Vulnerability in adolescence: prevalence, pandemic impact and prevention

Vulnerabilität im Jugendalter: Prävalenzen, Einfluss der Pandemie und Prävention

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List of contents

Abstract

This compilation focuses on adolescent mental disorders and their prevention. It comprises three distinct studies, each contributing to a deeper understanding of this critical topic. This work addresses a critical gap in the understanding of, and approach to, adolescent mental health, and as a result reveals a critically important and urgently needed policy implication for action. The thematic structure of these studies begins with an examination of the epidemiology of child and adolescent mental disorders. Baseline data were collected from N = 877 adolescents with a mean age of 12.43 years (SD = 0.65). Mental health problems, such as depressive symptoms, non-suicidal self-injury, suicidal ideation, symptoms of eating disorders, and gender differences, are thoroughly examined. Results revealed a significant portion of our sample displaying mental health problems as early as the 6th and 7th grades, with girls generally being more affected than boys. The findings underscore the importance of early adolescence in the emergence of mental health problems and thereby emphasize the need for preventive measures. Moving beyond prevalence estimates, the compilation delves into the etiology of these disorders, exploring their potential correlation with a COVID-19 infection. Understanding the early signs and risk factors is crucial for timely support. While numerous studies have investigated potential risk and protective factors during the pandemic, our focus shifts to adolescents' coping when an infection with the virus was involved (N = 2,154, M = 12.31, SD = 0.67). We hypothesized that students infected or with close family members infected, would exhibit an increased psychopathology and a decreased functioning of protective factors such as self-efficacy or self-esteem. We found no connection between infection and the mental health status within our sample, but protective factors and mental well-being were positively associated. Thus, universal primary prevention appears to be the preferred approach for promoting mental health. Lastly, the compilation introduces LessStress, a noteworthy contribution to more evidence-based prevention programs. This universal approach is designed to reduce stress in schools, accompanied by a cluster-randomized trial to evaluate its effectiveness (estimated sample size N = 1,894). Existing studies have demonstrated the effectiveness of stress prevention, leading us to introduce a short and easy-to-implement prevention program. There is positive evidence for one-lesson interventions in schools for promoting well-being and health behaviors among adolescents. *LessStress* is designed based on a life skills approach that not only imparts psychoeducational content but also teaches skills relevant to everyday life and directly applicable. Throughout these studies, a common thread emerges: the pressing need to address mental disorders during childhood and adolescence. These formative years play a pivotal role in the development of mental health problems. These formative years play a crucial role in the development of mental health problems. They highlight the importance of epidemiological data collection and analysis based on the latest models to develop prevention interventions that are not only effective but also reach young people on a global level.

Zusammenfassung

Diese Zusammenstellung konzentriert sich auf psychische Störungen bei Jugendlichen und deren Prävention. Sie umfasst drei verschiedene Studien, die jeweils zu einem tieferen Verständnis dieses wichtigen Themas beitragen. Es wird eine kritische Lücke im Verständnis und Umgang mit der psychischen Gesundheit Jugendlicher adressiert und damit ein wichtiger und dringender politischer Handlungsbedarf aufgezeigt. Die thematische Struktur dieser Studien beginnt mit einer Untersuchung der Epidemiologie psychischer Störungen bei Kindern und Jugendlichen. Es wurden Ausgangsdaten von N = 877 Jugendlichen mit einem Durchschnittsalter von 12,43 Jahren (*SD* = 0,65) erhoben. Psychische Gesundheitsprobleme wie depressive Symptome, nicht-suizidale Selbstverletzungen, Suizidgedanken, Symptome von Essstörungen und geschlechtsspezifische Unterschiede werden eingehend untersucht. Die Ergebnisse zeigen, dass ein erheblicher Teil der Stichprobe bereits in der 6. und 7. Klasse psychische Probleme aufweist, wobei Mädchen stärker betroffen sind als Jungen. Die Ergebnisse unterstreichen die Bedeutung des frühen Jugendalters für die Entstehung psychischer Probleme und verdeutlichen damit die Notwendigkeit von Präventionsmaßnahmen. Die Zusammenstellung geht über Prävalenzschätzungen hinaus und befasst sich mit der Ätiologie dieser Störungen und untersucht ihren möglichen Zusammenhang mit einer COVID-19-Infektion. Während zahlreiche Studien potenzielle Risiko- und Schutzfaktoren während der Pandemie untersucht haben, konzentriert sich unsere Studie auf die Bewältigung von Jugendlichen im Zusammenhang mit einer Infektion mit dem Virus (*N* = 2.154, *M* = 12.31, *SD* = 0,67). Wir stellten die Hypothese auf, dass eine Infektion mit einer erhöhten Psychopathologie und einer verminderten Funktion von Schutzfaktoren einhergeht. Wir fanden keinen Zusammenhang zwischen der Infektion und dem psychischen Gesundheitszustand in unserer Stichprobe, aber Schutzfaktoren und psychisches Wohlbefinden waren positiv assoziiert. Somit scheint die universelle Primärprävention der bevorzugte Ansatz zur Förderung der psychischen Gesundheit zu sein. Schließlich wird in der Zusammenstellung mit *LessStress* ein entscheidender Beitrag zu evidenzbasierten Präventionsprogrammen vorgestellt. Dieses universelle Konzept zur Stress-reduzierung in Schulen wird von einer cluster-randomisierten Studie zur Bewertung seiner Wirksamkeit begleitet (geschätzte Stichprobengröße N = 1.894). *LessStress* wurde auf der Grundlage eines Life-Skills-Ansatzes entwickelt, der nicht nur psychoedukative Inhalte vermittelt, sondern auch alltagsrelevante und direkt anwendbare Fähigkeiten lehrt. Aus den drei vorgestellten Studien geht ein roter Faden hervor: die dringende Notwendigkeit, psychische Störungen im Kindes- und Jugendalter anzugehen. Diese prägenden Jahre spielen eine entscheidende Rolle bei der Entwicklung von Problemen der psychischen Gesundheit. Sie machen deutlich, wie wichtig die Sammlung epidemiologischer Daten und deren Analyse auf der Grundlage neuester Modelle für die Entwicklung von Präventionsmaßnahmen ist, die nicht nur wirksam sind, sondern auch junge Menschen auf globaler Ebene erreichen.

Introduction to mental health and this compilation

"There is no health without mental health."

World Health Organization

Mental health is defined not only as the absence of mental disorders, but also as a state of wellbeing in which people recognize their abilities, cope with normal life stresses, work productively, and contribute to society [1]. Almost 1 billion people worldwide suffer from a mental illness. Depression and anxiety cost the global economy US$1 trillion in lost productivity annually. It has been estimated that poor mental health, combined with reduced productivity, will cost the global economy between US$2.5 trillion and US$6 trillion annually by the year 2030 [1].

Among 13,984 international students surveyed for the six most common mental disorders based on the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV) [2], 35% reported experiencing at least one of these common lifetime disorders (major depressive, manic/hypomanic, general anxious, panicky, alcohol and drug use disorders)[3]. These syndromes typically manifested in early to mid-adolescence and persisted into the year of the survey. Correlates associated with higher psychological symptomology included female gender, unmarried or deceased parents, no religious affiliation, non-heterosexual identification, and behavior[3]. A recent large-scale meta-analysis (n = 708,561) revealed that 35% of individuals had experienced a mental disorder before reaching the age of 14. This finding aligns with previous research indicating that the onset of the most common mental disorders typically occurs during early to mid-adolescence [4]. A breakdown of specific clinical conditions in children and adolescents corresponded to 62% being related to neurodevelopmental disorders, 38% to anxiety/anxiety-related disorders, 25% to obsessive-compulsive disorders/related disorders, 16% to feeding and eating disorders, and 17% to stress-related disorders [5]. A review assessing the global prevalence of mental disorders in children and adolescents suggested a pooled prevalence rate of 15% for each mental disorder [6]. The most common psychiatric disorders are anxiety disorders (31.9%), behavioral disorders (16.3-19.1%), substance use disorders (8.3–11.4%), emotional disorders (3.7-14.3%), hyperkinetic disorders (2.2-8.6%), and aggressive antisocial disorders (2.1-7.6%) [7]. In Denmark, the risk of receiving a diagnosis of any mental disorder before the age of 18 years stands at 15.0%, with girls being most affected by anxiety disorder (7.85%) and boys by attention-deficit/hyperactivity disorder (ADHD; 5.90%) [8]. In childhood, mental health problems are generally more common in boys than in girls (2:1). However, this trend undergoes a shift around the age of 13 when gender-based differences start to manifest more prominently. In general, externalizing disorders

and substance use disorders tend to be more common in boys, whereas internalizing disorders such as depressive disorders and eating disorders are more prevalent among girls [9-11].

Facing these high numbers of affected adolescents, another crucial aspect is determining how to provide the best possible care and ensure it for these age groups [12]. As the global population of children and adolescents constitutes nearly a quarter of the world's population [13], it is imperative to establish robust methods for assessing the prevalence of mental disorders within this age group. The accuracy of prevalence estimates depends on the availability of comprehensive and representative data. An alternative approach to achieving this is by generating weighted estimates called population coverage, that consider essential study parameters such as location, age and sex. A study among adults has already applied this method [14], and revealed that data were only available for approximately a quarter of the world's adult population. However, in contrast to adults, the average global coverage for all diseases in the 5-17 age group was limited to 6.7%. Astonishingly, out of 187 countries, a staggering 66% (124 countries) lack any data on the prevalence of the six most common mental disorders in this age group [15]. This glaring absence of reliable data, especially in the realm of mental health, underscores the urgent necessity for more targeted research efforts, particularly concerning children and adolescents. **Figure 1** illustrates global coverage. While Europe ranks fourth in terms of data availability, the weighted estimates in other industrialized countries, such as Australia or the USA, are more than twice as extensive. This severe dearth of scientific initiatives, specifically focusing on mental health, underlines the urgent need for more targeted research, particularly in childhood and adolescence. This serves as the foundational objective of the first study presented in Chapter One.

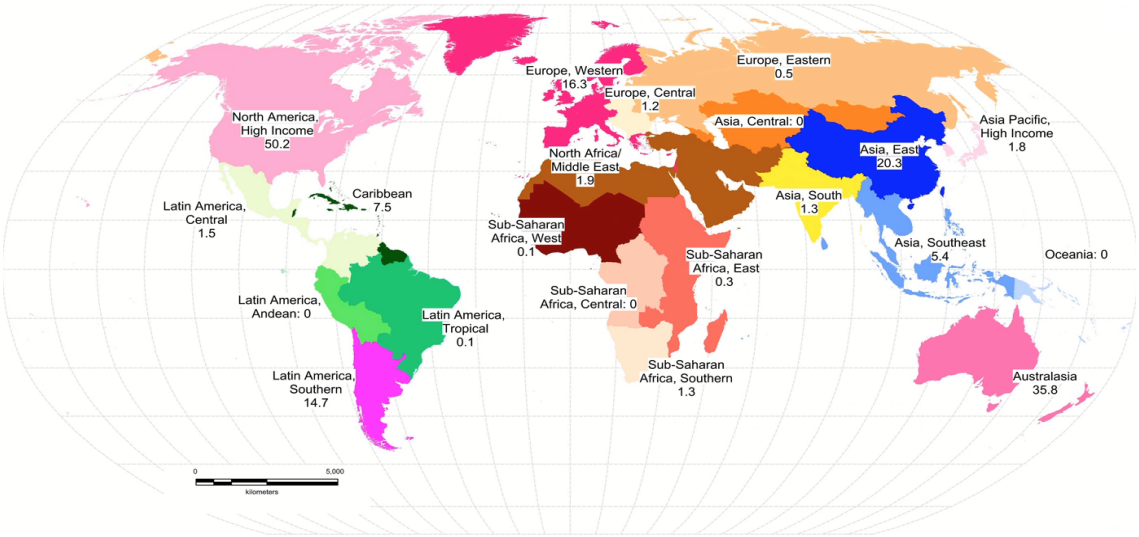

Figure 1. Worldwide coverage of weighted mental health estimates

Vulnerability in adolescence

Simultaneously collecting etiological data is a vital consideration of valid epidemiological research. This approach not only provides insight into the dynamic development of mental illness during childhood and adolescence but also helps in identification of potential risk factors. Furthermore, this knowledge can be instrumental not only for tailoring treatment approaches but also in designing and developing effective universal prevention strategies. In the subsequent sections of this compilation, I will refer to this transactional approach as the '*Epidemiological-Etiological-Preventive Approach*' (EEP-Approach), aligning with the notion of combining various research focal points. In the context of adolescence, characterized by a high prevalence of mental disorders and a dearth of valid data as previously demonstrated, it is crucial to have a more in-depth look at puberty. Early adolescence represents a exceptionally critical period for individuals, particularly concerning their mental health. This stage involves significant developmental transitions such as hormonal changes, changes in the body and brain, and navigating a more complex social environment. [16]. What factors contribute to alterations in the risk of psychopathology during this transformative period? A major factor in this phase is the brain itself, undergoing substantial structural and functional changes [17]. Important protagonists are the prefrontal cortex and the limbic system, both of which are crucial for emotional regulation and decision-making. Adolescence represents a pivotal juncture in life during when teenagers develop various coping strategies to navigate emotional challenges and establish regulatory neural circuitry [18]. Consequently, adolescents may exhibit heightened vulnerability to mental health problems while simultaneously displaying greater receptivity to mental health promotion interventions [19, 20]. Moreover, adolescence signifies a period of identity formation and self-esteem development. The social environment, particularly peer relationships and romantic experiences, plays an increasingly significant role. While new peers can provide support and enhance resilience, they may also introduce conflicts. Additional environmental factors such as school, substance abuse, violence, trauma, and the influence of social media can further complicate this stage, in conjunction with the ongoing brain development and hormonal fluctuations. This complexity can result in psychological symptoms or even lead to disorders such as depression, anxiety and non-suicidal self-harm (NSSI) [16]. Hence, adolescence emerges as a particularly vulnerable period, not only for the onset but also for the chronicity of mental disorders [12]. Thus, the research and elucidation of mental health in childhood and adolescence hold central importance [21, 22]. It is imperative not only to address epidemiological inquiries but also to unravel etiological connections. Moreover, it becomes increasingly critical to develop preventive approaches aimed at preserving the mental well-being of as many individuals as possible, ensuring long-term protection.

Prevention in adolescence

The 1986 Ottawa Charter for Health Promotion was published by the World Health Organization (WHO) at the First International Conference on Health Promotion [23]. Advocating "Health for all", political concepts encompassing health education, guidance, nurturing, self-help, and preventive medicine are discussed. The Ottawa Charter is based on the principle of salutogenesis, which brings the promotion of health to the fore [24]. Prevention is therefore a high priority for WHO, with a clear mandate to policy-makers and society. Both, prevention and treatment are essential for mitigating the considerable public health burden associated with mental illness [25]. Considering the previously mentioned prevalence estimates in childhood and adolescence, with conservative estimates suggesting around 1.9 million affected children and adolescents in Germany, coupled with the heightened vulnerability during adolescence and the risk of disorders persisting into adulthood, prevention research emerges as an imperative challenge, particularly in childhood and adolescence [26]. To delve into the topic of prevention in the following sections of this compilation, it is essential to begin with a clear definition of the term and position prevention research within a comprehensive framework. According to research findings, prevention can be categorized based on the timing into primary, secondary, and tertiary prevention [26, 27]: Primary prevention's objective is to avert new cases and diminish incidences rates. It involves enhancing an individual's resources or competencies to offset potential risk factors. Secondary prevention, on the other hand, aims to halt the progression of symptoms, the manifestation, or the chronicity of a disease. Lastly, tertiary prevention is designed to prevent further deterioration of pre-existing conditions, secondary ailments, and comorbid disorders, encompassing relapse prevention. The primary focus here is on restoring or maintaining functional capacity and quality of life. Further differentiation in prevention is determined by the intended target group, guides by the three approaches of universal, selective, and indicated prevention [26, 28]: The former embodies the concept of health promotion, as universal prevention does not focus on specific groups or risk populations. Instead, its objective is to maintain health by strengthening resources. Selective prevention, in contrast, narrows its scope to individuals at an elevated risk of developing a disorder or those displaying initial symptoms. The latter form, indicated prevention, is designed for patients who have already exhibited manifest symptoms of a disorder.

Scientific guidelines play a pivotal role in the domain of prevention research, particularly. as the quality of clinical and preventive studies often falls below average [26]. The European Medicines Agency defines *Good clinical practice (GCP)* as an international ethical and scientific quality standard for planning, documenting, and reporting trials involving human subjects. Adherence to GCP ensures public confidence in the protection of participants' rights, safety, and wellbeing, as well as the credibility of trial data [29]. Buerger and Kaess [26] have outlined specific phases based on the GCP, originally developed for drug studies. These phases can be considered beneficial for preventive research, offering

to enhance the long-term quality of studies. A practical example of research aligned with GCP principles in the field of prevention for adolescents can be found in Chapter Three, which discusses the study protocol of a cluster-randomized controlled trial in schools. This chapter focuses on *LessStress*, a universal stress reduction intervention, and its evaluation using a two-arm design.

The COVID-19 pandemic

Throughout my PhD journey, the COVID-19 pandemic loomed large, significantly influencing various aspects of our lives, and consequently, holding immense relevance within my thesis. Notably, the prevalence of adults experiencing symptoms of anxiety or depression increased significantly from August 2020 to February 2021 [30, 31]. A recent survey by the Centers for Disease Control and Prevention (CDC) in the United States underscored how the pandemic has triggered an increase in mental health problems among adolescents, encompassing anxiety, depression, and suicidal thoughts. Data collected in Germany confirms this pattern, with children and adolescents experiencing a similar upturn [32]. Measures such as isolation and contact restrictions have left profound impact on the mental well-being of many young individuals. Alongside concerns about oneself and one's own family, a lack of interaction with peers and limited opportunities for stress regulation were primary stressors. Additionally, children and adolescents from disadvantaged backgrounds face even higher risks. Consequently, one of the central research inquiries during this period revolves around gaining a comprehensive understanding of how social distancing has affected mental health. This inquiry aims to identify both risk factors and resilience factors [33, 34]. Chapter Two of this compilation delves deeper into the intricate connections between mental health, protective factors, and an infection with COVID-19.

Research question and aim

My thesis primarily focuses on the topic of mental health, particularly in the context of adolescence. Within this compilation, I address several key questions pertaining to adolescent mental health. In the first chapter, I explore general psychopathology of adolescents, drawing insights from a German sample (N = 877, mean age = 12.43 years, SD = 0.65) [35]. Given their heightened vulnerability to mental disorders [36], this chapter presents a comprehensive analysis of their mental health status and explores gender differences, which have been observed in other studies worldwide [35]. The second chapter shifts focus to the profound impact of the COVID-19 pandemic, spanning from spring 2020 to winter 2022. Here, I construct a structural equation model (SEM) to examine the complex interplay between

factors influencing COVID-19 infection and psychopathology, incorporating measures of resilience, self-efficacy, quality of life, and self-esteem. This exploration aims to shed light on the complex dynamics that affect adolescents during this challenging period and inform preventive strategies [37]. In the third chapter, I introduce a prevention program named *LessStress*, which I have developed on a robust scientific foundation. This program adopts a universal approach, targeting adolescents aged 12 to 18 years with the goal of enhancing their stress regulation skills. Built upon principles of mindfulness, emotion regulation, and self-compassion, *LessStress* aims to improve students' stress management abilities, thereby enhancing their quality of life and mental health [38]. In this chapter, I present the study protocol, discuss its implementation, and highlight any limitations encountered thus far. Finally, in concluding discussion of this compilation, I will summarize the key findings and insights derived from my research. I will contextualize these findings within the current landscape and explore their implications for further research in the field of childhood and adolescence. My aim is to provide a comprehensive overview of the most significant results and offer valuable directions for further investigations in this critical area.

To summarize, this compilation serves to explore adolescent mental health. For each chapter, I have identified specific research questions. From adolescent psychopathology to the significant impact of the COVID-19 pandemic to the presentation of a prevention program. I have provided comprehensive answers to the research questions. As a result, my dissertation is a contribution to the growing body of knowledge on adolescent mental health. This ultimately aims, not least through an approach that combines epidemiology, etiology, and prevention, to promote young people's well-being and resilience in coping with the challenges of adolescence.

Chapter 1: Mental disorders at the beginning of adolescence

This first paper presents the mental health status of children and adolescents in a German sample (N = 877, M = 12.43, SD = 0.65). As part of my role as in the DUDE project, which stands for '*Du und deine Emotionen*' (You and Your Emotions), I was involved in planning, organizing, and conducting data collection in schools. Collaborating with the Chair of Clinical Epidemiology, led by Prof. Herrmann, I established the database and provided guidance and supervision to the students working in the study. The DUDE project aims to evaluate a universal prevention program designed to improve emotion regulation and reduce harmful coping strategies. The study follows a cluster-randomized design with four measurement points conducted in two survey waves at schools (at the start of summer and the start of winter). However, due to the COVID-19 pandemic, the initiation of the study had to be postponed twice. More information about DUDE is available in the study protocol [39]. The subsequent paper presents only the baseline data from the first survey wave. It examines mental health problems in early adolescence and hypothesized gender differences, as previous research has done [40]. The subsample consists of n= 877 young individuals from seven German high schools who completed questionnaires assessing their mental health using mobile phones, tablets, or PCs. We collected and managed study data using REDCap electronic data capture tools hosted at University Hospital Wuerzburg [41, 42]. Higher prevalence estimates were found compared to pre-pandemic studies, with approximately 30% of the students reporting mental health problems and stress related to COVID-19 and the associated restrictions during the survey period (autumn/winter 2021). Importantly, a significant portion of our sample displayed mental health problems as early as the 6th and 7th grades, with girls generally being more affected than boys. These findings underscore the importance of early adolescence in the emergence of mental health problems and emphasize the need for preventive measures.

Paper 1 - Public Health in Practice

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Mental disorders at the beginning of adolescence: prevalence estimates in a sample aged 11-14 years

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Personal contribution: In addition to organizing the data collection, I actively collected data from the schools. Prior to that, I collaborated with a colleague to create the database, select and enter the questionnaires. I conducted the statistical analysis of the dataset, including preprocessing the raw data, selecting appropriate methods, and writing the entire methods and results section. Additionally, I created all the tables. Regarding the development of the theoretical framework and discussion section, my contribution accounts for approximately 60% of the work, while the remaining 40 % is divided among the other co-authors.

Furthermore, I independently led the submission process and served as the corresponding author. During the revision process, I edited 90% of the revision independently, in consultation with the other authors.

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Mental disorders at the beginning of adolescence: Prevalence estimates in a sample aged 11-14 years

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ABSTRACT

Objectives: This study aims to provide a deeper insight into mental disorders in early adolescence. We report prevalence rates (mental health problems, depressive symptoms, eating disorders, NSSI, STBs) to be used in future studies and clinical ventures. We also expected to find gender differences, with girls being be more affected than boys are.
Study design: 877 adolescents (M = 12.43, SD = 0.65) from seven German high schools completed a series of questionnaires assessing their mental health (SDQ, PHQ-9, SEED, DSHI-9, Paykel Suicide Scale, FAS III).
Methods: We calculated cut-off-based prevalence estimates for mental health issues for the whole sample and compared estimates between genders.
Results: 12.5% of the sample reported general mental health problems. The estimated prevalence of depressive symptoms lay at of 11.5%. Additionally, 12.1% and 1.3% of the participants displayed relevant symptoms of anorexia or bulimia nervosa, respectively. A total of 10.8% reported engaging in non-suicidal self-injury (NSSI) at least once in their lifetime, of whom 5.6% reported repetitive NSSI. 30.1% of the participants described suicidal thoughts, 9.9% suicide plans, and 3.5% at least one suicide attempt. Girls were generally more affected than boys, except for bulimia nervosa, suicidal behavior, and partly NSSI.
Conclusion: Our findings corroborate the established relevance of early adolescence for the development of mental health problems and suggest that a substantial proportion of young adolescents suffer from such problems early on. Considering the ongoing COVID-19 pandemic and reported negative mental health consequences, the current findings underline the importance of preventive interventions to avoid the manifestation of mental disorders during adolescence.

1. Introduction

Early adolescence (11-14 years) marks a crucial period for the development and onset of mental health problems, which often manifest as disorders in the course of adulthood if they are not dealt with early on [1]. An international meta-analysis involving 27 countries found a pooled prevalence of 13.4% for mental disorders among children and adolescents [2], corroborated by estimates of around 20% reported by the Word Health Organization [3]. Recent epidemiological data show that the proportion of individuals with onset of any mental disorders before the age of 14 lies at 34.6%, which rises to 48.4% up to the age of 18 [1]. Various gender differences regarding the onset and type of mental disorders can be observed, especially in childhood and adolescence [4–6], potentially due to differing vulnerabilities depending on gender [7]. The high reported prevalence estimates and the early onset of mental disorders before the age of 14 years emphasize the importance of investigating the underlying processes and associations in this particularly vulnerable group. This is in line with a statement made by the WHO: Good mental health is accordingly defined as "a state of well-being in which the individual is able to realize their own capacities, cope with the normal pressures of life, work productively and fruitfully, and make a contribution to his or her community" [8,9]. This means that not having a mental disorder is not equivalent to being mental healthy and research suggests that the use of preventive measures is maximized

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when one intervenes at the time of the onset of mental disorders [1]. Hence, we need to find out more about the onset of mental health issues and the gender differences in order to establish well-chosen prevention programs at the right time.

The aforementioned gender differences appear to vary according to age. For instance, a German study reported that mental disorders were diagnosed earlier in boys, and mainly consisted of externalizing disorders such as attention deficit hyperactivity disorder (ADHD) or developmental disorders [10]. With the onset of adolescence, there appears to be a measurable shift, with more internalizing disorders such as depression and anxiety disorders being diagnosed, predominantly in girls [10,11] and with an increased incidence at around the age of 14 [12]. Latent growth curve modeling of depressive symptoms indicated that girls' symptoms accelerated early in adolescence whereas boys' symptoms accelerated later (with respect to internalizing disorders), with more girls (24%) experiencing an episode of major depression or dysthymia by the age of 20 [13]. Yet, these dynamics are not well explained or understood.

Taking a closer look at specific disorders such as depression, the prevalence in adolescents increased from 8.7% in 2005 to 11.3% in 2014 [14]. The incidence of depression increases rapidly during adolescence [15], with gender differences in major depression appearing by the age of 12 (OR 2.37) and peaking at ages 13–15 (OR 3.02) [16]. A recent meta-analysis confirmed these substantial gender differences, reporting that depression was more common in girls than in boys (2.41% vs. 0.92%), with a peak at around 14 years [17]. In addition, depression is associated with difficulties across the lifespan, such as failure to complete secondary school (OR 1.76) or unemployment (OR 1.66) [18].

Another type of mental disorders with onset in early adolescence is eating disorders such as anorexia or bulimia nervosa (AN and BN; [19]). In a cross-sectional survey in German schools, the authors reported a 12-month prevalence of 0.3% for full-syndrome AN, 10.9% for partial-syndrome AN, 0.4% for full-syndrome BN and 0.2% for partial-syndrome BN [20]. However, prevalence rates for body image symptoms such as fear of weight gain or overvaluation of body weight are estimated to be much higher in adolescents (14.3-25.7%) [20]. Furthermore, AN and BN tend to become chronic, can negatively influence socioeconomic achievement, and are often associated with serious physical complications as well as high rates of morbidity and mortality [21,22]. In individuals aged under 15 years, both AN and BN are substantially more frequent in girls than in boys, with sex ratios of 5 to 0 (AN) and 5 to 1 (BN) [20]. These findings suggest body and weight concerns to be especially important in female adolescents, warranting an updated investigation of these issues.

Transdiagnostically, there are other high-risk behaviors in adolescence that increase the likelihood of developing mental disorders, such as dysfunctional coping strategies [23]. Maladaptive emotion regulation strategies like rumination, alcohol or drug use, and non-suicidal self-injury (NSSI) are often associated with depression or even eating disorders [24,25]. A meta-analysis revealed a worldwide lifetime prevalence for NSSI of 17.2% among adolescents, ranging from 1.5% to 54.8% [26]. Moreover, repetitive NSSI was more strongly associated with severe mental health problems and suicidality [27]. Strikingly, suicide is a leading cause of adolescent death [28] and suicidal thoughts and behaviors (STBs) are elevated during adolescence [29,30]. In a German sample, the prevalence of suicidal ideation lay at 14.4% and 15.1% of girls and 10% of boys reported that they considered their lives as "not worth living" [31]. In general, data on the prevalence of suicide attempts among adolescents are equivocal, but probably range from 1.3% to 11.0%, with higher rates in girls [32–34]. In summary, early adolescence is a key period for the development of mental disorders. In particular, the increased occurrence of high-risk behavior and maladaptive emotion regulation strategies are reflected in very high rates of NSSI or suicidality.

Moreover, the restrictions during the COVID-19 pandemic have led to increased rates of mental health problems among adolescents in Germany, rising to 30% [35], thus adding another twist to the complex dynamics in adolescence. While the symptoms and rates of depression, eating disorders, suicidal behavior, and NSSI have increased across the world [36–40], to date, a nuanced investigation of a particularly young age cohort is lacking.

Given the described importance of early adolescence, this paper aims to provide deeper insight into the mental health status in early adolescence. In the current study, we therefore use self-report questionnaires answered by young adolescents to obtain prevalence rates to be used in future studies and clinical undertakings. Additionally, in view of the aforementioned gender differences reported in other studies worldwide, we also expected to find gender differences, insofar as girls would be generally more affected by mental health problems than boys would.

2. Methods

2.1. Study design

Data was drawn from the baseline assessment of a large prevention study and took place at seven German high schools [41]. Inclusion criteria were being in the 6th or 7th grade and informed consent of legal guardians and participating adolescents. The study was approved (127/19-me) and is conducted according to the guidelines of the Declaration of Helsinki and Good Clinical Practice (GCP).

2.2. Study population

In fall 2021, 877 adolescents aged 11-14 years participated in the baseline data collection. At the time of the baseline assessment, the number of pandemic-related restrictions was relatively low. While schools were open, the wearing of facemasks within all public spaces, including schools, was mandatory. In addition, vaccination for adolescents had become available and almost half of the German adult population had already been vaccinated, accompanied by a decrease in infection rates and deaths [42]. The seven high schools were located in cities (up to 130,000 residents) and rather rural areas (the smallest comprised 20,000 residents). All questionnaires were collected digitally in class on the participants' own mobile telephones or school tablets and were selected based on acceptable to good psychometrics properties.

2.3. Measurements

Besides socio-demographic variables, we assessed socioeconomic status (SES) using the revised and shortened Family Affluence Scale (FAS III) [43]. The FAS III is a 6-item self-report scale measuring family wealth, which results in a low (index score 0-4), medium (index score 5-9), or high SES estimate (index score 10-14). The scale has shown moderate validity and a test-retest reliability of r = 0.90 [43], and can mainly be used to identify low- and high-income households [44].

2.4. General mental health problems

The *Strengths and Difficulties Questionnaire* (SDQ) is a widely used diagnostic instrument comprising 25 items (rated as "not true", "somewhat true", "certainly true"), which are allocated to five subscales (range 0–10). Additionally, a total difficulties score (range = 0-40; without the subscale prosocial behavior) is calculated on which a score of 17 indicates the cut-off for high and very high difficulties (www.youthinmind.com). The five subscales of the SDQ are *emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems,* and *prosocial behavior* (reverse-coded). Furthermore, an externalizing score (range 0 to 20; sum of conduct and hyperactivity scales) and an internalizing score (range 0 to 20; sum of emotional and peer problems scales) can be calculated. The SDQ has shown satisfactory to good reliability (Cronbach's alpha 0.73-0.89) and validity [35,45]. The five subscales and an externalizing and internalizing score are

depicted in Table 1.

2.5. Mental disorders

2.5.1. Depression

To assess depressive symptoms within the last two weeks, we used the nine-item *Patient Health Questionnaire* (PHQ-9; [46], which is a screening instrument based on the diagnostic criteria for major depression from the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV) [47]. The nine items are rated on a 4-point Likert scale, with total scores higher than 10 indicating clinically relevant depressive symptoms (range = 0-27). The PHQ-9 is widely used among adults and has been validated for adolescents, showing good psychometric properties: sensitivity of 89.5% and specificity of 77.5% for detecting adolescents with major depression; Cronbach's α = 0.83, test-retest reliability *rtt* = 0.87 [48].

2.5.2. Eating disorders

The *Short Evaluation of Eating Disorders* (SEED) is a brief screening instrument for the main symptoms of AN and BN [49]. The instrument encompasses six items assessing body mass index (BMI) and the key eating disorder symptoms (fear of weight gain, distortion of body perception, over-concern with weight and shape, frequency of binge eating, frequency of compensatory behaviors). Item scores are converted to yield an individual severity index for AN and BN. To obtain prevalence estimates, we employed cut-off scores for AN (>2, clinically relevant symptoms) and BN (>1, mild clinical symptoms) regarding the an/bn_tsi scores in accordance with other studies [50,51]. The SEED is a widely used instrument and shows good psychometric properties [49].

2.5.3. NSSI

NSSI was determined using a modified nine-item version of the *Deliberate Self-Harm Inventory* (DSHI-9) [52], which was adapted for adolescents [53] from the original 17-item version by Gratz. Respondents are first asked whether they have ever intentionally harmed themselves. If this question is answered in the affirmative, further questions on the frequency, method and severity are asked. The modified short version of the DSHI-9 shows moderate to good internal consistency (Cronbach's α = 0.66 and 0.85) [54].

2.5.4. Suicidal thoughts and behaviors (STBs)

Suicidal behaviors including suicidal thoughts, suicide plans, and suicide attempts were investigated using the *Paykel Suicide Scale* (PSS). The scale comprises five questions, which are answered on a 3-point Likert scale ("never", "at an earlier time point", "within the last two weeks") [55]. If a student answered the first question *"Have you ever felt that your life is not worth living?"* in the affirmative (i.e., "at an earlier time point" or "within the last two weeks"), we considered the criterion of suicidality to be met; therefore, our estimate rate is based on suicidal thoughts. The PSS is a widely used questionnaire that shows good internal consistency (Cronbach's α of 0.85) [56].

2.5.5. Statistical analyses

Analyses were performed with R and RStudio (version R.app GUI 1.74, RStudio 1.4.1106) using de-identified participant information. To calculate prevalence estimates, the cut-off values mentioned above were used. To investigate gender differences between prevalence estimates, t-tests were used for continuous data (Welch test in the case of unequal variances), Wilcoxon-Mann-Whitney tests were used for ordinal data and chi-squared tests were used for categorical data. In the case of significant differences, effect sizes were calculated using Cohen's d for independent means (small effect d = 0.2; medium d = 0.5, large d = 0.8), product-moment for z-values (small effect r = 0.1, medium = 0.3, large = 0.5) and Cramer's V for chi-squared tests (small effect V = 0.1, medium effect V = 0.3, large effect V = 0.5) [57,58]. Note that due to the limited number of non-binary participants, they were not included in

Table 1
Sociodemographic and clinical characteristics for the total sample and for Girls, Boys and Non-Binary.

	Total	Girls	Boys	Non-Binary
Demographics				
N (%)	877	487 (56.0)	379 (43.2)	6 (0.8)
Age, mean (SD)	12.34 (0.65)	12.3 (0.64)	12.39 (0.66)	12.49 (0.82)
Range [min-max]	[11.08 - 14.92]	[11.17-14.17]	[11.08-14.92]	[11.25-13.17]
Participants born in Germany, n (%)	824 (94.0)	459 (94.3)	360 (95)	5 (83.3)
Father born in Germany, n (%)	735 (83.8)	408 (83.8)	323 (85.2)	4 (66.7)
Mother born in Germany, n (%)	720 (82.1)	400 (82.1)	317 (83.6)	3 (50.0)
Participants with siblings, n (%)	754 (86)	425 (87.3)	324 (85.5)	5 (83.3)
Chronic illness, n (%)	58 (6.6)	29 (6.0)	28 (7.4)	1 (16.7)
Mental illness, n (%)	16 (1.8)	10 (2.1)	5 (1.3)	1 (16.7)
in therapy[a], n (%)	5 (0.6)	1 (0.2)	3 (0.8)	1 (16.7)
Strenghts and Difficulties				
SDQ total, mean (SD)	11.17 (5.36)	11.69 (5.56)	10.37 (4.91)	17.83 (6.49)
Range [min-max]	[0-30]	[1-30]	[0-26]	[11-26]
SDQ emotional, mean (SD)	2.98 (2.38)	3.52 (2.52)	2.25 (1.93)	5 (3.1)
Range [min-max]	[0-10]	[0-10]	[0-8]	[1-10]
SDQ conduct problems, mean (SD)	2.03 (1.52)	2.01 (1.52)	2.04 (1.50)	3.17 (2.56)
Range [min-max]	[0-8]	[0-8]	[0-8]	[1-7]
SDQ hyperactivity, mean (SD)	3.85 (2.17)	3.85 (2.14)	3.85 (2.22)	5.17 (1.83)
Range [min-max]	[0-10]	[0-10]	[0-10]	[3-8]
SDQ peer problems, mean (SD)	2.30 (1.62)	2.31 (1.57)	2.24 (1.67)	4.5 (1.05)
Range [min-max]	[0-9]	[0-9]	[0-9]	[3-6]
SDQ prosocial, mean (SD)	7.92 (1.81)	8.17 (1.70)	7.59 (1.89)	8.33 (1.86)
Range [min-max]	[0-10]	[2-10]	[0-10]	[6-10]
SDQ internalizing	5.28 (3.33)	5.83 (3.48)	4.49 (2.92)	9.5 (3.27)
Range [min-max]	[0-17]	[0-17]	[0-17]	[6-15]
SDQ externalizing	5.89 (3.17)	5.86 (3.17)	5.88 (3.15)	8.33 (3.53)
Range [min-max]	[0-17]	[0-17]	[0-17]	[4-13]
Depression				
PHQ-9, mean (SD)	4.75 (4.71)	5.36 (5.11)	3.87 (3.79)	10.6 (10.83)
Range [min-max]	[0-27]	[0-27]	[0-20]	[1-27]
mean (SD) above cut-off	15.62 (4.09)	15.89 (4.27)	14.42 (2.75)	21.5 (7.78)
Eating disorder (SEED)				
Anorexia, mean (SD) whole sample	1.42 (0.62)	1.51 (0.6)	1.31 (0.63)	1.56 (0.83)
Anorexia, mean (SD) above cut-off	2.36 (0.18)	2.37 (0.19)	2.32 (0.15)	2.5 (-)
n (%)[b]	106 (12.1)	68 (14.0)	37 (9.8)	1 (16.7)
Bulimia, mean (SD) whole sample	1.36 (0.41)	1.35 (0.44)	1.42 (0.29)	-
Bulimia, mean (SD) above cut-off	1.52 (0.39)	1.54 (0.44)	1.42 (0.29)	-
n (%)[c]	11 (1.3)	8 (1.6)	3 (0.8)	-
SES				
FAS III score, mean (SD)	10 (1.90)	10.02 (1.9)	9.98 (1.9)	9.5 (1.87)
Range [min-max]	[2-14]	[4-14]	[2-14]	[7-12]
FAS categorized, n (%)				
Low	2 (0.2)	1 (0.2)	1 (0.3)	0
Medium	343 (39.1)	185 (38.0)	155 (41.0)	3 (50.)
High	526 (60.0)	301 (61.8)	222 (58.7)	3 (50.0)

[a] According to the study protocol these participants were excluded from analysis.
[b] This number is based on a cut-off score > 2 equivalent to clinical relevant symptoms.

[c] This number is based on a cut-off score > 1 equivalent to mild clinical symptoms.

these tests. Effects were regarded as statistically significant at an alpha <.05.

3. Results

3.1. Socio-demographic characteristics

The sample comprised n = 877 adolescents with a mean age of 12.34 years (SD = 0.65). There were slightly more girls (55.5%) than boys (43.2%), and 0.7% of the adolescents identified as non-binary. The majority of participants (94.0%) and parents (83.0%) were born in Germany, and most of the participating adolescents had siblings (86.0%). The socioeconomic status in this sample was rather high, with 60% reporting a high socioeconomic status as measured by the FAS III and only 0.2% reporting a low socioeconomic status. A total of 6.6% of the participants were affected by a chronic illness, 1.8% stated that they had a psychiatric disorder, and 0.6% were in therapy. For further details on all socio-demographic information as well as means, SDs and ranges in the questionnaires used, see Table 1.

3.2. Prevalence estimates for mental disorders

3.2.1. Mental health problems (SDQ)

Regarding mental health problems in general, the estimate was 12.5% within the last six months. Split by gender, the prevalence rate was 14.4% for girls, 9.2% for boys, and 50% for the non-binary group. There was a significant gender difference ($W = 99404$, $p < .001$) with a small effect size ($r = 0.12$), insofar as girls showed significantly more mental health problems than did boys. The mean scores on the different subscales of the SDQ differed slightly according to gender, with girls showing more emotional symptoms [3.52 (2.52) vs. 2.25 (1.93)] and more prosocial behavior [8.17 (1.70) vs. 7.92 (1.89)] compared to boys. There were no noteworthy gender differences on the rest of the subscales (see Table 1). Furthermore, a significant difference emerged on the internalizing problems scale [5.83 (3.48) vs. 4.49 (2.92)] with a small effect size ($W = 99404$, $p < .001$, $r = 0.2$), indicating more internalizing problems in girls than in boys. By contrast, no differences emerged on the externalizing problems scale.

3.2.2. Depression (PHQ-9)

Regarding depression, we found an overall prevalence estimate of 11.5%, with 14.4% of girls and 9.2% of boys scoring above the clinically relevant cut-off. This difference was significant, with a small effect size ($t(852.94) = 4.893$, $p < .001$, $d = 0.33$). Girls had a higher mean score [5.36 (5.11)] than did boys [3.87 (3.79)], and non-binary participants had the highest mean score [10.6 (10.83)], indicating more depressive symptoms.

3.2.3. Eating disorders (SEED)

The overall prevalence estimates for eating disorders were 12.1% for AN symptoms and 1.3% for BN symptoms. Half of the non-binary adolescents reported clinically relevant symptoms. More girls reported anorexic symptoms (14.0%) than did boys (9.8%). There was a significant difference between girls and boys regarding the anorexia severity index with a small effect size ($t(831) = 4.82$, $p < .001$, $d = 0.34$), but not for the bulimia severity index ($t(14) = -0.261$, $p = .798$). The girls had a slightly higher mean score than the boys [1.51 (0.6) vs. 1.31 (0.63)]. When considering only the participants scoring above the cut-off, the mean scores differed only slightly between girls and boys, regarding both AN symptoms [2.37 (0.19) vs. 2.32 (0.15)] and BN symptoms [1.54 (0.44) vs. 1.42(0.29)].

3.2.4. NSSI (DSHI-9)

Overall, 10.8% of the sample reported having engaged in self-injurious behavior at least once in their lifetime. NSSI was reported by 12.3% of the girls, 9.0% of the boys and 16.7% of the non-binary participants. This difference was not significant for the whole sample ($\chi^2(1) = 1.961$, $p = .161$). However, when analyzing only those participants who had engaged in NSSI, a significant gender difference emerged ($\chi^2(1) = 7.192$, $p = .007$), with a medium effect size (Cramer's $V = 0.28$). Additionally, 5.59% of the sample reported engaging in repetitive NSSI. The main methods used were cutting (40%) and scratching (45.3%), followed by wound picking (36.8%), hitting oneself (32.6%), and burning (10.5%). As only one out of the six non-binary participants reported engaging in NSSI, the interpretation of these findings for the non-binary group is limited.

3.2.5. STBs (PSS)

In total, 30.1% of the participants reported suicidal thoughts at any time point or within the last two weeks, 9.9% reported suicide plans, and 3.5% reported having attempted suicide in the past. When referring only to the last two weeks, these figures were as follows: 7.1% (n = 62) suicidal thoughts, 1.8% (n = 16) suicide plans, and 1.0% (n = 9) attempted suicide. Compared to boys, more girls reported suicidal thoughts (35.5% vs. 23.0%), had made suicide plans (11.7% vs. 7.4%), and had previously attempted suicide (3.7% vs. 1.6%). There was a significant gender difference for suicidal thoughts with a small effect size ($t(853) = 4.477$, $p < .001$, $d = 0.31$), for suicide plans ($t(853) = 2.72$, $p = .007$, $d = 0.19$), and for suicide attempts ($t(853) = 2.678$, $p = .008$, $d = 0.19$), suggesting more suicidal behavior overall among girls. It should be noted here that of the six adolescents who identified as non-binary, three stated suicide thoughts, two reported suicide plans, and one had previously attempted suicide.

An overview of the prevalence estimates can be found in Table 2. It can be observed that all six of the non-binary participants had higher scores on all questionnaires compared to girls or boys.

4. Discussion

With the current paper, we sought to provide an updated overview of the prevalence estimates of various mental health difficulties in early adolescence, which is known to be a critical period for the development and manifestation of mental health problems in general. To account for previously reported gender differences in adolescent mental health status, we also compared the obtained prevalence estimates between boys and girls.

In the whole sample, the six-month prevalence estimate for general mental health problems lay at 12.5%. Clinically relevant depressive symptoms within the last two weeks were reported by 11.5% of the participating adolescents. Although the prevalence estimate for general mental health problems found is lower than recently reported by another German longitudinal study [59], it is in line with a further German study [60] and slightly lower than pre-pandemic rates [61]. Accordingly, our results suggest no increased psychopathology in young German adolescents in temporal relation to the COVID-19 pandemic. Nevertheless, these results should be interpreted with caution, as given the observational nature of our data, we cannot draw any causal inferences about the participants' mental health status before the pandemic.

Furthermore, our results strongly suggest that girls are significantly more affected by mental health problems compared to boys. Regarding the subscales of the SDQ, we found significant differences between girls and boys on the internalizing scale. This finding is in line with previous literature, suggesting girls tend to be affected more by internalizing disorders such as depression or anxiety [62,63]. Surprisingly, we found no significant difference between boys and girls on the externalizing scale. This contrasts with the generally accepted assumption boys are more affected by externalizing symptoms than girls, which is also

Table 2
Prevalence estimates in total and stratified by gender and grade.

		Total	Total sample (N = 871)			
			6th grade		7th grade	
			Girls	Boys	Girls	Boys
Mental health problems *(SDQ)*		105	33	16	37	19
	Prevalence[3]	12.49%	13.52%	9.04%	15.16%	9.22%
Depression *(PHQ-9)*	n	100	32	17	39	12
	Prevalence	11.48%	13.12%	9.61%	15.98%	5.83%
	Mean (*SD*)[1]	4.74 (4.70)	5.23 (4.98)	4.14 (3.91)	5.48 (5.24)	3.64 (3.67)
NSSI *(DSHI-9)*	n	94	25	23	35	11
	Prevalence	10.98%	10.25%	13.00%	14.34%	5.34%
Suicidal behavior *(PSS)*[2]	n	263	84	50	90	39
	Suicide thoughts	30.82%	34.43%	28.25%	36.89%	18.93%
	Suicide plans	10.08%				
	Suicide attempts	3.71%				
Eating disorder *(SEED)*[4]	n (AN)	106	44	22	24	15
	Anorectic symptoms	12.67%	5.26%	2.63%	2.87%	1.79%
	n (BN)	11	3	3	5	0
	Bulimic symptoms	1.31%	0.36%	0.36%	0.60%	-

[1]PHQ-9 range: 0-29. Values of 10 and higher indicate depression.
[2] To determine this prevalence the answers "yes, within the last two weeks" and "yes, at a former time point", were added and divided by the total number.
[3]Based on cut-off score indicating high and very high scores.
NOTE: only two pupils being above the cut-off stated their gender as "divers"/non-binary, hence we did not include them in this table; f = 488, m = 383, d = 6.
[4] The SEED cut-off scores are explained in the method section as well.

clinically reflected in the increased diagnostic frequency of AD(H)D in boys [10]. Potentially, this finding might be explained by the fact that AD(H)D is often underrated by parents and harder to diagnose in girls [64]. As such, the commonly observed difference in externalizing symptoms between boys and girls might be explained by a gap between self-perceived symptoms and third-party assessments (e.g., clinicians, parents). The current finding that girls and boys are equally affected by externalizing symptoms suggests that the ubiquitous conception of a higher frequency of externalizing symptoms in boys may be flawed, thus leading to an undersupply of treatment options and assistance for affected girls. Future research utilizing multi-informant assessment strategies is needed to further investigate gender-specific differences in the diagnostic frequency of externalizing symptoms.

The prevalence estimate of 11.5% of adolescents screening positive for depressive symptoms is in line with findings from before the pandemic [65] and with a recent longitudinal German study [59]. Nevertheless, other studies have revealed a mixed body of evidence, with some reporting lower rates of depressive symptoms in adolescents during the pandemic [60] and others reporting an increase in depressive symptoms [66]. Thus, while our findings suggest that the pandemic has not led to an increase in rates of depressive symptoms in this age group, the estimates reported here are not fully comparable to previous studies due to the lower mean age of our sample and the use of different assessment procedures, and different assessment time points. Further, due to the volatile nature of the ongoing COVID-19 pandemic, it could be that at the time of data assessment, the participants in the current study had fewer depressive symptoms due to relatively mild restrictions. Resilience research has shown that children who were already struggling with risk and developmental harm (poverty, racism, neglect, food insecurity, violence, or chaos in the home) prior to the pandemic have become even more isolated and stressed due to the pandemic. Therefore, high resilience relative to the overall population may be another factor explaining the findings in our sample [67]. More generally, the effects of COVID-19 on prevalence estimates remain largely unknown, calling the comparability of (inter-)national prevalence estimates over the last two years into question. However, our results suggest a comparably high rate of depressive symptoms overall and that girls are significantly more affected. More longitudinal research, especially in young adolescents, is needed to verify the prevalence of self-reported depressive symptoms found in the present study and investigate the effects of the COVID-19 pandemic in greater depth.

For eating disorder symptoms, the prevalence estimates in the present study was 12.1% for anorexic symptoms and 1.3% for bulimic symptoms. Girls were significantly more affected by anorexic symptoms, while this was not the case for bulimic symptoms. These estimates are in line with a multicenter study conducted in 2019, which found similarly high rates, especially for girls [21]. While the prevalence estimate of 12.1% for AN seems surprisingly high, it corresponds to a previous study which distinguished eating disorders into a partial and full syndrome [20]. Specifically, the latter study reported a similar proportion of participants fulfilling criteria for only a partial syndrome to the present study. Accordingly, our results may reflect an overestimation of full syndrome AN, while nevertheless raising concerns given the high proportion of participants meeting the criteria for a partial syndrome. Moreover, the high prevalence estimate in the present study may be explained by the fact that some eating disorder habits resemble the eating habits commonly observed in adolescence, such as being on a diet, feeling too fat, and counting calories. In addition, our participants self-reported their height and weight. This may have led to a bias in the prevalence estimate for AN, as the calculated BMI is essential for the anorexia severity index. Lastly, the recently observed worldwide increase in patients with an eating disorder since the onset of the COVID-19 pandemic [68,69] may also be an explanation. With regard to bulimic symptoms, the prevalence of 1.3% is in line with other studies, which suggested that BN symptoms emerge at later time point in adolescence [20,70]. Further research is needed, particularly in the context of validation and standardization of the SEED in adolescence, as there are no general cut-offs or norms available for this age group. Given the complex nature of eating disorders in general and of AN in particular, future research should rely on clinical interviews to assess the prevalence rates of eating disorders.

For NSSI, a dysfunctional coping behavior often associated with mental health problems, we found a 12-month prevalence estimate of 10.8%. This finding is lower compared to a European study from 2014, which found a lifetime prevalence of 17.1% to 38.6% across various countries [52]. Another meta-analysis found estimates ranging from 6% to 26% in a comparable age range worldwide [71]. Therefore, our results indicate a moderate occurrence of NSSI in early adolescence. A meta-analysis [72] showed that women were significantly more likely to report a history of NSSI than men, with no significant association between age and effect size. In terms of methods of NSSI, women were more likely than men to use some NSSI methods (here: cutting and scratching), but there was no significant difference for other methods (here: burning, wound picking, hitting). These results are consistent

with the present findings. However, research suggests that more girls engage in NSSI, with associations between NSSI and mental health difficulties [73]. Another possible explanation for the occurrence of NSSI in adolescence and the partially found gender differences lies in females' increased vulnerability to internalizing disorders. A cluster analysis confirmed that especially girls who engage in cutting often show higher scores on the SDQ difficulties scale and on the internalizing scale, while this association was not found in boys [54]. Accordingly, girls who have more internalizing problems appear to have a higher vulnerability to NSSI. More generally, the assessment of NSSI is complicated by the lack of consistent definition of self-harm and consequently the fact that there is no standard questionnaire to measure NSSI, rendering it difficult to draw international comparisons. Given these limitations, we consider our findings to be preliminary and a starting point for future epidemiological investigations.

30.1% of adolescents reported suicidal ideation, 9.9% had planned suicide and 3.5% had attempted suicide. These estimates are broadly consistent with the literature, with a 2008 study reporting 12-month prevalence estimates of 15.0% to 29.0% for suicidal ideation and 12.6% to 19.0% for suicide plans [74]. Interestingly, the present study found a very high prevalence of suicidal ideation. A recent article pointed out that in the US, suicide rates have increased by 300% in the last 10 years [75]. When testing for gender differences, we found significant differences regarding suicidal thoughts, plans and attempts, with girls being more affected than boys. There is still a large gap in research on the mechanisms of self-harm and STB/suicide in early adolescence. However, again, there is some evidence of increased prevalences in females, which are associated with hormonal changes during puberty [76], and it is suggested that this should be addressed using a more individual and social approach. Moreover, the well-known gender paradox of suicide (higher prevalence of suicidal behavior in women yet men are more likely to die by suicide [28]) is in line with our findings of more girls being affected than boys.

Other notable aspects of our data, besides capturing pandemic-related effects, include the high SES of the sample. Considering that low SES tends to be a risk factor for increased stress [77,78], it may also have been assumed that prevalence estimates for mental disorders should be rather low in a sample with a rather high SES such as in the current study [79]. As reported, this is only partly the case, as at least partially high symptom rates were reported, especially for girls and for non-binary individuals. These findings are therefore contrary to expectation, and underline that SES cannot explain the effects found in the present sample. Potentially, the impact of the COVID-19 pandemic may have moderated the results, reflecting the vulnerability in this particular age group.

4.1. Strengths and limitations

When interpreting the present results, some limitations should be taken into account. First, the present data come from a cross-sectional observation with limited sample size and a distinct region. Generalization of our findings to other populations is therefore limited. Second, our estimates rely entirely on self-report and may thus be affected by social desirability and demand characteristics. For example, participants might have been reluctant to report their honest feelings in response to items assessing mental health problems, which are still subject to public stigmatization. Nevertheless, to the best of our knowledge, the present study is the first to assess prevalence estimates of mental health problems and mental disorder symptoms in adolescents within the selected age range of 11–14 years. Which is known to represent an important time for the onset of mental disorders in general [1]. Despite limited generalizability, our findings therefore provide important insights into a particularly vulnerable population. Moreover, the COVID-19 pandemic itself poses another limitation. The different data collection periods of individual studies assessing the impact of the pandemic make it difficult to compare results in general, as exposure to COVID-19 fluctuates worldwide, and changes in the course of a pandemic influence mental health on an individual basis. Nonetheless, our data contribute to some degree gaining an understanding of the dynamics surrounding COVID-19 in a selective sample assessed 1.5 years after the outbreak.

4.2. Conclusion

Our findings underline the profound problem of mental health difficulties and mental disorders in youth, which should finally be given the necessary public attention in order to secure and maintain the mental health of our young people. A societal rethink on both a social and political level is required, not only to protect our health care system in the long term, but also to strengthen the younger and following generations to cope with the demands of daily life. According to our findings, it is essential that researchers and clinicians pay greater attention to gender differences regarding the onset and course of mental disorders in early adolescence. Moreover, it is important that adolescents are strengthened at an early stage to enable effective and efficient prevention at the right time. Given the vulnerability to mental disorders during adolescence, there is an urgent need for intervention and preventive approaches. Such interventions could be routinely delivered in schools. Moreover, adolescents' parents or guardians should be sensitized to potential issues faced by their children and should be given guidance in providing the necessary help to prevent mental health difficulties. Preventive interventions can be subdivided into selective or universal approaches. Selective programs aim to reduce risk in those who benefit most and therefore reach a small proportion of the population, while universal approaches aim to reduce the risk of a more general population [1]. According to our results, we should therefore ask ourselves what is the most appropriate and effective way to strengthen adolescent mental health in early adolescence in order to increase resilience and protect against mental illness in the long term.

Author affiliation

CS helped design and coordinate the study, participated in its coordination, wrote the manuscript, and did the statistical analysis; JG participated in the study coordination and helped draft the manuscript; NK helped draft the manuscript and did the statistical analysis; AB conceived the study and participated in its design and coordination and helped draft the manuscript. All authors read and approved the final manuscript.

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Ethics

The Ethics Review Committee of the University of Würzburg approved the trial (127/19-me). The Ministry of Education and Cultural Affairs has also approved the trial (IV.7-BO5106/200/12). Written informed consent from the participants and their parents was mandatory for participation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. This publication was supported by the Open Access Publication Fund of the University of Wuerzburg.

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Summary Chapter 1

We have learned that adolescence is a critical period for the development and manifestation of mental health problems, attributed to the challenges of puberty and neurocognitive transformation. In the previous paper, we revealed prevalence estimates for general mental health problems, with 12.5% of students affected, depressive symptoms observed in 11.5%, accompanied by a decline in the students' health related quality of life (HRQoL) [35]. This data collection took place in fall 2021, when the pandemic and its associated restrictions were still part of daily life, including the use of face masks in public places and schools, and mandatory COVID-19 rapid testing in schools twice or three times a week. Comparing our findings to pre-pandemic data and studies conducted during the pandemic, our sample reported slightly lower prevalence estimates. This difference can be partly attributed to the very high socio-economic status (SES) of the sample and the unique anthropogeography of the Franconian area. Factors such as small cities and rural areas, low crime incidence, and Bavaria's strong financial support for communities might have contributed to these lower prevalence rates. Additionally, due to the cross-sectional nature of the data, we cannot draw causal conclusions about the students' pre-pandemic mental health status. Longitudinal data would be more appropriate to monitor changes in behavior and emotions for more reliable conclusions [43-45]. Nonetheless, these reported numbers are alarming, particularly concerning girls, who were significantly more affected than boys, especially in terms of internalizing problems. Surprisingly, we did not find any differences regarding the externalizing subscale of the SDQ, indicating a substantial number of girls who reported difficulties in attention focusing. One concerning finding was the high incidence of suicidal ideation in our sample, with 30.1% of adolescents reporting thoughts that their lives were not worth living. Additionally, 9.9% reported having suicide plans, and 3.5% reported having attempted suicide in the past. These statistics are both disturbing and alarming, underscoring the urgent need for preventive action. Moreover, the significant gender differences should raise awareness among parents, teachers, psychologists, and doctors. Dealing with girls may require different strategies than dealing with boys, highlighting the importance of investigating gender-specific preventive interventions during adolescence.

As mentioned at the beginning of this brief summary, pandemic-related restrictions were still part of our daily lives. At the onset of the pandemic, there was an increase in mental health symptoms and disorders among children and adolescents [46]. However, there were also many who coped with the crisis relatively unscathed. Factors such as low SES or a migration background were identified as a risk factors. Given that the sample studied in the first paper exhibited a high functionality, we turned our attention to other protective factors. We became particularly interested in understanding the interaction between COVID-19 infection, the observed mental health status, and protective factors such as resilience or self-esteem. For a more detailed exploration, please refer to Chapter 2.

Chapter 2: The COVID-19 pandemic and its impact on mental health in adolescence

Lockdowns, quarantines, school closures, and social distancing measures have been associated with a variety of negative consequences, particularly a sharp deterioration of mental health [33, 37, 47, 48]. Pre-pandemic data suggests that around a third of German adolescents were affected by some form of mental disorder. During the pandemic, this figure climbed as high as 40% [49]. Longitudinal research has also indicated a rise in anxiety and depressive symptoms compared to the years before 2019 [37, 50]. Significantly, groups at risk, whether due to pre-existing mental health problems or social disadvantage, were even more profoundly affected. In addition to studying mental disorders, several investigations focused on protective factors. Engaging in sports, exercise, and spending more time with family and friends were found to have a mitigating effect on the impact of pandemic-related restrictions [51].

Building on the findings from Chapter 1, which revealed a high prevalence of mental health problems in a largely well-functioning sample, we aimed to look more closely at etiological factors based on our epidemiological data. Given that known interactions among protective factors, we sought to explore these connections in greater detail. For this reason, we decided to consider various pathological variables and protective variables within a unified model, while also factoring in co-infection with COVID-19. This approach allowed us to gain a better understanding of the complex and interconnected effects, drawing upon both the diathesis-stress model and the resilience model.

- The diathesis-stress model, also known as the vulnerability model, seeks to explain the development of mental disorders by considering an individual's inherent vulnerability (diathesis). According to this model, the likelihood of the occurrence of a disorder depends on the interaction between an individual’s vulnerability level and the amount of stress experienced. The greater an individual’s vulnerability to a specific disorder, the less stress is needed to trigger its development [52]. In the context of the pandemic, this model helps to clarify why some children and adolescents exhibited an increased prevalence of mental disorders. It can be attributed to their personal vulnerability combined with stressors such as poor academic performance, heightened conflicts at home, social isolation, and loneliness.
- The resilience model [53] primarily focuses on an individual’s ability to adapt positively during or after facing significant challenges, adversities, or risks. Resilience encompasses an

individual's skills and capacities for effectively handling life's difficulties and managing daily stressors. Factors such as problem-solving skills, a positive family environment, and close peer relationships are pivotal in the interaction between mental health and resilience [53, 54].

Building upon the initial results presented in Chapter 1 and the foundations of the diathesis-stress and resilience models, we conducted a more detailed examination of the impact of COVID-19 on our sample. As the pandemic emerged after our study protocol was published, we could only implement minor adjustments to our questionnaire. Initially, our survey included questions related to infection with the virus in oneself or close relatives up to the death of a relative. However, it provided us with an opportunity to further elucidate infection with the virus under the following conditions: Our sample has a very high SES, the data were collected in supposedly high-functioning schools, and psychological distress was measurable but lower than in other studies published at the time. It was therefore interesting to see which protective factors were involved and which worked best to predict this.

The impact of the pandemic will be examined in more detail in the forthcoming paper. Psychopathological abnormalities, COVID-19 virus infection and protective factors, including resilience, are the main criteria of interest.

Paper 2 - International Journal of Environmental Research and Public Health

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Psychopathology, Protective Factors, and COVID-19 Among Adolescents: A Structural Equation Model

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Personal Contribution: As mentioned in Chapter 1, I played a pivotal role in creating the database and collecting the data. For this paper, I conducted the statistical analysis of the dataset, including pre-processing of raw data, and authored the entire Methods and Results section. In addition, I created the graphics for the model. Regarding the development of the theoretical framework and the discussion part, my contribution makes up about 60% of the work. Mr. Christian Seis contributed 30% to the theoretical part, and the remaining shares are divides among the other co-authors.

Furthermore, I independently managed the submission process for this paper and served as the corresponding author. During the revision process, I independently edited 90% of the revisions, in consultation with the other authors.

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Article

Psychopathology, Protective Factors, and COVID-19 among Adolescents: A Structural Equation Model

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Abstract: Since the outbreak of the COVID-19 pandemic in December 2019 and the associated restrictions, mental health in children and adolescents has been increasingly discussed in the media. Negative impacts of the pandemic, including a sharp increase in psychopathology and, consequently, reduced quality of life, appear to have particularly affected children and young people, who may be especially vulnerable to the adverse effects of isolation. Nevertheless, many children and adolescents have managed to cope well with the restrictions, without deterioration of their mental health. The present study therefore explored the links between COVID-19 infection (in oneself or a family member, as well as the death of a family member due to the virus), protective factors such as self-efficacy, resilience, self-esteem, and health-related quality of life, and measures of psychopathology such as depression scores, internalizing/externalizing problems, emotion dysregulation, and victimization. For this purpose, we examined data from 2129 adolescents (mean age = 12.31, SD = 0.67; 51% male; 6% born outside of Germany) using a structural equation model. We found medium to high loadings of the manifest variables with the latent variables (COVID-19, protective factors, and psychopathology). Protective factors showed a significant negative correlation with psychopathology. However, COVID-19 had a weak connection with psychopathology in our sample. External pandemic-related factors (e.g., restrictions) and their interaction with existing psychopathology or individual protective factors appear to have a greater influence on young people's mental health than the impact of the virus per se. Sociopolitical efforts should be undertaken to foster prevention and promote individual resilience, especially in adolescence.

Keywords: adolescence; mental health; psychopathology; protective factors; COVID-19

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1. Introduction

In March 2020, the World Health Organization (WHO) [1,2] declared the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as a pandemic. First detected in December 2019, the virus spread rapidly [3], reaching over 500 million infections and around six million deaths worldwide by July 2022 [4]. Great hope was placed in vaccination, which was available in Germany from December 2020 [5]. The chronology of the pandemic in Germany, including the dominant types of the virus, infection rates, and vaccine availability is illustrated in Figure 1.

In response to the outbreak, countries around the world imposed protective measures such as lockdowns, quarantines, school and workplace closures, social distancing, contact restrictions, and the wearing of facemasks in public. However, these restrictions to everyday life came with a variety of negative consequences [6–8], with current research showing a significant and sharp deterioration of mental health [7–10]. Young people seem to be especially vulnerable to the adverse effects of isolation, as they show a higher risk of developing

mental health problems [11]. A recent meta-analysis examining the impact of COVID-19 on mental health in children and adolescents (mean age = 11.3 years, 49.7% female) found a prevalence of anxiety and depressive symptoms ranging from 1.8–49.5% and 2.2–63.8%, respectively [12]. Longitudinal research has demonstrated a rise in anxiety and depressive symptoms compared to before the lockdowns, with longer lockdowns having a significantly greater impact on mental health in at-risk groups [12]. Another recent study found that exposure to pandemic-related stressors was associated with higher levels of internalizing problems among adolescents during the pandemic [13]. Studies investigating internalizing and externalizing problems have reported that social connectedness represents a protective factor against increased psychopathology [14,15]. Therefore, we sought to take a closer look at depression scores and internalizing/externalizing problems in young people during the pandemic.

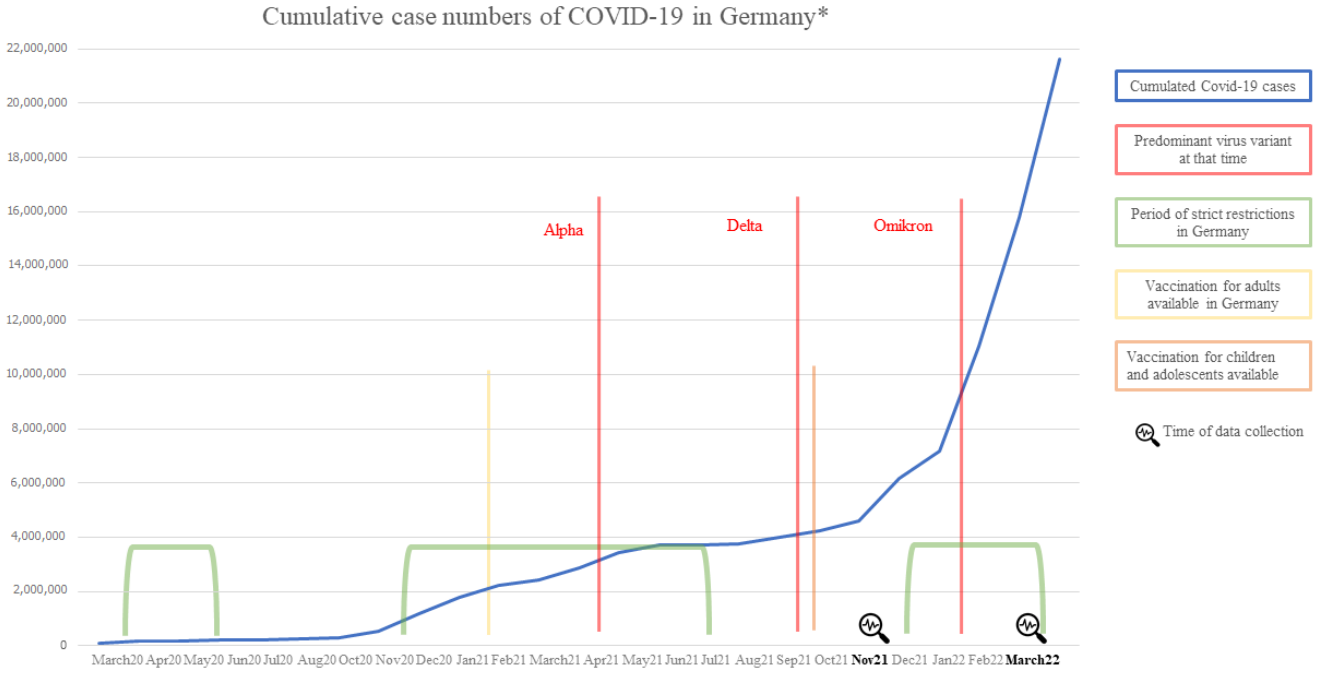

Figure 1. Chronology of COVID-19 in Germany (data based on WHO Health Emergency Dashboard 2022, * Data based on research of the RKI [4]).

Since the start of the pandemic, research has been examining risk and protective factors in adults and adolescents. In a large sample of adults in China, no significant changes in depression or anxiety over time were found [16]. With regard to adolescents, research has reported increased concerns about COVID-19, loneliness, feeling disconnected from friends, and social media use. On the other hand, sport/exercise was found to mitigate the negative effects of the pandemic among adolescent males, as did spending more time with family and friends [17–20]. Compliance with stay-at-home orders and social connectedness during the COVID-19 lockdown have been identified as protective factors for mental health. Early longitudinal evidence suggests that adolescents are more concerned about government restrictions than about the virus itself, and that these concerns are associated with a deterioration of their mental health [20]. Moreover, a Spanish study reported that adolescents who had been infected with COVID-19 were more likely to remain mentally healthy [21]. In the present study, we therefore examined to what extent only infection-specific factors, such as one's own infection, or infection or death in the family, have impacted adolescents' mental health.

Although children and adolescents were generally at a lower risk of infection and less likely to become severely ill with COVID-19 [22], they have nevertheless been tremendously affected by the pandemic, mostly due to the social restrictions [23,24]. Rider et al. (2021) [25]

summarized stress factors that rendered the pandemic particularly challenging for children and adolescents' mental health and well-being (see Table 1). It should be noted that these stress factors do not usually act and occur alone, but rather interact, and thus become amplified, with relevant implications for, e.g., emotion regulation [26,27]. Adaptive emotion regulation with adaptive coping is associated with lower levels of psychopathology. Accordingly, maladaptive coping, such as suppression, avoidance, and denial, has a reinforcing effect on psychopathological symptoms [28]. With regard to COVID-19, studies have demonstrated that emotion dysregulation increases the risk of persistent negative mental health [29] and that reducing pandemic-related stressors and promoting adaptive emotion regulation strategies can exert protective effects on adolescents, especially in times of increased stress [13]. For these reasons, we also included emotion dysregulation in our analysis.

Table 1. Challenging restrictions and stress factors during the pandemic [25].

Problem	Example
Separation, loss and grief	Separation from or loss of attachment figures due to COVID-19 illnesses, no normal way of grieving possible (e.g., ban on funerals).
Social determinants of health	Financial, housing, or food problems caused by the pandemic.
Social isolation, quarantine and loneliness	School closures, loss of contact with teachers, friends, peers, disrupted contact with potential support systems, domestic conflicts and violence, fewer recreational opportunities.
Physical, intellectual, and/or learning disability	Problems accessing appropriate therapies, closure of appropriate facilities.
Disrupted daily and school routines	Higher media use, less physical activity, change in sleep patterns.
Previous traumas	Pre-existing trauma caused by, e.g., caregivers (abuse, neglect).
Previous mental health	Pre-existing psychological impairments and problems in accessing appropriate forms of therapy.

Despite the stress factors (displayed in Table 1), which could have affected all children and adolescents equally, most have managed to get through the pandemic well and have maintained their mental health. Particularly in the case of highly dynamic and stressful events, such as a pandemic, it is essential to better understand the role of protective factors [24,30]. Research has already begun to determine which children and adolescents are at particular risk of deteriorated mental health. Health-related quality of life (HRQoL), for instance, has become a major health outcome examined in epidemiological research in children and adolescents, and reflects physical and psychological well-being, family life, school environment, and peer relations [31]. Girls were found to report a lower HRQoL than boys, especially in adolescence. Furthermore, a low socioeconomic status (SES) and greater mental health problems have been associated with a low HRQoL. In contrast, self-efficacy, self-esteem, and social support are reported to have protective effects on HRQoL [32,33]. For these reasons, we also investigated HRQoL, self-efficacy, self-esteem, and SES in the present study.

In sum, the present study sought to find out more about the effects of protective factors as a consequence of COVID-19 in a sample of adolescents. For this purpose, we used a structural equation model (SEM) [34] with manifest variables based on our dataset and in line with the literature regarding protective factors (self-esteem, self-efficacy, resilience, and HRQoL), the influence of COVID-19 (infection of self and family), and psychopathology (externalizing and internalizing problems, emotion dysregulation, and depression scores). With this model, we wished to gain deeper insights into the complex interplay of these different constructs in order to inform further and targeted research or prevention measures and support this group of children and adolescents.

2. Materials and Methods

2.1. Participants & Procedure

In fall 2021 and spring 2022, 2129 adolescents aged 11–14 years (mean = 12.31, SD = 0.67) were recruited from 18 different high schools in Germany. The utilized data stem from the baseline assessment of a longitudinal RCT called DUDE ("You and Your Emotions", German: "Du und deine Emotionen"). Data collection took place within the aforementioned timeframes and data were not assessed continuously. The participants completed all questionnaires in the classroom under supervision by the study staff, using their own mobile phones or school-owned tablets to access the survey platform REDCap [35]. Inclusion criteria were being in the 6th or 7th grade and the provision of informed consent from parents/legal guardians and the adolescents themselves [36]. The study was approved by the responsible Ethics Committee of the University of Wuerzburg.

2.2. Questionnaires

2.2.1. To Measure the First Latent Variable "Protective Factors"

HRQoL: The KIDSCREEN-10 Index was used to generate the index for Health-Related Quality of Life. It was derived from the 27-item version and operationalizes general HRQoL in the last week. The index has shown good internal consistency (Cronbach's $\alpha = 0.82$) and good test-retest reliability (r = 0.73; ICC = 0.72) [37,38].

Self-efficacy (S_p/S_d/S_a): The revised Regulatory Emotional Self-Efficacy Scale (RESE-R) was used to assess self-efficacy in general, without a given timeframe [39,40]. It contains 12 items rated on a 5-point Likert scale from 1 (=not at all good) to 5 (=very good) and is composed of two dimensions: one for perceived self-efficacy in expressing positive emotions (POS) and the other in expressing negative emotions (NEG). The negative dimension is further subsumed into self-efficacy in dealing with dejection/despair (DES) and self-efficacy in dealing with anger/irritation (ANG). Good internal consistencies have been reported for the individual domains ($\alpha = 0.68$ to 0.79) [39].

Self-esteem (SE): To assess self-esteem, we used the Single Item Self-Esteem scale (SISE; [41]). The SISE includes the item "I have high self-esteem", which is rated on a 5-point Likert scale from 0 (=does not apply at all) to 4 (=applies very much) referring to the last week. The reliability lies at 0.75 [41].

Resilience (Re): The Connor-Davidson Resilience Scale 10 (CD-RS 10, [42]) was used to measure resilience in general, without a given timeframe. It comprises of ten items rated from 0 (=not at all true) to 4 (=almost always true). The items deal with resilience to stressful events such as illness, painful feelings, and stress. A high total score is interpreted as a high ability to recover well from stress.

2.2.2. To Measure the Second Latent Variable "Psychopathology"

Internalizing and externalizing problems (int./ext.): Two subscales of the Strengths and Difficulties Questionnaire (SDQ) were used to assess internalizing problems (emotional difficulties and peer problems) and externalizing problems (behavioural problems and hyperactivity) during the last six months [43,44]. The SDQ is a widely used diagnostic instrument for measuring behavioural problems and behavioural strengths in children and adolescents aged from 3 to 16 years using 25 items (items are rated as "not true", "somewhat true", or "certainly true") [45].

Depression (De): To assess depressive symptoms during the last two weeks, we used the nine-item Patient Health Questionnaire (PHQ-9) [46], which is a screening instrument based on the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV [47]. The items are rated on a 4-point Likert scale, with scores higher than 10 indicating probable depression (range = 0–36). The measure is widely used among adults and has been validated for adolescents, showing good psychometric properties (sensitivity of 89.5% and specificity of 77.5% for detecting adolescents with major depression; Cronbach's $\alpha = 0.83$, rtt = 0.87) [48].

Emotion regulation difficulties (Emt): The DERS-SF [49], an 18-item short version of the original 36-item Difficulties in Emotion Regulation Scale [50,51], was used to assess difficulties in emotion regulation in general without a given timeframe. The DERS-SF shows good psychometric properties, with a Cronbach's alpha of 0.98 for the total score [52].

2.2.3. To Measure the Third Latent Variable "Impact of COVID-19"

Covid-infection (fml/pos): To assess the impact of COVID-19 on the participants, two questions were derived from the Robert Koch Institute (RKI) Corona-Warn-App to measure individual exposure to the pandemic within the last year. Questions were extracted based on how well they fitted our aim of exploring the pandemic's influence on the adolescents within their families [53]. The questions were "Have you tested positive for the COVID-19 virus?", and "Has someone in your family tested positive for COVID-19?".

2.3. Statistical Analysis

As psychology contains many constructs that are subject to measurement error, such as stress or resilience, the analysis of latent variables is recommended [54]. A structural equation model [34] consists of a measurement model with exogenous/manifest variables and a structural model with endogenous/latent variables [55]. To test our hypotheses, we ran a series of structural equation models (SEMs) in R [56,57] using the lavaan package [58]. All analyses were conducted using latent variables for the impact of COVID-19, protective factors, and psychopathology, following similar approaches to those used elsewhere [59]. A key advantage of a latent SEM approach is that it enables one to model measurement error [60].

After checking for normality, multicollinearity, and outliers, and transforming the data (one variable was not linear; we also standardized the whole data frame for easier comparison), we calculated the first SEM model with minimal structure. Cases with missing data were excluded from the analysis (total of missings = 263, distributed across 14 variables). In summary, we constructed two different SEM models. The first contained only the measurement model consisting of three equations and one regression. To the second model, we added three residual correlations to improve model fit. Models were estimated using the maximum likelihood method, which is a rather robust method in the case of outliers (MLM; [61]). To minimize the impact of outliers, we further bootstrapped the final model to obtain confidence intervals. Model estimates were also standardized. p-values smaller than 0.05 were considered statistically significant.

2.4. Research Question and Hypotheses

As outlined above, we examined the impact of COVID-19, protective factors, and adolescents' psychopathology. The hypothesized model is presented in Figure 2. We hypothesized a positive correlation of COVID-19 infection on psychopathology (the more virus, the more psychopathology) and a negative correlation of protective factors on both psychopathology and on the impact of Covid-infection (the more protective factors, the less psychopathology or virus related impact). The manifest variables (see Section 2.2) measured latent variables such as the impact of COVID-19, protective factors (HRQoL, self-esteem, self-efficacy, and resilience), and psychopathology (externalizing and internalizing problems, emotion regulation difficulties, and depression score). With this model, we wished to contrast the complex relationships between the external adversities of COVID-19 and individual internal resilience such as protective factors and measures of psychopathology.

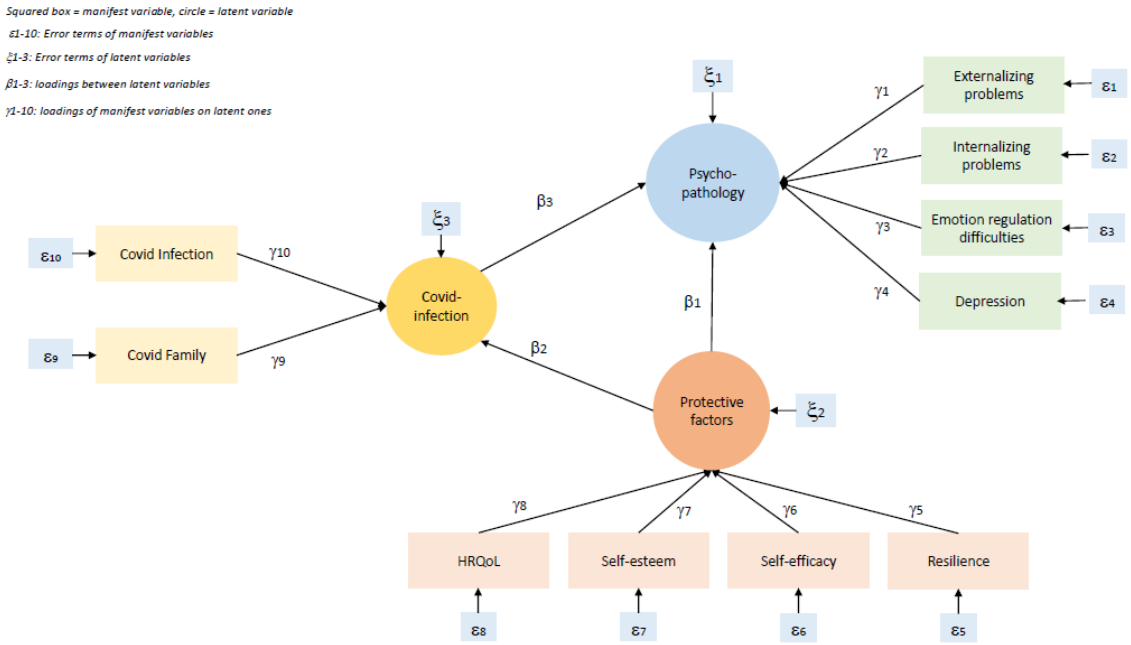

Figure 2. Hypothesized SEM with error terms.

2.5. Measures of Model Fit

In general, a chi-square (χ^2) test is used to assess model quality. This test examines the deviation of the sample variance-covariance matrix from the variance-covariance matrix of the estimated model in inferential statistics. A non-significant deviation indicates acceptable model quality, i.e., a model that fits the data well. However, the chi-square (χ^2) deviation test is very sensitive to the sample size. Since this was the case in our sample (more than 400 cases), we relied on other indices. Specifically, we used the Tucker-Lewis index (TLI) and the comparative fit index (CFI) as incremental measures of quality. These indices compare a null model with the postulated model. Model fit is deemed to be acceptable if the TLI is greater than 0.9, and good if the TLI is greater than 0.95 and the CFI is greater than 0.95 [62,63]. As an absolute index, we used the root mean square error of approximation (RMSEA). A common threshold value for the RMSEA reported in the literature is 0.06, which indicates a good model fit to the data. A value of 0.08 is considered average/acceptable [62]. The standardized root mean square residual (SRMR) is another absolute measure of quality, with a value of less than or equal to 0.08 denoting a good model fit [62,64]. Furthermore, we used the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), with smaller AIC or BIC values suggesting a better model fit. For the improvement of model fit, we included covariances in the next steps.

3. Results

3.1. Sample Description

The sample was comprised of 2154 adolescents with a mean age of 12.31 years (SD = 0.67). A total of 51.1% were 6th grade students, 51% were male, and 12 adolescents stated that they were gender diverse. One tenth of the sample was not born in Germany. See Table 2 for mean scores and standard deviations.

Table 2. Means, standard deviations, and range for the whole sample.

		M	SD	Range
HRQoL (KIDSCREEN-10)		44.68	6.21	0–55
Self-efficacy (RESE-R)	positive emotions (S_p)	4.31	0.82	0–5
	dejection/despair (S_d)	3.65	0.97	0–5
	anger/irritation (S_a)	3.56	1.02	0–5
Self-esteem (SISE)		2.57	0.87	0–4
Resilience (CD-RISC-10)		24.70	6.95	0–40
Externalizing problems (SDQ)		5.93	3.17	0–18
Internalizing problems (SDQ)		5.24	3.28	0–19
Depression score (PHQ-9)		4.75	4.49	0–27
Emotion dysregulation (DERS-SF)		39.30	10.67	0–88
		Yes		
COVID-19	infection (pos)	18.98% (n = 404)		
	inf. family (fml)	46.83% (n = 997)		

3.2. Correlation Matrix

A correlation matrix of the variables included in the SEM is shown in Table 3. The factor intercorrelations indicate positive relationships among the protective factors themselves (HRQoL, self-efficacy, self-esteem, and resilience) and negative relationships between psychopathological factors (externalizing and internalizing problems, depression score, emotion dysregulation, and bullying/victimization) and protective factors. The relationships among the COVID-19 measures indicate the strongest correlation between infection of oneself and infection of a family member. The correlations of COVID-19 measures with protective factors and psychopathological measures were small.

Table 3. Intercorrelation matrix of the manifest variables included in the SEM.

		QoL	Self-Efficacy			SE	Re	Ex	In	De	Emt	COVID-19	
			POS	DES	ANG							pos	fml
HRQoL		1											
Self-efficacy	positive emotions	0.45 **	1										
	dejection/dispair	0.50 **	0.63 **	1									
	anger/irritation	0.46 **	0.51 **	0.66 **	1								
Self-esteem (SE)		0.63 **	0.61 **	0.63 **	0.51 **	1							
Resilience (Re)		0.61 **	0.42 **	0.62 **	0.51 **	0.58 **	1						
External difficulties (ext)		−0.42 **	−0.14 **	−0.23 **	−0.40 **	−0.29 **	−0.35 **	1					
Internal difficulties (int)		−0.60 **	−0.33 **	−0.44 **	−0.37 **	−0.50 **	−0.53 **	0.41 **	1				
Depression score (De)		−0.67 **	−0.33 **	−0.43 **	−0.39 **	−0.54 **	−0.51 **	0.50 **	0.67 **	1			
Emotion dysregulation (Emt)		−0.42 **	−0.14 **	−0.33 **	−0.37 **	−0.34 **	−0.39 **	0.43 **	0.55 **	0.60 **	1		
COVID-19	infection (pos)	−0.01	0.05 *	0.05 *	0.01	0.03	0.00	0.06 *	−0.02	0.03	0.02	1	
	inf. family (fml)	−0.04	0.07 **	0.04 *	0.03	0.03	−0.01	0.08 **	0.03	0.07 **	0.04	0.43 **	1

Note: * indicates $p < 0.05$. ** indicates $p < 0.01$.

3.3. SEM

3.3.1. Final Model

The first model tested (model 1) indicated an acceptable fit to the data according to all criteria: $\chi 2$ (51, N = 2129) = 825.034, $p < 0.001$, CFI = 0.885, TLI = 0.851, RMSEA = 0.084, SRMR = 0.060, AIC = 61,935.813, and BIC = 62,088.725 (note: for all indices, we used the robust parameters/the adjusted parameters). An alternative model 2 was tested including covariances for the three subscales of self-efficacy, which indicated a slightly better fit to the data: $\chi 2$ (48, N = 2129) = 645.790, CFI = 0.919, TLI = 0.889, RMSEA = 0.097, SRMR = 0.050, AIC = 61,519.747, and BIC = 61,689.649. A scaled chi-square difference test (using the method "Satorra Bentler") showed a significant superiority of model 2 ($\chi^2(3) = 97.35$, $p < 0.001$). Given the large number of outliers in the data frame and the fact that not all variables were perfectly normally distributed, we additionally bootstrapped model 2, leading to the following final result: χ^2 (48, N = 2129) = 1045.697, $p < 0.001$, CFI = 0.917,

TLI = 0.886, RMSEA = 0.099, and SRMR = 0.050. All hypothesized paths were significant and in the expected direction, except for the ones between Covid-infection positive and Covid-infection family as protective factors. Our final SEM is visualized in Figure 3.

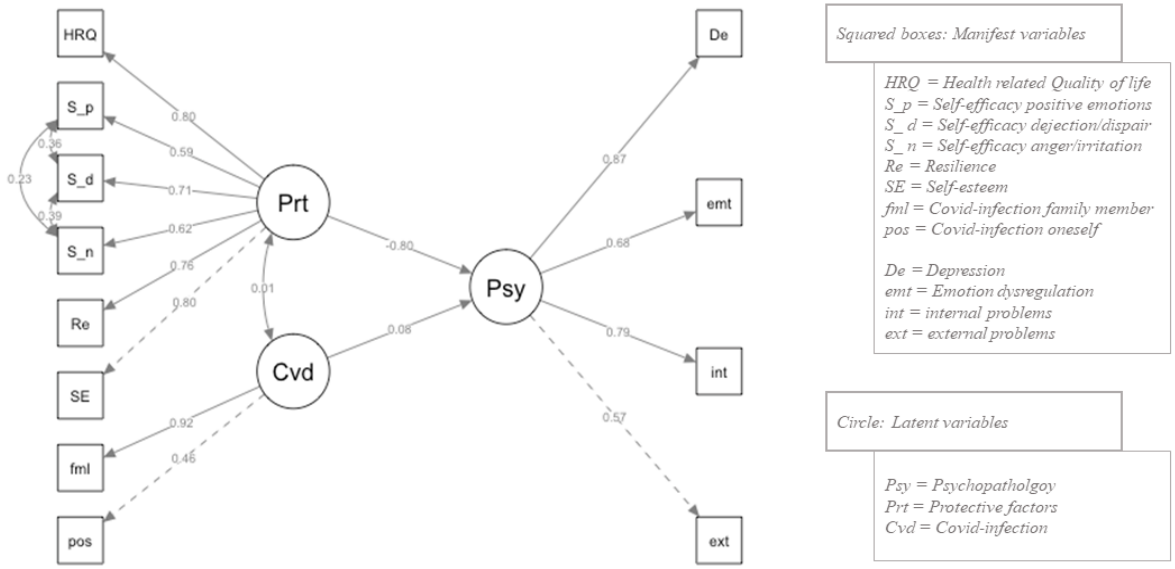

Figure 3. Final SEM path model.

3.3.2. Overall Effects

A significant negative association was found between protective factors and psychopathology (A: $\beta = -0.57$, $p < 0.001$; $r = -0.80$) and a significant positive association emerged between impact of COVID-19 and psychopathology (B: $\beta = 0.10$, $p < 0.001$; $r = 0.08$). Protective factors and COVID-19 were not significantly associated (C: $\beta = 0.04$, $p = 0.68$, $r = 0.01$).

3.3.3. Loadings on Manifest Variables

In terms of the loadings on adolescent psychopathology, this latent variable showed moderate to strong significant correlations with externalizing problems (r = 0.57) and internalizing problems (r = 0.79), emotion dysregulation (r = 0.68), and depressive symptoms (r = 0.87).

The factors self-esteem (r = 0.80), resilience (r = 0.76), self-efficacy (r = 0.62/0.71/0.59), and HRQoL (r = 0.80) also showed strong and significant correlations with the latent variable protective factors.

Finally, the latent variable Covid-infection showed significant correlations with the manifest variables own infection (r = 0.46) and with the infection of a family member (r = 0.92).

4. Discussion

The present study examined the relationship between protective factors and psychopathology as influenced by COVID-19 (infection of oneself or a family member, death of a family member). Using a structural equation model, we found a strong negative correlation between the protective factors and psychopathology in our sample, suggesting that adolescents who scored high on, for instance, resilience or self-efficacy were in good mental health. Despite good loadings of the manifest variables measuring the latent variable impact of COVID-19, it only showed a very small positive correlation with the latent variable psychopathology. This finding is in line with recent research suggesting that adolescents are more concerned about government-mandated restrictions than about the virus itself. Furthermore, this study found adolescents more likely to remain mentally healthy when they are infected with the virus [20,21]. We cannot confirm this finding with

our data; however, only a minority of this sample had a COVID-19 infection. Moreover, the correlation between the protective factors and the impact of COVID-19 was zero, suggesting no mutual influence of these two latent variables. This finding does not confirm our suspected influence between protective factors and COVID-infection, but rather suggests that being infected with the virus is not associated with resilience, self-efficacy, or quality of life. Hence, the observed deterioration in mental health that has started with the outbreak of COVID-19 and the following restrictions might rather be attributed to, e.g., the stress factors summarized and suggested by Rider et al. (see Table 1) [25]. In sum, the restrictions due to the virus, and not the virus itself or virus-related fears, seem to be responsible for the deterioration in adolescents' mental health over the last two years. The pandemic has led not only to social isolation but also to disrupted routines (altered school schedule, sleep patterns, and fewer leisure activities). Children and adolescents have undertaken less physical activity, their media use has frequently increased, and in some cases, they have even witnessed or suffered increased domestic conflicts and violence (perhaps even trauma), resulting in a lower ability to regulate stress and emotions [23,65,66]. However, there is reason to believe that the elevated levels of psychopathology (depression, internalizing and externalizing problems, and emotion regulation difficulties) in the adolescents in our sample are unlikely to be explained by an infection with COVID-19 (self, family, or death in the family). Therefore, it is particularly important to investigate the impact of COVID-19 restrictions on mental health.

In terms of the manifest variable psychopathology and its correlations, we found medium to high correlations between externalizing problems, internalizing problems, depression, emotion dysregulation, and psychopathology. This is in line with recent research suggesting that an increasing number of children and adolescents have been suffering from psychological symptoms since the beginning of the COVID-19 pandemic [67,68]. These meta-analyses mention closed schools and social distancing, among other things, as the main stress factors for families during the pandemic, which have in turn also caused psychological problems in the caregivers [67,68]. The findings are partially consistent with our hypothesis, that the reasons for a deterioration in mental health are not directly related to COVID-19 infections per se and must be sought elsewhere. As described in the Introduction, a number of social restrictions were introduced in Germany during the pandemic, including lockdowns and school closures. School closures were—and remain—a matter of debate in research and politics, as the relative degree of effectiveness and efficiency of this measure, when balanced against the adverse effects on students' mental health and school attainment, remains unclear. A recent study examining school closures and school reopening in Germany during the pandemic [69] reported that especially the youngest of the sample (11–13 years) suffered most in terms of decreased HRQoL and increased psychopathology, which is also in line with findings from Ravens-Sieberer et al. (2021) [24]. In summary, it seems that school routines represent very important coping mechanisms for children and adolescents, specifically those with mental health problems [70], and the long-term effects on these individuals, as well as on young people with no prior mental health issues, should be investigated in more detail in the future.

Looking at our results regarding the protective factor, we see that the correlations between the individual manifest variables are medium-sized (r = 0.45−0.66). The loadings on our latent variable are medium to large (r = 0.59–0.80). From this we conclude that the interaction of individual protective factors could be decisive with regard to salutogenesis and, consequently, future prevention programs. Furthermore, we have to consider that the quality of life, as well as self-efficacy in relation to positive emotions and self-esteem, are quite high in our sample. This could mean our sample was reported to have a rather high quality of life. When looking at the means of external/internal problems, emotion dysregulation, and depression, it seems as if our sample did show very low mental health problems to begin with. Surprisingly, resilience in particular is rather low on average (M = 24.70), because a value of <23 can be considered as clinically relevant [71]. Accordingly, one conclusion to draw for universal prevention is that it might make sense to specifically

strengthen the resilience of students. Targets like coping with stress, to deal with failure, to stay focused under pressure, or to handle unpleasant feelings are recommendations for future prevention trainings, especially in a general and mixed population, which you find at schools. This conclusion is in line with a systematic review of resilience-focused interventions that found such interventions to be effective in terms of reducing depressive symptoms, internalizing problems, externalizing problems, and general psychological distress [72]. Evidently, not only does the timing of the intervention (childhood or adolescence) seem to play a role, but also which specific factors one seeks to strengthen and whom one includes (e.g., the parents). This question of when, who, and how is crucial in terms of prevention. The meta-analysis mentioned in the Introduction of paper [12] identified routines, parent-child discussion/communication/relationship, play, and physical activity as protective factors for mental health during the COVID-19 lockdown. According to the literature, younger boys coped the worst with the pandemic situation [24,69]. Therefore, gender differences should be taken into account in schools and in terms of prevention programs/interventions. Indeed, there is some evidence suggesting different coping and mental health among girls and boys in childhood and adolescence [73,74].

Limitations

Some limitations of the present study should be mentioned. While we focused on protective factors and revealed their relevance in adolescence, we did not analyze factors such as reduced physical activity, limited social experiences, parental stress, family conflict/domestic violence, and so on. Future research should therefore investigate these factors. Although our sample is quite large, with over 2000 adolescents, the age range (11–14 years) and examined region (state of Franconia) are limited. Furthermore, as we collected data at two time points (fall 2021 and spring 2022), our data are likely biased due to differing pandemic-related restrictions at these time points. With regard to our assessment of the impact of COVID-19, our design could have been more elaborate. Rather than using a dichotomous design (infection: yes/no), it would have been useful to ask about thoughts and fears regarding COVID-19, when/how long ago infections occurred, and the severity of illness. This would have enabled us to generate a variable including these aspects and represent interindividual affectedness. In addition, we did not assess any risk factors in our sample, which would have improved this SEM. Considering the assessment of victimization, the reliability of this variable might be decreased in terms of the altered school life at data assessment, plus adolescents were not given a strict definition of bullying/victimization beforehand. Furthermore, we only interviewed students at German grammar schools, which are usually associated with a higher functional level of the students and a higher socioeconomic status. Accordingly, the generalizability of our results is limited. The floor effect in relation to deaths from infection with the COVID-19 virus, as mentioned in the Results section, entails statistical difficulties. Moreover, no causal conclusions can be drawn from our SEM. Longitudinal data that consider changes over the course of the pandemic would be desirable. Longitudinal studies would be appropriate at this point in order to make truly causal statements about an improvement and specific promotion of resilience or self-efficacy.

5. Conclusions

In summary, empirical evidence regarding the consequences of the COVID-19 pandemic demonstrates a strong psychological burden in terms of increased pandemic-related stress, lower emotion regulation ability, increased depression and anxiety, and a lack of social skills training in children and adolescents [9,29]. A recent study with a one-year follow-up found a deterioration of mental health in 15% of participants from before the outbreak of the pandemic to one year later, and those who reported dysfunctional regulation strategies, such as self-harm, binge-drinking, or binge-eating, were more likely to show a worsened mental health condition [75]. Importantly, our analysis did not find any evidence of a direct link between an infection with COVID-19 (self or family members) and

a deterioration of mental health. Future research should therefore rather focus on the personal and individual experiences of the pandemic-related restrictions and the associations with mental health. However, our results suggest that functional emotion regulation, high levels of self-efficacy and self-esteem, and a higher quality of life make adolescents more resilient, enabling them to deal with negative experiences such as pandemic restrictions in a healthier way. To promote resilience in school, a positive student-teacher relationship is essential, as it is associated with fewer mental health problems and also seems to moderate the relationship between cyberbullying and mental health, as well as difficulties in online learning and academic engagement, according to a recent study in China [76]. The latter study also revealed that parents and youth wish for more interactions with teachers and more support from teachers and school psychologists to address the social and emotional needs of students during COVID-19 [76].

There is a clear implication of this paper: Perhaps we need to think of schools more as a company whose staff needs support. A different philosophy and a more modern and innovative culture within the school system could help to promote individual strengths and resources. In particular, contact with and support from parents/guardians and teachers in terms of strengthening protective factors seems to be very important, as well as addressing other issues such as victimization. At the same time, we need to come up with new ways of implementing prevention programs in school. Innovation and more modern, interesting, and appealing transition methods may be key not only to attracting adolescents' interest, but also to changing the image of prevention. Prevention programs do not just need to be conducted; they need be rethought and implemented with sustainability in mind. So far, there is no research exploring the associations not only with effectiveness, but also with longevity and change.

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Summary Chapter 2

The aim of our previous work was to investigate the associations between reported psychopathology, individual protective factors such as resilience or self-esteem, and COVID-19 infection (either in oneself or close family members) in an adolescent sample (n = 2,154) with a mean age of 12.31 years (SD = 0.67) [37]. We were motivated by published articles during the pandemic that stated psychologically affected and socially disadvantaged children were more burdened by the imposed restrictions [55, 56]. We aimed to understand what proportion of the increase in mental health problems among young people might be attributed to COVID-19 infection. Surprisingly, our findings did not support a significant association between self-infection or infection in close relatives and psychopathology or protective factors. Instead, it appeared that the limitations imposed by the virus, such as social isolation, disrupted routines, increase media consumption, an, in some cased, domestic conflict or violence, were more likely contributors to the decline in adolescents' mental health [37]. While we cannot draw causal conclusion due to our operationalization, our evidence suggests that strengthening protective factors can help safeguard the mental health of children and adolescents even in exceptional situations such as a pandemic.

As previously discussed in the introduction of this compilation, prevention research, particularly among children and adolescents, is of paramount importance. Chapters 1 and 2 have underscored the urgency of prevention in this age group due to the high susceptibility to mental health problems. Consequently, universal primary prevention emerges as a vital strategy for achieving the WHO's health management objectives. For a practical illustration of how to enhance mental health in adolescence, please refer to Chapter 3.

Chapter 3: Stress and its relation to mental health

Adolescence is a phase characterized by tasks such as identity formation, academic pressures, navigating conflicts, distancing from parents, and forming/ strengthening relationships with peers [57]. This inherently complex and stressful developmental period has been significantly exacerbated for many young people since the onset of the COVID 19 pandemic [35, 58]. Prevention during adolescence was already of great significance, but with the alarming rise in psychiatric symptoms among children and adolescents during the 2020 pandemic, its importance has become even more pronounced. Schools, serving as natural environments for cognitive and social learning among young people, are particular suitable for implementing universal prevention efforts [38, 59].

In the first chapter, we gained insight into the epidemiological data of a local sample. Chapter 2 utilized SEM to investigate the association between COVID-19 infection and mental health problems/protective factors. Contrary to our hypothesis, our model did not reveal a significant association. However, this finding aligns with the general hypothesis of current research, suggesting that restrictions have a much greater impact on adolescents' mental health than previously assumed. To complete the *Epidemiological-Etiological-Preventive Approach* (EEP-Approach) outlined in the introduction, a universal prevention program is now presented. This program focuses on a fostering effective emotion regulation, mindfulness, and self-compassion to enhance adolescents' of self-efficacy, self-esteem, and overall quality of life, thereby promoting resilience and equipping them to cope with negative experiences [37]. Promoting resilience is crucial for improving adolescents' mental health. Creating a universal prevention program that not only serves as useful but is also engaging for students is a challenge. Addressing the prevalent issue of stress is one approach to capture young people's attention and involve them in universal prevention efforts. Stressors such as academic performance and conflicts, amplified by social media, are increasingly threatening, underscoring the importance of addressing these needs of students [60]. We are all acquainted with stress; it is ubiquitous and particularly prevalent among adolescents. Adolescence is a phase characterized by various challenges, which can be overwhelming. Stress is a complex construct encompassing both physical and psychological reactions, exhibiting interindividual differences and having significant consequences when chronic [61]. It is considered as one of the most potent predictors of mental illness [38, 62], especially during adolescence, where factors like media overstimulation, (cyber-) bullying, and conflicts with parents contribute to its severity [38]. Incorporating improved emotion regulation, along with essential tools such as mindfulness and adequate self-compassion, can be instrumental in managing the everyday stressors. To address these challenges, we must innovate and implement new prevention methods to create a school system that not only educates but also provides support and nurturing.

While there is now global recognition of the importance of mental health, there is still a notable gap in research into the specific extent to which young people experience their lives as stressful, uncontrollable or overwhelming [63]. To address this gap and build on the proven effectiveness of stress prevention programs, I aimed to design a brief, easy-to-implement prevention program suitable for multiple grade levels. Traditionally, mainly programs have been criticized for their time-intensive nature, resulting in significant teaching time loss [64, 65]. Nevertheless, research has shown the positive impact of one-lesson interventions on adolescent well-being, health behaviors [66], and body image [67]. However, most of these programs have primarily increased knowledge about stress without effectively reducing students' self-perceived stress levels [68]. Therefore, *LessStress* adopts a life skills approach that not only imparts psychoeducational content but also equips students with directly applicable skills for their daily lives. In the following chapter, I will present the published study protocol for *LessStress,* a program designed for seamless integration into school routines and adaptable for different grade levels. The effectiveness of *LessStress* is being evaluated in a cluster-randomized controlled trial involving approximately 1,894 students. The outcomes of this study hold the potential to provide valuable insights into students' stress experience and contribute to long-term qualitative stress prevention, enhancing resilience and mental health.

Paper 3: Trials

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LessStress – how to reduce stress in school

Evaluation of a universal stress prevention in schools: Study protocol of a cluster-randomized controlled trial

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Personal contribution: The concept behind this preventive program was collaboratively developed with my mentor Dr. Arne Bürger. My role encompassed several key responsibilities throughout the program's development and implementation. I was crafting the initial drafts of the program, laying the foundation for its structure and content. I also took the responsibility of preparing the ethics application and the comprehensive study protocol. This involved several intricate tasks, such as determining the required sample size, addressing amendments and revisions stipulated by the relevant authorities, and drafting the necessary information letters and consent forms for the study participants. Additionally, I played a pivotal role in the selection of measurement instruments. Beyond this, I entered data into the database, recruited participating schools, and provided support throughout the study to ensure a smooth and effective participation process.

It is important to acknowledge the design department of Wuerzburg University Hospital for their valuable role in providing the final professional design and preparation of the program's materials. Their expertise significantly enhanced the program's presentation and accessibility.

Trials

STUDY PROTOCOL

Open Access

LessStress - how to reduce stress in school: evaluation of a universal stress prevention in schools: study protocol of a cluster-randomised controlled trial

Christin Scheiner[1,2], Andrea Daunke[3], Alexandra Seidel[1,2], Sabrina Mittermeier[1,2], Marcel Romanos[1,2], Michael Kölch[3] and Arne Buerger[1,2*]

Abstract

Background Chronic stress is detrimental to health, and children and young people have had to cope with significantly more stress since the start of the COVID-19 pandemic. In particular, stress at school and in relation to learning is a major problem in this age group. Studies in Germany have indicated that the pandemic has led to a reduced quality of life (QoL) and an increased risk for psychiatric disorders in children and adolescents. Schools are an ideal setting for interventions against stress, which is one of the strongest predictors for the development of psychosocial problems. The present study seeks to address stress by means of a short prevention training programme in schools, including emotion regulation, mindfulness, and self-compassion. In addition to information material for self-study, students should have the opportunity to actively deal with the topic of stress and develop coping strategies within a short space of time. In contrast to very long stress reduction programmes that often last several weeks, the programme is delivered in just 90 min.

Methods The effectiveness of the short and economical prevention programme *LessStress* will be examined in a cluster-randomised controlled trial (RCT) encompassing 1894 students. At several measurement time points, students from two groups (intervention and control) will be asked about their subjectively perceived stress levels, among other aspects. Due to the clustered nature of the data, mainly multilevel analyses will be performed.

Discussion In Germany, there are no nationwide universal prevention programmes for students against stress in schools, and this gap has become more evident since the outbreak of the pandemic. Universal stress prevention in schools may be a starting point to promote resilience. By dealing with stress in a healthy way, mental health can be strengthened and maintained. Moreover, to reach at-risk students at an early stage, we advocate for a stronger networking between child psychiatry and schools.

Trial registration German Clinical Trials Register (DRKS) DRKS00025721. Registered on November 4, 2021

Keywords Stress, Stress reduction, Prevention, RCT, School, Resilience, Emotion regulation, Mindfulness, Self-compassion

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Administrative information

Note: the numbers in curly brackets in this protocol refer to SPIRIT checklist item numbers. The order of the items has been modified to group similar items (see http://www.equator-network.org/reporting-guidelines/spirit-2013-statement-defining-standard-protocol-items-for-clinical-trials/).

Title {1}	**LessStress – how to reduce stress in school** **Evaluation of a universal stress prevention in schools: Study protocol of a cluster-randomized controlled trial**
Trial registration {2a and 2b}.	German Clinical Trials Register (DRKS): DRKS00025721, registration date November 4th, 2021. https://www.drks.de/drks_web/navigate.do?navigationId=trial.HTML&TRIAL_ID=DRKS00025721 https://trialsearch.who.int/Trial2.aspx?TrialID=DRKS00025721
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Name and contact information for the trial sponsor {5b}	Deutsches Zentrum für Präventionsforschung Psychische Gesundheit Julius-Maximilians-Universität Würzburg c/o Zentrum für Psychische Gesundheit Klinik für Kinder- und Jugendpsychiatrie, Psychosomatik und Psychotherapie Margarete-Höppel-Platz 1 97080 Würzburg Telephone: +49 931 201 78000 E-Mail: DZPP@ukw.de
Role of sponsor {5c}	The sponsor or the funding source had no role in the design of this study and will not have any role during its execution, analyses, interpretation of the data, or decision to submit results.

Introduction

Background and rationale {6a}

Background

The negative impact of the SARS-Cov2 pandemic on adolescents' mental health and QoL is becoming increasingly apparent. Recent studies in Germany and Austria have revealed an alarming decrease in QoL and an increase in the risk of developing psychiatric disorders among children and adolescents [1, 2]. School is the natural environment for cognitive and social learning in young people, but several lockdowns and school closures over the past pandemic school years have exerted a strong impact on students' learning: Learning goals have generally not been reached, and students from disadvantaged backgrounds have been especially impacted [3, 4]. The digitalisation of education had been rather hesitant prior to the pandemic, and it remains an enormous challenge for schools, teachers, students, and their parents [5]. It is clear that the past 2 years have led to increased stress for young people, which must be surmounted given the students' increasing knowledge gaps.

One extremely important conclusion that can be drawn from the ongoing pandemic situation is that children and young people are suffering [6–8] due, among other factors, to adverse home conditions, family stress, or mental illness. Therefore, it is essential to provide rapid assistance and to develop and evaluate effective, efficient prevention programmes that are easy to access and implement [6]. As child and adolescent mental health is hugely multifaceted [7], we limit ourselves here to one risk factor of which we are all aware, and with which students have struggled a great deal over the last 2 years: stress [1, 2]. A very broad definition of stress goes back to Hans Selye, a twentieth-century physician, biochemist, and hormone researcher, who said "Stress is the nonspecific response of the body to any demand" [9]. There are many different definitions of stress depending on the context. In the behavioural sciences, stress describes the perception of a threat, which is reacted to with anxiety, emotional tension, and discomfort. Neuroendocrinological stress can be described as a reaction of the body, more precisely the sympathetic nervous system, to release ACTH and adrenal glucocorticoids in response to a stimulus [10]. In the psychological context, it is assumed that the induction of negative affective states (e.g. feelings of anxiety and depression) influences the pathogenesis of physical illnesses [11]. Chronic stress is likely to result in long-term or lasting changes in emotional, physiological, and behavioural responses, which in turn affect susceptibility to and progression of disease, including stressful events such as trauma [12]. The endocrine response triggered by stress is composed of two endocrine response systems that are particularly responsive

to psychological stress: the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic-adrenal medulla (SAM) system [13, 14]. Cortisol as the primary effector regulates a wide range of physiological processes. The repeated and prolonged activation of the HPA and SAM systems can severely impair physiology and is therefore at increased risk for physical and psychiatric disorders [11]. Symptoms associated with stress include loss of appetite, headache, stomach pain, difficulty concentrating, sleep disorders [15], and a decrease in QoL [16]. Stress is perceived differently from person to person, has a cumulative effect, and is seen as one of the strongest predictors of mental illness [15, 17]. A survey of around 230,000 6–18-year-olds conducted by the Kaufmännische Krankenkasse in 2017 [18] revealed a significant increase in mental disorders among children and adolescents with stress being identified as the major issue. Another prospective cohort study reported depression or neurotic and somatoform disorders to be the main disorders comorbid to stress [19]. This finding is supported by a body of evidence conducted in other studies [20–22]. The increased stress in young people pertains not only to school and academic achievement, but also to further factors such as stress with parents (regarding both school and home life), overstimulation by media, bullying in social networks, or general fears, which all contribute to a higher stress perception. School and school-related stress is certainly a major concern, even in elementary school: Young children are vulnerable to stress and show stress symptoms, and it has been identified that girls are more susceptible to stress and are coping differently compared to boys [20, 23]. Stress levels among children and adolescents appear to be higher in more academic school types than in vocational schools [24], and rise during adolescence [25]. With respect to school, and specifically stress caused in school, it is necessary to address and prevent anxiety (separation anxiety, fear of school, social anxiety, and test anxiety) together with the students themselves [26]. Crucially, moreover, stress leads to neurocognitive alterations [27].

But is stress prevention effective and feasible? In a recent study examining the mediating effects of mental and physical health problems on health care costs in a sample of German school ($N = 284$, $M = 16.75 \pm 0.64$ years), Eppelmann and colleagues found that adolescents' perceived stress had a significant effect on overall health care costs. An increase of stress by 1 *SD* increased the chances for costs by an odds ratio of 1.39. This effect was fully mediated by mental health (problems) [28]. Mental illnesses are the second largest cost drivers in the German health system [28, 29].

Prevention research has yielded mixed findings regarding school programmes targeting stress (stress management, coping skills, mindfulness/awareness, relaxation, life skills training): While meta-analyses have found some to be effective [30, 31], other meta-analyses have shown different results [32, 33]. However, due to methodological limitations within these reviews, more research is necessary. So far, the meta-analyses in this area have led to the following major conclusions:

- The tested programmes were quite long (up to 50 min per session over several weeks, 8–30 sessions)
- The frequency of sessions was very high (just 10 min per session but implemented several times a day, or up to 42 times)
- Sample sizes were very low (21 to 323)
- Follow-ups were often missing
- Measurement of stress symptoms was not incorporated
- Not aimed at adolescents of middle-school age
- Lack of internal consistency for the applied measures
- It may be necessary to integrate parents into stress prevention programmes

In sum, while children and adolescents did gain more knowledge about stress and coping with stress, the programmes did not reduce self-perceived stress. One approach is mindfulness at school, which has become highly popular in the USA and the UK, where there are even mindfulness-based apps for teachers and students [34]. A recent stress prevention programme for German students (3× 45 min) revealed significant effects in terms of knowledge gains but no reduction in self-perceived stress between the control and intervention groups, although the students did like the programme and would recommend it [35]. The authors stated that in contrast to their prevention programme, other interventions such as mindfulness-based stress reduction (MBSR) [36], when executed more than 20 times, or a programme lasting for 10 units [37], were effective in stress reduction. They concluded that in order to acquire individual stress coping models, students need more time to generalise to their own situation. At this point, the following question arises: How do the effectiveness, required effort, and practicability of a programme relate to one another? For example, what can we achieve with a combination of psychoeducation and group work? With *LessStress*, we take the approach of conveying knowledge about stress by means of a booklet and targeting stress-coping strategies through one training unit.

Reason for the trial

The COVID-19 pandemic has made the urgent need for stress prevention in adolescence even more apparent. In the field of prevention research, there have long been

calls for more, and especially effective programmes for children and adolescents [38], given the frequent onset of mental disorders in adolescence, the persistence of the disorders, and a particular vulnerability in this age group [39, 40]. We are currently faced with a situation of many children and adolescents with high levels of stress, especially concerning school [18, 41]. Life during the pandemic has significantly exacerbated stressful situations at home and at school. Meta-analyses have demonstrated the effectiveness of stress prevention programmes at schools, but due to the acute nature of the situation, we need to evaluate short, easy-to-implement, and cost-effective programmes [38, 42–45]. *LessStress* differs from the programmes that have been developed and evaluated so far: It saves time and money, is easy to implement in schools, and combines different approaches such as skills-based methods, mindfulness, and preventive measures. In view of the high levels of self-perceived stress among children and adolescents, with the pandemic multiplying the challenges at school, effective prevention is essential.

Objectives {7}

Research hypothesis

The universal prevention program *LessStress* reduces students' subjective stress experience and can thus help to maintain or strengthen their mental health.

Objectives

In order to find out whether the universal prevention programme *LessStress* has a significant impact on students' subjective experience of stress, the intervention group (IG) will be compared with a waiting list control group (WL) in terms of scores on the *Perceived Stress Scale 10* (PSS-10) [46, 47].

We expect that students who take part in the universal prevention programme *LessStress* will significantly benefit, as measured by the primary and secondary outcomes. Given the preventive nature of the programme, we expect to find a decrease in self-perceived stress and fewer mental health problems in the IG after 6 months, which will be assessed with the secondary outcomes.

To test the efficacy, we will collect data using self-administrated questionnaires, which will be implemented within an online survey. The questionnaires are standard instruments in the field of psychology and show good psychometrics properties. Questionnaires remain the means of choice to assess personal states and feelings.

Primary objectives

Self-perceived stress will be assessed using the German 10-item version of the *Perceived Stress Scale* (PSS-10) [47]. We expect a significant decrease for the primary outcome "self-perceived stress" in the IG.

Secondary objectives

In addition to the primary outcome, the evaluation of *LessStress* will include the following secondary outcomes: emotion regulation, self-compassion, sleep quality, depression index, anxiety index, self-injurious behaviour, eating disorder symptoms, and health-related quality of life. To investigate adolescents' resources, we will assess protective and resilience factors (see Table 1 for further details).

Finally, we will record demographic variables (e.g. age, gender) and socioeconomic status.

Aims

The study will be carried out with 1894 adolescents at different schools in the Federal states of Bavaria, Mecklenburg Western Pomerania, and Hesse and encompasses the following aims:

- Improving stress managing skills in students
- Enhancing students' quality of life and their mental health

Trial design {8}

The *LessStress* trial is designed as a cluster-randomised, controlled, non-blinded superiority trial with two parallel groups and a primary endpoint of self-perceived stress after 6 months. We will perform a random assignment on the school level with a 1:1 allocation ratio. The study will last for 6 months and will include four measurement time points: Pre = baseline, Post = student and teacher evaluation, T2 = 3-month follow-up, and T3 = 6-month follow-up (Fig. 1).

Randomisation

Randomisation will be performed at the school level in order to avoid any interclass interference within the intervention and waiting list control group. To reduce bias, we will be supported by a co-worker of the clinic (Hans Aster), who is not involved in this project and a member of another working group (Cognitive and computational Neuroscience), and will perform the randomisation using Microsoft Excel.

Methods: participants, interventions, and outcomes

Study setting {9}

The study will be conducted in the Federal states of Mecklenburg-West Pomerania, Bavaria, and Hesse

Table 1 Overview of the questionnaires being used

Instrument	Content	Length
PSS-10: *Perceived Stress Scale* (primary outcome measure)	Primary objective Developed by Cohen, Kamarck, and Mermelstein, translated and validated by Klein, Brähler et al., 2016 [47]. Investigates the degree to which life was unpredictable, uncontrollable, and overwhelming within the last month. Very good internal consistency ($a = .84$). Positive correlation with depression and anxiety, negative one with quality of life.	10 items
DERS-SF: *Difficulties in Emotion Regulation Scale Short Form*	Measures emotion (dys-)regulation multidimensional. According to the model by Gratz and Roemer [48], the subscales "non-acceptance", "problems with target oriented behaviour", "impulsive conduct problems", "lack of emotional awareness", "limited access to emotion regulation strategies", and "lack of emotional clarity".	16 items
SCS: *Self-Compassion Scale*	The Self-Compassion Scale was developed by Neff in 2003 with 26 items. The shortened version showed satisfactory to good psychometric properties so far [49].	12 items
WHO-5: *WHO Fragebogen zum Wohlbefinden*	The facets of psychological well-being like mood, interest, energy, and drive within the last 2 weeks are assessed. Used worldwide, non-invasive questions, translated in 30 languages, the first version was published in 1998. Very good internal consistency with $a = .85$. German version by Allgaier [50].	5 items
PHQ-4: *Gesundheitsfragebogen für Patienten – Depressionsmodul*	The PHQ-4 is a valid screening instrument for symptoms of depression and anxiety symptoms (Cronbach α >0.80) [51]. Responses are scored as 0 ("not at all"), 1 ("several days"), 2 ("more than half the days"), or 3 ("nearly every day"). PHQ–4 scores go from normal (0 –2) to mild (3–5) to moderate (6–8) to severe (9 –12). Symptoms within the last 2 weeks are being interrogated.	4 items
DSHI-9: *Deliberate Self-Harm Inventory*	An initial question is asked whether someone has already intentionally injured his-/herself. If this is answered with yes, the type, onset, and frequency of self-harm are obtained [52].	1–6 items
ISI: *Insomnia Severity Index*	Measures the quality of sleep and goes back to [53]. Difficulties falling asleep or staying asleep and the impairment they cause in everyday life are in the focus.	7 items
SEED: *Short Evaluation of Eating Disorders*	It obtains the central symptoms of anorexia (underweight, fear of weight gain, impaired body awareness) and bulimia (binge eating, compensatory measures, excessive preoccupation with figure and weight) within the last month [54]. It has already been used in student samples with good experience.	6 items
SFF: *Schutzfaktoren*	This short questionnaire captures three scales of protective factors that correlate significantly with data from the SDQ. Children who have more social, personal, and family resources are correspondingly less conspicuous in the SDQ [55].	12 items
SISE: *Single-Item Self-Esteem Scale*	This 1-item version goes back to the 10-item scale of the Rosenberg Self-Esteem Scale (RSES) developed by Rosenberg in 1965. The original sheet captured self-esteem with 5 positive and 5 negative questions. Recent studies have also demonstrated very good measurement properties for the 1-item version [56]. The question asks how well the statement "I have high self-esteem" applies to oneself. A 4-point Likert scale is then presented.	1 item
CD-RISC-10: *Connor-Davidson Resilience Scale-short form*	The long version was designed by Connor-Davidson in 2003 to measure resilience. Resilience means the ability to cope with internal or external stressors. The CD-RISC is widely used and has good psychometric properties ($a = .84$) [57]	10 items
FAS III: *Family Affluence Scale*	The FAS III measures the socioeconomic status using 6 questions and has very good quality criteria. Furthermore, the MacArthur scale question is connected, which asks about the subjective assessment of the prosperity of the adolescents' own family [58]	6 items + 1

[59]. Due to the broad geographical sample and the wide age range of 12–18 years, we will be able to obtain a well-generalisable epidemiological overview. The number of participating schools or classes cannot be predicted at this stage, for the following two reasons: (1) the pandemic has dramatically increased the stress

	Enrolment	Allocation	Pre	Post	Follow-ups	
TIMEPOINT**	*fall´21-spring ´22*	*winter´21 – sommer ´22*	*Baseline*	*Evaluation programme by students*	t_2 *3 months*	t_3 *6 months*
ENROLMENT:						
Eligibility screen	X					
Informed consent	X					
Allocation		X				
INTERVENTIONS:						
Group A intervention			X	X	X	X
Group B TAU			X		X	X
ASSESSMENTS:						
PSS-10			X		X	X
DERS-SF			X		X	X
SCS			X		X	X
WHO-5			X		X	X
PHQ-4			X		X	X
DSHI-9			X		X	X
ISI			X		X	X
SEED			X		X	X
SFF			X		X	X
SISE			X		X	X
CD-RISC-10			X		X	X
FAS III			X		X	X

Fig. 1 Timetable for the study *LessStress*

and workload in schools, which is associated with less participation in non-school projects. (2) We are focusing on direct contact with teachers, school psychologists, and school social workers to bring the program to their schools, which can lead to more time required for recruitment.

Eligibility criteria {10}

Inclusion and exclusion criteria

Participants must be aged between 12 and 18 years and be in the 6th to 12th grade. We chose this age group for two reasons: (1) The onset of adolescence brings about a clear increase in social, cognitive, and emotional challenges and expectations. Furthermore, neurological and cognitive change processes are underway [60]. Taken together, this can correspondingly increase self-perceived stress. (2) Epidemiological data show that the end of childhood, the beginning of adolescence, and adolescence itself represent the period with the highest risk of onset of mental disorders [28, 61].

Only one exclusion criterion will be applied: lack of informed consent from the adolescents or their parents/guardians. Moreover, we will assess the presence of a psychiatric illness with accompanying psychotherapy in order to exclude these students from data analysis.

Who will take informed consent? {26a}

For the trial, the informed consent of the respective schools' head teachers is required, as well as the informed consent of a legal guardian and of the students. If schools express an interest in participating, a meeting will be organised in order to provide detailed information about the study. In the case of participation, the legal guardians of students in the participating grades/classes will be given detailed written information sheets and will be able to watch an online presentation, in which the study is orally explained. The students will receive posters with information. If students wish to participate, they will provide their written consent by clicking on "Yes, I do want to participate in the study" on the first page of the online survey.

Additional consent provisions for collection and use of participant data and biological specimens {26b}
Not applicable. No biological specimens will be collected.

Interventions

Explanation for the choice of comparators {6b}
In prevention research, a comparison of an intervention group and a waiting list control group is common for ethical reasons [42]. In order to test the effectiveness of a universal prevention program, comparing these two groups seems reasonable and cost-effective. As we will be working with adolescents, we will ensure that every school in the waiting list control group will be offered the intervention directly after the final assessment (6-month follow-up), enabling all adolescents to eventually benefit from the programme.

Intervention description {11a}
Intervention
LessStress - A universal prevention programme in school - was designed by a team of psychologists, scientists, and psychiatrists with a focus on preventing mental health problems in adolescents. The intervention consists of two parts: a 90-min interactive lesson in class, which is combined with a booklet, called *Stresserwizzer*. The 90-min lesson will be presented to the class by school staff, who will receive corresponding training in advance. The lesson is divided into three main topics of emotion regulation, mindfulness, and self-compassion. Students will be given background information (what are emotions, how do we know what we are feeling, how are our emotions linked to our body, thoughts and behaviour, how can we change emotions/what is mindfulness, how can I be mindful in my daily life/what is self-compassion, how can I be more compassionate) and exercises on each topic. All exercises can be done alone or in small groups. Each student receives a workbook that contains information conveyed in the lesson as well as the exercises themselves. An important topic discussed with students is their ability to use skills. The idea is to have the class discuss what they have been doing to maintain their health so far or what they usually do to improve their mood. In a next step, students should think about other things/strategies they could try out in the future. It is important to connect the things they have learned theoretically about controlling their own emotions with things they can apply and integrate into their daily lives. The open discussion in class should also be beneficial to students who have used fewer skills so far and are less integrated in terms of social life. By hearing others talk about their experiences, they might want to try new things. In a next step, mindfulness is discussed, and the students experience different types of meditation. They are asked to think of situations in their daily lives when they have already been mindful and to think of situations to be more mindful in. Following the topic of mindfulness, self-compassion and also the connection to the self-critical inner voice will be discussed (what is the difference between self-pity and self-compassion, do I know this critical inner voice in me, what does it do, how can I deal differently with defeats or mistakes in the future). The main basis of this intervention is dialectical behavioural therapy for adolescents (DBT-A [62–64]) as well as studies evaluating the effectiveness of mindfulness for stress reduction [30, 31]. The aim of this lesson is to (1) convey skills that can help students protect themselves from stress and its consequences using a rather open approach and (2) address the topic of stress in teenagers and stress in school. The "rather open approach" here refers to experiential education content: For the most part, the students need to work out the content for themselves and not be silent listeners (e.g. group work, small-group or the whole-class discussions, and so on). Actively involving the students in the process of the lesson should ultimately enable the content to be better linked and remembered. Particularly regarding the topics emotion regulation and self-compassion, we want the students to experience different strategies and find out what works best for them individually. For most students, it is very likely that *LessStress* will be the first time they have done a mindfulness exercise, as mindfulness is not yet very common in German schools. In addition, students are given a 40-page booklet that contains useful information about stress in general and specifically about stress at school, along with helpful advice about what to do when feeling overwhelmed [65, 66]. This booklet has a modern design targeted at arousing adolescents' interest. Students should read the booklet by themselves, and teachers should refer to the booklet from time to time to bring it back to the students' minds. The posters of the study, which serve to provide information for the students about the purpose and process of the study, also fulfil another task: Through their presence in the classroom, they provide a "daily reminder" and better transfer of the content from the lesson and booklet into students' daily lives.

Criteria for discontinuing or modifying allocated interventions {11b}
All participating schools will be supported by our study team during the implementation of the programme. Experience from other studies conducted in schools has shown that weekly contact by email and telephone is a good way to stay in touch and to clarify questions quickly. Through regular exchange and contact with the teachers carrying out the programme, difficulties should be

detected and corrected in advance in order to improve adherence.

Strategies to improve adherence to interventions {11c}

Adherence

Each participating school (and especially the staff) will receive online training before administering the programme. This training will focus on the implementation of the PowerPoint presentation guiding the lesson and will also refer to the booklet. Furthermore, two to three small role-plays on crises will be carried out to prepare the teachers for all eventualities, such as students reporting non-suicidal self-harm to the teachers or students becoming highly stressed (e.g. starting to cry, needing to leave the room). To check adherence during the intervention, we will ask the school staff to fill out an online survey measuring their adherence to the given instructions. Questions will be asked about the presentation itself, how well students have understood the topics, whether everything was discussed, what questions remained, how easy it was for the teachers, and how well they think the class liked it.

In a next step, this information should be used in order to improve the presentation if necessary.

Relevant concomitant care permitted or prohibited during the trial {11d}

During the implementation phase of *LessStress*, no other prevention programme should be carried out in the participating classes at the schools during the relevant period. Normal teaching and the general curriculum are, of course, allowed.

Provisions for post-trial care {30}

One positive side effect of this trial is the networking between schools and clinicians. We aim to reduce stigmatisation and encourage communication. If any student requires healthcare during or after the study, the Department of Child and Adolescent Psychiatry of Rostock will offer appointments. We are confident that by being present and talking to the schools and students, we can lower the threshold, enabling students to seek help more frequently and faster.

Outcomes {12}

Primary outcome

- Differences between the two groups (IG and WL) regarding self-perceived stress measured with the *Perceived Stress Scale* (PSS-10) [46, 47, 67] at 3- and 6-month follow-ups.
- Scores on the PSS-10 range from 0 = *no stress at all* to 40 = *maximum stress*. We assume a significant reduction in the intervention group.

Secondary outcome

- Furthermore, we assume that adolescents, who show a lack of emotion regulation skills measured with the short form of the *Difficulties in Emotion Regulation Scale* (DERS-SF) [48], will show higher levels of stress, lower QoL, and more mental health problems. The DERS-SF yields a sum score out of 18 items ranging from 0 = *no difficulties at all* to 90 = *extreme lack of regulation strategies*.
- We assume a correlation between self-perceived stress and self-compassion insofar as the more stress students have, the less self-compassion they show. Therefore, we will measure self-compassion with the German short form of the *Self-Compassion Scale* (SCS-SF) [49].
- We assume that a lower subjective well-being (WHO-5) [68] will be associated with higher stress levels among adolescents.

The same patterns are expected for psychopathological measurements such as depressive and anxiety symptoms (PHQ-4) [51], eating disorder symptoms (SEED) [54], and poor sleep quality [53, 69]. In order to verify these hypotheses, we will look at the symptom level itself and will also try to create a "psychopathology-score" (PP score) for each participant. This score will be determined by grouping: For every questionnaire, a scale will be drawn up with three different ratings (normal, abnormal, and pathological) by splitting at the 25% and 75% confidence intervals, with normal = 0 points, abnormal = 1 point, and pathological = 2 points. This way an individual score can be calculated for each participant representing his or her psychopathological level of health/illness. Furthermore, we assume the lower the HrQoL, the higher will be the PP score.

Participant timeline {13}

All participants will be assessed using the full battery of instruments as displayed in Table 1. The data assessment will take place 14–30 days after randomisation. For the intervention group (IG), the universal prevention programme *LessStress* will be administered by school staff within the 21 days after baseline. Post-assessment is due within a week after participating the lesson of *LessStress*. Follow-up interviews, using the full battery of questionnaires, will be conducted at 3 months (T2, 104–120 days) and 6 months (T3, 194–210 days) after randomisation. A 14-day window (± 7 days) will be permitted within which to schedule the time points for T2 and 3. For a graphic overview of the study, please see the flowchart in Fig. 2.

Sample size {14}

To analyse cluster-randomised trials, specific constraints must be followed, as individuals within a cluster are assumed to be more similar compared to individuals from different clusters. In order to detect significant effects, the sample size of the trial must be adjusted. This so-called clustering effect $(1 + (m\text{-}1)\times p$ [m = average number of subjects per cluster; p = intraclass correlation coefficient (ICC)]) resulted in an estimated $N = 1795$. For m, we assumed an average of 80 within an entire grade as the average class size in Germany varies nationwide (21.2–30.4 students per class), and the ICC was estimated quite conservatively at approximately 0.05 [70] on the basis of the primary outcome. Hence, a clustering effect of 4.95 was determined. Assuming a small effect size (Cohens $d = 0.2$) in universal prevention based on previous studies [71], with a significance level alpha = 0.05 and a power = 0.9, g*power suggests a total of $N = 306$ [72]. Considering the clustering effect, we have to multiply this by 4.95, reaching an overall $N = 1515$. Assuming a dropout rate of 25% due to moving out of the area, sickness, or other reasons, we must add another 379, leading to the final $N = 1894$.

Recruitment {15}

The recruitment will take place in autumn 2022. Schools are the most appropriate setting for universal prevention for the following reasons: (1) An adolescent's life is mostly played out at school, (2) compulsory school attendance provides the opportunity to reach a large number of adolescents, and (3) there is evidence that students are more likely to accept such programmes within school than during their free time. The School Boards will help us to get in touch with eligible schools. *LessStress* targets classes from the 6th to 12th grade at public and private schools. Any school

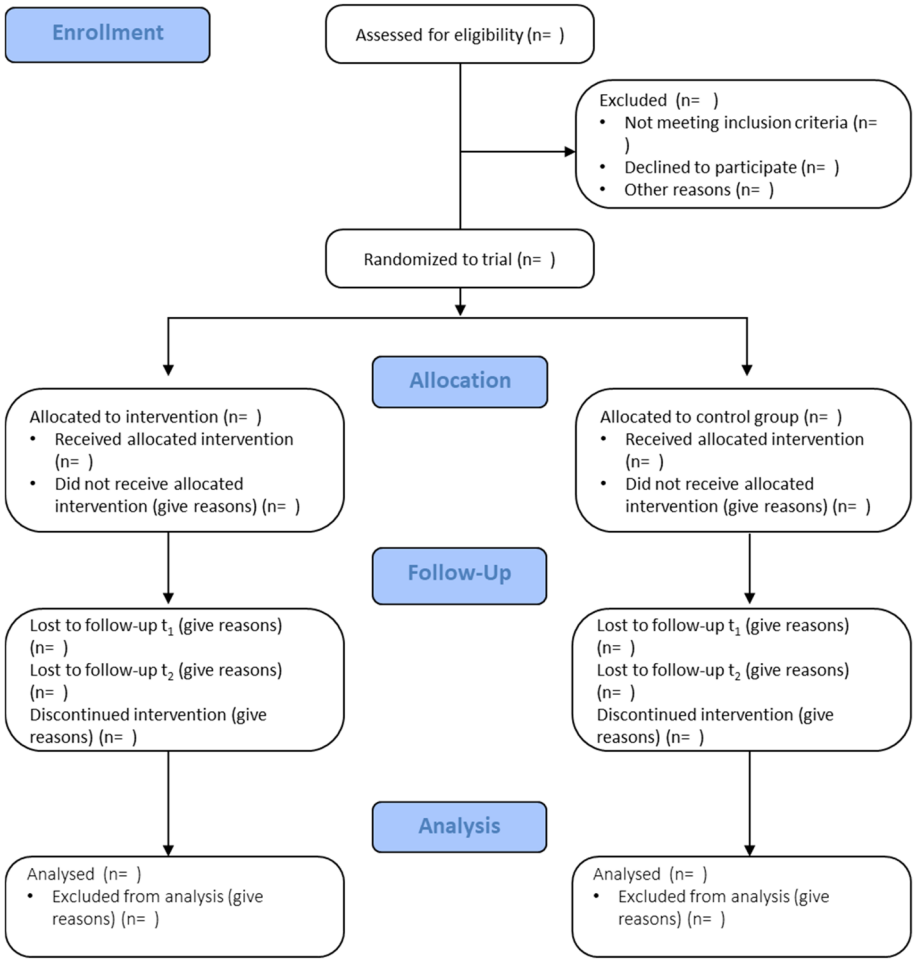

Fig. 2 Study flow chart

principal or council expressing an interest can officially register for potential participation via mail. In a next step, further information material regarding the study will be sent out if required. If schools agree to participate, a letter of consent has to be signed, stating how many grades and classes will participate in *LessStress*.

Assignment of interventions: allocation

Sequence generation {16a}

Participating schools will be randomly assigned to one of the two groups using Microsoft Excel. The randomisation will be carried out on the school level following a 1:1 allocation ratio. This enables interference between the IG and WL to be avoided.

Concealment mechanism {16b}

The schools will be immediately informed about the allocation via mail. For randomisation, we will use Microsoft Excel. To proceed with organising the appointments and the intervention, schools have to know to which group they have been allocated. The allocation will be executed in the presence of a third independent employee of the clinic (SM).

Implementation {16c}

As there are no patients involved in this study, we do not expect a risk of bias associated with the methods of sequence generation and/or inadequate allocation concealment. Schools do have to know in which group they are in, in order to proceed with the organisation of appointments and intervention.

Assignment of interventions: blinding

Who will be blinded {17a}

Due to the study design and the planned intervention, there will be no blinding. Schools need to know the group to which they have been allocated in order to plan and organise the next steps within the study. We do not expect any ascertainment bias shown in the answers to the questionnaires between the two groups.

Procedure for unblinding if needed {17b}

Not applicable. Due to the study design, schools and participants will know the group to which they have been assigned. However, to avoid manipulation of the questionnaires, participants will be unaware of the study hypotheses. The WL control group will merely be told that the intervention will take place in 6 months and that data will be collected in the interim.

Data collection and management

Plans for assessment and collection of outcomes {18a}

Data collection

The baseline data collection is scheduled for autumn 2022, if permission and recruitment are completed in time. The intervention should begin immediately after baseline data collection. During this time, the usual curriculum will be run in the waiting list control group. The post-data assessment will take place within 7 days post-intervention. The first follow-up will take place 3 months post-intervention (spring 2023) and the second follow-up will take place 6 months post-intervention (summer 2023). If permission and recruitment take longer than expected, e.g. due to possible pandemic-related restrictions, we plan to extend the recruitment phase until spring 2023.

Measures- questionnaire

Data collection will be conducted anonymously through a self-administered questionnaire completed on participants' own mobile devices either in school or at home. If no mobile device is available at school, students will either receive a loan device or will be able to use the school's IT room. Each student will generate an individual 12-item code consisting of numbers and letters based on different questions. This code can be used to link data from the three measurement time points without the need for a list combining name and data set, meaning that data security is guaranteed at all times. We have chosen to use mobile devices for the following reasons: (1) careful use of environmental resources, (2) greater willingness and enthusiasm to fill out the questionnaires on the part of the students, and (3) fewer missing data. A list of all questionnaires is presented in Table 1. Each questionnaire has been selected carefully (validated among the target group, sufficient to good psychometric properties, aimed at assessing a targeted construct, no iatrogenic effects known so far, use of an adapted version for adolescents whenever possible).

For the assessment of our primary outcome stress, we will use the 10-item version of the *Perceived Stress Scale* (PSS-10; original by Cohen, Kamarck, and Mermelstein [67], German validation by Klein, Brähler et al. [47]; $\alpha = .84$). The PSS-10 examines the degree to which life seems unpredictable, uncontrollable, and overwhelming, with responses referring to the last month. PSS-10 has been found to correlate positively with depression and anxiety negatively ones to QoL.

Emotion regulation will be assessed using the *Difficulties in Emotion Regulation Scale* DERS-SF [48], an 18-item short version of the original 36-item version [73, 74]. The DERS-SF measures emotion regulation on six dimensions and has shown a Cronbach's α of .90.

To assess self-compassion, we will use the total summed score of the short form of the *Self-Compassion Scale* (SCS-SF) [49]; the original *Self-Compassion Scale* (SCS) was developed by [75, 76]. The original English-language 12-item short form has shown adequate internal consistency (Cronbach's $\alpha > .86$) and a near-perfect correlation with the long-form SCS. Within a German sample and for the German validation, the SCS also showed good internal consistency for the subscales, ranging from .71 to .79 [76].

The *Insomnia Severity Index* [69] was developed by Morin [77] and the German validation was conducted by Gerber [53]. It is a useful screening instrument consisting of seven items, including night-time and daytime components of insomnia. A Cronbach's α of .76 has been reported for boys and girls.

The four-item Patient Health Questionnaire (PHQ-4) is a brief screening scale for symptoms of depression and anxiety, showing good internal consistency (Cronbach's $\alpha > 0.80$) [51, 78]. The PHQ-4 is a combination of the 2-item Patient Health Questionnaire (PHQ-2) [79, 80] and the 2-item Generalized Anxiety Disorder screening tool (GAD-2) [81]. Questions are answered on a scale ranging from 0 to 3 and result into mild (3-5), moderate (6-8), and severe PHQ-4 categories (9-12).

The *Short Evaluation of Eating Disorders* (SEED) [54] consists of six items exploring the main symptoms of anorexia nervosa (underweight, fear of gaining weight, body image disturbance) and bulimia nervosa (binge eating, compensatory behaviour, preoccupation with body shape and weight) within the last month or week. The SEED has previously been employed successfully in school students [82].

The five-item *World Health Organization Well-Being Index* (WHO-5) was first published in 1998 and has been translated into more than 30 languages. It measures subjective well-being and was derived from the WHO-10 [83], which was itself derived from a 28-item version [84]. It is used worldwide, and a recent systematic review found the WHO-5 to be highly clinimetrically valid, sensitive, and specific [85].

To assess the students' self-esteem, the *Single-Item Self-Esteem Scale* (SISE) will be used [86], which has its origin in the Rosenberg Self-Esteem Scale [68] and has been shown to be a valid, reliable, economical, and practical instrument in German samples [56].

To evaluate participants' ability to cope with internal or external stressors, we will assess their resilience, using the *Connor-Davidson Resilience Scale-short form* (CD-RISC 10), which is derived from the long version designed by Connor and Davidson in 2003 [87]. The CD-RISC is widely used and has good psychometric properties ($a = .84$) [57].

To assess protective factors for mental health in children and adolescents, we will use the German Scales for the Assessment of Protective factors (*Skalen zur Erfassung von Schutzfaktoren*) following the suggestions of Bettge and Ravens-Sieberer [55]. The scales have been validated in adolescents aged from 11 to 17 years and proved to be valid and practicable.

To measure non-suicidal self-injury (NSSI), we will use a shortened version of the nine-item *Deliberate Self-Harm Inventory* (DSHI-9), which was used in the SEYLE study. The original version of the DSHI [88] contains 17 items, and the DSHI-9 is an adaptation for adolescents [89]. To avoid confusing adolescents who do not harm themselves, we will introduce the questionnaire with a single question ("Have you ever hurt yourself with the intention of causing yourself physical pain?"). If they answer with "Yes", NSSI will be explored further in terms of frequency, severity, and duration, using the DSHI-9. If they answer with "No", NSSI will proceed to the next questionnaire. The internal consistency for the DSHI-9 lies between alpha = .66 and .85 [90].

In addition to demographic questions, the socioeconomic status will be captured using the *Family Affluence Sale* (FAS; [58] and the MacArthur Scale [91].

Finally, six questions regarding the COVID-19 pandemic will be asked, which explore stress factors, general mood, and well-being in families during the pandemic. These questions are from the Corona Health App, which was developed as part of a scientific cooperation between university partners, the Robert Koch Institute, and software companies (for detailed information, see www.corona-health.net).

Plans to promote participant retention and complete follow-up {18b}

To promote retention throughout the study and maximise the completeness of data collection, we will give monthly feedback to the school heads, the involved teachers, and the participating students. Feedback may consist of a little insight into results of the first data collection, schedule reminders, a newsletter, or small business gifts (pens or stickers).

Should any student withdraw from the study for any reason, he or she must inform us, whether we are permitted to use the data already collected or we should delete it. If deletion is requested, the student must provide us with his/her pseudonym to enable deletion.

If non-retention occurs and more than one follow-up data assessment is missing for a student, this student will not be included in the analysis.

Data management {19}

Data entry

Within the study *LessStress,* all data will be entered electronically. This will usually be accomplished using the participants' own devices (cell phones, tablets, laptops) or they can use devices provided by their school. The data collection itself will take place online using the SoSciSurvey. This software solution is firmly established in academic research, e.g. at the University of Würzburg; the company headquarters are in Germany; and the software is in accordance with the European Union General Data Protection Regulations (GDPR—sometimes referred to as DSGVO in Germany). The data are directly recorded digitally and do not have to be entered separately by hand, which minimises the risk of input errors.

Coding process

Since there will be four measurement time points, the data cannot be collected completely anonymously, but are initially requested pseudo-anonymously. This enables the individual data records to be merged. The complete anonymisation of the data will take place after the 6-month follow-up. A written assignment of code to individual students is completely dispensed with in order to protect data. The data will not be passed on to third parties and the results will not be transmitted by email or post. The ethical and legal aspects according to the declaration of the World Medical Association in the current version will always be observed during data collection and processing.

Data security

The data will be transmitted via a secure network of the University of Würzburg. It will be impossible to assign the devices used to the individual adolescents by storing the IP address. The transmission of the data or the recording and storage of the results of the measurements are subject to a tested data protection concept. The digitally collected data will be encrypted at all times. Only authorised members of the study team will have access to the processes of data collection and monitoring of data processing.

Data storage

The anonymised data will be electronically stored on the servers of the computer centre of the University of Würzburg, password-protected, and deleted 4 years after the end of the study in accordance with data protection regulations. If a participant revokes his/her declaration of consent to participate in the study, the data obtained up to that point will be excluded from further analysis and destroyed, if they are still available in pseudonymised form. However, if the data have already been anonymised, they can no longer be assigned to the students. Accordingly, the data cannot be deleted. The adolescents and their legal guardians will be provided with detailed information in this regard.

Confidentiality {27}

All information related to the study and its participants will be stored securely in either locked files or cabinets. Furthermore, information that contains personal identifiers (e.g. names) will be stored separately. Concerning this trial, there will be no list of names assigned to pseudonyms.

Plans for collection, laboratory evaluation, and storage of biological specimens for genetic or molecular analysis in this trial/future use {33}

Not applicable. There are no plans for the collection of biological specimens and there will not be any genetic or molecular analysis.

Statistical methods

Statistical methods for primary and secondary outcomes {20a}

The intervention group will be compared to the waiting list control group in terms of the difference in change. The data structure will be clustered at different levels (school type, school, grade, class, student), and we must take this into account. To check for the impact of levels, the ICC will be calculated. If the ICC is bigger than 0.1, we will analyse the data using (general) multilevel models. If not, mixed ANOVAS will be performed. First, a null model will be built consisting of the dependent variable and the random intercept. The model fit will be given using the Akaike information criterion AIC. Based on the null model, the independent variables of interest will be included, for the primary outcome self-perceived stress (measured with the PSS-10) and for the secondary outcomes the remaining measure (DERS-SF, SCS, ISI, PHQ-4, CD-RISC, SEED, DSHI-6, SISE, WHO-5, protective factors, FAS III). The AIC will be used to compare the models to one another.

Interim analyses {21b}

Interim analyses are planned for baseline data collection. Epidemiological studies will be reported and, if appropriate, a comparison with data from another region will be explored. The study will automatically end with the last data collection in the last class after 6 months. Access to these interim results and the final decision on the termination of the study will be at the discretion of the study management (MK, AB, CS).

Methods for additional analyses (e.g. subgroup analyses) {20b}

We plan to split all of the participant data into subgroups for comparisons between males and females, different school types, age categories (younger vs. older determined by school grade), and healthy vs. clinically relevant. Depending on the variables, different methods will be used (*t*-test, Wilcoxon test, chi-squared), but we prefer multilevel modelling to explore associations between intervention effects and student characteristics.

Methods in analysis to handle protocol non-adherence and any statistical methods to handle missing data {20c}

If parts of the protocol need to be changed, this will always occur in consultation with the study management and the cooperation partners. The final decision on any changes will be made by the study management. Missing data should be minimised by the online survey. However, if this should occur, the procedure of multiple imputation will be chosen.

Plans to give access to the full protocol, participant-level data, and statistical code {31c}

The datasets analysed during the current study and statistical code are available from the corresponding author on reasonable request, as is the full protocol (note: this is only possible if the school board in charge approves this).

Oversight and monitoring

Composition of the coordinating centre and trial steering committee {5d}

Principal investigator and research physician: Christin Scheiner, Arne Bürger, Andrea Daunke, and Marcel Romanos—design and conduct of LessStress, preparation of protocol and revisions, organising steering committee meetings, publication of study reports, and members of TMC

Steering committee (SC): Michael Kölch, Arne Bürger, and Andrea Daunke—agreement of final protocol, all lead investigators will be steering committee members, recruitment of participants and liaising with the principal investigator [Michael Kölch], reviewing the progress of the study, and if necessary agreeing changes to the protocol

Trial management committee (TMC): Michael Kölch, Christin Scheiner, and Arne Bürger—study planning, organising steering committee meetings, advice for lead investigators, data verification, and budget administration

Data manager: Christin Scheiner, Andrea Daunke, and Marcel Romanos—maintenance of trial IT system and data entry and data verification

Lead investigators: Arne Bürger and Michael Kölch

Composition of the data monitoring committee, its role, and reporting structure {21a}

As the trial will not be conducted in patients or any at-risk group, and as its duration is relatively short (time from the first to last data assessment is 6 months), there will not be a data monitoring committee (DMC). In addition, the trial cannot be modified once the intervention group has started. Of course, after each data assessment, we will check whether everything has ensued satisfactorily. There are no competing interests and the data are independent from the sponsor.

Adverse event reporting and harms {22}

We do not expect any harms caused by the questionnaires or the prevention programme itself. However, we do offer consulting for students who are in need of a higher level of psychiatric care. The Department of Child and Adolescent Psychiatry, Neurology, Psychosomatics and Psychotherapy, University Medical Centre Rostock, can offer appointments locally and the University Hospital of Wuerzburg, Center of Mental Health, Department of Child and Adolescent Psychiatry, Psychosomatics and Psychotherapy, can offer consulting appointments online. Furthermore, the webpage and the brochure every student receives contain numbers of hotlines, where help is available 24/7. If any adverse events occur during the time of the trial, we will collect and document them and report the type of event as well as the managing process. Furthermore, during the training, teachers will be instructed about dysfunctional coping behaviour and how to deal with this in terms of the dialectical behavioural therapy for adolescents (DBT-A).

Frequency and plans for auditing trial conduct {23}

There will be team meetings on a monthly basis within the members of the working group. Audits with the cooperation partners and with the sponsor will take place if necessary, but at the latest after the last follow-up at 6 months.

Plans for communicating important protocol amendments to relevant parties (e.g. trial participants, ethical committees) {25}

Any modifications to the protocol will require a formal amendment to the ethics committee in Rostock as well as the Ministry of Education of Rostock.

Dissemination plans {31a}

We plan to report all results, no matter the outcome following the guidelines of good scientific practice. Furthermore, we will endeavour to give easy access to

the prevention programme *LessStress* for use in other schools.

Discussion

According to the latest figures, over 20 million people in Germany are affected by mental illness (prevalence of 27.8%), including 2.7 million children and adolescents [92]. The goal of universal prevention is to increase competencies within a large population without prior selection. We want to contribute to this through the prevention programme *LessStress*. The advantages of *LessStress* lie in its short implementation time, the integration into normal school lessons, and the easy training of already existing school staff. If effects can be proven, a step would be taken towards keeping children and adolescents healthy in the school setting. If *LessStress* does not prove to be effective, it is important to find out what we can improve to bring scientifically evaluated and effective prevention programmes into schools. At the same time, some of the benefits of *LessStress* should also be seen as limitations. In particular, the short implementation time and the implementation by teachers may influence our outcomes. Moreover, the different schools with different requirements for the students could have a negative impact on this study. However, with our adjusted case number estimation, even small effects will be visible, insofar as they exist.

Trial status

Protocol version 1, 04 November 2021

Start recruitment: 1 October 2022

Approximate date when recruitment will be completed: July 2023

Abbreviations

CD-RISC 10	Connor-Davidson Resilience Scale
DERS-SF	Difficulties in Emotion Regulation Short Form
DMC	Data Monitoring Committee
DSHI-9	Deliberate Self-Harm Inventory 9-item version
FAS III	Family Affluence Scale
GAD-2	Generalized Anxiety Disorder Screening with 7 items
GDPR	European Union's General Data Protection Regulations
HrQoL	Health-related quality of life
ICC	Intraclass correlation coefficient
IG	Intervention group
ISI	Insomnia Severity Index
KKH	Kaufmännische Krankenkasse
MBSR	Mindfulness-based stress reduction
PHQ	Patient Health Questionnaire
PSS-10	Perceived Stress Scale 10-item version
QoL	Quality of life
RCT	Randomised controlled trial
SCS	Self-Compassion Scale
SEED	Short Evaluation of Eating Disorders
SISE	Single-Item Self-Esteem
SFF	Schutzfaktoren Fragebogen (protective factors questionnaire)
WHO-5	World Health Organization 5 items for Well-Being
WL	Waiting list

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Authors' contributions {31b}

CS planned and designed the study. AB and MK initiated the study. MK and MR provided research and statistical expertise in clinical trial design. SM and MR witnessed the allocation process as independent employees. CS wrote the draft. AS developed the booklet. AB and CS revised the booklet. CS, AB, AD, AS, MR, and MK edited the manuscript. All authors contributed to the study protocol and approved the final manuscript.

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Availability of data and materials {29}

All principal investigators will be given access to the cleaned data sets. As this is a multicentre study, only the steering group has access to the full trial dataset. The data will remain on the server of the Data Centre of the University of Wuerzburg, where it will be safe, crypted, and not available for third parties. Any data required to support the protocol can be supplied on request, if the School Board in charge approved this.

Declarations

Ethics approval and consent to participate {24}

The trial ***LessStress*** has been approved by the ethics committee in Rostock (A 2021-0168; August 24, 2021) and the Rostock School Board (AZ: HRO, July 9, 2021). The approval contains all templates for informed consent as well as the questionnaires used.

Access to the protocol and information for the public is ensured through the registration and regular update of the trial in the German Clinical Trials Register (DRKS00025721, registration date November 4, 2021).

All confidential information will be subject to the rules of medical confidentiality and in line with the requirements of the European, Federal, and State Data Protection Act (Europäische Datenschutzverordnung (EU-DSGVO), Bundesdatenschutzgesetz (BDSG), Landesdatenschutzgesetz (LDSG)).

Consent for publication {32}

In accordance with the Declaration of Helsinki, the schools, teachers, students, and parents/guardians will all be adequately informed about the purpose of the trial, its potential benefits and risks, the participants' rights, and data safety. The final drafts are only available in German. No identifying images or other personal or clinical details of participants are presented here or will be presented in reports of the trial results.

Competing interests {28}

The authors declare that they have no competing interests.

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Publisher's Note

Summary Chapter 3

Living in today's world, it is common place to encounter daily stressful situations, and the concept of being entirely stress-free is beyond most of our imaginations. Biologically, stress is influenced by a combination of genetics, epigenetics, the number of stressful situations, and the frequency and duration of stress exposure. Stress triggers the activation of the hypothalamic-pituitary-adrenal axis (HPA), leading to the production of glucocorticoids that bind to receptors in our brains, affecting our behavior [69]. Even though this is an automated bodily process, we can modify the neurological response. For instance, individual perception, coupled with the ability to articulate stressful situations accurately, can enhance one's capacity to manage negative emotions and minimize their experience of stress [70, 71]. Emotion regulation influences social skills and the development of psychological problems and can explain comorbidities between different disorders. Therefore, strengthening adolescents' ability to regulate emotions is a key strategy for enhancing resilience.

LessStress is a preventive program designed to improve stress regulation, with a particular focus on emotion regulation, mindfulness, and self-compassion. Given its brevity and the user-friendly approach, achieving nationwide implementation of *LessStress* in various types of schools would be highly desirable. Such an endeavor could prompt transformation in school philosophy. Modern prevention should extent beyond the mere executing of programs and student training. It should evolve into a new approach that unites school management, staff, and students, ultimately leading to lasting changes. Mental health offerings, such as mindfulness exercises, meditation rooms, expanded psychology courses addressing specific symptoms, an open approach to discussing mental health problems, and user-friendly support for those in need, could be established.

Status of the trial

To date, data collections have been completed for approximately 600 students. Based on current recruitment rates, it is expected that the calculated sample size will be reached by the end of summer 2024, which is crucial for detecting potential effects. The sample currently consists of N = 697 students with an average age of 16.1 (1.9) years, ranging from 11.5 to 25.7 years. Among the participants, 49.2% attend a Gymnasium, 23.5% a Gesamtschule and 11.2% a Realschule. In terms of their home state, 30.7% come from Baden-Wurttemberg, 27.9% from Hesse and 24.8% from Mecklenburg-Western Pomerania. The distribution between the intervention and control group is 42.8% and 30.6%, respectively. However, it is worth noting that a significant proportion of students (25.8%) indicated that they were unsure about their group assignment.

Discussion of the compilation

Summary of studies

In my compilation, I first looked at the mental health status of adolescents in the region of Franconia. As early adolescence seems to be of significant importance with regard to the onset of affective disorders [16], students in the 6th and 7th grades of secondary schools were studied in a cluster RCT. It was noticed that the prevalence estimates of this sample are high, but lower when compared to global studies [35]. Possible explanations for the lower prevalence estimates could be the high and homogenous SES of this sample, which is known to be a protective factor and further, we assume that at secondary schools such as the ones participating, the students' level of functioning is significantly higher compared to other types of schools, resulting in an improved emotion regulation. Nevertheless, 30% of the students had reported suicidal thoughts, which is alarming considering the mean age of only 12.34 (SD = 0.65) years. This finding might reflect a short-term reaction to the restrictions of the COVID-19 pandemic, indicating worries at the time of data assessment. In addition, we were able to confirm the hypothesized gender difference, showing that girls are significantly more affected by depressive symptoms or symptoms of eating disorders [35]. Beyond this well-known gender-shift in mental disorders in adolescence [40], our data indicated distinct problems among girls when considering problems with hyperactivity/ attention deficits. This finding is rather counterintuitive, as usually boys are known for regulatory problems, being reflected by a much higher prevalence rate of attention deficit hyperactivity disorder (ADHD) diagnoses [72]. Hence, we assume due to girls' socially adjusted behavior, teachers and parents often do not recognize problems related to attention control in girls. Missing out on detecting problems at school, stress among girls might reinforce rumination and depressive symptoms, which are very common in female adolescents [73]. Future research therefore needs to explore possible moderating or mediating effects in this field to invent tailored and effective prevention particularly for young teenage girls.

The sample we studied showed a general pattern of mental health problems. Hence, we wanted to shed more light on the connections between the pandemic and other possible risk and protective factors. Therefore, we set up a SEM that revealed no significant association between psychopathology and an infection with COVID-19 or the infection of a close family member with the virus. We consequently hypothesized that adolescents' increased psychiatric distress was rather provoked by the ongoing restrictions, together with the reduced ability to regulate one's emotion and the social isolation, than by the virus itself. Yet, with our data obtained (cross-sectional), we cannot answer this question. Positive about our SEM was the fact that protective factors such as resilience, self-efficacy, and self-esteem were negatively associated with psychopathology [37]. Derived from our findings we concluded that targeted prevention is needed, especially in the area of children and adolescents, which is not only scientifically

evaluated but can also be applied more flexibly in our school system. Enhancing protective factors, enabling children and adolescents to better regulate their feelings, should be a major goal for the upcoming years [74]. Based on this assumption, I finally presented a study protocol of a universal prevention program I designed due to the pandemic related situation: *LessStress*. It aims to reduce one's own stress experience in the shortest possible time on the basis of adaptive emotion regulation, self-compassion, and mindfulness, and to find a mentally healthy way of dealing with it using appropriate skills.

In the following part of the discussion, I would like to introduce new and recent information, trying to give a broader and different perspective on mental health in adolescence. At the same time, I'd like to put my research in a broader context including the pandemic and its consequences.

The impact of the Lost Generation

The term 'Lost Generation' has gained widespread recognition in relation to the COVID-19 pandemic that began in 2020. The current young generation, transitioning into adulthood, faces not only the pandemic but also concerns related to the economic situation with inflation, the Ukraine war, and climate change [75]. This generation experiences a notable decline in perceived mental health, compounded by a perception of political stagnation. A generation survey (n = 6247) [76] presented at the Congress of the European Society for Child and Adolescent Psychiatry (ESCAP) in 2022, revealed that 19% Generation Z in Germany (currently in the transitional age between adolescence and adulthood) rate their mental health as poor or very poor [75]. Gender differences show that 15 % of young men and 23% of young women in Germany describe their mental health as poor or very poor. The prospects for this generation seem less rosy considering that this particular phase between 18 and 29 years, also known as emerging adulthood, brings many demands and changes with it [77, 78]. If every fifth individual of Gen Z describes its mental health as poor or very poor, what implication does this have for our socio-political future? Apart from the fact that around 10 million young adults in Germany [79] report poor mental health and are at risk of developing a mental disorder, there is an even younger generation, which is not only being burdened by COVID-19. As my research among adolescents has revealed, students in early adolescence often experience mental health challenges. Additionally, the literature on stress indicates a significant increase in stress levels during this period, largely attributable to school-related and academic pressures. My research over the past three years, which has included interactions with schools, staff, and students. Provides further confirmation of these findings.

Consequently, this prompts the question of how to address this situation in the future. My findings partially confirm the existence of poor mental health. We observed abnormalities in psychopathology within our sample, even though it comprises individuals with a high SES, which is typically linked to a higher quality of life. Regrettably, I am unable to make specific assertions regarding current concerns or sensitivities. Hence, I propose a more comprehensive and contemporary approach to epidemiological data collection, one that is engaging for young participants. The use of an online portal where users can create accounts and participate in surveys at regular intervals, allowing for the collection of longitudinal data. Users would receive periodic prompts to complete life-related questions, addressing topics such as current fears, future outlook, and their impact on mood and behavior. Additionally, it would explore the fluctuations in hopelessness and negative emotions over time, examining their connection to generational conflicts. To enhance the relevance of the data, prompts would be synchronized with chronologically coordinated media events. For instance, data could be collected to gauge sentiment shortly after major news events, such as 'widespread fires' or 'global catastrophic storms'. Through these longitudinal surveys, we could obtain well-controlled insights into the mental stat of specific groups, complemented by concise screening instruments like the 4-item Patient Health Questionnaire (PHQ-4) [80]. Incorporating questions related to skills, protective factors, and screening instruments into the dataset could provide another rich source of epidemiological insights. These insights, derived from the comprehensive EEP-Approach (see introduction, vulnerability in adolescence for further details), could prove instrumental in addressing the deficiency in valid epidemiological data. Furthermore, this approach has the potential to facilitate the development and implementation of highly effective preventive intervention programs.

The influence of COVID-19

On June 2, 2020, ministers and senators in the German Bundestag reached an agreement to restore normal school operations as quickly as possible, recognizing every student's right to education. The federal states planned to address potential learning deficits by advancing digitization and implementing hygiene and protection plans in schools [81]. Unfortunately, Germany fared poorly in a European country comparison, experiencing the second-longest school closures and ranking last in terms of online learning platforms and resources for digital devices in the classroom [82]. Furthermore, the learning time for schoolchildren was significantly reduced during the school closures (from 7.4 to 3.6 hours per day), which had a negative impact on their career expectations and future income [83, 84]. There was a substantial disparity in extracurricular home learning between students with lower academic performance and those with higher academic performance. When considering the sample assessed in both the first and the second papers, it is noteworthy that the SES was relatively high, with a mean of 10 (*SD* = 1.9, range). This partially explained the well-being of this sample and that this sample coped

with the situation comparatively well. Underperforming students faced extreme challenges in self-regulated learning at home, with decreased self-regulation during school closures [85]. Moreover, the school closures had severe psychological consequences, including increased anxiety, depression, and feelings of isolation among two-thirds of children and young people [86]. They reported a reduced quality of life compared to before the pandemic, and mental health problems approximately doubled [55]. Socially disadvantaged children, in particular, experienced heightened stress due to the pandemic [49]. Medical and psychotherapeutic care deteriorated during the COVID-19 pandemic, despite increased demand for such services [33]. States and schools made efforts to support and address the mental health needs of young people. However, access to counseling services remains often restricted and stigmatized, and resources within schools themselves are limited [87, 88].

How can we address the long-term consequence of the pandemic that may not be fully apparent yet? Previous pandemic waves [89] have shown that measures such as quarantine, fear of infection, frustration, boredom, inadequate information, financial losses, and perceived stigma have contributed to deteriorating mental health [56]. The recent disruptions to the lives of children, adolescents, and their families during the COVID-19 pandemic, which resulted in heightened psychological challenges [90, 91], elevated the risk of mental health issues in children and adolescents from 18% to 31% during the COVID-19 crisis [38, 92]. The COVID-19 pandemic acted as a multidimensional stressor intensifying psychological challenges and simultaneously restricting conventional coping mechanisms such as socializing with friends or participating in sports. To better understand the underlying mechanisms, a more comprehensive scientific investigation is needed to develop precise predictive models. In Chapter two, we found no influence of infection. Other papers describe connections with the SES, migration background, and protective factors such as positive affect [32, 93-95]. An overarching model that integrates both the infection-based and socioeconomic approaches would be desirable. The ultimate goal of such a thorough investigation is, of course, to enable effective prevention. What can we do before the next pandemic arrives? How can we equip future generations to tackle the rising incidence of mental health issues in this age group? This requires not only a deep understanding of potential prevention targets, such as early intervention programs, but also a comprehensive reform of our sociopolitical system [96, 97]. Particularly, access to timely and high-quality psychiatric care is lacking for adolescents and young adults [98], despite adolescence being a pivotal and formative period. The mental health needs of young people share commonality and are based on fundamental principles and design features.

Treatment and therapy

Mental health issues such as depression and anxiety in children and adolescents present a significant challenge for our society, as they can have profound consequences for their well-being, development,

and future prospects. Adolescence is a pivotal period in overall growth, marked by numerous changes and challenges that individuals must navigate [99]. Only about every fifth child or adolescent with a mental health disorder receives adequate professional treatment [100]. Long waiting times for mental health care were a concern before the pandemic, but they have increased dramatically since the outbreak of COVID-19 [101]. Moreover, the duration of therapies has significantly increased, resulting in longer waiting times and placing additional strain on the healthcare system [102]. Another problem in addition to the supply shortage is the discontinuity of the helper systems when reaching the age of majority. A pioneer in counteracting the loss of support experienced by adolescents and young adults upon reaching the age of majority is the *Heidelberg Early Intervention Centre*, which provides interdisciplinary care for adolescents and young adults with mental disorders [103]. The Early Treatment Centre provides services on an inpatient, day-care and outpatient basis. In addition to the Mobile Reference Person System (MBS), a form of outreach treatment that accompanies patients through all phases of treatment, ensuring continuity of staff to stabilize the support system plays an important role in crisis management and relapse prevention. The cooperative center consists of the departments of general psychiatry and child and adolescent psychiatry and treats patients aged 14-28 with mainly schizophrenic and affective disorders (16 full inpatient and open treatment places, 3-6 partial inpatient places, pre-/postinpatient and outpatient treatment places, postinpatient mobile support system) [103]. Maintaining close contact with general practitioners, ensuring prompt admissions, and offering flexibility in the treatment setting are core principles of a service designed to be as accessible as possible. Patients' needs are matched with treatment goals through a modular concept of therapeutic services. The Heidelberg Early Treatment Centre can be seen as a blueprint for the future of psychotherapy. This center is a pioneer of modern health care, but unfortunately it is the only one of its kind in Germany. In order to complete the concept of comprehensive mental health support, a preventive extension would be desirable: more contact with the local schools, regular workshops, raising awareness of mental health, making people aware of possible points of contact, reducing fears and prejudices. Of course, this additional pillar requires human and financial resources, but in terms of the health of children and adolescents it is a sensible and worthwhile idea, especially in view of the high health care costs for chronic and secondary diseases. The focus on early detection and intervention in psychiatric disorders is well established in other clinical areas. In the field of psychiatry, early intervention can prevent serious long-term consequences of chronic conditions, leading to improved functionality and quality of life over the long term [104]. Future prevention research could consider using surveys to identify potential barriers in our health system and seek proposed solutions within the adolescent population. Surveys among patients are meanwhile an integral part of quality management in most clinics. But what about surveys in the general population, what about the specific needs of adolescents? To obtain valuable results, it is essential to consider the generalizability of the data. Different school types, locations, and social classes must be included to obtain a comprehensive picture

that can inform practical strategies within our health system. Adolescence is a critical period because manifest and severe mental illness can jeopardize the attainment of crucial developmental milestones and have lasting impacts on one's life and health. The WHO's recommendation to prioritize youth mental health as a central component of health policy is crucial for addressing mental illnesses [104]. Based on these findings, the universal prevention program *LessStress* was developed to help adolescents find a functional way to deal with stress. Health promotion and education on topics such as emotion regulation, mindfulness and self-compassion are indispensable components for strengthening the mental health and resilience of adolescents. The flexible and inclusive approach of *LessStress* can effectively address the specific challenges faced by various age groups, ideally motivating at-risk young individuals to initiate positive changes or seek assistance for their behavioral adjustments. When discussing universal prevention, which encompasses everyone, it becomes possible to avoid issues related to the selection and recruitment of participants as well as the stigmatization of individuals [105]. Furthermore, children and adolescents with more adaptive skills can serve as models for those with corresponding deficits in school. It was argued more than ten years ago that universal programs can have enormous effects on society through a multitude of small effects on a larger number of participants [106].

However, one major factor hindering young people from seeking assistance is a reduced or non-existing tendency to seek help for mental health issues. Rickwood and Thomas [107] define help-seeking for mental health problems as "*an adaptive coping process that is an attempt to obtain external help to manage mental health problems"* [p. 180, 12], such as health services or friends and family. However, only about 30% of young people who experience mental problems actually seek professional help [33]. Reasons given for this reluctance include stigma and negative beliefs about mental health services and professionals [108]. Factors that can facilitate help-seeking may encompass emotional literacy, knowledge, positive attitudes towards seeking professional help, social encouragement, and the easy and availability of established and trusted relationships with professionals [109]. Approximately 44 % of Generation Z in Germany who experience mental illness themselves report self-stigmatization. Positively, nearly 58 % of Generation Z in Germany reported that they did not engage in discriminatory behavior towards individuals with mental illness. However, German schools exhibit the highest levels of stigmatization related to mental illness internationally, with a rate of 71% [76]. This highlights the urgent need for reform in our education system and our politics. Additionally, young people perceive our care system as challenging to access. According to the study, there is a lack of sufficient low-threshold care services for young people in the transitional age, emphasizing the need for political changes. In order to bridge the gap between those who navigate crises well and demonstrate greater resilience, and those who are disadvantaged from the start, it is not solely the responsibility of psychologists and doctors.

Instead, addressing this gap requires the implementation of a comprehensive political strategy on a national scale [110]. In addition, ensuring adequate support, especially for young people at-risk such as individuals who engage in NSSI, is one of the greatest mental health challenges of our time [111]. Preventive measures may involve giving more attention to young individuals outside the educational system [112, 113]. There is a need for further normalization of mental illness, its inclusion in the school curriculum, universal prevention in every school year with different focuses, more promotion of apps, informed parents and professionals who can educate and advise.

Digitalization and Tele-Therapy

One possible idea to start the journey of implementing new preventive measures is digital media. Digitalization is advancing; there is no young person without a mobile phone anymore. Throughout our data assessments, it became evident how proficient adolescents are using mobile phones and tablets, and their eagerness to utilize these devices. Students were disappointed if they could not use an electronic device due to technical issues. Considering this, one promising approach to improve out health care system could be apps or online platforms to basic services, which can be easily accessed and that give digital support [97, 98]. With regard to the question of whether profitable psychoeducation can take place using an app, for example, there is evidence that the use of digital media supports the learning of rather passive content [114]. The type of media device being used (e.g., mobile phones, tablets, or computer) as well as the topic play a role in the effectiveness, whereby the use of media seems to be particularly favorable if content can be presented in a more understandable way. Although mental health problems are common among young people, many are afraid to seek help or talk openly about their mental health. The stigma surrounding mental health and the fear of being judged or labelled as 'weak' or 'crazy' can prevent young people from seeking the help they need (the National Institute of Mental Health in the United States). Downloading an app can be especially beneficial for those at risk. When talking about digitalization it just makes sense to use digital media (devices) to inform students about dangers, risks, symptoms and offers of help. To give an example for effective school-based prevention and using digital media at the same time, research showed that exergaming is a suitable tool to influence elementary students' physical fitness positively by just using the game 20 minutes twice a week [115]. Another positive example is the use of hybrid digital prevention, resulting in a significant increases in health knowledge, skills knowledge, and life skills [116]. Digitizing *LessStress*, such as through the development of a mobile app, could also be a viable option. Short daily questions such as *"How stressed are you?"* or *"Do you feel good today?"* could illustrate the personal stress level over a period of time. There are various exercises, including instructions that are based on mindfulness and self-compassion. You could save your favorite exercises like meditation and access them again and again. Furthermore, one can integrate a quiz that playfully queries and thereby promotes knowledge

about stress and mental health. All in all, this would be a very appealing approach that considers the needs of young people and their use of smartphones and, after tested in an RCT and its scientific evaluation, might have a preventive effect at the same time. Nevertheless, there remains a research gap in the field of digital prevention of efficient and effective digital prevention programs in educational settings.

One aspect not to leave out when considering digitization and new media is the fact that they bring both a blessing and a curse. In other words, today's youth is a digital generation that has more skills in using technology, but at the same time is confronted with the endless possibilities of the world wide web, which is often accompanied by excessive demands and social difficulties in using it. Keywords here are cyberbullying or TikTok challenges, which even ended fatally. Recent research has highlighted the impact of social media and technology on stress and mental health in adolescents [117]. Our German school system has evidently fallen short in providing adequate media literacy education, including guidance on recognizing warnings and responsible media use. However, it is often not only teachers who lack the necessary competence and knowledge about new media, but also parents. Preventive measures for teachers and parents represent another important pathway, which unfortunately receives far too little attention. Social media in particular are developing so rapidly that regular information and psychoeducational content addressing the use and dangers would make perfect sense for these two target groups. Teaching a healthy use of smartphones and social media at home by parents, and by monitoring and supervising their screen time, a new but very important protective factor for the mental health of adolescents could be addressed. This is line with recent research demonstrating the importance of valuable parent-child discussion as a protective factor during the pandemic [118]. After all, there are studies that have been able to show that an increase in screen time is associated with increased incidence and severity of mental health issues and addictions such as self-harm or depression, and a lower level of self-esteem with girls being significantly more at risk [119-121]. A study involving data of 38 countries stated that prolonged screen use is positively associated with school stress and inversely associated with school satisfaction [122]. In short, it seems the more time adolescents spend ‘online’, the more stressed they feel and the lower their mental health is. Hence, clear guidelines and rules for media use are imperative; however, many parents either be unaware of these risks or choose not to enforce them at home. Speaking of prevention at home, what is it that teachers could do to improve (social) media use among their students? For instance, there could be a mandatory class once or twice a week, focusing on currently popular apps like TikTok or Instagram, where topics such as data safety are discussed using relatable stories. In Germany in particular, teachers need training to improve their knowledge and technological skills. This training would enable most teachers to address this topic

effectively in the classroom, and the long-term inclusion of a 'digitization class', similar to mathematics, would be sensible.

At the same time, there are multiple advantages as well, that could be used for prevention, information, and support: all of these things could be offered in a very low-threshold and easily accessible way. Maybe specialized teletherapy or tele-counselling could be an attractive approach, both for students as well as for schools. In the future, video and telephone consultation hours could be provided and their offer should be clearly communicated [123]. Teletherapy indeed gained new attention during the pandemic. The advantages are clear: no need for travel, no parking hassles, easier appointment scheduling, and the ability to access help during lockdowns. However, its effectiveness is often questioned by professionals as well as the general population. A recent meta-analysis [124] compared the effectiveness between teletherapy and face-to-face therapy. It was shown that teletherapy led to a significant reduction in symptoms after treatment and at follow-up. These results are promising and provide a strong foundation for expanding teletherapy services to address long-term supply gaps. Schools, school psychologists and school social workers were already very important before the pandemic and have been under constant stress ever since. With regard to *LessStress*, online consultation hours could take place around the topic of stress after corresponding proof of effectiveness. The possibilities are extensive. Alongside open meetings featuring meditations or mindfulness exercises, establishing an 'online stress consultation hour' is also a viable option. The appointments should be easily bookable via the homepage. Students may seek a degree of anonymity, but the school environment, with familiar teachers and social workers, provides sense of safety. Again, this is something to figure out. For instance, nationwide surveys among children and adolescents might help to paint a clearer picture of what they need, look for, and are willing to actually use. Meanwhile, it remains unclear what schools can and want to achieve. Apart from expertise and specialized personnel, the additional financial effort and cooperating and coordinating with ministries remains to be seen. Germany's federal system poses challenges in establishing a nationwide, standardized set of services to promote mental health in schools.

Salutogenesis

Another approach to prevention is salutogenesis. This is a somewhat broader concept that emphasizes the health of society. Mental disorders, alongside cardiovascular diseases, diabetes mellitus, and respiratory diseases, rank among the most prevalent health issues in Germany [125, 126]. Health expenditure in Germany in 2022 amounted to 499 billion euros [127], of which around only 30 billion went into prevention and health protection [127]. According to the database of the Federal Statistical Office, in 2021 more than 17 million psychiatric diagnoses were made in hospitals in the age group 0-

25 years, with behavioral and mood disorders making up the majority with around 600,000 cases [128]. The concept of maintaining health is by no means new, dating back to the time of Hippocrates in 400 BC when the famous saying '*prevention is better than cure*' was coined [26]. Salutogenesis represents a complementary approach to the prevailing pathogenetic paradigm in our society. The difference lies not only in the care of the sick, but also in the areas of prevention and health promotion in order to prevent diseases in time [129, 130]. With the help of prevention, people should on the one hand be enabled to take care of their health in a self-determined way and on the other hand risk factors should be prevented or reduced [131, 132]. But how can we enable adolescents to take care of their health in a self-determined way? One promising and effective approach with reasonable effort is increasing the knowledge about mental health and the support system by implementing mental health literacy (MHL) programs. MHL describes the knowledge and beliefs about mental disorders that influence their recognition, treatment and prevention [133, 134]. By establishing MHL programs in our schools, we could enhance the ability to recognize various mental disorders, increase knowledge about risk factors and causes of mental disorders, and improve opportunities for self-treatment or seeking professional help. Furthermore, altering attitudes toward mental disorders has the potential to diminish stigma, thereby encouraging young people to seek help [135]. With the study *LessStress*, the use of a MHL addressing stress in general and particularly stress at school with additional information on contacts/ support will be examined besides the training in class [38]. So far, the feedback of teachers, who have already participated and used the brochure in class, report great satisfaction, want to use it more often, or even asked for the use in counselling. One significant aspect to reconsider is that trained staff needs to guide students through the MHL program to facilitate their understanding and coping with the issue, such as stress. A recent scoping review found significant improvements among adolescents' MHL levels for gaining more knowledge of mental disorders and stigma reduction. The MHL were taught by regular teachers, used face to face interventions, and were implemented in a classroom environment [136]. These are first major achievements. However, we must explore additional strategies to provide young people with greater opportunities for proactive engagement and self-empowerment. Drawing from my experience in collecting data within school settings, it becomes evident that there is not only a knowledge gap among both teachers and students but also a strong desire for support and knowledge. However, it es evident that there is both stigma and avoidance surrounding discussion about mental health disorders. But why not engage in open discussions and, in doing so, work toward reducing stigma? Research shows that help-seeking behavior of affected individuals is increased, when individuals actually believe that seeking help will help them [137]. One way to reach this goal is to increase MHL, which I have already explained above. If MHL is increased among the youth and school-/ kindergarten-staff, parents and teachers would be able to recognize symptoms earlier and react accordingly [138]. Essential cornerstones for establishing a strong preventive foundation and socio-political orientation include ensuring access to basic necessities (such as several meals a day, security,

protection, medical care), providing quality and equitable education for all (with appropriate early childhood support), and offering education and guidance for parents (including training and supervision) [53].

Limitations and current approaches

The papers covered in this compilation are subject to limitations. Similarly, the points made in this discussion should be treated cautiously. First, I would like to talk about validity. A frequently debated concern is the validity of data. Self-reports, a commonly used measurement tool, are generally considered valid but are often subject to bias [139]. Several factors play a role here, such as the population surveyed, the instructions, the measuring medium or the environment [140, 141]. For example, compliance with privacy regulations can reduce bias [142], but there are still many confounding variables, especially in school classes, which affect the validity of our data. The presence of the other students could be irritating, their conversations or the feeling of being observed, a possible coming out or not working fast enough to please the coaches and to respond appropriately or socially correct. Students often had no advance information from the school about the date of assessment, concentration and attention levels were very variable, and some students had no understanding of the purpose of the survey. Social pressure to be 'cool', to give the same answers as their neighbors, to be as fast as their neighbors or to laugh at the questions also plays a big role in filling in the questionnaires. Some students took it very seriously, spending several minutes thinking about each question. Indeed, a classroom survey, often without the teacher in charge, is very difficult and error-prone. As a result, it is acknowledged that the data obtained may exhibit a degree of bias. Additionally, for both the first and also the second papers, only baseline data was included in the statistical analysis. This cross-sectional approach limits our ability to assess changes over time.

Second, there have been notable challenges associated with *LessStress* and its implementation. Maintaining the commitment of teachers and school social workers has been proven to be difficult. The initial enthusiasm often wanes due to demands of everyday stress, illnesses, additional tasks, and general overstrain. Moreover, the six-month monitoring period, though relatively short, has posed greater challenges than initially anticipated.

Another limitation of my research is the sample composition, which limits its generalizability. We focused on a specific age group and geographic location with a very similar socio-economic background. Therefore, it is essential to expand future studies to include different types of schools and age groups. It is precisely these thoughts that *LessStress* tries to address these considerations. LessStress aims to address these considerations.

Additionally, there are general limitations in prevention and prevention research, particularly regarding the selection of suitable staff for implementation in schools. Teachers or school social workers, being on-site and well-acquainted with the school environment, possess clear advantages. However, they may lack psychological expertise, and their proximity to students could be potentially hinder open communication. Existing research has produced mixed results regarding the effectiveness of preventive interventions when implemented by psychologists versus teachers. For instance, a German study found that effects were observed only among girls in the psychologist group, with no significant effects for boys or teachers [143]. Further, factors such as migration background and gender may also play a crucial role in the efficacy of preventive measures, warranting further investigations [144]. The forthcoming quantitative and qualitative evaluations hold the potential to illuminate these limitations in greater detail.

Conclusion

Half of all mental illnesses in adulthood originate in childhood and adolescence. Yet, children and adolescents who are vulnerable or at risk are far too rarely identified or treated appropriately. We face a global public health problem with severe implications for future generations. The statistics and data clearly highlight the urgent need to prioritize the mental health of young peoples. A comprehensive nationwide political concept is long overdue. It requires well-coordinated and consistent policies. The EEP-Approach presented in this compilation, with its emphasis on the collection of valid longitudinal epidemiological data, is also a valuable guide to the design of effective prevention programs based on the results of etiological modelling. But we should consider other strategies as well. We need to implement Mental Health Literacy (MHL) initiatives in kindergartens, primary schools, and secondary schools to reduce stigma, enhance knowledge from an early age, and normalize discussions about mental health. MHL efforts should also extend to universities and the workplace, using engaging materials that impart knowledge effectively. Digitalization can play a crucial role in this endeavor. Why do free apps only display advertisements for various products? What about MHL advertising, and apps with MHL content and exercises to help you build your own resilience? Here, too, the state could have a role in the regulation and control of advertising. Another crucial issue is therapy. Tele-therapy, which gained prominence during the COVID 19 pandemic, should continue to be a focus. Mental health problems are on the rise, and the healthcare system needs to adapt to modern means to provide easily accessible professional help, especially for adolescents. Tele-therapy can be such a valuable tool in addressing mental health problems, not only in youth. Moreover, gathering feedback from adolescents or young adults by conducting surveys may be highly beneficial. Obtaining data directly from the specific target group is essential for identifying their unique needs and preferences. The stress experienced by a 6^{th} grader is likely to differ from that of a 12^{th} grader, and young adults who have recently left home

due to university may face distinct challenges. Understanding which medium is most suitable (e.g., an app or videos), who should deliver prevention programs (e.g., teachers, social educators, psychologists), and how frequently adolescents or young adults are willing to engage in prevention activities is crucial. On the basis of this valuable data, it becomes possible to design and implement tailored and comprehensive prevention programs that effectively addresses the specific needs and preferences of adolescents and young adults.

These thoughts and ideas might appear forward-looking, as they necessitate substantial changes supported by policy. To achieve the goal of nationwide integration and distribution of MHL, it is imperative to establish binding legal requirements across all federal states, creating the necessary frameworks and structures. Prevention and education should be firmly incorporated into the school curriculum, staring as early as kindergarten. Factors such as the appropriate timing for introducing various topics, potential gender-specific approaches, the importance of well-trained staff and educators, and the use of evidence-based prevention measures with evaluations of their effectiveness must be carefully considered. Our shared societal objective should focus on reducing stigmatization, promoting help-seeking behavior, and strengthening resilience in children and young people.

Only through comprehensive and unified policies can we effectively address the growing prevalence of mental illness among this challenging age group. By tailoring prevention measures to their unique needs, we can better support the mental well-being of our future generation.

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Abbreviations

ADHD	Attention deficit hyperactivity disorder
CDC	Centers for Disease Control and Prevention
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders
EEP Approach	Epidemiological-Etiological-Preventive Approach
ESCAP	European Society for Child and Adolescent Psychiatry
GCP	Good clinical practice
Gen Z	Generation Z
HPA	Hypothalamic-pituitary-adrenal axis
HRQoL	Health related quality of Life
M	Mean
MHL	Mental Health Literacy
N / n	Sample size
NSSI	Non-suicidal self-injury
PHQ-4	Patient-Health-Questionnaire, 4 items
RCT	Randomized Controlled Trial
SD	Standard deviation
SEM	Structural Equation Model
SES	Socio economic status
WHO	World Health Organization

Statement of individual author contributions

Manuscript 1:

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Participated in	**Author Initials,** Responsibility decreasing from left to right				
Study Design	CS	JG	AB	NK	
Methods Development	CS	NK	JG	AB	
Data Collection	CS	JG			
Data Analysis and Interpretation	CS	JG	NK	AB	
Manuscript Writing	CS	JG	AB	NK	
Writing of Introduction	CS	AB	JG		
Writing of Materials & Methods	CS	NK	JG		
Writing of Discussion	JG	CS	AB	NK	
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Data Analysis and Interpretation	CS	NK	AB		
Manuscript Writing	CS	CS (2)	AB	NK	
Writing of Introduction	CS	CS (2)	AB		
Writing of Materials & Methods	CS	NK			
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Data Analysis and Interpretation					
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Writing of Introduction	CS	AB	AD		
Writing of Materials & Methods	CS	AD	SM		
Writing of Discussion	CS	AB	MK	MR	
Writing of First Draft	CS	AD			

If applicable, the doctoral researcher confirms that she/he has obtained permission from both the publishers (copyright) and the co-authors for legal second publication.

The doctoral researcher and the primary supervisor confirm the correctness of the above mentioned assessment.

Christin Scheiner 13.09.2023 Würzburg

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I also confirm my primary supervisor's acceptance.

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Affidavit

I hereby confirm that my thesis entitled

"Vulnerability in adolescence: prevalence, pandemic impact and prevention"

is the result of my own work. I did not receive any help or support from commercial consultants. All sources and / or materials applied are listed and specified in the thesis.

Furthermore, I confirm that this thesis has not yet been submitted as part of another examination process neither in identical nor in similar form.

Place, Date Signature

Eidesstattliche Erklärung

Hiermit erkläre ich an Eides statt, die Dissertation

„Vulnerabilität im Jugendalter: Prävalenzen, Einfluss der Pandemie und Prävention“

eigenständig, d.h. insbesondere selbstständig und ohne Hilfe eines kommerziellen Promotionsberaters, angefertigt und keine anderen als die von mir angegebenen Quellen und Hilfsmittel verwendet zu haben.

Ich erkläre außerdem, dass die Dissertation weder in gleicher noch in ähnlicher Form bereits in einem anderen Prüfungsverfahren vorgelegen hat.

Ort, Datum Unterschrift

Statement of individual author contributions to figures/tables

Manuscript 1:

Scheiner, Christin, Grashoff, Jan, Kleindienst, Nikolaus, & Buerger, Arne (2022). Mental disorders at the beginning of adolescence: Prevalence estimates in a sample aged 11-14 years. Public Health in Practice, 4, 100348. DOI: https://doi.org/10.1016/j.puhip.2022.100348

Figure	Author Initials, Responsibility decreasing from left to right				
-	-	-	-	-	-
Table	Author Initials, Responsibility decreasing from left to right				
1	CS	JG	NK	AB	
2	CS	JG	NK	AB	

Explanations: no figures included

Manuscript 2:

Scheiner, C., Seis, C., Kleindienst, N., & Buerger, A. (2023). Psychopathology, protective factors, and COVID-19 among adolescents: a structural equation model. *International journal of environmental research and public health*, *20*(3), 2493. DOI: https://doi.org/10.3390/ijerph20032493

Figure	Author Initials, Responsibility decreasing from left to right				
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3	CS	NK	AB		
Table	Author Initials, Responsibility decreasing from left to right				
1	CS	CS	AB	NK	
2	CS	AB	NK		
3	CS	NK	AB		

Manuscript 3:

Scheiner, C., Daunke, A., Seidel, A., Mittermeier, S., Romanos, M., Kölch, M., & Buerger, A. (2023). LessStress - how to reduce stress in school: evaluation of a universal stress prevention in schools: study protocol of a cluster-randomised controlled trial. *Trials* **24**, 44.

DOI: https://doi.org/10.1186/s13063-022-06970-x

Figure	Author Initials, Responsibility decreasing from left to right				
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2	CS	AB	AD	MK	
Table	Author Initials, Responsibility decreasing from left to right				
1	CS	AD	AB	MK	

I also confirm my primary supervisor's acceptance.

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Doctoral Researcher's Name Date Place Signature