

Mental health problems among adolescents in Sweden

Analysis of trends, developmental trajectories and associated factors

Benti Geleta Buli



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MENTAL HEALTH PROBLEMS AMONG ADOLESCENTS IN SWEDEN

**ANALYSIS OF TRENDS, DEVELOPMENTAL
TRAJECTORIES, AND ASSOCIATED FACTORS**

Benti Geleta Buli

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School of Health, Care and Social Welfare

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Abstract

The overall aim of this thesis was to investigate trends and trajectories of mental health problems and associated factors among adolescents in Sweden. The project consisted of four studies, with the first presenting trends and the subsequent ones exploring influencing factors. The first two studies used data from SALVe, repeated cross-sectional surveys from 2004 – 2020, while the third used national HBSC data from 2002 – 2018. Study IV was based on data from SALVe cohorts conducted among young people born in 1997 and 1999 where data were collected in four waves every three years from 2012 – 2021.

Study I investigated trends in mental health problems among adolescents in Västmanland County, revealing an overall decrease but disparities based on socioeconomic status (SES) and sex. Higher SES was associated with reduced mental health problems, while lower SES showed an increase. Girls exhibited a more pronounced decrease in depressive symptoms and suicidal ideations than boys. Study II, using the same dataset, confirmed these trends and identified school-related factors influencing mental health problems, with improvements correlating with reduced problems in the high SES group. Study III found a significant increase in PSS over time, higher in girls, and linked to lifestyle factors, particularly alcohol drunkenness among high SES adolescents. Study IV focused on cohorts born in 1997 and 1999, exploring the impact of family and peer relationships on depressive and anxiety symptoms among young people.

The results indicate that intermediary factors, including school-related factors, lifestyle choices, and social relationships, which vary across SES gradients, are linked to adolescent mental health problems. The associations between these intermediary factors and the mental health problems were, in most cases, influenced by a group of factors, including SES, sex, country of origin, and birth cohort, collectively named structural determinants. These determinants discriminated results between boys and girls, high SES and low SES, Nordic and non-Nordic origin, and the 1997 and 1999 cohorts. This underscores the need for at least two-tiered policy intervention. The first involves an immediate to mid-term response, targeting these intermediary factors with a special focus on the low SES group, girls, and young people with foreign backgrounds. The second entails a long-term policy intervention to narrow the divide.

*To the young people of today,
May you find the courage to face your challenges, and the wisdom to understand that mental health is just as important as physical health. I dedicate this work to you, in the hope that you will always prioritize your well-being and support one another in achieving a balanced and fulfilling life. Your resilience and potential inspire us all.*

Abstract

The overall aim of this thesis was to investigate trends and trajectories of mental health problems and associated factors among adolescents in Sweden. The project consisted of four studies, with the first presenting trends and the subsequent ones exploring influencing factors. The first two studies used data from SALVe, repeated cross-sectional surveys from 2004 – 2020, while the third used national HBSC data from 2002 – 2018. Study IV was based on data from SALVe cohorts conducted among young people who were born in 1997 and 1999 where data were collected in four waves every three years from 2012 – 2021.

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Keywords: Adolescent, mental health problems, trends, trajectories, Social Determinants of Health

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I. Buli, B. G., Larm, P., Nilsson, K., & Giannotta, F. (2023). Trends in adolescent mental health problems 2004–2020: do sex and socioeconomic status play any role? *Scandinavian Journal of Public Health*, 14034948231165552. <https://doi.org/10.1177/14034948231165552>
- II. Buli, B. G., Larm, P., Nilsson, K. W., Hellström-Olsson, C., & Giannotta, F. (2024). Trends in mental health problems among Swedish adolescents: Do school-related factors play a role? *PloS one*, 19(3), e0300294. <https://doi.org/10.1371/journal.pone.0300294>
- III. Buli, B. G., Lehtinen-Jacks, S., Larm, P., Nilsson, K. W., Hellström-Olsson, C., & Giannotta, F. (2024). Trends in psychosomatic symptoms among adolescents and the role of lifestyle factors. *BMC public health*, 24(1), 878. <https://doi.org/10.1186/s12889-024-18327-x>
- IV. Buli, B. G., Larm, P., Nilsson, K., Åslund, C., Hellström, C., & Giannotta, F. (forthcoming). The impact of family and peer relationships on developmental trajectories of depressive symptoms and anxiety symptoms among young people. *In manuscript*.

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Abbreviations

ADHD	Attention-deficit/hyperactivity disorder
AAS	Adult Anxiety Scale
AS	Anxiety symptoms
CI	Confidence interval
DALYs	Disability-adjusted life-years
DS	Depressive symptoms
DSM	Diagnostic and Statistical Manual of Mental Disorders
DSRS	Depression self-rating scale
FAS	Family affluence scale
GBTM	Group-based trajectory model
GDPR	General Data Protection Regulation
HBSC	Health Behavior in School-aged Children
HVV	Hälsa, vård och välfärd
MAR	Missing at random
MCAR	Missing completely at random
MDD	Major depressive disorders
NMAR	Not missing at random
OECD	Organization for Economic Co-operation and Development
OR	Odds ratio
PA	Physical activity
PSS	Psychosomatic symptoms
RR	Relative risk
SA	suicide attempts
SALVe	Survey of adolescent life in Västmanland
SCAS	Spence Children's Anxiety Scale
SDH	Social determinants of health
SES	Socioeconomic status
SI	Suicidal ideations
UK	United Kingdom
UNICEF	United nations children's fund
WHO	World Health Organization

Introduction

This research project focuses on adolescent mental health and positions itself within the context of health and welfare, which emphasizes sustainability perspectives on societal development, lifestyle, and health (Mälardalens högskola (MDH), 2020). One of the defining characteristics that situates this project within the health and welfare framework is its focus on the adolescent population, a segment of population in a critical phase of life characterized by enormous physical, social, and psychological changes that influence both their present and future health outcomes (Blakemore, 2019).

Adolescence marks the onset of various behaviours, both positive and negative, that play a pivotal role in determining the burden of disease both during this phase of development and in later life, as well as shaping the health and development of future generations (Sawyer et al., 2012). Behaviours initiated during adolescence have far-reaching implications, including accounting for a substantial proportion of premature adult deaths. Negative behaviours in adolescence that are related to negative health outcomes may include, but are not limited to, the use and abuse of substances such as tobacco and alcohol, poor dietary habits, and a lack of physical activity (Manninen et al., 2015; Maughan et al., 2014; Sawyer et al., 2012).

Moreover, approximately half of all mental health problems in adults start manifesting before or during adolescence (Kessler et al., 2007). This makes pursuing mental health among adolescents so crucial because mental health problems that arise during this period can pose significant challenges both in adolescence and later in life (Kessler et al., 2007), yet mental health remains a vital asset that warrants dedicated attention and care. World Health Organization (2022), for example, recognizes mental health as an asset that empowers individuals to realize their potential and make meaningful contributions to the development and well-being of their society.

Finally, in addition to the health risks, adolescence presents opportunities for health promotion and prompts investments in adolescent health, with a specific emphasis on mental health, to safeguard the well-being of both current and future populations (Baltag & Servili, 2016). This project, aiming to shed light on the trends in, well as developmental trajectories of, adolescent mental health problems and the associated factors, is thus aptly situated within the health and welfare research domain.

Background

While adolescence is often regarded as the healthiest phase of life (Graham, 2004) and a time with great opportunities for health (Sawyer et al., 2012), it's also a stage marked by immense stress attributed to enormous physical, social, and psychological changes (Blakemore, 2019). Yet, not all individuals possess the resources to effectively cope with the stress due to these changes (Lazarus & Folkman, 1984; Schneiderman et al., 2005a), and those lacking the resources may encounter various forms of mental health challenges (Casey et al., 2010).

This chapter delves into the multifaceted realm of adolescent mental health, shedding light on the range of mental health challenges that can manifest during this critical stage of development. From psychosomatic complaints and anxiety to more complex conditions, adolescents struggle with a spectrum of mental health problems that can shape their present and future well-being. It is imperative to understand the magnitude and trends of these problems, not only on a global scale but with a particular emphasis on Sweden. By examining prevailing factors associated with these trends, this thesis aims to untangle the complex pattern of influences that contribute to the changing setting of adolescent mental health in the present world.

The chapter endeavors to offer a comprehensive understanding of the major mental health problems relevant to this project that adolescents face, along with the associated factors. It also seeks to provide valuable insights that empower individuals, families, and communities in their collective mission to enhance the mental well-being of adolescents.

Mental health and mental health problems in adolescence and their measurement

Definitions

The World Health Organization (WHO) defines mental health as "a state of well-being in which an individual realizes their own abilities, can cope with the normal stresses of life, can work productively, and is able to make a contribution to their community" (World Health Organization, 2022). This definition underscores the significance of mental health, as it plays a vital role in

enabling individuals to be productive and resilient for both their own and their communities' well-being by empowering them to effectively deal with life's stressors.

While good mental health is crucial for everyone, its significance becomes particularly noticeable for children and adolescents due to several reasons beyond those discussed earlier. Children and adolescents make up about one-third of the world's population, with over half of them falling within the 10-19 years age range (UNICEF, 2023). This significant proportion of population, undergo enormous life changes, rendering them vulnerable to adverse health outcomes, notably negative mental health outcomes (Blakemore, 2019).

Mental health problems, on the other hand, are defined in terms of their impact on everyday functioning. The Swedish National Board of Health and Welfare et al. (2020), for example, defines mental health problems as a collective term for conditions of varying severity and duration that are associated with difficulties in functioning in everyday life, causing suffering either to individuals themselves or to those around them. This definition portrays mental health problems as a broad concept that encompasses mental distress, covering mild to severe problems that do not meet the criteria for psychiatric diagnosis of mental disorder, and a more serious form of mental health problem. This aligns with the specific definition of mental health problems among adolescents provided by Michaud and Fombonne (2005), who describe them as various difficulties and burdens that interfere with adolescent development and adversely affect emotional, social, and vocational aspects of life.

Mental health problems that emerge during this stage of life may impose a lifetime burden, as they may continue or recur in adulthood (Kessler et al., 2007) or their impacts or consequences may persist, tormenting well-being in adulthood (Holmbeck et al., 2004). In fact, adolescence is generally considered the healthiest stage across the life course (Graham, 2004), but individuals within this stage may develop mental health problems when they lack the resources to cope with the stress that result from the changes they undergo (Casey et al., 2010).

Measurements

Regarding measurement of mental health outcomes, including mental health problems, two practical approaches are commonly employed: categorical and dimensional (Caspi & Moffitt, 2018; Vasey et al., 2014). The categorical approach hinges on diagnostic procedures, labeling individuals as, for instance, psychotic if symptoms are present, or non-psychotic if they are not. In contrast, the dimensional approach situates symptoms on a continuum, with higher scores indicating greater severity of the problem, and lower scores or no symptoms indicating lower severity or absence of problems, respectively (Caspi & Moffitt, 2018; Lewis, 2014). Pryjmachuk (2011) describes the

dimensional approach as a "two-continua" model, where the healthiest individuals occupy one end, and those with the most severe forms of mental health problems reside at the opposite end of the spectrum represented by double-arrows.

This thesis adopts Michaud and Fombonne's (2005) definition of mental health problems and employs a dimensional approach to measurement, which considers symptoms as continuous spectra rather than as discrete categories (Caspi & Moffitt, 2018; Vasey et al., 2014). This approach is particularly beneficial in differentiating the transient psychological distresses experienced by adolescents due to the significant but normal developmental changes they undergo (Blakemore, 2019; Sawyer et al., 2012; Vasey et al., 2014) from pathological manifestations of mental health problems. Unlike the categorical approach, which relies on distinct diagnostic criteria, the dimensional approach places symptoms along a continuum (Caspi & Moffitt, 2018), allowing for a more nuanced understanding of mental health dynamics.

Major mental health problems among adolescents

Adolescent mental health problems manifest in various forms, which Caspi and Moffitt (2018) present in two main domains: internalizing and externalizing problems. They further expand the domains into three when dealing with individuals who are over 18 years of age, with psychotic symptoms becoming the third. The internalizing domain includes conditions such as depression, generalized anxiety disorders, panic disorder, and social phobia. On the other hand, the externalizing domain encompasses substance use disorders and antisocial behaviors. The psychotic dimension includes clinically diagnosed experiences such as dissociation, disorganized thoughts, unusual beliefs, fantasies, hallucinations, and related experiences. This thesis mainly focuses on internalizing problems due to their relevance to adolescents, in terms of disturbances in introverted emotions (Caspi & Moffitt, 2018; Zahn-Waxler et al., 2000), and suicidality, the worst possible outcome of these problems (Commisso et al., 2023; Durkheim, 1951/1897; Kim et al., 2021).

Internalizing Problems

Internalizing problems, along with externalizing problems, comprise the two primary categories of child and adolescent psychopathology. The internalizing problems indicate disruptions in introverted emotions and moods, encompassing feelings such as sadness, guilt, fear, and worry (Achenbach, 1966; Caspi & Moffitt, 2018). Defining internalizing problems precisely within this domain remains challenging due to the range of symptoms and disorders they involve. Nevertheless, Graber (2004) provides a functional definition,

describing internalizing problems as issues related to emotions or moods arising from the dysregulation or excessive internalization of specific emotions, like guilt, anxiety, or becoming overly enmeshed or involved in others' emotions. Similarly, Merrell (2008) suggests that internalizing problems emerge when individuals attempt inappropriate control or regulation over their internal emotional or cognitive states, implying that these issues develop and persist within the individual.

While this domain may comprise various symptoms or disorders, Merrell (2008) identifies four main types: depression, anxiety, social withdrawal, and somatic or physical complaints. Others, Caspi and Moffitt (2018) and Zahn-Waxler et al. (2000), for example, emphasize that the most prevalent problems in this category are depression and anxiety disorders. However, this thesis takes the path of Achenbach's classification, highlighting three major disorders among children and adolescents: depression, anxiety, and somatic or physical symptoms (Achenbach, 1966). In the following few paragraphs, I will present brief accounts of each of these problems, namely depressive symptoms (DS), anxiety symptoms (AS), and psychosomatic symptoms (PSS), before moving on to the trends of the problems in the adolescent population over time.

Depressive symptoms

According to Garber and Rao (2014) and Sameroff (2014), depression encompasses a spectrum, incorporating manifestations ranging from sadness and a cluster of symptoms that form a syndrome to a disorder constituted by a constellation of symptoms that share course, prognosis, etiology, and treatment response. While occasional feelings of sadness or irritability in children and adolescents are common facets of daily life (Blakemore, 2019; Sawyer et al., 2012), the persistent presence of these symptoms for at least two weeks can lead to significant issues (Garber & Rao, 2014). Extended periods of sadness or irritability, a loss of interest in daily activities, alongside changes such as altered appetite, disrupted sleep, reduced concentration, decreased energy, feelings of worthlessness, recurrent thoughts of death, or suicidal ideations (SI), can ultimately impair normal functioning (American Psychiatric Association, 2022b; Garber & Rao, 2014).

Depression ranks among the most prevalent mental health issues in children and adolescents. For instance, in 2019, depression stood as the fourth leading cause of disability-adjusted life-years (DALYs) among young people aged 10-24, with prevalence ranging from 3% to 7% (Vos et al., 2020). The Institute of Health Metrics and Evaluation (2019) presented similar data, reporting that in 2019, 3.2% of adolescents aged 10-19—2.3% of girls and 4.1% of boys—were diagnosed with these issues. Sweden reported a similar prevalence of 3%, with males at 1.9% and females at 4.0%, in 2019 as documented in the same report.

Detecting DS in children and adolescents may require awareness of the differences in how symptoms manifest compared to adults (Mullen, 2018). These differences might be primarily attributed to the variation in risk factors, prevalence, distribution, and manifestations of mental disorders across developmental stages (Bernaras et al., 2019). For instance, certain risk factors like perinatal insults and motor deficits associated with childhood depression are absent in adulthood (Garber & Rao, 2014). Another explanation could be that, although children might already be experiencing depression, their comparatively lighter responsibilities in life than adults can mask functional impairments, leading to a subtle onset of depression. As a result, depressed children might silently endure their suffering and go unreported (Hazell, 2002).

Anxiety symptoms

Anxiety is a natural adaptive response to stress that enables individuals to detect and deal with potential threats to survive (Ana & Carlos, 2013). However, problems emerge when these responses generate excessive fear or anxiety that persists beyond developmentally appropriate periods, typically lasting six months or more. These disorders have the potential to interfere with development, increasing the risk of ranges of maladaptive outcomes, such as impaired social and cognitive functioning (American Psychiatric Association, 2022a; Vasey et al., 2014).

The literature outlines several types of anxiety disorders, including separation anxiety disorder, selective mutism, specific phobia, social anxiety disorder (previously known as social phobia (National Collaborating Centre for Mental Health, 2013), panic disorder, panic attack specifier, agoraphobia, generalized anxiety disorder, substance/medication-induced anxiety, anxiety due to other medical conditions, and other specified or unspecified anxiety disorders (American Psychiatric Association, 2022a, 2022b; Vasey et al., 2014; Zahn–Waxler et al., 2000). While these various types of anxiety disorders have distinct etiologies, they all share a common feature: the persistence of fear and anxiety for at least several months, accompanied by an array of somatic and psychological symptoms. These symptoms may include excessive worry, apprehension, crying (mostly in children), palpitations, sweating, trembling, shortness of breath, lack of concentration, insomnia, or restlessness (American Psychiatric Association, 2022a).

However, identifying anxiety disorders among young individuals, particularly adolescents, presents several challenges. A primary issue, as previously discussed, revolves around the increased frequency of normative developmentally appropriate anxiety experienced by youth due to the significant changes they undergo (Blakemore, 2019; Sawyer et al., 2012; Vasey et al., 2014). This presents a challenge in differentiating between the transient anxiety considered normal during this developmental stage and the pathological forms of anxiety in adolescents (Chiu et al., 2016). Hence, it becomes imperative to inquire about the appropriate methods to measure anxiety, and, as a result, this

thesis aligns with the dimensional approach, wherein higher scores indicate a greater likelihood of encountering anxiety disorders (Caspi & Moffitt, 2018).

Children and adolescents bear a high burden of AS. In the latest report by the Institute of Health Metrics and Evaluation (2019), for example, a notable percentage of adolescents aged 10-19 experienced various forms of anxiety disorders. Globally, 3.5% (males: 2.7%, females: 4.4%) were affected, while in Sweden, the figures were higher at 6.8% (males: 5.2%, females: 8.3%) in 2019.

Somatic symptoms

Somatic symptoms are characterized by physical symptoms or discomforts that lack known or identifiable physical or medical bases. Essentially, it is a situation in which the physical manifestations experienced by an individual cannot be explained through pathological findings (Kallivayalil & Punnoose, 2010). The prevailing assumption is that these symptoms stem from emotional distress and manifest as unexplained physical symptoms, rendering them more psychological than physical (Abbey, 2005; Chen et al., 2014). Hence, they are often referred to as PSS (Brill et al., 2001). These unexplained symptoms include a range of complaints such as headaches, stomach pains, nausea, chronic fatigue, limb or joint pain, and sleep disturbances, with dizziness being less common among children (Chen et al., 2014; Merrell, 2008). Studies have consistently indicated that somatic symptoms may predict more severe mental disorders in both adolescence (Ginsburg et al., 2006) and adulthood (Bohman et al., 2018; Giannotta et al., 2022). Therefore, recognizing that PSS can serve as potential precursors to underlying psychological disorders underscores the necessity for purposeful assessment rather than dismissal.

The pivotal characteristics in individuals presenting somatic symptoms may not solely reside within the symptoms themselves but also within how the individuals perceive and interpret them, alongside any abnormal thoughts, feelings, or behaviors triggered by these symptoms (American Psychiatric Association, 2022c). Thus, comprehending the diverse backgrounds that influence how individuals express and interpret medical complaints is imperative. Studies have highlighted variations in the perception and reporting of PSS across various factors such as sex and age (Kelly et al., 2010; Romero-Acosta et al., 2013; van Wijk & Kolk, 1997), family socioeconomic status (SES) (Kelly et al., 2010), peer relationships, school satisfactions, and educational stress (Berntsson & Gustafsson, 2000), among others.

Somatic symptoms are highly prevalent complaints during childhood and adolescence. For instance, a meta-analysis of 29 studies found a global rate of 31% for somatic symptoms (Vesterling et al., 2023). A recent study conducted in Germany reported an even higher prevalence rate of approximately 45% (Geremek et al., 2024). Similarly, Hagquist et al. (2019) noted a higher prevalence and increasing trends in somatic complaints in Sweden compared to

other Nordic countries. Therefore, in studying adolescents' mental health problems, including PSS, it is crucial to consider diverse contextual factors for a comprehensive understanding of the issues.

Suicidal behaviors: ideations and attempts

Durkheim (1951/1897) defines suicide as “any death that is the direct or indirect result of a positive or negative act carried out by the victim themselves.” While Durkheim (1951/1897) explained suicide emphasizing the role of social isolation, others have described the phenomenon from various perspectives. For instance, Shneidman (1985) viewed it as a response to overwhelming pain, Baumeister (1990) as an escape from self and world, and Abramson et al. (2002) as symptom of hopelessness depression in the continuum from SI to completed suicide. The explanation given by Abramson et al. (2002) aligns in some aspects with Durkheim's (1951/1897) perspective, suggesting that suicide manifests as an outcome of other situations including mental health setbacks rather than being viewed as a distinct phenomenon in itself. Consistent findings have been reported by other studies where both internalizing problems — especially depression — and externalizing problems, such as delinquent and aggressive behaviors, were associated with an increased risk of suicidality (Commisso et al., 2023; Kim et al., 2021).

Breaking down suicidality along its continuum, Klonsky et al. (2016) define SI as contemplation, consideration, or planning of suicide, while characterizing a SA as a nonfatal, self-directed, potentially harmful act, with an intent to die. However, Sveticic and De Leo (2012) argue against this generalization, suggesting that it is not always possible to establish a clear predictive link between SI and more severe forms of suicidal behaviour. They posit that variations may arise owing to various factors that influence the progression from mere thoughts to concrete plans and attempts.

Although the suicidality continuum theorizes that other important aspects, including SI or SA, occur before the actual completed phenomenon (Abramson et al., 2002), the lines may blur when it comes to young people. In children and adolescents, the interlocking of SI, suicide attempts (SA) and completion of suicide is complex, with clear differences often absent between attempters and completers (Nruham & Prakash, 2012), necessitating comprehensive approach. Understanding the landscape of suicidality in terms of a continuum that involves SI or SA therefore is crucial for bolstering prevention efforts (Sveticic & De Leo, 2012).

Suicide poses significant challenges to global public health (World Health Organization, 2014). For instance, a recent population study in Belgium found that 8.6% of respondents reported experiencing SI, while 6.5% stated they had attempted suicide at some point. The problems were more prevalent among young individuals, those facing economic difficulties, and females (Rens et al., 2023).

In Sweden, the Public Health Agency (2024) has identified suicide as a significant public health concern due to its prevalence. In 2022, the agency reported 14 deaths per 100,000 inhabitants to suicide, with rates among young people failing to decrease despite an overall decline in the country. Junuzovic et al. (2022) estimated a rate of 1.1/100,000 child population with mean age of 16 and found that the rates increased by 2.2% each year between 2000 and 2018. These figures were based on completed suicide reports, which suggest that higher proportions of young people may experience SI and SA.

Against this backdrop, this thesis focuses on exploring trends in SI and SA dimensions, delving into the multifaceted factors of suicidality, and other adolescent mental health problems.

Trends in adolescent mental health problems

Over the past three decades, global health has seen significant improvements (Vos et al., 2020), yet an alarming trend has emerged: adolescent mental health problems have surged to become the leading causes of disease burden among young people worldwide (Patton et al., 2016; Vos et al., 2020). This concerning reality is not confined to low-income regions; even high-income countries like those in Europe, including Sweden, are grappling with this problem (Ferrari et al., 2022). Despite strides in healthcare, mental health concerns among adolescents persist and even worsen over time. Studies indicate a troubling uptick in adolescent mental health problems across various nations, spanning Europe, North America, Australia, New Zealand, Israel, and China (Bor et al., 2014; Lien et al., 2023; Potrebny et al., 2017).

Speaking of specific mental health problems, increasing trends in *DS* (Blomqvist et al., 2019; Daly, 2022; Keyes & Platt, 2024; Lien et al., 2023; Myhr et al., 2020; Thorisdottir et al., 2017), *AS* (Blomqvist et al., 2019; Durbeej et al., 2019; Keyes & Platt, 2024; Thorisdottir et al., 2017), *suicidal behaviors* (Abraham & Sher, 2019), and *psychosomatic complaints* (Blomqvist et al., 2019; B. Högberg et al., 2022) have been reported in several countries. Sweden, despite its advanced healthcare system (Schneider et al., 2017), was not immune to this increasing trend (Blomqvist et al., 2019; Bremberg, 2015; B. Högberg et al., 2022).

Factors contributing to these alarming trends are diverse, ranging from socioeconomic disparities (Kim et al., 2019; Kim & Hagquist, 2018; Weinberg et al., 2019) to gender differences (Campbell et al., 2020; Högberg et al., 2020), help-seeking behavior and the quality of screening services, (Collishaw, 2015), lifestyle changes, social relationships (Collishaw & Sellers, 2020), and many others. Selected factors relevant to this thesis will be discussed in depth below, under the section "Factors associated with adolescent mental health problems".

Understanding the evolving landscape of adolescent mental health problems necessitates tracking *three critical aspects* over time: the *prevalence* of these problems at a population level, changes in *underlying factors* that influence vulnerability, and the *trajectories* of mental health outcomes among affected individuals (Collishaw & Sellers, 2020). Such comprehensive analysis is crucial for crafting effective interventions and support systems (Collishaw, 2015).

This thesis endeavors to dissect historical trends in the prevalence of adolescent mental health problems, examining how these rates fluctuate alongside changing societal dynamics. To accommodate the third variety of trends, the *trajectories* of the outcomes among affected individuals (Collishaw & Sellers, 2020), this thesis undertakes analysis of developmental trajectories of DS and AS among young people. By examining the complexities of these problems, this thesis envisions informing policies to work towards a future where the mental well-being of our youth is prioritized and safeguarded.

Factors associated with adolescent mental health problems and their trends.

In its aim to investigate the magnitude of and trends in adolescent mental health problems, this thesis never problematizes adolescence as the source of the problems. Instead, it acknowledges adolescence as generally the healthiest stage of life (Graham, 2004), albeit filled with immense stress due to substantial physical, social, and psychological changes (Blakemore, 2019). While the capacity to cope with such stress may vary among individuals (Lazarus & Folkman, 1984; Schneiderman et al., 2005a), long-term exposure to excessive stress can lead, among other things, to mental health problems (Schneiderman et al., 2005b; World Health Organization, 2021), mainly affecting those with lower coping capacities (Casey et al., 2010).

Grounded in the theories underpinning the social determinants of health (SDH) model (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010), i.e., theories of disease distribution (Krieger, 2001b), this thesis begins with the premise that the major factors that influence distribution of mental health problems among adolescents are the conditions in which they were born, grew, lived, schooled, and socialized. These conditions, among many others, may include sex (Högberg et al., 2020), SES (Weinberg et al., 2019), ethnicity (Lu et al., 2021), school-related factors (Högberg, 2021), lifestyle (Biddle & Asare, 2011; Maenhout et al., 2020), or social relationships with family and friends (Cohen & Hoberman, 1983; Cohen & Wills, 1985; Krause, 1987). Brief accounts of each of these factors will be presented below.

Sex/gender

Studies in Sweden (Hagquist, 2009; Salmi & Berlin, 2017) and several other countries (Campbell et al., 2020; De Looze et al., 2020; Twenge et al., 2017) have consistently demonstrated that girls generally endure more pronounced mental health challenges than boys. In addition to the gender disparity in terms of burden, girls have exhibited a growing trend in experiencing the mental health problems, including AS, DS, somatic problems, and SI, over several years compared to boys (Fink et al., 2015; Högberg et al., 2020; Sigfusdottir et al., 2008; Tick et al., 2008; Twenge et al., 2019; van Vuuren et al., 2018). Moreover, studies have indicated distinct gender differences in the types of mental health problems one may experience. For instance, Patel et al. (2007) have demonstrated that girls face a higher risk of DS and SA than boys do, whereas boys are several times more prone to develop conduct or behavioral disorders. This makes gender one of the major determinants that discriminate the burden of and trends in mental health problems among adolescents (Wiklund et al., 2012; Wolman, 1988).

Although there is plenty of evidence that shows gender difference in mental health problems among adolescents, the causes of this difference remain unclear. Van Droogenbroeck et al. (2018) and Fink et al. (2015), for example, have shown increasing trends in mental health problems among girls, while the trends remained either stable or insignificantly changed for boys, despite similar backgrounds, including SES. One explanation, among others could be based on a study that reported boys are less inclined than girls to disclose common mental health problems like depression (Tedstone Doherty & Kartalova-O'Doherty, 2010).

Socioeconomic status (SES)

The exploration of connections between SES and health outcomes has a long history. Fox et al. (1985) were among the pioneers who demonstrated bidirectional relationships between SES and health outcomes, highlighting that SES has a greater impact on health outcomes than the reverse. Specifically, low SES was consistently linked to poorer health outcomes. Despite this association, the underlying mechanisms largely remain unclear. Wilkinson (1999), however, introduced an alternative perspective, suggesting that it's not solely the absolute SES that drives health inequity. Instead, he argued that individuals' perceptions of their relative standing on the social hierarchy play a significant role in shaping health disparities.

Adler et al. (2000) also reported that low subjective social standing was associated with heightened stress levels, which subsequently adversely impact both physiological and psychological functioning, with more pronounced effects on the latter. The study explicitly compared the effects of objective and subjective SES on health inequities and consistently found the latter to be

more strongly and consistently related to the inequities. Quon and McGrath (2014) also reported similar findings. This aligns with Marmot's social selection pathway, which suggests that the factors that determine social gradients also determine health inequities, indicating that lower social standing correlates with poorer health—specifically in our case, mental health status (Marmot, 2004a, 2015). Durkheim (1951/1897) applied this theory to his study on suicide long before Marmot, observing that perceiving oneself in an inferior social position was linked to a higher tendency toward suicidal behaviors. However, such findings need to be interpreted with caution, given the possibility of reciprocal relationships between subjective SES and mental health problems (Garbarski, 2010).

Numerous studies in Sweden (Ahlborg et al., 2017) and elsewhere (Hazell et al., 2022; McLaughlin et al., 2012; Reiss et al., 2019; Weinberg et al., 2019) have consistently demonstrated robust associations between adolescent mental health problems and SES, in which perceived SES significantly influences this relationship. These studies conclude that lower SES is associated with an elevated risk of mental health problems, both in terms of cross-sectional associations and trends. The pathways of these associations, however, need further studies.

This thesis employs SES as a moderator, alongside sex, in alignment with the vulnerability hypothesis (Högberg et al., 2020; Sweeting et al., 2010). The theoretical framework section will mention how this interaction will work. Separate trends in mental health problems are estimated across diverse SES gradients over time. Two dimensions of SES, subjective SES (Åslund et al., 2009; Quon & McGrath, 2014) and objective SES (Boyce & Dallago, 2004; Currie et al., 1997), will be utilized in the analysis. The specifics of these SES dimensions will be presented in the methodology section.

Ethnicity/country of origin

According to Krieger (2001a), ethnicity is a social construct rather than a biological classification. It typically signifies a collective group sharing cultural heritage and ancestry. The distinctions between these groups are frequently rationalized through ideology, wherein one group assumes dominance over another, defining both itself and others based on this power dynamic and the selective use of arbitrary physical traits (such as skin color, for instance). Solar and Irwin (2010) have highlighted ethnicity as one of the key stratifiers in the SDH model that significantly shapes health outcomes through intermediary determinants. Beyond its influence on outcomes through these intermediary determinants (Solar & Irwin, 2010), ethnicity also plays a defining role in one's societal status and affects health outcomes through the status syndrome theory (Marmot, 2004a). Marmot (2004b) defines the status syndrome as the psychological experience of inequality—measuring the degree of control one

has over their life and the opportunities for full social participation attributed to their social standing—which significantly impacts health.

Previous studies have consistently reported a heightened risk of mental health issues among ethnic minorities (Lu et al., 2021), migrants in general (Patel et al., 2017), and particularly among first-generation migrants (Close et al., 2016). Additionally, a study conducted in Europe indicated that migration to Europe from non-European countries correlated with a higher risk of psychotic disorders compared to migrations within Europe (Selten et al., 2020).

In Sweden, Kim et al. (2020) found that immigrant adolescents reported more mental health problems compared to their native Swedish peers. However, the researchers noted a lower rate of immigrants in the Värmland region where the study was conducted, which they suggested might limit the broader applicability of their findings. In contrast, Västmanland county has a higher proportion of people with foreign background (30%) compared to the national (27%) and Värmland (17%) proportions (Statistics Sweden (SCB), 2022). This limitation serves as motivation to explore this matter, using a study design distinct from the repeated cross-sectional approach employed by Kim *et al.*

This study adopts the use of ‘country of origin’ instead of ‘ethnicity’, following previous recommendations (Osanami Törngren, 2022), to discuss inequities in mental health outcomes among the adolescents.

School and adolescent mental health

Brief account of the Swedish school system

The Swedish school system comprises levels that include preschool, primary school, and upper secondary school, which branches into college preparatory and vocational schools. As per the law, parents are required to enroll their children in the nine-year compulsory school between the ages of seven and sixteen, whereas preschool and upper secondary schools are not mandatory. Children have the freedom to attend either public or private/independent schools, both of which receive funding from public sources (Swedish National Agency for Education, 2000).

The Swedish school system had gone through extensive reforms during the early 1990s with the aim, among other things, of increasing inter-school competition and influence of parents, teachers, and students over schools and education (Lundahl, 2002b; Lundahl et al., 2013). The system swung, as a result, from being one of the highly centralized systems to one of the highly decentralized systems in Organization for Economic Co-operation and Development (OECD) countries in a few years (OECD, 1999).

Studies have revealed that the introduction of independent schools and free choices of school to go to (voucher system) has led to increased segregation

based on SES (Böhlmark et al., 2015; Brandén & Bygren, 2022) and school achievements (Epple et al., 2017; Hansen & Gustafsson, 2016). These findings hold importance for this thesis, as evidence suggests that inequities in adolescents' mental health are associated with SES (Ahlborg et al., 2017) and disparities in school achievement (Keles et al., 2018).

Lindbom (2010), however, argues that excessive emphasis on the segregation effect of the voucher system, without clear strategy to mitigate it, has overshadowed the positive impact the reform has had through enhanced inter-school competition, ultimately improving education quality. Edmark et al. (2014), on the other hand, asserted that the impact of the reform remained consistent across SES gradients, with school choice not preferentially benefiting either low or high SES groups. However, in instances where variation occurred, it yielded marginally more favorable outcomes for individuals from disadvantaged backgrounds compared to their more privileged counterparts, albeit the effects were notably minimal or approaching negligible.

The aim of this brief account was to provide background information on the schools where the targets of this thesis spend most of their awake hours (Eccles & Roeser, 2011), without taking sides in favor of or against school reforms.

School-related factors

Young people spend a significant portion of their awake hours in schools, where most of their life experiences, whether positive or negative, take root (Eccles & Roeser, 2011). They engage with diverse social actors in school, such as their peers and teachers, on almost daily basis. Hence, schools serve as the primary environment for young people to build their social networks (Crosnoe, 2011). On the other hand, schools can be demanding environments, inducing stress linked to managing exams and meeting educational expectations, which may lead to psychological distress (West & Sweeting, 2003) and subjective health complaints (Eriksson & Sellström, 2010). Nevertheless, the safe and supportive social connections young people cultivate at school may play crucial roles in improving academic performance (Rosenfeld et al., 2000) and positively influencing health outcomes, including mental well-being (Viner et al., 2012).

While the cross-sectional association between mental health and school demands has been well established (Eriksson & Sellström, 2010), Nygren and Hagquist (2019) reported that the increase in PSS over time, for example, was not related to temporal changes in school demands. Högberg (2021) further demonstrated how the educational stressors hypothesis could explain trends by considering changes in overarching structural contexts, such as economic growth and educational expansion. The educational stressors hypothesis argues that society's increasing emphasis on and value of educational attainment contributes to heightened school-related stress, potentially leading to negative

mental health outcomes (West & Sweeting, 2003). The works of Nygren and Hagquist (2019) and Högberg (2021) suggest that the influences on trends in adolescents' mental health problems within school settings surpass what the educational stressors hypothesis entails and involve multiple contributing factors. This emphasizes the need to investigate the interconnected relationships between adolescents' mental health problems and the array of many other factors, including school-related factors.

The safe and supportive social relationships that young people establish at school have been found to enhance academic achievement, acting as a buffer against stress resulting from school demands (Rosenfeld et al., 2000). This, in turn, positively contributes to fostering mental well-being (Eriksson & Sellström, 2010). This aligns with previous research (Cohen & Hoberman, 1983; Cohen & Wills, 1985) that suggested that the support from individuals within one's ecological environment, particularly concerning school-related matters, significantly influences the mental health of the recipient. Cohen and Hoberman (1983) outlined four domains through which this support can manifest: 1) The emotional domain, which bolsters self-esteem; 2) the informational domain, facilitating proper situational appraisal contributing to stress reduction; 3) the tangible or instrumental domain, addressing academic challenges and material shortages; and 4) the companionship domain, offering love and affection (Cohen & Wills, 1985; Krause, 1987). These pathways likely serve as the primary channels through which support from parents (Ramberg, 2021; Wang & Sheikh-Khalil, 2014; Westerlund et al., 2015) and teachers (Cavioni et al., 2021; Guo et al., 2020) reaches the adolescents.

Another factor that plays a context for where adolescents spend most of their time is the school physical environment, especially the classrooms. This is so because evidence from a previous study revealed that physical characteristics of school facility such as cleanliness, space and tranquility of classrooms are directly or indirectly associated with educational motivation that in turn is associated with mental health (Wang & Degol, 2016).

A conducive environment, where adolescents cultivate safe and supportive social relationships that help buffer stress from demanding schoolwork, significantly influences students' perceptions and feelings about school (Graham et al., 2016). This positive attitude, often referred to as 'school liking' (Graham et al., 2016; Jerdén et al., 2011), in turn, is strongly associated with overall well-being (Rönkä et al., 2017).

The extensive interconnectedness of school-related factors raises the question of how actively students engage in shaping their learning experiences. Thomas (2007) defines students' participation as involvement in a wide array of decision-making activities within social settings, notably schools in our context. In Sweden, both compulsory (Swedish National Agency for Education, 2018) and upper secondary school (Swedish National Agency for Education, 2013) curricula prioritize and underline students' active involvement. These curricula grant students the right to influence how they intend to

learn and have a say in overarching decisions pertaining to the educational process. An OECD report highlights that besides contributing to academic achievements, engaging in decision-making activities within schools significantly impacts students' well-being, including their mental health (OECD, 2017). However, only a few studies (de Róiste et al., 2012; Wilson, 2009) have offered support for this assertion. Thus, there is a critical need to explore the potential impact of participation in decision-making activities on students' mental health.

Lifestyle factors

While the term “lifestyle” can have numerous definitions, I found that the one implied in the Ottawa Charter for Health Promotion (World Health Organization, 1986) forms the foundation for contemporary interpretations. Nutbeam (1998) documented the 1986 WHO definition of lifestyle as ‘a way of living based on identifiable patterns of behavior which are determined by the interplay between an individual’s personal characteristics, social interactions, and socioeconomic and environmental living conditions’. Jensen (2009) presents a more recent version of the definition that concisely describes lifestyle as ‘a set of habits that are directed by the same main goal’, implying that individuals' habits carry consequential, whether positive or negative, outcomes.

Several studies have linked adolescents’ mental health with their ways of life. For instance, positive behaviors such as regular physical activity, low or no alcohol and substance use, adequate sleep, and healthy dietary habits, have been linked to positive mental health outcomes (Biddle & Asare, 2011; Maenhout et al., 2020). Conversely, disturbed sleep patterns, consumption of junk foods, and lack of physical activity are associated with a higher risk of mental health problems (Aoki et al., 2022; Marino et al., 2021; Rossa-Roccor et al., 2021). Alcohol abuse (Crews et al., 2007) and smoking (Boksa, 2017) during adolescence disrupt brain development, leading to alterations in brain structure and neural circuitry in specific regions. These substances also affect the maturation of executive functions, and these changes are implicated in the development of mental disorders.

Beyond their individual impacts on mental health, these behaviors can also cluster together, either exacerbating or improving outcomes. For instance, a cluster of negative behaviors—such as physical inactivity, binge drinking, smoking, and cannabis use—has been linked to an increased risk of DS in young individuals (Bannink et al., 2015). Furthermore, physical activity, known for its independent positive influence on mental health (Dishman & O'Connor, 2009), not only yields direct benefits but also improves sleep efficiency, which itself is linked to mental well-being (Lubans et al., 2016).

Although associations between lifestyle factors and mental health problems are well documented, little or none is known about the influence of these

factors on trends in mental health problems. This thesis therefore endeavors to unveil these associations.

Social relationships and adolescent mental health

The importance of supportive social relationships in enhancing mental health has been emphasized for decades. Cohen and Hoberman (1983) and Cohen and Wills (1985) have shown that social support plays a critical role in buffering the impacts of life stress and reducing the risks of mental health problems. The perceived availability of social support in any of the four domains described above—emotional, informational, tangible and companionship—is associated with a decreased risk of mental health problems among young people (Cohen & Hoberman, 1983; Cohen & Wills, 1985; Krause, 1987).

Examining the influence of social relationships on mental health, Chen and Harris (2019) discovered significantly lower levels of DS among adolescents who experienced positive family relationships during adolescence compared to those with less positive ones. Moore et al. (2018) also found similar association linking positive relationships with family, school staff, and friends to reduced risks of mental health problems in adolescents.

Studies have shown that the parenting styles parents choose to follow establish the context for children's social relations and influence their psychological development (Martinez-Escudero et al., 2020). These parenting styles can be positive or negative, supportive or thwarting parenting practices, as Costa et al. (2019) names them, each with its own consequences. Skinner et al. (2005) have introduced six dimensions of these parenting styles, where three of them (warmth, structure, and autonomy support) are positive and the remaining three (rejection, chaos, and coercion) are not. Further studies have shown that acceptance and love (warmth) (Rohner, 2021; Rohner et al., 2012), clear and predictable guidance and expectations from parents (structure) (Farkas & Grolnick, 2010; Flammer, 1995; Schneewind, 1995; Smetana, 2017; Stattin & Kerr, 2000), and encouraging independent problem-solving, choice and participation in decision-making (autonomy support) (Grolnick & Ryan, 1989; Iotti et al., 2023) have a positive influence on adolescent's mental health.

Adopting the terminology of supportive parenting styles (Costa et al., 2019), this thesis focuses on the positive parenting styles and investigates their association with mental health among young people.

Regarding peer relationships, previous studies have shown positive associations between positive peer relations and mental health among adolescents, where supportive peer relations are protective factors (Roach, 2018) and negative relationships, such as peer victimization, are associated with negative mental health outcomes during adolescence and later in life (Armitage et al., 2021).

Given that schools serve as crucial environments for adolescents' social and academic development (Eccles & Roeser, 2011), the interplay between peer relationships and school connectedness plays a pivotal role in adolescent mental health (Bond et al., 2007). School connectedness, exemplified by liking other students in one's classes, has been associated with a reduced risk of mental health problems. On the other hand, strong social connectedness—having someone to talk to, someone to depend on when angry or upset, and someone who could be trusted with private feelings and thoughts—proved beneficial to mental health only in the presence of robust school connectedness. In the absence of school connectedness, Bond et al. (2007) explain that social connectedness can be detrimental to mental health, as young people who are socially connected but not connected with school may be susceptible to negative influences that predispose them to mental health problems. Allen and Antonishak (2008) link these associations to attachment theory, highlighting that socialization involves a willingness to be influenced by others and to face the resulting consequences, whether negative or positive.

The associations between mental health outcomes and adolescents' relationships with family (Chen & Harris, 2019) and peers (Armitage et al., 2021; Roach, 2018; Tillfors et al., 2012) have been well documented. The question that may be asked in the wake of the increasing trends in mental health problems reported in the Nordic Region, including Sweden (Hagquist et al., 2019) and elsewhere (Potrebny et al., 2017), is whether social relationships could predict changes in these problems over time. While previous studies, for example De Looze et al. (2020), attempted to explain trends from a social relationship perspective, only a few studies, such as those by Chen and Harris (2019) and Finan et al. (2018), have explored whether social relationships could predict the developmental trajectories of developing mental health problems during adolescence and later in life.

This necessitates more studies to broaden the evidence base on how social relationships influence individual development and pave the way for possible interventions. It is against this backdrop that this thesis attempts to predict the likelihood of individuals belonging to specific groups with mental health profiles based on data from a longitudinal study.

Theoretical Framework

This doctoral thesis draws upon the SDH model (Dahlgren & Whitehead, 1993) supported by Krieger's social epidemiology theory to investigate the association between mental health problems and the factors that may influence the magnitude as well as the trends of these problems (Krieger, 2000). It also employs the chronosystem perspective of Bronfenbrenner's ecological systems theory (Bronfenbrenner, 1977) to synthesize the temporal dynamics of the interplay between determinants and outcomes. While the SDH model offers the conceptual framework, the social epidemiology theory serves as the theoretical foundation for understanding the relationships between determinants and outcomes. Additionally, the chronosystem within the ecological systems theory illuminates the temporal dynamics inherent in these relationships.

The Social Determinants of Health (SDH) model

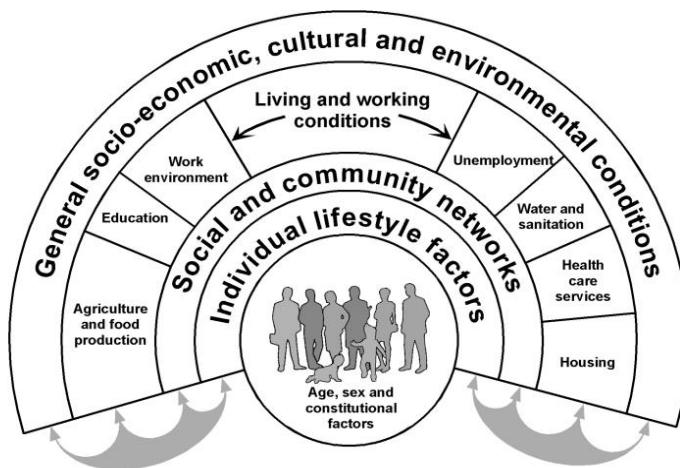
The WHO defines SDH as non-medical conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems that influence a wide range of health outcomes (CSDH, 2008). McDowell (2023) further describes the SDH as nonspecific factors forming a hierarchy, which runs from immediate antecedents to upstream distal determinants. These determinants create a context for personal risk and protective factors for disease within the population.

Dahlgren and Whitehead (1993), widely considered pioneers in devising the SDH, described the "Main Determinants of Health," initially named as such, to encompass factors that pose health threats, promote health, and protect health. These factors are structured in layers, each stacked atop the other, spanning from an individual's genetic makeup to the overarching structural environment, as illustrated in Fig. 1.

This model elucidates the interplay between upstream/distal factors, which provide overarching foundation or contextual backdrop for the situation under assessment, and downstream/proximal factors, which can be immediate causes of the outcomes of interest (Braveman et al., 2011; Spencer, 2018), mental health problems, in this case. While distal/upstream determinants impact mental health problems at a population level, proximal/downstream determinants influence individuals' mental health outcomes (Pester et al., 2023).

Among practical examples relevant to this thesis that could illustrate the operationalization of this model is the association between school-related factors and adolescent mental health problems. The early 1990s reform of the Swedish education policy, which aimed to increase inter-school competition and the influence of parents, teachers, and students over schools and education (Lundahl, 2002b; Lundahl et al., 2013), represents the upstream determinants. On the other hand, the role of parents and teachers in supporting students with school matters represents the downstream determinants. Studies have demonstrated a reciprocal relationship between parental and teacher support, and mental health problems among adolescents (Eriksson & Sellström, 2010; Rosenfeld et al., 2000). This indicates that parental and teacher support, which takes place within the immediate external environment of adolescents and exemplify the proximal determinants, influences mental health outcomes.

The Main Determinants of Health



Source: Dahlgren and Whitehead, 1993

Figure 1. The Main Determinants of Health by Dahlgren and Whitehead (reproduced with permission)

Solar and Irwin (2010) elucidate that the genesis of the SDH model finds its roots in social epidemiology theory, particularly in the theories of disease distribution as described by Krieger (2001b). These theories are believed to facilitate a critical and systematic analysis of the connections between our social and biological existence (Krieger, 2001b). The theories of disease distribution posit that the distribution of advantages and disadvantages in health and disease mirrors the distribution of advantages and disadvantages in society, encompassing factors ranging from political or social contexts to individual level differences, such as sex, for example (Krieger, 2014). This implies that

societal inequalities directly or indirectly influence the inequities in the distribution of health and disease (Krieger, 2001b; Krieger, 2014).

Solar and Irwin (2010) employed three approaches to explain the SDH model. The first posits that psychosocial factors, linked to individuals' perceptions of their social status, dictate susceptibility to ill health. This argument stems from Cassel's theory (Cassel, 1976) hypothesizing that health outcomes aren't solely determined by the pathogenicity of disease-causing organisms but also by host resistance, itself influenced by an individual's societal position. Krieger (2001b) affirms that psychosocial factors—such as SES, social support, and responses to status-induced stress—are rooted in social, political, and economic policies, suggesting that comprehending health issues necessitates an understanding of their underlying context. The second entails that income inequalities among individuals and under-investment in public infrastructure due to the structural imbalance may lead to inequities in health.

The third approach emphasizes the intricate nature of disease causation, advocating that its response should encompass this nuanced understanding. As noted by Marmot (2017), the Solar and Irwin's model (Solar & Irwin, 2010) adopted the flow of causal relationship from Dahlgren and Whitehead (1993). This doctoral thesis recognizes the similarities but chooses to adopt the Solar and Irwin's model, depicted in Fig. 2, as it aligns more suitably with the approach this thesis aims to present.

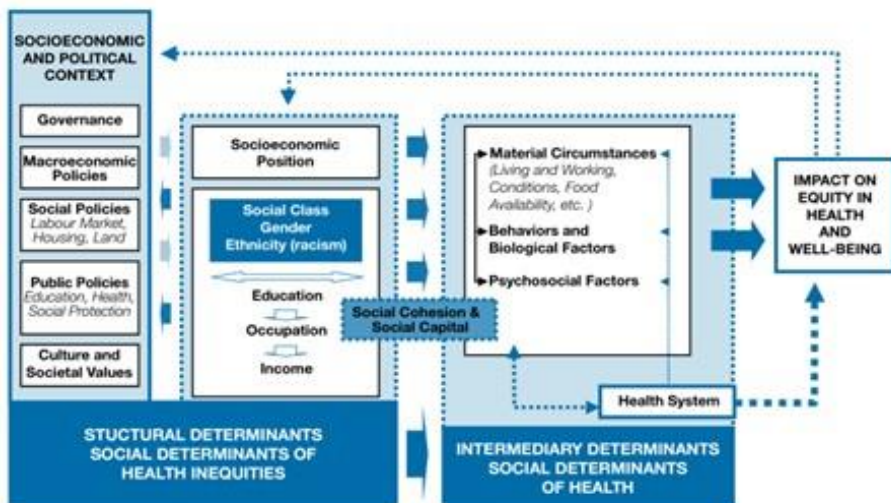


Figure 2. Social determinants of health, by Commission of Social Determinants of Health (Source: Solar and Irwin, 2010. Reproduced with permission from WHO, ID: 202402363).

In this model, the first two columns—socioeconomic and political context and socioeconomic position—jointly form the structural determinants, while the third, alongside the health system become the intermediary determinants. These determinants are arranged such that the structural determinants influence health outcomes either directly or through the intermediary determinants. This sequence of influence significantly shapes health outcomes through the social causation pathways (Marmot, 2004a; Solar & Irwin, 2010). While an individual's health status might also influence their social position through health selection pathways (Marmot, 2004a; Solar & Irwin, 2010), this aspect is not the main focus of this thesis. Specific to mental health, Shim et al. (2015) assert that there are no distinct differences in the basic understanding and application of SDH to mental health, but underscores that its application to mental health needs more focus attributed to the high magnitude, severity, and scarcity of effective treatment of the problems.

Integrating SDH with Chronosystem

Solar and Irwin (2010) have demonstrated that the SDH model considers the significance of time by adopting a life course perspective to address changes in exposure and health outcomes throughout one's lifespan. However, the mechanisms by which the model tracks potential variations in exposure levels and outcomes over time remain unclear. Therefore, integrating the SDH with an aspect of Bronfenbrenner's ecological system theory, the chronosystem (Bronfenbrenner, 1977), becomes imperative to fulfill this need.

The rationale behind this integration lies in understanding the ongoing interaction between the human psyche, particularly within the scope of my study, and the surrounding environment across time (Lewis, 2014). This interactional model generates outcomes aligned with an individual's adaptive capacity. Sameroff (2014) describes this model as transactional, indicating that all involved features including individual traits as well as environmental forces, transform due to their interaction. In the context of this thesis, Studies I – III uses historical time, while for Study IV, I refer to time in terms of individual development.

Building upon these concepts and the diverse associations between various factors and adolescent mental health problems discussed earlier, I propose the following framework to steer this doctoral thesis. This framework illustrates how intermediary factors significantly intertwine with individuals' SES, ethnicity, and gender to impact mental health. These structural determinants—SES and gender—not only exert influence on the intermediary factors but can also directly affect the vulnerability levels to mental health problems, as extensively discussed in their respective sections. Given that the thesis relies on

survey questions with individuals, the model will not encompass factors associated with the broader socioeconomic and political context.

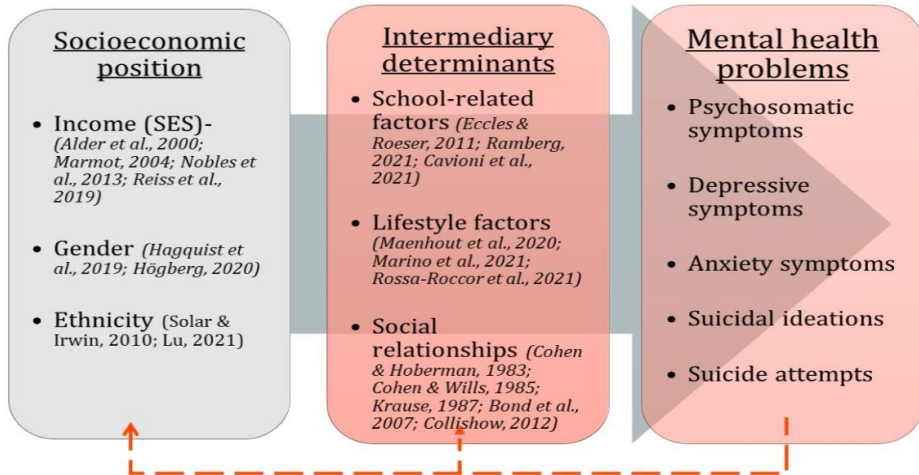


Figure 3. The interplay between socioeconomic position and intermediary determinants and their association with mental health problems.

Operationalizing the integrated SDH Model

Guided by previous evidence, this thesis integrates factors from the structural determinants and intermediary determinants domains of the SDH model to assess their individual and collective roles in influencing adolescents' mental health outcomes. Accordingly, structural determinants such as sex (Van Droogenbroeck et al., 2018), SES (Hazell et al., 2022; Kim et al., 2019; McLaughlin et al., 2012; Reiss et al., 2019; Weinberg et al., 2019), and country of origin (Kim et al., 2020; Lu et al., 2021) that were shown to have associations with adolescent mental health in the previous studies are included in this model.

From the intermediate determinants perspective, school-related factors, including parental and teacher support (Chen & Harris, 2019; Moore et al., 2018), school-liking (Mitic et al., 2021; Thornberg et al., 2023), participation (Young et al., 2011), and the school's physical environment (Uji & Kawaguchi, 2021), alongside lifestyle factors (Aoki et al., 2022; Biddle & Asare, 2011; Maenhout et al., 2020; Marino et al., 2021; Rossa-Roccor et al., 2021), and relationships with family (Hagquist, 2016; Moore et al., 2018; Rosenfeld et al., 2000) and peers (Roach, 2018) are considered. The broken redlines in the integrated model symbolize the health selection pathway (Marmot, 2004a; Solar & Irwin, 2010), is beyond the scope of this thesis, as mentioned above.

In the analysis of relationships between these factors and the trends in the outcomes of interest, this thesis employs *exposure* and *vulnerability* hypotheses (Högberg et al., 2020; Sweeting et al., 2010). The *exposure* hypothesis assesses whether changes in the factors in the intermediate determinants' domain explain the changes in the magnitude and direction of mental health problems over time. On the other hand, the *vulnerability* hypothesis investigates whether changes in mental health problems over time vary across the selected structural determinants (Högberg et al., 2020; Sweeting et al., 2010).

Rationale

The point of departure of this doctoral thesis is the substantial burden (Silva et al., 2020) and increasing trends (Blomqvist et al., 2019; Björn Högberg et al., 2022) in adolescent mental health problems coupled with intricacy of the associated factors (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010). Mental health problems are inherently complex (Michaud & Fombonne, 2005; Zimmerman et al., 2018), exhibiting high comorbidity among various conditions (Caspi & Moffitt, 2018). The increasing socioeconomic inequities in health, including mental health (Ahlborg et al., 2017), further compound this complexity. These factors collectively emphasize the necessity for more studies to elucidate the problems and bridge the existing gaps.

One notable gap lies in the tendency to discuss trends in mental health problems generally while focusing solely on one or a few specific conditions, such as PSS (Kim & Hagquist, 2018), or DS (Blomqvist et al., 2019). It is crucial, however, to acknowledge that mental health problems are complex (Michaud & Fombonne, 2005) and necessitate consideration of multiple indicators, rather than just one or two (Zimmerman et al., 2018). This thesis addresses this gap by examining diverse aspects of mental health problems, including PSS, DS, AS, SI, and SA, to comprehensively assess the adolescent population's mental health landscape.

This thesis also brings added value by exploring the positive factors within the school environment that contribute to fostering mental health. Schools constitute the primary setting where young individuals spend a significant portion of their active hours (Eccles & Roeser, 2011) and establish a substantial part of their social network (Crosnoe, 2011). This research specifically delves into the roles of school-related support (from parents or teachers), youth participation in decision-making, their school liking, and the classroom physical environment in enhancing mental health. This addresses the void present in previous studies, which primarily concentrated on school stress or demands as risk factors influencing adolescent mental health (Bersia et al., 2022; Cosma et al., 2020; De Looze et al., 2020; Högberg, 2021; Högberg et al., 2020) with minimal attention, if any, given to the protective roles of school-related factors.

Another crucial perspective is that while most existing studies have analyzed trends in mental health problems based on external factors, whether proximal or distal, as discussed above, individuals' lifestyles are also key

influencers of mental health outcomes. However, it remains unclear whether lifestyle factors are associated with trends in these problems. This thesis aims to address this gap and provide a comprehensive understanding of the trends and influencing factors. Additionally, equally vital to understanding the magnitude and trends in mental health problems is predicting the trajectories these problems take throughout the life course once identified (Collishaw & Sellers, 2020). The scarcity of studies addressing this aspect is evident, underscoring the importance of filling this gap.

In summary, this doctoral thesis is driven by the substantial burden and increasing trends in adolescent mental health problems, compounded by the complexity of associated factors and socioeconomic inequities. Existing studies often focus on specific conditions rather than considering the multifaceted nature of mental health problems. To address this gap, the thesis comprehensively examines various aspects of mental health problems among adolescents, including PSS, DS, AS, SI, and SA. It explores the positive roles of school-related factors in fostering mental health, filling a void in previous research that primarily concentrated on stressors. Moreover, the thesis aims to elucidate the influence of lifestyle factors on trends in mental health problems as well as assess the impact of social relationships in predicting trajectories of mental health problems throughout the life course of individuals. Grounded in the SDH model (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010), the study evaluates the changes in mental health problems in relation to various factors over time, across gradients of subjective and objective SES (Adler et al., 2000). By addressing these gaps and complexities, the research seeks to provide valuable insights into adolescent mental health problems and contribute to effective interventions and policies aimed at promoting mental well-being in this population.

Aim

The overall aim of the thesis was to investigate the trends in, and factors associated with, mental health problems among adolescents in Västmanland region in Sweden.

The project has undertaken four intertwined studies specific aims to:

- I. Analyze trends in adolescent mental health problems and moderating role of gender and SES.
- II. Investigate association between school related factors and trends in adolescent mental health problems and the moderating role of SES.
- III. Study association between lifestyle factors such as physical activity, food habits, alcohol use or cigarette smoking and trends in adolescent mental health problems, moderated by SES.
- IV. Examine the impact of social relationships on developmental trajectories of DS and AS among adolescents.

Methods

Design

This thesis comprises four interrelated studies aimed at providing evidence on trends in adolescent mental health problems and the factors influencing these trends. The studies were designed such that the first study estimates trends in selected mental health problems including PSS, DS, SI, and SA while the second and third studies investigate the factors associated with these trends. The fourth study was designed to assess the trajectories that the identified mental health outcomes may follow over time by profiling individuals based on their self-reported DS and AS.

The studies utilized quantitative methods by analyzing data collected through repeated cross-sectional surveys for Studies I, II, and III, while Study IV was based on longitudinal data collected every three years in four waves. Data for Studies I, II, and IV were sourced from the Survey of Adolescent Life in Vestmanland (SALVe) project (Region Västmanland, n.d.), whereas Study III utilized data from the Swedish Health Behavior in School-aged Children (HBSC) studies conducted in 2002, 2006, 2010, 2014, and 2018 (Eriksson et al., 2019). Table 1 presents an overview of the methods employed in this project.

In operationalizing the design, historical time trends were estimated for the first three studies, utilizing data collected through repeated cross-sectional surveys. Consequently, all relationships between the outcomes of interest and associated factors were interpreted in terms of associations rather than causal relationships (Setia, 2016). In contrast, the fourth study identified distinct trajectory groups (Nagin, 2005) based on individuals' reported levels of DS and AS collected longitudinally from the same sample at different points in time. In this study, the relationship between the outcomes of interest (membership in distinct trajectory groups of DS or AS) and associated factors was interpreted as predicting causality (Larsen, 2006).

Table 1. Summary of methods employed in the research project.

Study	Focus	Sample	Data collection	Data analysis
I	Analysis of trends in adolescent mental health problems	15-year-old adolescents with sample size:	Paper based survey from 2004 – 2017,	Logistic and linear regression analyses
II	Association between trends in adolescent mental health problems and school-related factors	PSS: 15,750 DS & SI: 13,539 SA: 19,496	and web-based for the 2020 wave	Logistic and linear regression analyses followed by mediation analysis
III	Association between trends in adolescent mental health problems and lifestyle factors	National survey among 9,196 15-year-old adolescents	Paper based survey questionnaire were used	Reverse Helmert Contrast for trends and linear regression analysis to investigate associations
IV	The impact of family and peer relationships on developmental trajectories of DS and AS among adolescents	Wave 1: 1834 (51%) * Wave 2: 1643 (52%) * Wave 3: 1212 (50%) * Wave 4: 1067 (51%) *	Survey questionnaire administered every 3 years to cohorts born in 1997 & 1999	Group-based trajectory modelling followed by multivariate logistic regression analysis

*The specified proportion of the sample were born in 1997 while the rest were born in 1999.

Research participants

This research project focused on 15-year-old school youth in Sweden. However, each study within this project targeted a specific data source. Studies I and II utilized repeated cross-sectional data from the SALve project, collected every 2–3 years since 1995 to monitor the psychosocial health of adolescents in the Västmanland region. Surveys were conducted across all secondary and upper secondary schools in the county. Studies I and II were based on data collected from a total of 19,873 grade 9 students (15-year-olds) from all schools in the county, excluding special schools, between 2004 and 2020. The overall average response rate was 80.4%, with the lowest response rate (75%) in 2017 and the highest (87%) in 2014.

The sample equally comprised boys and girls, with about 84% of participants belonging to a high SES. However, data availability varied throughout the study period (2004–2020) for the different mental health domains. For

instance, information specific to DS and SI was collected until 2012, while data specific to PSS was collected until 2014. On the other hand, data on SA were available for all waves of data collection except in 2014, resulting in varying sample sizes. After implementing listwise deletion to handle missing values, considering the minimal missing data proportions ranging from zero for the survey year to 9% for SA, the final analyses in Study I included n=15,127 for PSS, n=13,138 for DS, n=12,659 for SI, and n=15,397 for SA. In Study II, the final analyses comprised n=15,750 for PSS, n=13,539 for DS, n=12,972 for SI, and n=16,073 for SA.

Study III was based on data obtained from national HBSC surveys in Sweden conducted between 2002 and 2018 (Eriksson et al., 2019). The data were collected in four waves in 2002, 2006, 2010, 2014 and 2018 from 9,196 fifteen-year-old school youths, with nearly equal proportions of girls (50.5%) and boys. About 80% of the participants belonged to the high SES group. The participation of schools was reasonably high across the survey years, except in 2018 when it decreased to 47%. Students' response rates were high in all years, ranging from 81% to 88% (Public Health Agency of Sweden, 2018).

The participants in Study IV were adolescents born in 1997 and 1999, residing in the Västmanland region of Sweden at the time of the study. A total of 1850 girls (556%) and boys were enrolled in a prospective cohort study named 'The Survey of Adolescent Life in Västmanland Cohort' (SALVe cohort) in 2012 when they were 15 and 13 years old, respectively. Subsequent surveys were conducted every three years, where the fourth wave took place in October 2021, during which data were collected from 1067 individuals (64.4% of whom were girls) (Mohamed et al., 2023; Vadlin et al., 2018).

Table 2. Summary of the number young people who participated in Studies I - IV.

Study	Participants		
	Girls n(%)	Boys n(%)	Total
I & II	9751 (50)	9745 (50)	19 496
III	4647 (50.5)	4549 (49.5)	9196
IV (wave1)	1019 (56)	815 (44)	1834
IV (wave 2)	961 (58)	682 (42)	1643
IV (wave 3)	753 (62)	459 (38)	1212
IV (wave 4)	687 (64)	380 (36)	1067

Data collection

For Studies I and II, data collection involved cross-sectional surveys conducted every two years between 2004 and 2014, followed by a shift to surveys every three years until 2020. The surveys were primarily paper based, except for the 2020 edition, which was conducted online. In 2020 wave, students were provided with login information instead of pen and paper. Students completed the questionnaires during class hours under the supervision of teachers and typically spent about 1 hour on this task. The self-reported questionnaire involved various aspects, including demographic background, family income, perception of social status, social relationships and support, school environment, and subjective health complaints such as psychosomatic, musculoskeletal, and DS (Åslund et al., 2010). The data collection procedure for Study IV followed a similar approach, albeit with variations in design and survey intervals. This study involved data collection every three years from cohorts of adolescents born between 1977 and 1999 (Vadlin et al., 2018).

Data for Study III were sourced from the HBSC, a multinational study carried out in partnership with the WHO. In Sweden, Statistics Sweden oversees the data collection process. The data were collected through repeated cross-sectional surveys that used a two-stage cluster approach, with schools serving as the primary sampling units. At stage one, three random samples of Swedish schools are chosen, each corresponding to a different school grade (grades 5, 7, and 9). At the second stage, one school class is randomly selected from each school, inviting all students in that class to participate in the survey at their will. The surveys took place within the classroom setting, supervised by the teacher. Study III used data collected from grade nine students totaling 9196. The survey questionnaire included, among other things, demographic background, family affluence, food habits, physical activity, alcohol and illicit drug use, and symptoms of nonclinical health complaints such as headache, stomachache, backache, feeling low, feeling irritable, feeling nervous, sleeping difficulties, and feeling dizzy.

In summary, Studies I, II, and III were based on repeated cross-sectional surveys. Data for the first two studies were gathered from 15-year-old adolescents living in the Västmanland region, while the third study used nationally representative data from the same age group. Study IV utilized cohort data from young individuals born 1997 and 1999 and residing in the Västmanland region.

Description of variables

Outcome variables

Psychosomatic symptoms (PSS): This is a scale variable developed through series of field test for DSM-5 (American Psychiatric Association, 2022c; Narrow et al., 2013) to measure frequencies of PSS during three months before the survey. The items are headache, stomachache, pain in the shoulders or neck, pain in the back or hips, pain in hands/knees/legs/feet, difficulty in sleeping, feeling nervous, and feeling irritated (Gierk et al., 2014). Participants responded when asked whether they had experienced any of the eight symptoms with responses ranging from never (0) to always (4). The sum of these responses produces a scale of 0 – 32 scores, where the higher the score is the worse mental health status. More about this variable is reported in a previous research (Åslund & Nilsson, 2013).

Depressive symptoms (DS): This is a scale variable assessed using the adolescent version of the Depression Self-Rating Scale (DSRS-A). The participants were asked 15 questions to determine if they had experienced any of the DS in the two weeks preceding the data collection. These 15 individual items were then consolidated into nine distinct DS, aligning with the criteria outlined in the Fourth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (Svanborg & Ekselius, 2003). The resulting variable was scored on a scale from 0 to 9, with higher scores indicating a greater severity of symptoms.

In cases where dichotomization was necessary to determine the presence or absence of a diagnostic major depression (in Study IV, for example), the DSM-IV A-criterion (Svanborg & Ekselius, 2003) was adhered to. The criterion outlines that the presence of either of the following conditions may suggest a potential diagnosis of major depressive disorders (MDD): 1) meeting at least one of the general criteria for depression, which includes experiencing two weeks of either dysphoric or irritable mood or loss of interest or pleasure in most activities; 2) displaying at least four other symptoms, such as sleep disturbances, changes in weight or appetite, psychomotor agitation or retardation, fatigue or loss of energy, feelings of worthlessness or guilt, difficulties with concentration, and thoughts of suicide. Previous studies have used the term 'High symptoms of depression' instead of MDD due to the self-report nature of the measures, and this thesis adopts a similar approach.

Anxiety symptoms (AS): Spence Children's Anxiety Scale (SCAS) (Spence, 1997) and the shorter version Adult Anxiety Scale (AAS-15) (Spence & Essau, 2017) were used to measure AS in adolescents during waves 1 and 2 and among young adults in waves 3 & 4, respectively. The SCAS comprises

44 items, encompassing 38 items that address the six categories of anxiety disorders highlighted in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2022a) with the remaining six acting as filler items aimed at mitigating bias. Each question offered response alternatives ranging from 0 (never) to 3 (always). The AAS, on the other hand, consists of 15 items with similar response alternatives, and scale ranging from 0 to 45. The use of these among the Swedish population has been reported in previous studies (Giannotta et al., 2022; Olofsdotter et al., 2015).

Suicidal ideations (SI): This is a dichotomous variable where the participants responded 'yes' if they had experienced recurring thoughts of taking their lives during the two weeks preceding the survey date, and 'no' otherwise. This thesis followed the WHO Composite International Diagnostic Interview (CIDI) (Kessler et al., 1998; Nock et al., 2009) to measure SI based on a single-item self-reported question. Although studies show that the use of single-item questions to assess SI may lead to misclassifications, for instance, Millner et al. (2015) reported a 9% misclassification rate, while Nock et al. (2008) reveal that more than half of studies on suicide, including SI and SA, use a single-item approach.

Suicide attempts (SA): This is also a dichotomous variable where participants responded 'yes' if they had attempted to take their own lives during the two weeks preceding the survey, and 'no' otherwise. Since data on SA were collected from the same sample and at the same time as SI data, the same explanation regarding the measurement of SI applies to SA as well.

Independent variables

The theoretical framework outlined earlier encompasses various independent factors, broadly categorized into two groups: a) structural determinants, and b) intermediary determinants (Solar & Irwin, 2010). In this project, the structural determinants included gender, ethnicity, and SES. Meanwhile, the intermediary determinants involve school-related factors (such as school liking, participation, support from parents and teachers, and the school's physical environment), lifestyle factors (including dietary habits, physical activity, and substance use), and social relationship factors (such as relationships with family and friends). Detailed measurements of these factors are outlined in the corresponding studies exploring their association with mental health.

SES: Two measures of SES have been used in this thesis. The first is subjective SES, which gauges the relative position of an individual's family on the societal ladder based on income. This position was assessed using a question featuring a 7-point ladder presented as follows: "Imagine society as a ladder. Families with the least money are at the bottom, while those with the most

money are at the top. If you think about your family's wealth compared to that of society at large, where would you place your family on the ladder?" (Åslund et al., 2009; Quon & McGrath, 2014). The responses ranged from 0-6 and were treated as continuous variables based on existing recommendations (Robitzsch, 2020). Although SES is generally defined in terms of one's income, educational attainment, and occupation relative to others (Manstead, 2018), this thesis employs a single question on family income as an indicator of SES, owing to empirical evidence showing that income is the strongest predictor of SES in relation to health outcomes (Daly et al., 2002; Darin-Mattsson et al., 2017).

The second measure is the Family Affluence Scale (FAS), developed for HBSC surveys as an alternative measure of family wealth and utilized for over two decades (Boyce & Dallago, 2004; Currie et al., 1997). The scale comprises four items: family car ownership, bedroom occupancy, family holidays, and computer ownership. The scale was employed after testing the internal consistency of the individual items within the scale.

Data analysis

Study I

In Study I, the outcome variables of interest were PSS, DS, SI, and SA. The first two variables were measured on continuous scales, while the latter were categorical (binary). Linear and logistic regression models were fitted for continuous and binary variables, respectively. The decision to estimate linear trends was made after testing curvilinear estimations, revealing that linear estimation best suited the data. The independent variables included the year of the survey, SES, and sex. The year of the survey and SES were measured on a continuous scale, while sex was binary. Survey years were recoded as natural numbers in their chronological order (2004 = 1, 2006 = 2, 2008 = 3, 2010 = 4, 2012 = 5, 2014 = 6, 2017 = 7, 2020 = 8) and treated as continuous variables for ease of calculation. Each outcome variable was regressed separately on these independent variables.

For each outcome, two models were constructed: Model 1 and Model 2. Model 1 included the outcome variable and the independent variables. In Model 2, interaction terms between survey year and SES (year x SES) and between survey year and sex (year x sex) were included. The coefficients of the survey year determined trend direction and magnitude, while the interaction term coefficients indicated the moderating effects of SES and sex on the trends. Unstandardized beta coefficients were used for trend estimation. To

standardize the estimates and facilitate comparison between PSS and DS, which were measured on different scales, Z transformation was employed.

R-squared change and χ^2 change in the Omnibus test were used for linear and logistic regressions, respectively, to assess the significance of differences between Models 1 and 2. Cohen's d (Sullivan & Feinn, 2012) and the Agresti–Caffo (AC) confidence intervals (Agresti & Caffo, 2000) were employed to measure effect sizes for mean differences in continuous variables and proportional differences in binary variables, respectively. Data analyses were conducted using SPSS version 28.

Study II

Study II utilized the same dataset as Study I and assessed trends in identical outcome variables. The data preparation process for Study II mirrored that of the previous study. However, Study II aimed to explore the impact of school-related factors on the observed trends in these outcomes over time. These factors included school liking, participation in school decision-making (referred to as 'participation' henceforth), parental support in school-related matters, teacher support, and the school's physical environment. School liking and participation were assessed using Likert scales ranging from 1 to 5 and treated as continuous variables, aligning with prior recommendations (Pell, 2005). Meanwhile, the remaining three factors were evaluated using scales derived from individual items, resulting in total scores ranging from 3 to 15. These scales exhibited acceptable Cronbach's Alpha coefficients within the range of 0.78 to 0.82: parental support ($\alpha = 0.82$, range: 0.79 – 0.84), teacher support ($\alpha = 0.82$, range: 0.75 – 0.86), and school physical environment ($\alpha = 0.78$, range: 0.75 – 0.80).

Building upon Study I's findings that indicated increasing mental health problems only among individuals with low SES, while those with high SES experienced stable or declining trends, Study II separately analyzed trends for these two SES groups. Within each SES category, the analysis consisted of three levels. The initial level involved identifying time trends in mental health problems and school-related factors by comparing mean scores or average probabilities (for binary outcomes) of both outcome and independent variables across each survey year. The Reverse Helmert contrast method, a feature of the general linear model (Schad et al., 2020), was employed to contrast specific survey year scores or proportions with the averages from preceding years. Comparisons were made between 2006 and 2004, 2008 and the average of 2004 and 2006, and 2010 and the average of 2004, 2006, and 2008. This process extended until the mean scores or probabilities of the final survey year were compared with the average of all preceding survey years.

The second and third stages of analysis respectively focused on estimating the cross-sectional associations between each mental health problem and school-related factors and assessing the strength of these associations over

time. The decision to pursue single-level linear trend estimation followed testing for curvilinear modeling, as mentioned earlier, and examining the appropriateness of multilevel modeling using an intraclass correlation coefficient of 0.05 as the cutoff point (Glaser & Hastings, 2011).

Within each SES group, two distinct models were constructed. Model 1 explored the cross-sectional relationships between the outcomes and school-related factors. The analysis also delved deeper into the mediation effects of each school-related factor on the relationship between survey year and the outcome variables, employing the approach detailed in Hayes (2017).

Hayes' PROCESS macro was preferred to the classical approach by Baron and Kenny (1986) for several reasons. Firstly, while Baron and Kenny offer no direct test for the occurrence of mediation, Hayes' PROCESS provides robust output, including confidence intervals and effect sizes for the indirect effect, crucial for understanding mediation dynamics. Hayes' PROCESS also includes bootstrapping (Field, 2013; Hayes, 2013), which mitigates the limitations of the Sobel test recommended by Baron and Kenny (1986), ensuring more accurate estimation of the indirect effect. Additionally, Baron and Kenny's insistence on certain preconditions, such as 'exposure' significantly predicting 'outcome' in the absence of the mediator (Baron & Kenny, 1986), can be overly restrictive and may lead to misinterpretation, whereas Hayes' approach allows for a more nuanced understanding of mediation effects without unnecessary constraints. Finally, Hayes' rejection of terms like 'complete' and 'partial' mediation, in favor of a more comprehensive analysis (Hayes, 2013), reflects a more sophisticated approach that acknowledges the complexities of mediation processes, ultimately promoting more accurate and insightful research outcomes.

Model 2 aimed to estimate strength of the associations between school-related factors and the evolving trends in mental health problems over time by introducing interaction terms between survey year and each school-related factor.

To evaluate the significance of differences in predicting outcomes after introducing the interaction terms, we employed R-squared change and χ^2 change in the Omnibus test for linear and logistic regressions, respectively. Additionally, 'sex' was controlled for in both the linear and logistic regression models. Data analyses were performed using SPSS version 28. For the mediation analysis, the fourth version of Hayes' process in SPSS was utilized (Hayes, 2017). All the results in this study were adjusted for sex.

Study III

In Study III, two steps of analysis were conducted to estimate trends and explore the associations of lifestyle with PSS trends. The first step involved identifying time trends in both PSS and lifestyle factors using the Reverse Helmert contrast method (Schad et al., 2020), following the methodology outlined in

Study II. The second step entailed fitting multiple linear regression model to examine the associations between trends in PSS, and various independent variables such as breakfast regularity, dietary habits (healthy/unhealthy), physical activity (PA), smoking, and alcohol consumption. Employing a similar approach to Study II, distinct trends were estimated for both low and high SES groups.

Within each SES group, two models were fitted. Model 1 evaluated the main effects of each independent variable on PSS mean scores. In addition, exposure hypothesis was also tested at this stage using mediation analysis following a method similar Hayes' (2013) but more suitable for mediators that are continuous variables (Karlson et al., 2012). Model 2 assessed the impact of the interaction between time (survey year) and each independent variable on trends in PSS. The coefficients derived from the interaction terms were used to estimate the magnitude and direction of associations between trends in PSS and the independent variables. The significance of the difference between Models 1 and 2 in predicting trends in PSS, after the inclusion of the interaction terms, was assessed using R-squared change. The results were adjusted for sex.

Study IV

Study IV employed Group-based trajectory modeling (GBTM) (Nagin & Tremblay, 2001) to estimate developmental trajectories of DS and AS among young individuals enrolled in the SALVe cohort. To identify distinctive DS and AS trajectories, a finite mixture model (Nagin, 2005) was used to determine the optimal number of trajectory groups. The Bayesian Information Criterion (BIC) guided the selection of the best model with the most suitable number of groups. Time/survey year was the main independent variable while sex, country of origin, cohort (1997 vs 1999), family relationship and peer relationship were used as risk factors to predict group membership.

The Zero-Inflated Poisson (ZIP) model was used with combinations of linear, quadratic, and cubic polynomials to identify distinct DS trajectories. For identification of AS trajectories, the censored normal (cnorm) model with combinations of linear, quadratic, cubic, and quartic polynomials was used. The choice of models, whether ZIP or cnorm, was based on the distribution of the dependent variables, with DS exhibiting zero-inflated responses and AS following a normal distribution (Nagin, 2005).

Multinomial logistic regression analysis was performed to examine the effects of the risk factors on group membership as well as the shape of the trajectories (Nagin, 2005). Details of the statistical analysis are presented in the specific study report.

Missing data handling

Missing data is generally defined as the absence of one or more values within a study variable or variables in a dataset, and it is one of the common challenges of quantitative research (Bannon, 2015). Enders (2003) and Peugh and Enders (2004) state that missing proportions of 15% to 20% are common in educational and psychological studies. The missing data problems are not only due to the amount of the missed values but also the mechanisms of their missing, including missing completely at random (MCAR), missing at random (MAR), or Not MAR (NMAR) (Bannon, 2015; Enders, 2003). MCAR refers to situations where the missing observations are a random subset of all observations, and the missing and observed values have similar distributions. MAR, on the other hand, is a situation where there may be a systematic difference between the missing and observed values, but the situation is entirely explained by the observed variables rather than the unobserved ones. NMAR refers to a situation where the probability of missing is dependent on the missing values (Bannon, 2015; RUBIN, 1976).

In dealing with missing data, various types of techniques are recommended, mostly based on the missing patterns (Enders, 2003). Listwise deletion, for example, is a technique that is most used but only employed when the MCAR criteria are met. This approach omits those cases with missing data and analyzes the remaining data (Kang, 2013). The approach is also known as a complete case analysis method (Donner, 1982). Other studies reported that deletion of missing data of about 5% - 10% did not have detrimental implication on the estimations (Bannon, 2015). This thesis employed listwise deletion to handle missing data in Studies I – III, as the missing proportions in all variables are small and ranged from 0% - 9%, as presented in the respective studies. As the Little's MCAR test (Roderick, 1988) yielded mixed results, claiming MCAR became a very strong assertion (Rhoads, 2012), this thesis opted to base its justification of missing data handling on the evidence that removing missing data of small proportions does not harm the overall estimation (Bannon, 2015).

For study IV, despite high the attrition rate with dropout of 10% at T2, 34% at T3, and 42% at T4, no evidence was found of the dependence of the missing values on either the observed or unobserved values, as presented in Table 3. In GBTM, the analysis method employed in this study, subjects with missing data are included, but only available data for each subject are used. Therefore, randomness in missing remains crucial, as evidenced in this study (Nagin, 2005; Niyonkuru et al., 2013). As a result, no further treatment was necessary.

Table 3. Comparison of mean scores of DS and AS between participants in wave 1 (T1) only and those continuing assessment across subsequent waves (T2, T3, or T4).

	Participated in T1 only		T1 & subsequent waves		Z-test	
	Mean	SD	Mean	SD	z-statistic	p-value
Depressive Symptoms						
T1 vs T2	2.04	2.42	1.85	2.18	0.13	0.89
T1 vs T3	1.96	2.34	1.83	2.14	0.09	0.93
T1 vs T4	1.98	2.26	1.80	2.17	0.13	0.90
Anxiety symptoms						
T1 vs T2	0.72	0.29	0.71	0.29	0.006	0.99
T1 vs T3	0.71	0.29	0.71	0.28	0.001	0.99
T1 vs T4	0.71	0.29	0.71	0.28	0.003	0.99

Ethical considerations

The Declaration of Helsinki outlines a set of ethical principles to guide research on human subjects, wherein research standards promote respect for all humans, ensure their safety, maintain the confidentiality of their information, and minimize the impact of the study on the subject's physical and mental integrity, as well as on the personality of the subject (World Medical Association Declaration, 2013). This research upholds these principles, and all the studies in this thesis have been conducted in accordance with this Declaration and the Swedish guidelines for studies involving humans (Ethical Review Act 2003:460).

In all rounds of data collection, appropriate information regarding the studies has been presented, and consents were obtained from study participants, as well as parents where appropriate. The data did not contain information on personal identification; the data collection was anonymous, and participation was voluntary. The participants were also informed that they were free to discontinue participation whenever they felt it was appropriate to do so.

Approvals for the research studies conducted in this thesis were diligently sought from the Swedish ethical review authority, as mandated by Swedish law (Ethical Review Act 2003:460). For Studies I and II, the approvals were secured with the following reference numbers: Dnr 2013/464, Dnr 2016/480, and Dnr 2019/05620. In the case of Study III, approvals were granted with reference numbers Dnr 2010/1871-31/5 and Dnr 2011/142. Finally, for Study IV, the necessary approval was obtained with reference number Dnr 2012/187. These approval documents have been annexed to this thesis.

The research has also adhered to the European Union (2016) General Data Protection Regulation (GDPR), which establishes obligations to implement appropriate security measures for personal data. The data from SALVe and SALVe Cohort were received on an encrypted flash disc and were stored on a secured computer. The HBSC data were downloaded from <https://hbsc.org/data/> after filling out an application form that required identification of the researcher, the purpose of the data use, and a statement of compliance with data protection regulations. The data obtained from these sources were stored in secured computers accessible only by authorized researchers.

My position and how it is related to this research

Reflexivity has long been part of the everyday language for qualitative researchers, serving to ensure the validity and trustworthiness of their work. It involves not only interpreting empirical data but also reflecting on the interpretation process itself (Alvesson & Sköldbberg, 2009). This process requires researchers to contemplate their own identities, subjectivities, and biases and how these factors shape the research process, influencing their worldview (Jamieson et al., 2023; Wilkinson, 1988). While the significance of reflexivity is widely acknowledged, its application in quantitative research is limited, where among a few examples is the work of Lakew (2017). I aim to follow suit, sharing my own narrative.

Trained in public health in Ethiopia (B. Sc) and South Africa (MPH), I dedicated over a decade and a half to addressing public health issues in Africa, particularly in Ethiopia, Uganda, and Guinea. These challenges encompassed communicable diseases (Buli et al., 2015), malnutrition (James et al., 2016), pregnancy and childbirth-related complications, and other health issues linked to poverty, poor environmental and personal hygiene, weak healthcare systems, and low health literacy levels (Kaseje et al., 2005), along with governance and corruption issues (Kirigia & Barry, 2008). While my efforts targeted the general public, I also worked with specific populations such as children, adolescents, pregnant and lactating women, and those at higher risk of HIV.

One of my most compelling experiences was my involvement in an HIV prevention program for young people aged 10-24 from 2004 to 2006. The program aimed to prevent HIV transmission through sexual abstinence until marriage or safer behaviors (Oki et al., 2009). This initiative provided me with valuable insights into how human behavior can be shaped to address problems (Prochaska et al., 1992). That exposure gave me motivation to work more with adolescents.

An additional challenge was reconciling my perspective on public health in Africa (Kaseje et al., 2005) with public health in Sweden, a country ranking high in healthcare equity among high-income nations (Schneider et al., 2017).

A brief opportunity that I had to work with adolescents in Sweden (Buli et al., 2022; Fell et al., 2021; Rydenstam et al., 2020) before embarking on this PhD project has helped me reposition myself in the new context. This position of mine helped me approach this project with an open mind, setting aside my biases and prejudices.

While my exposure to adolescent health in both Africa and Sweden may have influenced my interest in working with adolescents, it did not dictate my choice of the current specific topic. As further detailed in the methodological considerations section, the selection of quantitative design and analysis methods, and interpretation of results thereby, was also solely guided by the research questions at hand, in agreement with Alvesson and Sköldberg (2018). This reflexive assessment aims to provide readers with insight into my position and how I maintain balance in undertaking this research.

Results

Study I: Trends in mental health problems and the role of SES & sex.

Study I investigated trends in PSS (2004–2014), DS (2004–2012), SI (2004–2012), and SA (2004–2020) among adolescents in the County of Västmanland. The results revealed that the overall mean PSS score for adolescents was 11.6 (range: 10.7–12.2), mean DS score was 2.9 (range: 2.7–3.0), with overall average probabilities for SI at 0.15 (0.13–0.17), and for SA at 0.12 (0.10–0.15). Girls and adolescents in the low SES group consistently reported a higher burden of mental health problems. This pattern was also evident in cross-sectional associations, wherein being in the high SES was linked to lower mean scores or probabilities of mental health problems while being a girl was associated with higher mean scores or probabilities of mental health problems.

The results also revealed overall decreasing trends in adolescent mental health problems over time, but these trends differed by SES and sex. There was a significant decline in all mental health problems in this study, except for SA, among adolescents with high subjective SES. Conversely, the trends increased among adolescents with low subjective SES. The results from linear regression for PSS ($B = -0.112$; CI: -0.160, -0.070) and DS ($B = -0.084$; CI: -0.114, -0.055), and logistic regression for SI (OR = 0.953; CI: 0.924 - 0.983), indicated that an increase in SES was associated with decreasing trends in mental health problems. Sex was also found to be significantly associated with decreasing trends in DS ($B = -0.068$; CI: -0.115, -0.020) and SI (OR = 0.862; CI: 0.817, 0.911), with the decline being more pronounced among girls than boys.

Study II: Trends in mental health problems & the role of school-related factors.

This study utilized the same dataset as Study I, and the findings regarding mean scores and trends are similar. However, to precisely quantify changes over time in the mean scores/probabilities of specific mental health problems, this study employed the Reverse Helmert contrast, yielding consistent results.

Accordingly, a generally increasing trend in mental health problems was observed among adolescents in the low SES, while a generally decreasing trend was found among those in the high SES group.

The mean scores of school-related factors generally increased over time, with occasional decreases, such as in 2006 and 2014. School-related parental and teacher support decreased in 2014, while school liking showed a decline after a steady increase until 2014. Overall, participation increased, except in 2014 and 2017 when data were not collected. The school's physical environment consistently improved from 2004 to 2014. Mean scores of school-related factors increased more in the high SES group ($p < .001$) than in the low SES group over time, except for participation and the school's physical environment. Regarding SES, there was a significant increasing trend in mean scores from 3.53 in 2004 to 3.70 in 2020, with fluctuations over time. There was a slight decrease from 2004 to 2008, stability in 2010 and 2012, and a significant increase since 2014.

The results from the test of cross-sectional associations between the school-related factors and mental health problems reveal that school liking, parental support, teacher's support, and the school's physical environment exhibited significant negative associations with PSS in both the low and high SES groups. Similarly, all school-related factors, except for teacher's support and participation, demonstrated significant negative associations with DS in both SES groups. School liking and parental support showed significant negative associations with SI in both SES groups, while teacher support exhibited a negative association with SI only in the low SES group. Finally, the findings indicated that only school liking showed a significant association with SA. Overall, the school-related factors in this study demonstrated negative associations with mental health problems at the cross-sectional levels.

The exposure hypothesis test revealed that among adolescents in the low SES group, school-related factors in this study did not mediate the relationship between the survey year and mental health problems. But all the factors, except participation, mediated this association in the high SES group, indicating indirect protective effects of the school-related factors against mental health problems. This suggests that changes in mental health problems among low SES adolescents may not be directly linked to changes in school-related factors over time. In contrast, in the high SES group, improvements in school-related factors appear to be associated with a reduction in mental health problems over time.

The interaction analyses, examining the vulnerability hypothesis, reveal varying associations between school-related factors and trends in mental health problems across SES gradients over time. Among low SES adolescents, only parental support ($\beta = -.063$; $p < 0.05$) has shown a stronger protective association with trends in PSS over time. In the high SES group, the protective associations between school-related factors, including parental support ($\beta = -.043$; $p < 0.001$), school liking ($\beta = -.056$; $p < 0.001$), and a positive school

physical environment ($\beta = -.037$; $p < 0.01$), and trends in PSS grew stronger over time. For DS trends, the protective association between parental support and trends in DS became stronger over time among adolescents in both low ($\beta = -.065$; $p < 0.01$) and high ($\beta = -.076$; $p < 0.001$) categories of SES. However, the protective association between school liking ($\beta = -.039$; $p < 0.001$) and trends in DS grew stronger only in the high SES group. In the low SES group, no change in association was observed between school-related factors and SI trends, whereas, for the high SES group, the protective association between school-related parental support and trends in SI grew stronger over time (OR = .964; CI [.949, .979]). Regarding trends in SA, protective roles of participation (OR = .925; CI [.877, .974]) and school liking (OR = .945; CI [.919, .972]) on trends in SA grew stronger in low and high SES groups, respectively. A separate analysis for 2004-2012, for the period complete data were available, revealed consistent associations between school-related factors and SA trends over time compared to the original analysis.

Study III: Trends in mental health problems & the role of lifestyle factors

The results showed a significant increase in mean PSS scores for each survey year compared to preceding years, except for 2010, where the increase was only marginally significant. The overall changes over time were significant ($F = 23.858$, $df=4$, $p < 0.001$), although effect sizes were small (Cohen's d ranging from 0.09 to 0.17). Girls consistently had significantly higher mean PSS scores than boys across all years (Cohen's d ranging from 0.62 to 0.71; $p < 0.001$). After 2010, both girls ($F = 16.783$, $df=4$, $p < 0.001$) and boys ($F = 8.157$, $df=4$, $p < 0.001$) experienced significant increases, with a more pronounced rise among girls (interaction term $B = 0.029$; $p = 0.026$).

High FAS adolescents had significantly lower mean PSS scores than the low FAS counterparts, especially during 2002 – 2014, with generally small effect sizes (Cohen's d ranging from 0.03 to 0.22, $p < .01$). In 2018, there was no significant difference. A significant interaction between FAS and survey year ($B = 0.036$; $p = 0.021$) indicated that increasing FAS is associated with rising mean PSS scores over time. Especially, the high FAS group saw a significant increase in 2006 and post-2010 ($F = 24.911$, $df=4$, $p < 0.001$), while the low FAS group showed no significant change ($F = 1.241$, $df=4$, $p = 0.291$).

The trend analysis of lifestyle factors yielded mixed results. Positive behaviours remained stable or slightly increased, except for breakfast intake, which significantly decreased in 2018 ($p < .01$), particularly in the low FAS group. Vegetable consumption consistently increased, except for a non-significant change in 2010. Negative behaviours, except for sweets and soft drinks, significantly decreased over time at significance level of $p < .05$. Alcohol

drunkenness prevalence decreased by -71% ($p < .001$) from 2002 to 2018, significant in both low (-66%, $p < .001$) and high (-72%, $p < .011$) FAS groups.

Cross-sectional association tests in both SES groups linked regular breakfast consumption to lower PSS mean scores, while smoking and alcohol drunkenness were associated with higher PSS mean scores. Physical activity was statistically significantly associated with lower PSS mean scores only in the high FAS group. In the interaction analysis, only the high SES group showed a significant factor ($B = .057$; $CI: .016, .087$; $p < .01$), indicating that alcohol drunkenness is the only lifestyle factor associated with PSS trends over time. The increase in mean PSS scores over time was higher among high FAS adolescents who reported getting drunk at least twice compared to those who had been drunk only once or never.

Study IV: developmental trajectories of DS & AS, and the role of social relationships.

This study followed young people in a county of Sweden who were born in 1997 and 1999, starting from when they were 15 and 13 years old, up to the age of about 24 and 22 respectively, to assess developmental trajectories of DS and AS.

The analysis revealed patterns where female participants consistently reported higher mean scores for both DS and AS across the study waves. Participants from outside the Nordic region exhibited significantly higher mean scores for DS at several time points, indicating a potential association between geographical origin and mental health outcomes. Interestingly, while there was variability in DS mean scores between different cohorts, AS mean scores did not significantly differ across cohorts, suggesting a potentially distinct underlying mechanism for AS compared to depressive symptoms.

The group-based trajectory analysis identified distinct patterns in DS and AS trajectories over time. For depressive symptoms, four trajectory groups were identified, ranging from Stable-low levels to Persistent High levels. Similarly, four trajectory groups were identified for AS, illustrating varied patterns of stability and change over time. These trajectories provide valuable insights into the longitudinal dynamics of mental health symptoms, highlighting the diversity of experiences among individuals within the studied population.

Predictors of membership in trajectory groups shed light on factors associated with the development and persistence of DS and AS. Increased family relationships were consistently associated with decreased likelihoods of being placed in trajectory groups characterized by elevated DS or AS. Similarly, increased peer relationships were linked to reduced likelihoods of being placed in DS and AS trajectory groups other than the reference groups that were characterized by lower mean scores. Furthermore, sex, country of origin,

and birth cohort were identified as significant predictors, with females, individuals born in 1997, and those originating from non-Nordic countries were more likely to be placed in trajectory groups characterized by higher depressive symptom levels. Membership in any of the AS trajectory groups other than the reference group was independent of country of origin or birth cohort.

Discussion

This research project aimed to analyze trends, trajectories, and factors associated with adolescent mental health problems using four interconnected studies. It utilized diverse data sources, including the SALVe, HBSC, and the SALVe Cohort. Study I investigated trends in mental health problems such as PSS, DS, SI, and SA. Studies II and III explored the associations between school-related and lifestyle factors, respectively, with these trends. Further, Study IV focused on how mental health outcomes progressed over time among distinct groups of individuals with homogeneous mental health conditions. As mentioned earlier, Studies I, II and IV utilized data from Region Västmanland while Study III was based on nationally representative data.

This chapter of the thesis aims to synthesize and discuss the findings from each study within the framework of the SDH model (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010). The discussion will focus on the historical trends and trajectories of mental health problems among adolescents over time, while also examining the interaction between these issues and the social conditions that shape their lives, upbringing, and schooling experiences. It will also present narratives illustrating the evolution of mental health trends over time among groups of individuals with similar mental health profiles and their trajectories. Furthermore, the discussions will emphasize the relationships between distal and proximal social factors (Braveman et al., 2011; Spencer, 2018) and mental health outcomes.

Adolescent mental health problems: Trends/Trajectories

A) Trends

The trend analysis in this thesis has yielded two patterns of findings, regional and national.

The *regional* trend analysis showed generally decreasing trends in PSS, DS, and SI, with stability observed in SA. However, this decrease was not uniform across all groups. Divergent trends in mental health problems over time were observed between adolescents in low and high SES groups, with increasing trends in the low SES group and decreasing trends in the high SES group. These findings align with prior research reporting a higher burden of mental health problems among adolescents in low SES compared to those in

high SES (Hazell et al., 2022; McLaughlin et al., 2012; Reiss et al., 2019). They are particularly consistent with previous research (Ahlborg et al., 2017; Weinberg et al., 2019) that focused on subjective SES, linking individuals' perceptions of their status in the socioeconomic ladder with mental health outcomes (Marmot, 2004a, 2004b, 2015).

Subjective SES involves the cognitive averaging of standard markers of SES, such as income, education, and ownership of various material assets. Individuals place themselves in a certain position in society relative to their fellow society members based on this cognitive average (Singh-Manoux et al., 2003). This aspect of the SES has been shown in previous studies to be more relevant in explaining mental health problems than objective SES (Adler et al., 2000; Singh-Manoux et al., 2003). This relationship may be explained in two ways. First, SES, as a structural determinant, may influence mental health through its effect on intermediary determinants (Solar & Irwin, 2010), and the trends in mental health problems increase over time among those in the disadvantaged groups. Secondly, individuals in the low SES group may develop status-induced stress that negatively affects their capacity to deal with normal life stressors (Cassel, 1976; Krieger, 2001b).

However, a question may arise with respect to the increasing trends in mental health problems in the low SES group despite improving SES over time, as found in Studies I & II, for example. Why were the trends in mental health problems not commensurate with the improvement in SES among those in the low SES group? This may underscore the importance of investigating the role of other factors in the association between SES and mental health, or vice versa. It may suggest that SES moderates or influences the effects of other factors on mental health problems (Reiss et al., 2019), highlighting the need for future studies to explore the complex pathways between SES and mental health problems. In the context of this thesis, this will be discussed within the framework of the SDH.

The results also highlighted variations in trends in mental health problems across sexes, with girls bearing a heavier burden but experiencing a significant decrease in DS and SI. These findings are consistent with prior research in Sweden (Hagquist, 2009; Salmi & Berlin, 2017) and several other countries (Campbell et al., 2020; De Looze et al., 2020; Twenge et al., 2017), indicating that girls endured a higher burden of mental health problems than boys throughout the study period. While the reasons why girls bear an unfair burden of mental health problems remain largely unclear, this thesis adopts the recommendations by Martin and Hadwin (2022) and pays attention to both genetics and social and environmental factors in relation to the etiological influence of sex/gender on mental health. From a genetic point of view, the authors explained that syndromes affecting the sex chromosomes have significant effects on the emotional, behavioral, and cognitive development of adolescents and thus may be related to mental health, but still require further studies. From an environmental perspective, Martin and Hadwin (2022) argue that males and

females could be differently affected by economic disadvantages, family adversity, or parental stress, leading to differences in mental health outcomes.

The decreasing trends in DS and SI for girls, not for boys, on the other hand, were inconsistent with previous studies reporting more increasing trends among girls than boys (Fink et al., 2015; Högberg et al., 2020; Sigfusdottir et al., 2008; Tick et al., 2008; Twenge et al., 2019; van Vuuren et al., 2018). While explaining this discrepancy remains challenging, the fact that these findings were based on region-specific data suggests the need to assess any interventions that targeted high-risk groups, especially girls, over the past few decades.

The trend analysis based on the *national* data yielded a generally increasing trend in PSS mean scores over time, with a steeper increase among adolescents in the high SES (measured on an objective indicator FAS) group with a history of ever being drunk. While the increasing trend in PSS was consistent with findings from the previous studies (Eriksson & Stattin, 2023; B. Högberg et al., 2022; Potrebny et al., 2017), the more significant increase in the high SES group contrasts with existing evidence that indicates increasing trends among adolescents with low SES than among those with high SES (Kim et al., 2019). This inconsistency could be due to the complex relationship between the outcome and drunkenness across gradients of SES and could be explained using two theories. The first is the Threshold-saturation theory (Morales & Guerra, 2006; Shuval et al., 1981) where the trends in PSS might level off after a certain point at one side of the SES scale while it could still be rising at the other end of the SES scale. The other is the hardening theory (Oldham et al., 2021) that suggests individuals who tend to continue to drink are those who are at greater risk for negative consequences of drinking behaviour, and hence increased trends in the outcome of interest (Gmel et al., 2003).

One important question to be asked is why there is a discrepancy between the trends based on *regional* data and *national* data. The first possible explanation may come from previous evidence that reported differences in levels of psychosomatic complaints based on regional differences in life event stresses (Frisenstam et al., 2017). This explanation seems a viable one due to the fact that this thesis is based on data collected from schools, and we know that schools are the most decentralized institutions in the country (Lundahl, 2002b; Lundahl et al., 2013; OECD, 1999). Although schools are following curriculum from the same source (Swedish National Agency for Education, 2011), every small operational level detail may contribute to differences in exposure. The other possible explanation is the fact that an objective SES measure, FAS, was used as a moderator in the study that used national data while the regional data used subjective SES as a moderator. As discussed earlier, previous studies have reported substantial differences in the association between mental health outcomes and SES when measured objectively or subjectively.

Further, the inconsistency of findings at national and regional levels could also be attributed to the varying capacities of regions and municipalities to

implement the broad national mental health policy delegated to them. Fjellfeldt (2023), for example, highlights that while the policy mandates a comprehensive, societal-level approach to mental health, inconsistent implementation across regions often reduces it to addressing individual issues, neglecting broader preventive measures. This lack of uniformity may introduce differences in the magnitude of the problem across regions, explaining the discrepancy between the findings based on the national and regional data.

B) Trajectories

The fourth study of the thesis investigated the developmental trajectories of DS and AS among adolescents in a Swedish county born between 1997 and 1999, tracking them from 2012 to 2021. The study identified four distinct trajectory groups for both DS and AS, with patterns partly aligning with previous studies (Duchesne & Ratelle, 2014; Martinez & Armenta, 2020; Spence et al., 2022; Yaroslavsky et al., 2013) but also revealing unique nuances in trajectory shapes and progression.

Specific to the depressive symptom trajectories, all groups, except the Stable-Low, have shown increased mean scores of DS between T1 and T2 and exhibited different patterns thereafter. This is consistent with previous studies that reported an increase in DS from childhood through adolescence (Ge et al., 2006; Natsuaki et al., 2009). At T2, two of the groups—Declining and Persistent High—started to decline and stabilize, respectively, aligning with reports by Ge et al. (2006) and Natsuaki et al. (2009) that showed a decrease in DS in adulthood after an increase from childhood through adolescence. The other two groups—Stable-Low and Rising-D—took a different trajectory, continuing with the increasing pattern, with the former exhibiting only a slight increase, consistent with previous reports that showed higher depressive symptom mean scores in the post-adolescence period (Ge et al., 2001). The increase in DS with age may be attributed to DS during adolescence due to various reasons (Terhi Aalto-Setälä et al., 2002)—also known as homotypic sequential comorbidity (Hankin et al., 2016)—, increased life stresses secondary to increased responsibilities with age (Hazell, 2002) or an increase in predicting factors such as substance use or other somatic problems with age (Saluja et al., 2004).

The four-group solution of the AS trajectory was partly consistent with Spence et al. (2022), where the majority of the group members belonged to groups (the Low & declining and Stable-Moderate groups, in this case) that had fewer AS that remained stable, slightly increased or declined over time. The Rising-A and High trajectory groups, however, have shown increasing scores of AS over time that may be explained by co-occurrence with depressive symptoms, similar to what was reported by McLaughlin and King (2015). The increasing trajectory of AS can be understood from various perspectives. One explanation is the concept of heterotypic sequential comorbidity, where DS during adolescence may predict anxiety in early adulthood (Hankin et al.,

2016). Another possibility is the progression of AS from subthreshold levels to a diagnostic threshold or the effect of pubertal testosterone on brain organization or a new causal pathway for anxiety in early adulthood (Spielberg et al., 2019) could also contribute to this increase. Therefore, the rise in AS observed in this study could be attributed to any of these factors, along with the potential co-morbidity with DS during adolescence.

Understanding the interplay of key factors and mental health problems within the SDH Framework

As described in the Theoretical framework section, this thesis assessed the individual as well as collective roles of structural and intermediary determinants in the SDH model in influencing adolescents' mental health outcomes. This section discusses the study results within the context of the SDH framework.

Structural determinants: SES, sex, and country of origin

Consistently with the foundational concept of the SDH (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010) and the underlying theories (Krieger, 2001b; Krieger, 2014), the studies in this thesis have shown that SES, sex and country of origin have not only influenced mental health outcomes but also dictated the association between other factors and mental health outcomes. This means that SES, sex, and country of origin played structural determinants role (Solar & Irwin, 2010) and discriminated mental health outcomes between girls and boys, low SES and high SES, as well as adolescents originating from Nordic and non-Nordic countries.

In the analysis of the role of SES, the studies showed that lower SES was consistently associated with a higher burden of mental health problems, as evidenced by higher mean scores or probabilities of mental health problems among adolescents in the low SES group. Trends further demonstrated that while mental health problems decreased among adolescents with high subjective SES over time, they increased among those with low subjective SES. These findings are consistent with previous research (Ahlborg et al., 2017; Hazell et al., 2022; McLaughlin et al., 2012; Reiss et al., 2019; Weinberg et al., 2019) both in Sweden and globally. The influence of SES was not limited to a direct association with mental health problems but also moderating the effects of other factors. For example, school-related factors played a significant protective role where improvements in these factors was associated with reduced mental health problems over time, particularly among those in the high SES groups. This falls in line with the theory that health

outcomes are the results of complex interplay between various factors that are also dependent of inequalities of the underlying factors (Krieger, 2001b; Krieger, 2014; Solar & Irwin, 2010),

With consideration to the social and environmental aspect of sex (Martin & Hadwin, 2022), the studies in this thesis highlighted notable influence of sex on both trends and trajectories of mental health problems among adolescents in Sweden. Across various analyses, including trends over time in and trajectories of mental health problems, girls consistently reported higher mean scores of mental health problems compared to boys. Additionally, associations between SES and mental health outcomes varied by sex, with girls and adolescents in the low SES group consistently reporting a higher burden of mental health problems over time. These findings are consistent with previous reports that associated being a girl with higher burden and increased trends in mental health problems (Fink et al., 2015; Kwong et al., 2019; McLaughlin & King, 2015; Van Droogenbroeck et al., 2018; Yaroslavsky et al., 2013). This confirms that sex plays structural determinant role and discriminates the outcome between girls and boys and dictates the association between other factors and mental health outcomes.

Country of origin, as one of the structural determinants in this framework, was associated with mental health outcomes, wherein individuals originating from non-Nordic countries were more likely to be placed in groups with higher mean scores of DS and increasing trajectories. This finding aligns with previous studies in Sweden (Kim et al., 2020) and elsewhere (Hargrove et al., 2020). In the search of the pathways through which ethnic inequalities contribute to mental health problems, a study conducted in the United Kingdom (UK) reported findings relevant to the studies presented in this thesis. The study linked ethnic inequalities with mental health problems through disparities in income, social support from friends and family, experiences of adversities such as bullying or victimization, and levels of participation in social activities. This confirms that ethnic differences play a significant role as structural determinants in the SDH model (Ahmad et al., 2022) upon which this thesis has been founded. A more comprehensive analysis would have been preferred if the data included a wider range of information on countries of origin, as migrations from non-European countries to Europe are associated with a higher risk of mental health problems compared to migrations within Europe (Selten et al., 2020).

Intermediary determinants: Role of factors related to school, lifestyle, and social relationships.

Exploring the intricate relationship between intermediary determinants and mental health outcomes, this section briefly discusses the influence of school-related, lifestyle, and social relationship factors on adolescents' mental health.

These factors lie between the structural determinants and the outcomes of interest, mental health problems, as illustrated in Figures 2 and 3 above, and are directly associated with the outcomes with or without the influence of the structural determinants (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010).

This thesis, as evidenced in Study II, highlighted the importance of school-related factors in influencing mental health outcomes. Specifically, increased parental support, a positive attitude toward school, and a willingness to participate in decisions about their learning were associated with decreasing trends in mental health problems. The beneficial effects were most pronounced when teachers' support complemented parental support. In the discussion about school-related factors, it is relevant to mention the early 1990s Swedish school reform (Lundahl, 2002a) and subsequent policy directives (Swedish National Agency for Education, 2011) that aimed to increase the influence of parents, teachers, and students on education and to strengthen the partnerships between parents and teachers to improve education quality. These changes, alongside other factors, might partly explain the increased protective role of school-related factors in mental health over time, as positive academic performance is positively associated with mental well-being (Gokhan, 2021), and negatively associated with subjective health complaints (Låftman & Modin, 2012), including mental health problems (Agnafors et al., 2021).

This aligns with the crucial role of schools in adolescents' lives, shaping their social and academic development (Bear et al., 2011; Crosnoe, 2011; Eccles & Roeser, 2011; Epps & Smith, 1984; Riglin et al., 2013; Zhang et al., 2016), which, in turn, plays a significant role in influencing mental health outcomes (Chen & Harris, 2019; Dufur, Parcel, & McKune, 2013; Dufur, Parcel, & Troutman, 2013; Klineberg et al., 2006; Moore et al., 2018; Ramberg, 2021). However, these positive influences of school-related factors on mental health outcomes were predominantly observed among students with high SES, suggesting that SES, a structural determinant, plays a crucial role in the effectiveness of these supportive factors, the intermediary determinants (Dahlgren & Whitehead, 1993; Solar & Irwin, 2010).

From the study that investigated the association between lifestyle factors and PSS (Study III), a complex interplay was evident between time and lifestyle factors, including regular breakfast intake, physical activity, and substance use, as well as structural determinants such as SES and sex in influencing mental health outcomes. While details of the findings are available from the specific article, the interesting finding is that adolescents in the low SES group had consistently higher PSS mean scores, while the increase over time was steeper among those in the high SES group who had a history of getting drunk on two or more occasions. Positive social relationships, which play a role in contributing to mental well-being through effective stress-buffering strategies (Cohen & Hoberman, 1983; Cohen & Wills, 1985; Krause, 1987) were also found, in Study IV, to have played a protective role against DS and AS. This suggests the importance of strengthening positive family and peer

relationships for positive mental health outcomes among adolescents. This demonstrates how the upstream factors, especially SES, dictate the influence of the downstream factors, for example, lifestyle behaviors (Braveman et al., 2011; Spencer, 2018) on the outcome of interest, mental health problems (Pester et al., 2023), suggesting that policy actions may need to consider the whole complex web of interconnections rather than just focusing on immediate or intermediate determinants (Solar & Irwin, 2010).

Overall, these findings underscore the complex interactions between structural and intermediary determinants over time in the SDH framework and their influence on adolescent mental problems, providing valuable insights for developing comprehensive mental health interventions.

Public health implications of the results

The studies outlined in the thesis reveal critical public health implications regarding adolescent mental health trends in Sweden. One of the most significant findings is the socioeconomic inequities in mental health outcomes among adolescents. Adolescents from lower SES backgrounds showed increasing trends in mental health problems, while those from higher SES backgrounds experienced a decrease. This SES gradient in mental health outcomes highlights the need for targeted interventions that address the specific needs of lower SES groups. Public health policies need to focus on reducing the socioeconomic inequities that contribute to these mental health disparities, such as enhancing school support systems and addressing broader social determinants of health that impact lower SES families more severely.

The studies also underscore the role of sex/gender differences in mental health trends, with girls showing persistently higher scores of mental health problems over time. This suggests that public health strategies should ensure that both boys and girls receive appropriate support. There was, in fact, a more pronounced decrease in trends in DS and SI among girls compared to boys in Västmanland, pointing out the need to investigate what interventions brought about the difference. Furthermore, the increasing trend of PSS linked to lifestyle factors such as alcohol consumption among adolescents of high SES points to the need for comprehensive programs that promote healthy lifestyle choices and address substance abuse. These programs may need to be integrated into school curricula and community health initiatives to mitigate the lifestyle-related mental health issues observed in this segment of population.

Finally, the findings emphasize the importance of social relationships and school-related factors in shaping adolescent mental health. Positive family and peer relationships, along with supportive school environments, were associated with better mental health outcomes. Public health interventions may thus promote family cohesion and peer support and enhance the school climate to

foster an environment conducive to mental well-being. By addressing these factors, public health initiatives can create a supportive framework that helps adolescents navigate the challenges of this developmental stage, ultimately leading to improved mental health outcomes and reduced long-term societal burdens associated with mental health problems.

Methodological considerations

As repeatedly described in the previous sections, this thesis is a comprehensive summary of four intertwined studies that estimated trends in adolescent mental health problems and associated factors. The limitations and strengths of each study have been discussed in respective reports. In this section of the thesis, the general methodological issues will be discussed.

Challenges associated with design and data collection

This thesis is fully based on a quantitative research design and is generally subject to the strengths and limitations inherent in such a design. One fundamental limitation is that quantitative studies offer limited capacity to capture contexts nuances, individuals' subjective experiences and perspectives (Rahman, 2020), as well as emotions (Queirós et al., 2017). However, well-planned and executed studies can potentially overcome these limitations by analysing complex relationships between variables and making predictions of conditions that may not be directly measurable (Creswell & Guetterman, 2019). The fact that this thesis utilized rich and diversified sources that have gathered data on a variety of information, ranging from individual characteristics and lifestyle behaviours to SES, social relationships, school environments, and psychosocial health (Creswell & Guetterman, 2019; Eriksson et al., 2019; Region Västmanland, n.d.), addresses these challenges. On the top of that, Alvesson and Sköldberg (2018) assert that choice of methods cannot be made in the abstract but must be appropriate to answer the research questions at hand. Thus, the choice can be either a purely quantitative or qualitative method, or mixed. In line with this, the choice of quantitative research methods in this thesis was based on the need to answer the research questions the thesis aimed at addressing.

The data were derived from self-report surveys, which may be susceptible to social desirability bias as respondents may lean towards providing socially acceptable responses (Brown et al., 1999). Such biases can potentially lead to an underestimation of mental health problems and an overestimation of well-being. However, studies have shown that self-administered self-report data are less prone to social desirability bias compared to interviewer-administered self-report data (Rickwood & Coleman-Rose, 2023). Therefore, it can be

inferred that social desirability biases have been minimized in the studies conducted in this thesis as the data were obtained from self-administered surveys in schools (Eriksson et al., 2019; Region Västmanland, n.d.). Another challenge associated with self-report data is the potential variation in responses based on the mental health status of respondents (Garbarski, 2010). To address this issue, in SALVe project, for example, students with known mental problems have been excluded from the study (Region Västmanland, n.d.).

Validity and reliability

There are five outcome variables in this thesis, three of which—PSS, DS, and AS—were measured on scales, and two—SI and SA—were binary. The scale variables were measured using well-validated, recognized scales known as the PSS-scale (Gierk et al., 2014) for PSS, DSRs-A (Svanborg & Ekselius, 2003) for DS, and the SCAS (Spence, 1997) for AS. These scales have also been used in several studies conducted among Swedish adolescents (Eriksson & Stattin, 2023; Giannotta et al., 2022; Hagquist, 2009). Similarly, the use of binary variables in assessing whether adolescents have experienced these symptoms has been reported from various parts of the world (Gijzen et al., 2021; Ivey-Stephenson et al., 2020; Kukoyi et al., 2010).

Furthermore, the measurement of the independent variables, for example, SES (Adler et al., 2000; Åslund et al., 2009; Boyce & Dallago, 2004; Currie et al., 1997), breakfast regularity (Pedersen et al., 2012), dietary habits (Kleppang et al., 2021), PA (Baceviciene et al., 2019), alcohol drunkenness (Strandheim et al., 2009) and others, followed the experience of previous studies. For school-related independent factors that were measured on scales, including school-related parental support, teacher's support, and school physical environment, exploratory factor analyses were conducted to test their internal consistency and the relationship between the measured variables. This shows that necessary efforts have been made to ensure that the work meets the expected validity, and this may be considered a strength of the thesis.

The datasets used in this thesis came from sources, including SALVe cross-sectional (Åslund et al., 2010), HBSC (Eriksson & Sellström, 2010), and the SALVe Cohort (Mohamed et al., 2023), that adhere to established standards of collecting data among adolescents. These sources have gathered data on various aspects of adolescent life, including personal characteristics as sex and ethnicity, perceived health, individual lifestyle behaviors, social relationships, SES, and school activities. They have employed well-defined variables consistently over the years, ensuring the measurement's reliability. Data from these sources have also been used to produce reliable and consistent results in previous studies (Eriksson & Stattin, 2023; Eriksson & Sellström, 2010; Hagquist, 2009; Mohamed et al., 2023). Additionally, as discussed in the analysis section, this thesis employed standard analysis methods, and these methods have been clearly described in the reports of the respective studies.

Future research

While this thesis is comprehensive in its approach to provide valuable insights into the trends and trajectory of mental health problems among adolescents in Sweden, there remain avenues for future studies to explore.

1) Further investigation into the complex relationship between SES and mental health is necessary, especially to guide the use of objective and subjective measures of SES, a topic that has been debated extensively (Adler et al., 2000; Quon & McGrath, 2014; Singh-Manoux et al., 2003; Svedberg et al., 2016; Wilkinson, 1999). Adolescents may struggle to provide accurate information on their families' SES, leading to irregularities in measurement (Svedberg et al., 2016). Therefore, further empirical research is needed to disentangle this situation.

2) As this thesis exclusively followed the social causation pathway in the relationship between the social determinants of health and mental health outcomes (Marmot, 2004a; Solar & Irwin, 2010), further research is needed to investigate the reverse pathway, known as health selection (Marmot, 2004a; Solar & Irwin, 2010), to provide a complete picture of the relationships.

3) Future research needs to focus on refining methodologies to capture contextual nuances over time, at macro and micro levels, that may influence trends and developmental trajectories of mental health among adolescents. Few studies exist, for example (Högberg, 2021), that attempt to examine macro-level contextual changes in the analysis of trends in adolescent mental health problems.

4) Lastly, it is essential to investigate the discrepancies between regional (Västmanland) and national trends in adolescents' mental health, as found in the first three studies of this thesis. Exploring the reasons for these regional differences, including variations in exposure to stressors and differences in intervention effectiveness, is crucial.

In summary, further research is essential to address gaps left untouched by this thesis and to explore new dynamics within the field. Continued investigation in these areas is crucial for enhancing our comprehension of adolescent mental health and fostering positive outcomes for the youth.

Concluding remarks

This thesis provides a comprehensive analysis of trends, trajectories, and factors associated with adolescent mental health problems, employing a multidimensional approach within the framework of the Social Determinants of Health (SDH) model. Across four interconnected studies, significant insights were gained regarding the evolving landscape of adolescent mental health in the County of Västmanland, Sweden, and beyond.

The findings revealed nuanced patterns in trends and trajectories of mental health problems among adolescents, shedding light on the complex influence of two levels of determinants: a) structural such as SES, sex, and country of origin; and b) intermediary such as school-related factors, lifestyle behaviors, and social relationships.

The thesis elucidated the intricate interactions between the two levels of determinants within SDH framework in influencing mental health outcomes. It highlighted that the structural determinants not only influence mental health outcomes but also shaped the associations between the intermediary determinants and these outcomes. By illustrating these complex dynamics, this research provides valuable insights for policymakers, educators, parents, and healthcare professionals on SDH policy actions and approaches to reducing inequities. These policy actions may include targeted programs for the disadvantaged, closing the gap between worse-off and better-off groups, and addressing social health gradients across the whole population (Solar & Irwin, 2010).

Moving forward, continued research in this field is crucial to further refine our understanding of adolescent mental health and inform evidence-based interventions that promote positive outcomes for all young people.

Sammanfattning på svenska

Det övergripande syftet med denna avhandling var att undersöka trender och utveckling av psykiska hälsoproblem och associerade faktorer bland ungdomar i Sverige. Projektet bestod av fyra studier, där den första presenterade trender och de följande undersökte påverkansfaktorer. De två första studierna använde data från SALVe, upprepade tvärsnittsstudier från 2004 till 2020, medan den tredje använde nationella HBSC-data från 2002 till 2018. Studie IV baserades på data från SALVe-kohort genomförda bland ungdomar födda 1997 och 1999 där data samlades in i fyra vågor med tre års intervall från 2012 till 2021.

Studie I undersökte trender i psykiska hälsoproblem bland ungdomar i region Västmanland och visade en övergripande minskning, men med skillnader baserade på socioekonomisk status (SES) och kön. Högre SES var associerat med minskade psykiska hälsoproblem, medan lägre SES visade en ökning. Flickor visade en mer uttalad minskning av depressiva symtom och självmordstankar än pojkar.

Studie II, med samma dataset, bekräftade de trender som rapporterades av Studie I och identifierade skolrelaterade faktorer som påverkade psykiska hälsoproblem, där förbättringar korrelerade med minskade problem i gruppen med hög SES. Studie III fann en betydande ökning av PSS över tid, högre bland flickor, och kopplad till livsstilsfaktorer, särskilt alkoholkonsumtion bland ungdomar med hög SES. Studie IV fokuserade på kohorter av individer födda 1997 och 1999 och undersökte påverkan av familje- och kamratrelationer på depressiva och ångestsymtom bland unga.

Resultaten visar att mellanliggande faktorer, inklusive skolrelaterade faktorer, livsstilsval och sociala relationer, som varierar över SES-graderingar, är kopplade till ungdomars psykiska hälsoproblem. Sambanden mellan dessa mellanliggande faktorer och de psykiska hälsoproblemen påverkades i de flesta fall av en grupp faktorer, inklusive SES, kön, ursprungsland och födel-sekohort, som kollektivt benämns strukturella bestämningsfaktorer. Dessa bestämningsfaktorer skiljde resultaten mellan pojkar och flickor, hög och låg SES, nordisk och icke-nordisk bakgrund samt kohorter födda 1997 och 1999.

Detta understryker behovet av åtminstone två nivåer av policyinterventioner. Den första innebär en omedelbar till medellångsiktig respons, som riktar sig mot dessa mellanliggande faktorer med särskilt fokus på gruppen med

låg SES, flickor och ungdomar med utländsk bakgrund. Den andra innebär en långsiktig policyintervention för att minska klyftan.

Nyckelord: Ungdom, psykiska hälsoproblem, trender, "trajectories", sociala hälsodeterminanter

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