Symptoms Check List (cut-off value ≥2.0), MVPA = moderate to vigorous physical activity, <150 = below 150 minutes, <300 = below 300 minutes, X^2 = Pearson chi-square, (df) = degree of freedom

4.4 Gender differences in association between psychological distress (HSCL-25) and PA level

A two-way ANOVA was conducted to determine if there was a statistically significant gender difference when it comes to association between psychological distress (HSCL-25) and PA (groups below and above MVPA150 and MVPA300). For this analytical purpose, the HSCL-25 variable was analysed as a continuous scale. The profile plots (Figures 5 and 6) show that both MVPA150 and MVPA300 were inversely associated with the symptom level of psychological distress among female and male students who did PA below and above the recommended level, and that female students scored significantly higher on psychological distress for both MVPA150 and MVPA300
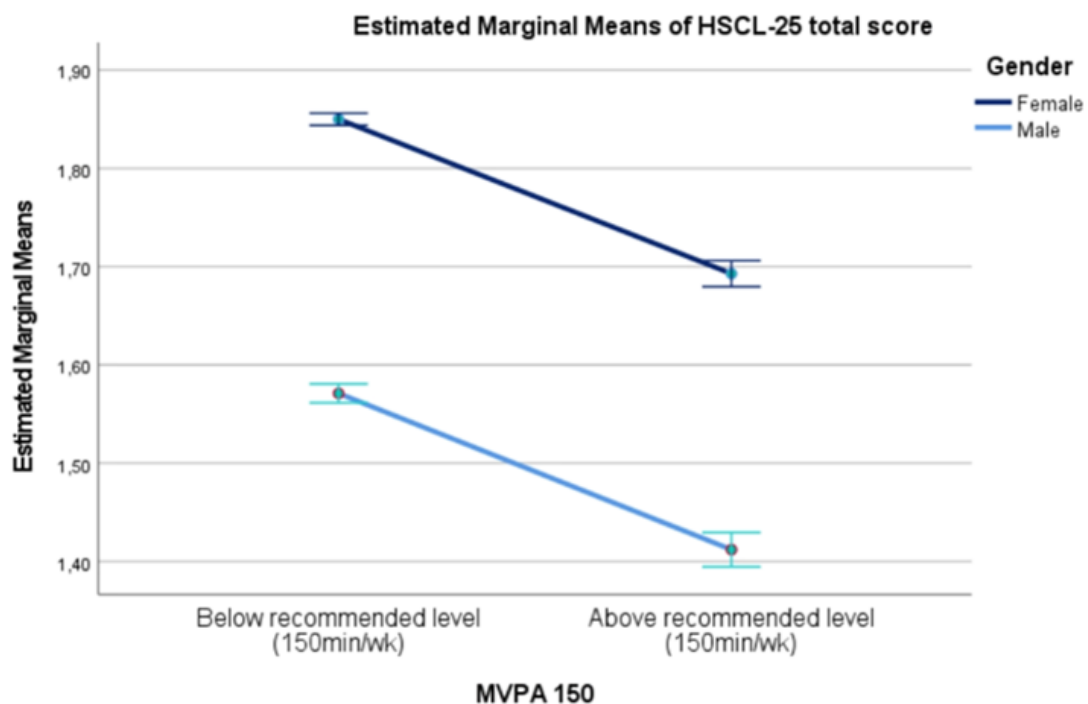
Figure 5: Two-way ANOVA interaction plot shows the estimated marginal mean of the Hopkins Symptom Checklist-25; HSCL-25, compared to the groups below and above MVPA 150 minutes per week, stratified by gender (female: dark blue, male: pale blue). It controls for BMI, alcohol-related problems, and sleep duration. Error bars represent 95% confidence intervals.
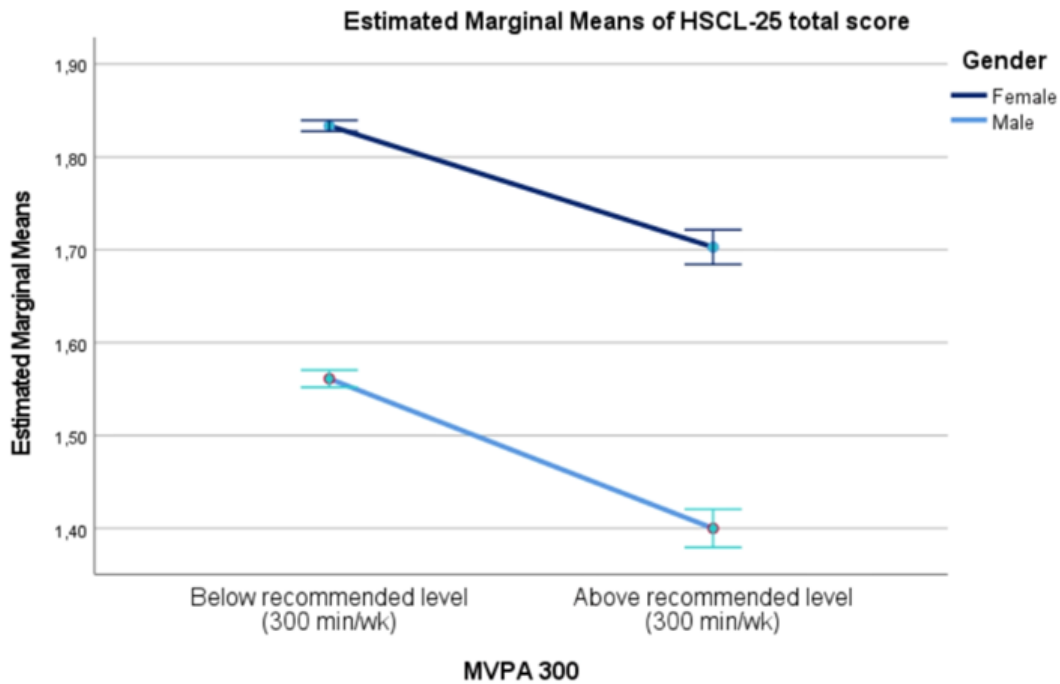
Figure 6: *Two-way ANOVA interaction plot shows the estimated marginal mean of the Hopkins Symptom Checklist-25; HSCL-25, compared to the groups below and above MVPA 300 minutes per week, stratified by gender (female: dark blue, male: pale blue). It controls for BMI, alcohol-related problems, and sleep duration. Error bars represent 95% confidence intervals.*

It was found a significant main effect of level of PA (MVPA150 and MVPA300) on students showing indications of psychological distress (p <.001). There was also a significant main effect of the participants' gender on students showing indications of psychological distress (p <.001). The analysis revealed no statistically significant interaction between the effects of MVPA150 and gender on psychological distress (p = .881), but a significant interaction was found between the effects of MVPA300 and gender on psychological distress (p = .045). These effects tell us that falling below MVPA of 150 and 300 minutes of weekly PA had a stronger effect on psychological distress among female students (MVPA150 [mean = 1.849; SE = .003], MVPA300 [mean = 1.834; SE = .003] than male students (MVPA150 [mean = 1.550; SE = .005], MVPA300 [mean = 1.561; SE = .005]).

4.5 The relationship between HSCL-25 and MVPA150 adjusted for age and lifestyle factors

A logistic regression analysis was conducted to investigate the likelihood of reporting HSCL-25 ≥2.0 vs HSCL-25 <2.0 in the MVPA150 low compared to high group. Gender specific models are presented in Table 4.4 (MVPA150). A significant relationship was found between the likelihood of reporting HSCL-25 ≥2.0 vs HSCL-25 <2.0 in the MVPA150 below vs above group for females (p < .001) and males (p < .001), respectively.

Female students who exercised less than recommended (MVPA < 150 min/week) had 1.69-fold increased odds (95% CI: 1.58-1.81) of scoring high on the HSCL-25 (above the cut-off score of ≥2.0), compared to the female students in the above MVPA150 group. Male students in the below MVPA150 group had 2.07-fold increased odds (95% CI: 1.76-2.30) of scoring high on the HSCL-25, compared to the male students in the above MVPA150 group.

The adjusted analyses for female students showed that MVPA150 (p <.001), age (p <.001), BMI (p <.001), AUDIT (p <.001), and sleep duration (p <.001) added significantly to the model. For the male students, the adjusted analyses showed that MVPA150 (p <.001), age (p <.001), AUDIT (p <.001), and sleep duration (p <.001) added significantly to the model, but BMI (p = .312) did not add significantly to the model. Adjusting for age and lifestyle factors only marginally attenuated the likelihood for reporting HSCL-25 ≥2.0 vs HSCL-25 <2.0 in the above vs below MVPA150 group.

Table 4.4: Logistic Regression Models on the relationship between symptoms of depression and MVPA150, and other lifestyle factors, by gender (N = 49 836)

	Females				Males			
	Odds ratios (95% CI)				Odds ratios (95% CI)			
Variables	Model #1	Model #2	Model #3	Model #4	Model #1	Model #2	Model #3	Model #4
Independent								
MVPA < 150	1.693*** (1.584, 1.811)	1.706*** (1.595, 1.824)	1.667*** (1.559, 1.784)	1.671*** (1.560, 1.789)	2.069*** (1.783, 2.401)	2.013*** (1.733, 2.337)	2.058*** (1.771, 2.390)	2.042*** (1.754, 2.378)
Age		.087*** (.980, .995)	.991* (.984, .999)	.980*** (.972, .987)		1.038*** (1.024, 1.052)	1.039*** (1.025, 1.053)	1.031*** (1.017, 1.045)
BMI			1.025*** (1.020, 1.031)	1.021*** (1.016, 1.027)			1.014* (1.002, 1.026)	1.006 (.994, 1.018)
AUDIT			1.042*** (1.036, 1.047)	1.037*** (1.032, 1.043)			1.045*** (1.036, 1.054)	1.040*** (1.031, 1.049)
Sleepduration				1.000*** (1.000, 1.000)				1.000*** (1.000, 1.000)
n	31 688	31 688	31 688	31 688	14 257	14 257	14 257	14 257

*** Significance at the p < .001 level
** Significance at the p < .01 level
* Significance at the p < .05 level

Abbrevation: n = number of participants, MVPA = moderate to vigorous physical activity, < 150 = Below 150 minutes, CI = Confidence Interval, AUDIT = Alcohol Use Disorders Identification Test

4.6 The relationship between HSCL-25 and MVPA300 adjusted for age and lifestyle factors

A logistic regression analysis was conducted to investigate the likelihood of reporting HSCL-25 ≥2.0 vs HSCL-25 <2.0 in the low compared to high MVPA300 group. Gender specific models are presented in Table 4.5 (MVPA300). A significant relationship was found between the likelihood of reporting HSCL-25 ≥2.0 vs HSCL-25 <2.0 in the low vs high MVPA300 group for females (p < .001) and males (p < .001), respectively.

Female students who exercised less than recommended (MVPA < 300 min/week) had 1.61-fold increased odds (95% CI: 1.47-1.77) of scoring high on the HSCL-25, compared to the female students in the aboveMVPA300 group. Male students who exercised less than the recommended MVPA300 had 2.03-fold increased odds (95% CI: 1.58-1.81) of scoring high on the HSCL-25, compared to the male students in the above MVPA300 group.

The adjusted analyses for female students showed that MVPA300 (p <.001), age (p <.001), BMI (p <.001), AUDIT (p <.001), and sleep duration (p <.001) added significantly to the model. For the male students, the adjusted analyses showed that MVPA300 (p <.001), age (p <.001), AUDIT (p <.001), and sleep duration (p >.001) added significantly to the model, but BMI (p = .299) did not add significantly to the model. Adjusting for age and lifestyle factors only marginally attenuated the likelihood for reporting HSCL-25 ≥2.0 vs HSCL-25 <2.0 in the above vs below MVPA300 group.

Table 4.5: Logistic Regression Models on the relationship between symptoms of depression and MVPA300, and other lifestyle factors, by gender (N = 49 836)

Variables	Females Odds ratios (95% CI)				Males Odds ratios (95% CI)			
	Model #1	Model #2	Model #3	Model #4	Model #1	Model #2	Model #3	Model #4
Independent								
MVPA < 300	1.614*** (1.473, 1.768)	1.629*** (1.487, 1.784)	1.586*** (1.447, 1.738)	1.637*** (1.491, 1.797)	2.028*** (1.584, 1.811)	1.988*** (1.751, 2.258)	2.019*** (1.777, 2.294)	1.989*** (1.748, 2.265)
Age		.989** (.981, .996)	.992* (.985, 1.000)	.981*** (.973, .988)		1.038*** (1.025, 1.052)	1.039*** (1.025, 1.053)	1.031*** (1.017, 1.046)
BMI			1.026*** (1.021, 1.032)	1.023*** (1.017, 1.028)			1.013* (1.002, 1.053)	1.006 (.994, 1.018)
AUDIT			1.042*** (1.036, 1.047)	1.037*** (1.032, 1.043)			1.045*** (1.036, 1.054)	1.040*** (1.030, 1.049)
Sleepduration				1.000*** (1.000, 1.000)				1.000*** (1.000, 1.000)
n	31 688	31 688	31 688	31 688	14 257	14 257	14 257	14 257

*** Significance at the p < .001 level
** Significance at the p < .01 level
* Significance at the p < .05 level

Abbrevation: n = number of participants, MVPA = moderate to vigorous physical activity, < 300 = below 300 minutes, CI = Confidence Interval, AUDIT = Alcohol Use Disorders Identification Test

CHAPTER FIVE

Discussion

Chapter 5

DISCUSSION

5.1 Summary of main findings

The findings in this thesis revealed that less than one of five female university students and less than one of four male students met the minimum recommended criteria for weekly PA (MVPA150). Similarly, less than one of ten female students and less than one of six male students met the preferable recommended weekly PA criteria of MVPA300. Furthermore, one of four showed indications of psychological distress, reporting a score above the cut-off of ≥ 2.0 on the HSCL-25. The strength of the association between psychological distress (HSCL-25) and level of PA was dependent on the weekly PA level, and those who met PA recommendations above MVPA150 and MVPA300 tended to have better mental health in terms of lower score on HSCL-25 (psychological distress). Also, more female than male students reported psychological distress both in the MVPA150 group (33.5% and 17.5% respectively) and in the MVPA300 group (32.4% vs 16.9%, respectively).

Male students who exercised less than recommended (MVPA < 150 min/week) had a 2.07-fold increased odds of scoring high on the HSCL-25, and female students had a 1.69-fold increased odds compared to the above MVPA150 group. Similar results were shown also for MVPA300, where males and females in the below MVPA300 group had an increased odds of 2.03 and 1.61 (respectively), compared to the above MVPA300 group. The impact of PA-level on the HSCL-25 did not change after adjusting for age and lifestyle factors (BMI, alcohol-related problems, and sleep duration).

5.2 Methodological aspects

5.2.1 Study design

This thesis was carried out on data from SHoT2018, which was a cross-sectional survey investigating the association between levels of PA and psychological distress among Norwegian university students. A weakness of the cross-sectional study design is that psychological distress and the level of the weekly PA are subjected to daily fluctuations and may differ from day to day and month to month. Due to the "snapshot timing", the cross-sectional design may be limited in detecting prevalence or revealing associations between

psychological distress and level of PA. Moreover, cause-effect conclusions cannot be drawn based on a cross-sectional study design.

On the other hand, an apparent strength of the cross-sectional design is that it allows collecting data from a large pool of subjects and compare differences between groups. A large sample size identifies outliers that could skew the data in a smaller sample, provides more accurate mean values, and provides a smaller margin of error[177]. However, it is important to note that of the students answering the SHoT2018 survey, the female-male ratio was 70-30, which may lead to unequal variances, a general loss of power and issues with confounding variables. Despite this, Keppel (1993)[268] states that you do not need equally sided groups to calculate accurate statistics. Since the sample size in this study is large (N = 49 836), it provides more power and provides a smaller margin of error.

A cross-sectional study is particularly suitable for estimating the prevalence of a disease or behaviour in a population. Moreover, it is possible to record exposure to many risk factors and to assess more than one outcome in a cross-sectional study. However, because data was recorded only one time for each participant, the temporal association between risk factors and outcome cannot be established. Thus, only an association, and not causation, can be inferred from a cross-sectional study. For this study, it is not possible to infer that the level of PA preceded the onset of psychological distress or vice versa. It can only be inferred that psychological distress was associated with the level of PA and gender.

5.2.2 External validity

There are specific circumstances regarding the sample's representativeness that should be addressed. The form of recruitment and inclusion criteria based on the SHoT2018 survey may attract specific demographics of university students, increasing the risk of particular selection bias[269]. We could hypothesize that the SHoT2018 study might have appealed to students having smaller funds, coming from low-income families, having a smaller social circle and students hoping to win the gift card. In case, it would be plausible that these students are different from other Norwegian university students.

An apparent strength of this thesis is the large sample size of the SHoT2018 study, because a large sample size has been shown to be more accurate in depicting the depression rate in university students[189]. Large sample size also allows studies of low frequent variables or conditions. However, a notable weakness is the relatively low response rate for the SHoT2018

study (31%). It may be that the use of only an email-based survey approaches aligned with this low response rate. This is because web-based platforms are shown to generally yield lower participation rates than traditional mail approaches, mainly face-to-face interviews or mail survey[270]. As response rates are essential in cross-sectional surveys due to being an indicator of the survey quality, care should be taken when generalising the current findings to the whole student population.

Nevertheless, since this thesis investigates the association between PA level and psychological distress and explore differences between females and males, the response rate is not as important because these estimates are less inclined to selection bias. The possible bias presented by selective recruitment to the cohort is an apparent limitation regarding prevalence measures, but it seems to have minimal influence on exposure-disease associations[262,271]. Thus, the current findings only apply to Norwegian students who reported psychological distress and fell into the PA groups' MVPA150' and 'MVPA300'. This implies that the results only indicate the explanatory role of psychological distress, and level of PA, for full-time Norwegian university students.

5.2.3 Survey

The main limitation of the current thesis was the low participation rates in the SHoT2018 survey (31%). Thus, care should be taken when generalizing the findings to the whole student population. Associated with this is the 69% female composition of the sample, which might depict a bias for the overall estimates. Females overall report worse mental health, PA level and worse sleep across most parameters than males. Nevertheless, as females form about 70% of the student population in Norwegian universities, at least up to a bachelor's degree, this gender gap should not represent a significant bias in the current thesis.

Moreover, poor mental health is commonly found to be related to non-participation. It would intrinsically lead to underestimating the actual level of psychological distress among students[272,273]. As discussed below, the uncertainty regarding the cut-offs of the HSCL-25, makes it uncertain to what extent the observed HSCL-25 scores translate into prevalence estimates of mental health problems, and the functional impact of distress is not known. Thus, the results cannot be used to indicate the service needs of mental health in the student population. Moreover, the lack of a comparison group with non-students prevented examining to what extent and whether a similar trend is evident among young people in Norway.

Further, there are several limitations to utilizing subjective measures in the form of questionnaires. The SHoT2018 questionnaires were anonymous. However, ID numbers were registered, which implies that the questionnaire can be traced to the participant by the researcher. This might contribute to the participants answering the questions with what they assume to be socially accepted, thus increasing the risk of social bias. Moreover, the participant's interpretation of the different questions might not have followed the questions' actual intention. Some sections in the SHoT2018 questionnaires include questions that asked participants to describe and recollect previously performed behaviours. Intrinsically, recall bias contested the validity of the information[274]. Thus, using a subjective survey may have played a role in the findings. An objective data collection method might have accurately depicted psychological distress and physical activity level.

The main strengths of the SHoT2018 survey include the large sample sizes, the invitation of all full-time Norwegian university students, and the use of the well-acknowledged instrument of psychological distress (HSCL-25). Moreover, some of the included questions concern sensitive topics (psychological distress). Participants might therefore feel a higher sense of anonymity from participating in questionnaires than in interviews, which might, in turn, motivate participants to answer truthfully.

5.2.4 Instruments

5.2.4.1 Hopkin Symptom Checklist-25

Self-reported psychological distress was assessed using the HSCL-25. There have not been conducted validation studies of the HSCL-25 against structural clinical interviews among students in higher education. This is particularly relevant as younger adults typically show higher symptom loads than older people[275]. Further, validation studies have primarily been conducted during the 1990s. They have found relatively insignificant correspondence between high HSCL-25 scores and clinical diagnoses, with relatively low sensitivity and specificity[276,277]. Therefore, it has been suggested that a high score on the HSCL-25 should be seen as an indicator of psychological distress rather than a diagnostic condition[277].

A notable increase in proportions with high symptomatology has been observed when applying conventional cut-off scores in previous studies in related populations. For example, a survey by Statistics Norway employing HSCL-25 found that 14% and 6% of females and males, respectively, aged 16-24, scored above the cut-off score of 1.75 in 1998 and 25% and

11% in 2012[278]. Previous research on the SHoT2018 survey found that 48% of females and 27% of males had a mean score of 1.75[279]. Such high estimates are disturbing and, thus, prompt further monitoring and examination of generalisability to the whole student population. However, the numbers should be interpreted in clinical terms[280].

Therefore, a conventional cut-off at ≥2.0 was employed in this current thesis. An average score on the HSCL-25 ≥2.0 is commonly used as a cut-off for identifying a high level of mental health problems in psychological distress. This cut-off aligns well with the original cut-off of 1.75 on the more extended version of the HSCL[281]. The measurement stability over time, longitudinal validity, of HSCL-25 has previously been confirmed[282]. However, even though the HSCL-25 is commonly used and often the most optimal method in large scale studies, self-reported symptom levels do not compare directly to diagnostic categories of depression and anxiety.

Moreover, there is an ongoing discussion of whether the '*everyday language*' employed in the HSCL-25 may normalise and probe the recognition of psychological distress[283]. On the other hand, one could argue that this may contribute to giving normal conditions clinical labels. An increase in psychological distress does not inevitably indicate a similar increase in mental health disorders. No evidence of an increase in the latter has been found in the general population[284]. The former may be more sensitive to changes in society, such as changes in ways of handling and perceiving mental health problems and changes in lifestyle factors. At the same time, the latter is more stable and, to a great extent, influenced by biology, genes, and more severe life events[284]. More research is needed to comprehend better the differences and similarities in the risk factors and deriving factors between clinical and subclinical mental conditions. Further, qualitative and quantitative research is needed to examine the implications, causes and meaning of psychological distress among the students who show elevated HSCL-25 scores.

5.2.4.2 Three-item questionnaire

Physical activity is difficult to measure; however, this thesis has employed a self-reported questionnaire to measure PA (a three-item questionnaire). A weakness and concern for self-reported PA are how well-reported PA accurately represents habitual activity. In the absence of a '*gold standard*', cardiorespiratory fitness, maximal oxygen uptake (VO2max) has been used as a validation standard for PA surveys[285]. Nevertheless, a perfect correlation between

cardiorespiratory fitness and self-reported PA would not be expected due to, for instance, genetic factors. Thus, solely employing self-reported PA measurements could be a possible limitation.

Moreover, strong correlations between PA and aerobic fitness may be observed for vigorous activity[286]. Also, published correlations with fitness have been most notable for the most challenging forms of activity[287,288]. Others have concluded that the ability to assess habitual PA was more remarkable for vigorous than lower PA intensity[289]. Further, the answers from the three-item questionnaire were split into two dichotomous variables in this study, focusing solely on moderate to vigorous PA. This may be a strength due to previous findings identifying stronger correlations between vigorous PA and psychical health[287,288,289].

Furthermore, the SHoT2018 survey was conducted over two weeks. Thus, the moderate and vigorous PA questions should be valuable measures of PA when time and space allow only very brief assessment. However, more detailed and better defined PA questionnaires measuring self-reported PA are of future need.

Furthermore, recall accuracy usually decreases with increasing time since an event[290]. Repeatability for the question concerning light activity is poor, even at one week, which indicates that it is difficult to recall or that light PA must be better defined or operationalized in the questionnaire to make recall easier[247]. Thus, the absolute amount of PA could be better determined using objective devices, as for example accelerometers. However, this would not be feasible in large samples. Accounting for these limitations, the questionnaires employed in the SHoT2018 survey have been reviewed as reliable and valid for measures of PA intensity, duration, and frequency[163,248].

5.2.4.3 Alcohol Use Disorders Identification Test

Potential alcohol-related problems were measured by the Alcohol Use Disorders Identification Test (AUDIT): a widely used instrument developed by WHO for identifying harmful or risky alcohol use[260]. A notable strength of the present thesis is the inclusion of a validated and detailed instrument for assessing potential alcohol-related problems: AUDIT. Previous research on the SHoT2018 survey found that more than half of the male students scored above the cut-off of 8 points on the AUDIT, which indicates increasing risk when it comes to alcohol-related problems, compared with approximately 4 out of 10 female

students[291]. These results advocate a recent contribution that pointed to worryingly high levels of alcohol use among Norwegian university students[292].

It should be noted that young adults that drink heavily over time are characterized by a range of risk factors and functional and behavioural adjustment difficulties[293]. Despite this, no meaningful changes occurred when adjusting for alcohol-related problems in this thesis. However, monitoring these trends is vital for all branches of public health, from policymakers to local schools, authorities, and researchers.

5.2.4.4 Sleep questionnaire used in the SHoT2018 survey

A sleep questionnaire was utilised (see appendix 1, table 3) to measure the sleep duration among Norwegian university students. A possible limitation is that only a single item assessing sleep duration was included in the SHoT2018 survey. Even though this item has been found to highly correlate with individual items in the insomnia questionnaire ($r = 0.73$)[262] and has an acceptable accuracy (0.77) in detecting insomnia cases based on the DSM-5 definition, caution must be exercised when generalising findings on sleep problems to diagnostically operationalised insomnia.

Also, existing prevalence studies of insomnia rarely use the same operationalisation, despite closely resembling the DSM-5 criteria. Intrinsically, differences in prevalence rates might occur with this methodological consideration in mind. Moreover, despite sleep problems being both prevalent and increasing among students, no meaningful changes occurred when adjusting for sleep duration in this thesis. Which have also the case in previous research conducted on the SHoT2018 survey[10]. However, changes in sleep quality have been found to have larger effects on the well-being and health outcomes[294]. Therefore, other studies should explore the cause-effect relationship between sleep duration on psychological distress and PA level to determine if sleep duration can be a causal effect on psychological distress in this population.

5.2.5 Statistical analyses

5.2.5.1 Pearson chi-squared test

This thesis has both strengths and limitations of how the variables have been categorised in the chi-squared test of independence. Categorising continuous variables is common in clinical research; however, such simplicity is gained at some costs. Although grouping might help the data presentation, notably in tables, categorisation is unnecessary for statistical analyses and has shortcomings. However, converting continuous data into dichotomous groups is the most common approach in clinical research[295].

A common argument for dichotomising variables is that it leads to easy presentation and interpretation and dramatically simplifies the statistical analysis. For instance, a binary split compares groups of individuals with low or high measurement values, which leads to the simplest case of a chi-squared test and an estimate of the groups with the confidence interval. Nevertheless, there is no good reason, in general, to assume that there is an underlying dichotomy. If one exists, there is without cause why it should be at the median[296].

Dichotomising leads to numerous problems. First off, much information is lost, which leads to lower statistical power to observe a relationship between the variable and the patient outcome. Dichotomising a variable at the median reduces power at the same rate as disregarding a third of the data[296]. Disregarding data on purpose is undoubtedly ill-advised when studies already tend to be insufficient. Dichotomisation may also increase the risk of positive results being false positives[297]. Further, individuals close to but on opposite sides of the cut-off are characterised as quite different even if they may be rather similar. It is important to be aware of these factors and take the consequences into consideration before splitting variables for analytical purposes.

However, some variables have recognised cut-offs. For instance, the HSCL-25 have a cut-off at ≥2.0 to define university students who reported psychological distress. Also, PA has a cut-off of below and above WHOs recommendation of a weekly PA level of 150 to 300 minutes. Cut-offs presented in previous studies has been implemented in this thesis on both PA and HSCL-25. Employing similar cut-offs as used in other studies makes it easier to compare the results and is advantageous for future meta-analyses[298]. Dichotomising also makes it easier to get a visual presentation of the prevalence of study participants who are at risk for disease (i.e., mental disorders).

5.2.5.2 Two-way ANOVA

Analysis of variance (ANOVA) is commonly used in studies to analyse the impact of various variables on subjects. One or more predictor variables, such as time, age, or dose, can often be analysed as continuous variables instead of categorical. Such an approach has several advantages, providing a more straightforward and informative interpretation of the results and greater statistical power due to increased precision transformation of the predictor variable is possible. Hence, treating independent variables as continuous should initially be the method of choice, with ANOVA being used[299]. Thus, treating HSCL-25 in this thesis both as a continuous and categorical variable has the advantage of providing more detailed information.

Failing to use the most optimal analysis creates a risk of missing significant effects. It is unknown how many published studies have unsuccessfully found any significant effects or how many studies have not been published because of the lack of significant results due to an ANOVA analysis being used when a regression analysis would have been more powerful. Nevertheless, given the ubiquity of ANOVA analysis in experimental research, it is likely not a significant number[299]. Thus, when feasible, it is hoped that researchers should employ this approach to advance the statistical power and better understand their data[299].

5.2.5.3 Logistic regression

First, logistic regression method does not aim to indicate causality. Consequently, this thesis cannot ascertain if the model tested reveals independent variables or moderators of HSCL-25 or if HSCL-25 works as a moderator on the level of PA, gender, age, BMI, alcohol-related problems, and sleep duration. To analyse the nature of causality in these relationships, prospective cohort studies are required to investigate the succession of the variables.

Secondly, this thesis employed a manual approach to the selection of variables. Confounding variables for the logistic regression model were selected based on findings from the literature and previous studies on this data. Additionally, the three-item questionnaire used to measure PA[247] is an interesting addition to examining the relationship between PA level and psychological distress among female and male university students. This can be considered a moderate strength of this thesis because it gives a reasonably valid measure of moderate and vigorous physical activity[247]. This thesis also has a valuable measure of moderate to vigorous PA since time and space allow only a very brief assessment.

However, when employing automatic processes in statistics, regression models can falsely identify independent variables as significant[300]. Nonetheless, not employing automatic processes can be deemed a weakness as it heightens the risk of human error. Thus, PA was split into two dichotomous variables, MVPA150 and MVPA300, based on WHO recommendations for weekly physical activity[179]. Moreover, the incorporation of independent variables could be biased, and one might feasibly fail to identify variables that are important for explaining the variance in the dependent variable[300]. Utilising bivariate screening to minimise the effect of these potential limitations and only including variables that were significantly correlated with HSCL-25 could have increased the explanatory power of the regression model and is, therefore, a weakness of the analyses in this thesis.

Finally, cases were dropped from the analysis in a listwise deletion if they contained a missing value in at least one of the specific variables. This implies that the analysis is only done on cases with a complete set of data, increasing the validity and reliability. Moreover, the analysis run in this thesis used listwise deletion, which means that the statistical analyses include cases that could contain some missing data. Even though this procedure cannot include a specific variable with a missing value, the case can still be included when analysing other variables that do not have any missing values. Choosing listwise deletion reduces the sample size, but this does not cause a statistical problem in this thesis due to the large sample size. Moreover, listwise deletion may be problematic to utilise in self-reported questionnaires because the missing data may not be random. Thus, listwise deletion may be considered as a limitation in this thesis.

5.3 Interpretation of findings

5.3.1 Physical activity habits

Not surprisingly, the findings in this thesis show that the prevalence of Norwegian university students was higher in the below MVPA15 and below MVPA300 groups. Moreover, the findings show that the percentage of the students achieving WHOs minimum recommendation of weekly PA (MVPA150) was about 20%, similar to a Swedish national survey, concluding that 32% of Swedes reached the recommended PA level of 300 minutes a week in 2020)[301]. Moreover, the percentage decreased substantially to about 11% when looking at the number of students achieving the preferable recommended PA level of 300 minutes of weekly MVPA. These percentages indicate that Norwegian university students are under-active, considering that a healthy adult requires a minimum of 150 minutes of weekly moderate to vigorous PA.

These findings correspond with previous studies investigating the frequency of weekly PA among university students[3,10,183,184,185], also with regard to the finding that males are more physically active than females. The results from this thesis show that when comparing genders, there is, on average, a smaller percentage of female students, only 17.9%, who met the minimum recommended level of weekly MVPA compared to the male students, which were 23.2%. The percentage was even smaller for both genders when looking at the preferable recommended level of 300 minutes of weekly PA. Only 9% of the females and 16.8% of the males met this recommendation. This corresponds with findings from a Lancet paper from 2018[3], that included 1.9 million participants from 168 countries and 358 surveys, which reported a global gender-specific prevalence of inadequate PA of 27.5% (31.7% in females and 23.4% in males). Norwegian university students should therefore be encouraged to be more active to obtain beneficial health effects. Moreover, future studies should seek to further explore why the substantial majority of university students who fail to meet the recommendations for weekly PA are females.

5.3.2 Level of physical activity and psychological distress

This thesis provides valuable findings on the association between psychological distress and level of PA, and more specifically, information on the differences between the genders. The association between psychological distress and PA below 150 minutes and 300 minutes of weekly MVPA is in line with other studiesd[185]. Moreover, the findings in this thesis show that a higher percentage of inactive students reported psychological distress than more active students, which is consistent with the findings in a Norwegian study already in 2008[180], and the association between inactivity and low levels of PA and psychological distress has thereby been known for years[138]. Encouragement to be more active is essential for beneficial health effects, and an increment in physical activity among young adults may benefit the country's economy in the future.

Previous research examining the association between the level of PA and psychological distress has shown mixed results. Various Cochrane reviews on RCTs[189,232,233] have shown that having a higher PA level can diminish the risk of developing psychological distress, and that people who are already depressed might benefit from PA. Moreover, the findings in this thesis were broadly consistent with past research in similarly aged populations using self-reported measurements[10,180]. These studies have shown that PA level and psychological distress (HSCL-25) are associated. The results indicate that students who engage in weekly MVPA above 150 minutes to 300 minutes are less likely to report psychological distress than those below MVPA of 150 minutes.

However, the results from this thesis do not support the assumption that the preferable recommended level of 300 minutes of PA is better than the minimum recommended level of 150 minutes of PA. One intriguing thing to note is that the percentage of students showing indications of psychological distress, for both females and males, was almost the same for MVPA150 (29%) and MVPA300 (28%). Even though other studies have shown that a higher PA level is preferable for depression[180,227,228], these findings indicate that doing MVPA for more than 300 minutes each week may not reduce the risk of showing indications of psychological distress or be more beneficial in reducing the risk of developing mental health problems. Therefore, being physically active for more than 150 minutes each week might be enough to obtain beneficial health effects.

A meta-study[71] has suggested that PA's potential protective association on depression was similar for men and women. However, the gender differences found in this thesis align with previous research which also shows that psychological distress is more prevalent in females than males[64,70,94]. One could argue that the gender differences might be due to male students being more physically active than female students or females being more exposed to stress[64]. However, previous research has found that females report mild to moderate symptoms of psychological distress. In contrast, males report more severe symptoms of psychological distress[148,149,153]. Thus, employing equal cut-off scores on the HSCL-25 for both females and males may make it harder to detect psychological distress among males than among females[148,149,150,151]. Therefore, future studies could probably benefit from employing different cut-off scores on the HSCL-25 for females and males.

5.3.3 Distress

Previous research has shown that confounding factors may affect the HSCL-25 score[96]. Thus, the gender differences might not only stem from employing the same cut-off score for females and males, but it may also be a result of confounding factors. One of the main findings in this thesis is that the effect of PA level on psychological distress depends on gender, which is in line with previous research[10,180]. However, the data presented for the MVPA150 group is interesting because it differs from previous findings. The interaction effect between MVPA150 and gender on psychological distress was not statistically significant, which suggests that the effect of MVPA of 150 minutes on psychological distress does not depend on the effect of the gender. This means that the number of female and male students who reported psychological distress is almost the same for lower levels of weekly PA. The differences are shown when the level of weekly PA increases, where male students are more physically active than female students. Thus, it would be beneficial for both genders, but in particular for females, to increase their PA level for the added health effects it includes.

Moreover, findings in this thesis were similar to previous research[189,190], where an inverse relationship between psychological distress and level of PA was found. Both MVPA150 and MVPA300 were inversely associated with the probability of showing psychological distress for both female and male students. The inverse results indicate that a higher PA level positively affects mental health. Thus, doing PA less than WHOs recommendations negatively affects the students' score on the HSCL-25. This is in line with previous research,

which found that people engaging in weekly MVPA above 150 minutes to 300 minutes are less likely to score high on psychological distress (HSCL-25) than inactive people[180]. However, the results indicate that a PA level above MVPA150 seems enough to lower the risk of showing psychological distress. A study by Doré et al. (2018)[181] observed similar findings, which found a significant controlled direct effect for PA level on the association between mental health and team sports, indicating no benefit from increasing PA volume. Thus, a PA level of 150 minutes of moderate to vigorous physical activity seems enough to gain positive health effects among Norwegian university students.

In this thesis, not all effects were statistically significant. Some were relatively weak, which indicates that other confounding variables might influence both the development of psychological distress and the relationship between psychological distress and level of PA and gender. A casual model clarifying the development of psychological distress and level of PA would demand the inclusion of several confounding variables and differentiation of the concrete contribution from these factors. Thus, by adjusting for confounding variables such as age, BMI, alcohol-related problems, and sleep duration may provide a more appropriate estimate of the true association which is due to the exposure.

5.3.4 Odds ratio of psychological distress

Nicole and Toben's[188] research on mental health and vigorous physical activity in college students supported the findings in this thesis; they found that poor mental health was less common among college students who exercised compared to the students who did not meet recommendations. However, there was a 2.07-fold increased odds for showing indications of psychological distress among the male students falling below MVPA150 compared to female students (OR = 1.69). The same indications were shown for MVPA300, with a 2.03-fold increased odds for showing indications of psychological distress among the male students falling below MVPA300, compared to the female students (OR = 1.61). These findings are interesting because they correspond with previous research[153,161]. However, males have been found to be prone to report more severe psychological distress than females[148,149,150,151], which seems to be the case for this thesis due to the higher odds among males than females. Thus, employing equal cut-off scores on the HSCL-25 among females and males may be misleading. Therefore, it would be of interest to explore different cut-off scores to find out if this is of clinical value.

Furthermore, previous research on the general Danish population found that the difference between genders was only significant when minor depression was included[160], implying that females were more prominent in less severe depression levels. Hence, it has been suggested that the gender ratio among subjects with severe depression was no longer significant due to the lower number of females in this group[153]. As a result, the higher odds ratio for the male students may be explained by their tendency to report higher scores on the HSCL-25. Nevertheless, despite the higher odds of scoring high on the HSCL-25 among males, psychological distress has been found to be more prominent among female students. One could argue that this is due to females reporting their symptoms more thoroughly than the males and possibly that females are more forthcoming with their feelings. Previous research has found; that females are more prone to suffer from depression than males[189]. Thus, providing different or better guidelines for females and males on self-reporting psychological distress may be of clinical value.

The logistic regression analysis in this thesis suggests that a level of 150 minutes of weekly PA is associated with a decrease in the risk of developing psychological distress, which raises an inevitable question: How does the level of PA protect against depression onset? No single mechanism can likely elucidate this relationship. However, what is known is that a range of psychosocial, biochemical and environmental factors are likely to play a role [165,166,167,168,169,170,171], where large-scale studies have shown systematically that higher levels of PA are associated with a lower risk of developing depression[227,229]. Low levels of PA were associated with a higher risk of depression in this thesis. However, it does not explain whether the association between psychological distress and level of PA are an isolated result or if this association is affected by confounding variables. Suppose one looks at multiple explanatory variables independently. In that case, the possibility of ignoring the covariance among variables is more likely to happen and may lead to confounding effects. Thus, in this thesis, we adjusted for several confounding factors.

Looking more closely at the analyses, one can see that psychological distress and level of PA are associated with the confounding variables, age, BMI, alcohol-related problems, and sleep duration. However, the direction of the association varies among the female and male students. Among the female students, age and sleep duration are negatively associated with psychological distress and level of PA, whilst BMI and alcohol-related problems were

positively associated. Whereas, for the male students, age and alcohol-related problems were positively associated with psychological distress and level of PA, whilst BMI and sleep duration were negatively associated. These results suggest that the null hypothesis (age, BMI, alcohol-related problems, and sleep duration do not have any relationship with symptoms of depression and level of PA) can be rejected. On the other hand, adjusting for the confounding variables did not impact the final model, which is a finding that has been shown also in previous studies[10,163,262].

5.4 Ethical considerations

Patients and participants who consent for research are put at risk or inconvenienced. For instance, they might receive a potentially ineffective drug and thereby suffer illness and its attendant risks for a more extended period. Patients and participants consent for research with the expectation that their sacrifice will benefit future patients in particular and the course of medical science in general[302]. Moreover, when studies are being conducted, ethics and review committees spend time and energy overseeing the research. A founding organization pays for the research expenses, which can be pretty considerable. Thus, it is wrong for several reasons to conduct research that does not advance the course of science or answer meaningful questions.

The same ethical issues that apply to other study designs when patient information is collected apply to cross-sectional studies. However, they might seem less invasive, especially if one only abstracts information from medical records or previous surveys. These issues include Institutional Review Board (IRB) approval, participant confidentiality, and informed consent[303]. Like all studies, cross-sectional studies have to be submitted to the current IRB and approved by them before the study can be conducted.

In this thesis, the Regional Committee for Medical and Health Research Ethics (REK) in southeast Norway approved the research questions related to the SHoT2018 survey (no. 269726). Informed consent was obtained in 2018 electronically after the participants received a detailed introduction to the SHoT2018 study, which stated that the survey data could be saved and used for research. Thus, there was not necessary to obtain informed consent in this instance.

Moreover, participation in this thesis is associated with low risk. It is not related to the use of time or other burdens due to the data being collected beforehand. Further, no link to the SHoT2018 surveys' participants was present. The participants answered survey questions with potentially delicate issues, which might have made them realize that they had symptoms of anxiety or depression. Therefore, the team behind the SHoT2018 survey provided numbers for medical and psychological help if needed. A positive aspect of this thesis is the use of comprehensive data material to answer relevant questions related to the health of young adults, which is a group not so much studied. Being part of the study provided an opportunity to shed light on this population's health and factors potentially leading to poor health.

5.5 Implications of findings

The results of this thesis may have important implications for public health. The threat psychological distress has on the economical, educational, and social outcomes is considerable. The findings in this thesis support that PA should be promoted and encouraged, and efforts should be made to facilitate activity among university students.

CHAPTER SIX

Concluding remarks

Chapter 6
CONCLUDING REMARKS

6.0 Concluding remarks

This thesis has evaluated the association between the level of PA and psychological distress among Norwegian university students aged 18-35. It was tested for various combinations of the level of PA (MVPA150 and MVPA 300) stratified by gender, age, BMI, alcohol-related problems, and sleep duration in a logistic regression model. The regression analysis showed that the level of PA is associated with a decrease in the risk of developing psychological distress, confirming the hypothesis. Nonetheless, nothing of clinical importance happens by adjusting for age, BMI, alcohol-related problems, and sleep duration. Thus, adjusting for these confounding variables does little to change the odds ratio of reporting psychological distress; the effect lasts. This partially confirms the hypothesis; however, the association is not notable, where the confounding variables were positively and negatively associated with the HSCL-25 score and level of PA. This finding indicates that further exploration of potential explanatory variables to psychological distress and level of PA among Norwegian university students is required if we are to acquire a more comprehensive understanding of factors that affect psychological distress and PA level in university students.

The findings have some important public health implications, as they bring attention to the high prevalence of psychological distress among university students and the alarmingly high percentage of young adults who fail to meet the recommended levels of weekly PA. In terms of potential measures to handle the rising mental health problems currently observed in university students, the low levels of PA in this population might be one of the more modifiable factors that might be profitable to target. Concerning both treatment and prevention of mental health problems, PA and, in particular, activities outdoors have been suggested as advantageous. A recent systematic review shows that nature-based, outdoor exposure positively affects several emotional parameters related to stress relieving[144].

The level of PA was identified to have a significant association with the HSCL-25 score among Norwegian university students. Discrepancies in findings may be accounted for due to the usage of subjective measures of the level of PA in the current thesis compared to objective measures in similar populations. If we are to determine the usability of subjective measures of the level of PA on the HSCL-25 score among university students, further studies are required.

In comparison to the actual level of PA, motivation for PA has been proposed to provide a more comprehensive understanding of the relationship between PA and psychological distress. Therefore, future research might benefit from applying motivation for PA as an explanatory variable for HSCL-25 among students. This thesis' findings contribute to the presumption that the cut-off on the HSCL-25 and the weekly PA level mediates the association between the level of PA and psychological distress.

This thesis clearly illustrates that psychological distress is associated with the level of PA. At the same time, it raises the question of how the HSCL-25 sore and level of PA coincides in explaining psychological distress. It does not explain whether the association between the HSCL-25 scores and the level of PA are an isolated result or if this association is affected by intervening variables. It seems likely that other variables and the level of PA account for some of the variances in the HSCL-25 score that were previously assumed to only originate from psychosocial and biochemical factors. Thus, environmental factors are of importance. As a result, it is plausible that the level of PA, gender, age, alcohol-related problems, and sleep duration function as mediators for psychological distress among university students. Focusing on alleviating psychological distress and increasing the level of PA among university students could help lessen the burden on society later on. Studies have shown that there are differences between gender in reporting depression severity, which might be why studies indicate that more females are suffering from psychological distress. In reality, the number of males suffering from psychological distress could be much more significant.

Future studies could potentially benefit from utilizing different HSCL-25 cut-off scores for females and males because this might provide a more detailed view of what degree the different genders suffer from psychological distress. It could also have substantial clinical implications. This could, in turn, make positive or negative changes in mapping the prevalence of university students suffering from psychological distress. Thereby making it easier to implement measures in Norwegian universities that might help prevent students from reporting psychological distress and lessen the burden on society later on.

To conclude, prospective cohort studies are required if we are to increase our understanding of the temporal nature of the association between the level of PA and symptoms of psychological distress among university students.

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Appendix 1
INCLUDED INSTRUMENTS

Table 1: Hopkins Symptom Checklist-25: HSCL-25

Choose the best answer for how you felt over the past week:

Items		1: "Not at all"	2: "A little"	3: "Quite a bit"	4: "Extremely"
1	Being scared for no reason				
2	Feeling fearful				
3	Faintness				
4	Nervousness				
5	Heart racing				
6	Trembling				
7	Feeling tense				
8	Headache				
9	Feeling panic				
10	Feeling restless				
11	Feeling low in energy				
12	Blaming oneself				
13	Crying easily				
14	Losing sexual interest				
15	Feeling lonely				
16	Feeling hopeless				
17	Feeling blue				
18	Thinking of ending one's life				
19	Feeling trapped				
20	Worrying too much				
21	Feeling no interest				
22	Feeling that everything is an effort				
23	Worthless feeling				
24	Poor appetite				
25	Sleep disturbance				

The HSCL-25 score is calculated by dividing the total score (sum score of items) by the number of items answered (ranging between 1,00 and 4,00). It is often used as the measure of distress.

The patient is considered as a "probable psychiatric case" if the mean rating on the HSCL-25 is 1,55.

A cut-off value of ³ 1,75 is generally used for diagnosis of major depression defined as "a case, in need of treatment". This cut-off point is recommended as a valid predictor of mental disorder as assessed independently by clinical interview, somewhat depending on diagnosis and gender.

The administration time of HSCL 25 is 5 to10 minutes.

Table 2: The Alcohol Use Disorders Identification Test; AUDIT

The Alcohol Use Disorders Identification Test: Self-Report Version						
PATIENT: Because alcohol use can affect your health and can interfere with certain medications and treatments, it is important that we ask some questions about your use of alcohol. Your answers will remain confidential so please be honest. Place an X in one box that best describes your answer to each question.						
Questions	**0**	**1**	**2**	**3**	**4**	
1. How often do you have a drink containing alcohol?	Never	Monthly or less	2-4 times a month	2-3 times a week	4 or more times a week	
2. How many drinks containing alcohol do you have on a typical day when you are drinking?	1 or 2	3 or 4	5 or 6	7 or 9	10 or more	
3. How often do you have six or more drinks on one occasion?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
4. How often during the last year have you found that you were not able to stop drinking once you had started?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
5. How often during the last year have you failed to do what was normally expected of you because of drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
6. How often during the last year have you needed a first drink in the morning to get yourself going after a heavy drinking session?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
7. How often during the last year have you had a feeling of guilt or remorse after drinking?	Never	Less than monthly	Monthly	Weekly	Daily or almost daily	
8. How often during the last year have you been unable to remember what happened the night before because of your drinking?	Never	Less than monthly	Monthly	weekly	Daily or almost daily	
9. Have you or someone else been injured because of your drinking?	No		Yes, but not in the last year		Yes, during the last year	
10. Has a relative, friend, doctor, or other health care workers been concerned about your drinking or suggested you cut down?	No		Yes, but not in the last year		Yes, during the last year	
					Total	

The Alcohol Use Disorders Identification Test (AUDIT) is a 10-item screening tool developed by the World Health Organization (WHO) to assess alcohol consumption, drinking behaviours, and alcohol-related problems.

Both a clinician-administered version and a self-report version of the AUDIT (Table 3) are provided.

Patients should be encouraged to answer the AUDIT questions in terms of standard drinks.

A chart illustrating the approximate number of standard drinks in different alcohol beverages is included for reference.

A score of 8 or more is considered to indicate hazardous or harmful alcohol use.

The AUDIT has been validated across genders and in a wide range of racial/ethnic groups and is well-suited for use in primary care settings.

Table 3: Sleep questionnaire used in the SHoT2018 study

(Difficulty initiating and/or maintaining sleep (DIMS) was measured by one item of the depression subscale of the Hopkins Symptom Checklist (HSCL)-25).

The following questions about your sleep apply to how you typically sleep
(Tick one or more boxes)
    ☐ Sleep-inset problem
    ☐ Nightly awakenings
    ☐ Early morning awakening
    ☐ Snoring (according to others)
    ☐ Breathing cessations (according to others)
    ☐ Daytime sleepiness
    ☐ Daytime tiredness
 	
For each problem:

How many nights per week do you experience [*name of sleep problem*]**?** (0-7)
How long have you had such sleep problems? (<1 month, 1-2 months, 3-6 months, 7-11 months, 1-3 years, more than 3 years)
When do you usually go to sleep at night? **… on weekdays? … on weekends?** (Hours and minutes)
When do you usually get up in the morning? **… on weekdays? … on weekends?** (Hours and minutes)
How long does it usually take you to fall asleep (after turning off the lights)? **… on weekdays? … on weekends?** (Hours and minutes)
How long are you awake during the night (after you first have fallen asleep)? **… on weekdays? … on weekends?** (Hours and minutes)
How many hours of sleep do you need to feel refreshed? (Hours and minutes)