



# DISSERTATION | DOCTORAL THESIS

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Coping with Ongoing Crises: Identifying Risk Factors and  
Protective Factors for the Mental Health of Young People  
Experiencing Chronic Stress

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- O'Rourke, T., Dale, R., Humer, E., Plener, P., & Pieh, C. (2022). Problematic alcohol use in Austrian apprentices during the COVID-19 pandemic. *Addictive Behaviors Reports*, 15, 100414. <https://doi.org/10.1016/j.abrep.2022.100414>
- O'Rourke, T., Dale, R., Humer, E., Probst, T., Plener, P., & Pieh, C. (2022). Health Behaviors in Austrian Apprentices and School Students during the COVID-19 Pandemic. *International journal of environmental research and public health*, 19(3), 1049. <https://doi.org/10.3390/ijerph19031049>
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## **Abstract (English)**

The COVID-19 pandemic and the accompanying restrictive measures profoundly disrupted daily life, leading to elevated stress and adverse mental health outcomes worldwide. Adolescents and young adults were particularly burdened by the pandemic-related restrictions, reporting elevated stress levels and increased negative mental health symptoms. Accessible interventions are needed to mitigate similar outcomes in future public health crises. To inform the development of such interventions, it is crucial to understand the risk factors and protective factors that influence stress levels and mental health during such crises. This dissertation aims to address this need by integrating three complementary studies that examine chronic stress and mental health in young people using different contexts and methodological approaches.

Study 1, a large-scale cross-sectional survey of Austrian high school students (N=1,505), investigated potential stress-buffering effects of health behaviors in the second year of the pandemic. Physical activity, phone use, and problematic drinking emerged as small but significant moderators of the relationship between perceived stress and suicidal ideation, underscoring the role of everyday behaviors in shaping mental health outcomes.

While many studies reported increased stress levels and mental health symptoms after the onset of the pandemic, longitudinal studies examining trajectories over time were sparse. Study 2 therefore adopted a longitudinal perspective through an ecological momentary assessment (EMA) of German adults (N=288) over the course of the second year of the pandemic. By examining both linear and quadratic stress trajectories over time, younger age was identified as a consistent risk factor for overall increased stress; education, relationship status, and COVID-19 infection status were shown to influence the stress trajectories over time.

Recognizing that gender-diverse youth were particularly burdened during the pandemic but often excluded from direct gender comparisons, Study 3 applied a mixed-methods EMA design to specifically examine cisgender and gender-diverse adolescents and young adults (N=120). Gender-diverse youth reported higher gender minority stress, depressive symptoms, and suicidal ideation than their cisgender peers. The coping strategies of music listening, behavioral disengagement, and social support reduced subsequent stress across participants; the effectiveness of strategies like denial and venting varied by gender identity.

Integrating these findings across contexts and methodologies, this dissertation identifies younger age and gender diversity as key risk factors for chronic stress and poor mental health during public health crises and highlights specific coping strategies and health behaviors as protective factors. These findings might inform the development of low-threshold, tailored interventions that can support the mental health of young people in future public health emergencies.



## **Zusammenfassung (Deutsch)**

Die COVID-19-Pandemie und die damit einhergehenden restriktiven Maßnahmen haben das tägliche Leben tiefgreifend beeinträchtigt und weltweit zu erhöhtem Stress und negativen Auswirkungen auf die psychische Gesundheit geführt. Jugendliche und junge Erwachsene waren von den pandemiebedingten Einschränkungen besonders betroffen und berichteten von erhöhtem Stress und vermehrten negativen psychischen Symptomen. Um ähnliche Folgen in zukünftigen Krisen im Bereich der öffentlichen Gesundheit abzuschwächen sind niederschwellige Maßnahmen erforderlich. Um die Entwicklung solcher Maßnahmen zu unterstützen, ist es entscheidend, die Risikofaktoren und Schutzfaktoren zu verstehen, die das Stressniveau und die psychische Gesundheit während solcher Krisen beeinflussen. Diese Dissertation zielt darauf ab, diesem Bedarf gerecht zu werden, indem sie drei sich ergänzende Studien zusammenführt, die chronischen Stress und psychische Gesundheit bei jungen Menschen unter Verwendung unterschiedlicher Kontexte und methodischer Ansätze untersuchen.

Studie 1, eine groß angelegte Querschnittsumfrage unter österreichischen Schüler\*innen ( $N = 1.505$ ), untersuchte mögliche stresspuffernde Effekte von Gesundheitsverhalten im zweiten Jahr der Pandemie. Körperliche Aktivität, Handynutzung und problematischer Alkoholkonsum erwiesen sich als kleine, aber signifikante Moderatoren der Beziehung zwischen wahrgenommenem Stress und Suizidgedanken, was die Rolle des Alltagsverhaltens für die psychische Gesundheit unterstreicht. Während viele Studien über erhöhte Stresslevel und psychische Symptome nach Ausbruch der Pandemie berichteten, gab es nur wenige Längsschnittstudien, die die Entwicklung im Zeitverlauf untersuchten. Studie 2 verfolgte daher einen Längsschnittansatz und führte Ecological Momentary Assessment (EMA) Studie unter deutschen Erwachsenen ( $N = 288$ ) im Laufe des zweiten Pandemiejahres durch. Durch die

Untersuchung sowohl linearer als auch quadratischer Stressverläufe im Zeitverlauf wurde ein jüngeres Alter als konsistenter Risikofaktor für einen insgesamt erhöhten Stress identifiziert; Bildung, Beziehungsstatus und COVID-19-Infektionsstatus erwiesen sich als Einflussfaktoren für die Stressverläufe über die Zeit.

In Anbetracht der Tatsache, dass genderdiverse Jugendliche während der Pandemie besonders belastet waren, aber oft aus direkten Geschlechtervergleichen ausgeschlossen wurden, wurde in Studie 3 ein EMA-Design mit gemischten Methoden angewendet, um speziell cisgender und genderdiverse Jugendliche und junge Erwachsene (N = 120) zu untersuchen. Genderdiverse Jugendliche und junge Erwachsene berichteten höheren Gender-Minderheitenstress, depressive Symptome und Suizidgedanken als ihre cisgeschlechtlichen Altersgenossen. Die Copingstrategien Musikhören, Rückzug und soziale Unterstützung reduzierten den nachfolgenden Stress bei allen Teilnehmenden; die Wirksamkeit von Strategien wie Verleugnung und Gefühlsausdruck variierte je nach Genderidentität.

Diese Dissertation integriert diese Erkenntnisse aus verschiedenen Kontexten und Methoden und identifiziert ein jüngeres Alter und Genderdiversität als wichtige Risikofaktoren für chronischen Stress und schlechtere psychische Gesundheit während anhaltenden Krisen. Außerdem hebt sie bestimmte Copingstrategien und Gesundheitsverhalten als Schutzfaktoren hervor. Diese Erkenntnisse könnten in die Entwicklung von niedrigschwelligen, maßgeschneiderten Interventionen einfließen, die die psychische Gesundheit junger Menschen in zukünftigen Krisen unterstützen können.

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## **I. Introduction**

In March 2020, the outbreak of the Coronavirus disease (COVID-19) was declared a pandemic by the World Health Organization (WHO, 2020). Governments around the globe rushed to implement measures to contain the spread of the virus, including lockdowns, travel restrictions, school closures, remote work, and home schooling, which subsequently led to profound changes in the daily routines of many individuals. The COVID-19 pandemic and the subsequent restrictive measures had major effects on the lives of people all over the world. Gender and age were identified early on as risk factors for mental health problems, with adolescents and young adults, female and gender-diverse individuals showing particularly high rates. Adolescence is defined by crucial social and cognitive development (Blakemore, 2012) and is a particularly vulnerable time for the development of mental illness (Blakemore, 2019). Besides social and developmental challenges during this period, adolescence is accompanied by heightened physiological stress reactivity. Especially individuals in late adolescence show greater cortisol reactivity to stressors than individuals in earlier stages of adolescence or childhood (Gunnar et al., 2009; Stroud et al., 2009). This increased stress responsivity has been linked to neuronal maturing and changes in the hypothalamic–pituitary–adrenal (HPA) axis functioning that occur during puberty (Rome et al., 2013); it may support functional adaption to the developmental challenges experienced during adolescence and early adulthood. In high-risk individuals, however, such as those exposed to prolonged or frequent stress, this physiological stress sensitivity may contribute to the exacerbation of psychopathological outcomes such as anxiety or depression (Stroud et al., 2009). To mitigate alarming rates of mental health problems in young people in future public health crises and prevent negative long-term consequences, it is essential to identify risk factors and protective factors and to develop easily implemented, low-threshold, and low-cost interventions for vulnerable groups.

In May 2023, the WHO announced the end of the COVID-19 pandemic, and the outbreak was no longer classified as a global health crisis (Harris, 2023). Some projects included in this doctoral thesis were conceptualized and conducted in the midst of the pandemic, adding to the current research on the psychological effects on young people during the pandemic; COVID-19 was no longer considered a public health crisis at the time of writing this dissertation. In the following section, I will introduce the theoretical frameworks that help to understand the potential pathways explaining the increase in stress and mental health challenges witnessed after the onset of the pandemic and informing the empirical studies included in this dissertation. I will begin with the Transactional Model of Stress and Coping, followed by the Conservation of Resources Theory, Allostatic Load and finally Gender Minority Stress Theory.

## **I.1. Understanding the Why: Theoretical Frameworks of Stress and Coping**

### ***I.1.1. Transactional Model of Stress and Coping***

A theoretical framework describing the emergence of stress as well as the process of coping is the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984). According to this model, the individual stress response is influenced by personal coping strategies and resources and by individual cognitive appraisals of a stressor. The two major cognitive processes proposed in this model are primary appraisal and secondary appraisal. During primary appraisal, an individual assesses how important a situation is to themselves, their well-being, or their personal goals and whether they perceive this situation as harmful, challenging, or threatening. If the situation is identified as relevant, the individual assesses during the secondary appraisal whether they have enough coping resources to successfully overcome the stressful situation. According to the theory, these cognitive appraisals are then followed by either problem-oriented or emotion-oriented coping behaviors (Lazarus & Folkman, 1984). Problem-oriented coping strategies are targeted at actively removing or resolving a stressor; emotion-oriented coping strategies are employed to reduce

negative emotions following a stressful situation. These cognitive and behavioral processes can be influenced by personal beliefs and traits as well as by contextual and situational factors such as the novelty or predictability of a stressor.

In addition to this distinction, coping strategies are also often categorized into active and approach-oriented coping strategies, with the goal of removing a stressor, or avoidant coping strategies, attempting to withdraw from a stressful situation (Taylor and Stanton, 2007). Active coping strategies are often described as adaptive (e.g., McPherson (2003); avoidant coping strategies as more maladaptive (e.g., Frazier et al., 2005). However, what makes a coping strategy adaptive or helps an individual manage a stressful situation depends on personal factors, such as gender (Tamres et al., 2002; O'Rourke et al., 2022a) and personality (Carver & Conner-Smith, 2010), and also on the long-term consequences of coping behavior (Skinner et al., 2003). Some coping strategies, such as avoidance, can be adaptive for some time but maladaptive in the long-term (Suls & Fletcher, 1985). Thus, it is necessary to not only examine between-person differences in coping, but also temporal within-person dynamics of coping behaviors and stress.

### ***1.1.2. Conservation of Resources Theory***

A theoretical framework that can help understand the psychological burden experienced by individuals during the COVID-19 pandemic is the Conservation of Resources Theory (Hobfoll, 1989), which posits that a loss of resources or a perceived threat to resources can lead to the experience of stress and motivate an individual to protect and conserve existing resources or to acquire new resources. Resources according to this framework can include 1) personal resources such as individual coping strategies, attitudes, or abilities, 2) social resources such as social support and relationships, and 3) material resources such as income or capital. The theory posits that individuals with few resources are at higher risk of losing further resources, potentially leading to loss spirals, while resource-rich individuals are more likely to acquire further resources. Evidence

from Hobfoll et al. (2016) suggests that a loss of resources during stressful events is linked to worse psychological outcomes, with individuals with fewer resources being at increased risk. The COVID-19 pandemic was an epochal-normative life event that threatened personal (optimism, hobbies), social (interpersonal relationships), and material (job loss, education) resources, putting already resource-poor or vulnerable individuals at risk of losing additional resources, potentially leading to further loss spirals. This theory might help understand some of the alarming mental health consequences witnessed in certain sociodemographic groups such as adolescents and young adults, women, and gender-diverse individuals. To mitigate this risk and prevent negative long-term consequences of events like the COVID-19 pandemic, interventions tailored to such vulnerable groups are crucial.

### ***1.1.3. Chronic Stress and Allostatic Load***

Chronic stress exposure during adolescence has been directly linked to psychopathology later in life (e.g., Snyder et al., 2017), but stress is not inherently detrimental to mental health. The acute physiological stress response is an adaptive reaction from the body allowing an individual to successfully cope with a stressful situation, end the stress response, and return to a resting state. In contrast to a person faced with an acute stressor, an individual experiencing chronic stress does not know if or when the stressors will subside and the stressful situation will end.

McLean and Link (1994) described five distinct types of chronic stressors, namely 1) persistent life challenges, 2) role strain, such as being a caretaker, 3), chronic social strains, including minority stress, 4) community-wide ecological strains, and 5) aggregated daily hassles.

A theoretical framework explaining the impact of chronic stress on both the body and the brain is the allostatic load model (McEwen, 1998; McEwen, 2006). Allostasis is the body's ability to adapt to the experience of stressors (Sterling & Eyer, 1988) by activating the physiological stress



systems, e.g., the autonomic nervous system (ANS), the HPA axis, metabolic systems, and the immune system. Allostasis is a necessary process for maintaining homeostasis and enables individuals to successfully cope with acute challenging situations. However, when 1) the stress response is activated too frequently, 2) the stress system activation persists chronically without adequate rest periods, or 3) if the systems do not manage to activate adequately or at all in reaction to a stressor, allostatic load occurs (McEwen and Stellar, 1993). If this allostatic load, or “the cost of adaptation” persists over long periods of time, it causes “wear and tear” on physiological systems of the body and the brain and can ultimately lead to disease or psychological symptoms. Two additional processes that may contribute to allostatic load and are potentially involved in the development of physical and psychological disorders are the process of anticipation, including anxiety and worry about anticipated stressful events (Schulkin et al., 1994), and the adaptive and maladaptive health behaviors deployed to manage stressful situations. Several studies have reported links between allostatic load and negative mental health indicators, such as depression and anxiety (e.g., Juster et al., 2011; Juster et al., 2018; Kuhn et al., 2016). Moreover, a recent prospective cohort study found significant links between allostatic load and the development of anxiety, depression, and suicide later in life (Gou et al., 2025). The aforementioned heightened sensitivity to stress observed during adolescence poses a risk factor for the effects of allostatic load; adverse experiences during adolescence, such as harsh parenting and negative family interactions, have been associated with higher allostatic load in adulthood (Guidi et al., 2020).

To prevent the negative long-term effects of chronic stress, it is crucial to prevent allostatic load from occurring. This can be achieved by successfully coping with stressful situations, allowing the physiological stress systems to return to their resting state and thereby preventing chronic wear and tear. In regard to allostatic load, coping strategies have been shown to act as a buffer between

sociodemographic factors and allostatic load (Chen et al., 2012) and higher psychosocial resources have been linked to lower allostatic load (Wiley et al., 2017). In addition to problem-focused and emotion-focused coping, social support as a coping strategy encompasses emotional and instrumental support received by others during or after stressful situations. In adolescents, meta-analyses have revealed social support to be associated with less depressive symptoms (Rueger et al., 2016) and especially perceived support to be associated with well-being (Chu et al., 2010). In regard to allostatic load, social support received in childhood has been associated with lower allostatic load in adulthood (Slopen et al., 2016) and social support across the lifespan has been shown to mediate the association between adverse childhood experiences and allostatic load later in life (Horan & Widom, 2015).

Health behaviors seem to be linked with allostatic load as well, with studies showing physical activity to decrease allostatic load (Forrester et al., 2019; Gay et al., 2015); alcohol (Gallo et al., 2011; Petrovic et al., 2016) and cigarette consumption (Sotos-Prieto et al., 2015) seem to contribute to higher allostatic load. For adolescents specifically, a meta-analysis covering 114 distinct studies found significant associations between physical activity and overall improved mental health and reduced stress (Rodriguez-Ayllon, 2019). The COVID-19 pandemic was a high-impact societal event that was accompanied by changes in health behaviors, perceived stress, and mental health in young people (e.g. Knell et al., 2020; Viner et al., 2022).

#### ***1.1.4. Gender Minority Stress***

One factor contributing to the experience of chronic stress and heightened vulnerability to negative mental health in gender-diverse individuals is minority stress. The theory of gender minority stress (GMS; Meyer, 1995) describes the experience of distal stressors such as discrimination, victimization, and rejection by others, and proximal stressors like personal

expectations or the anticipation of discrimination, internalized stigma, and secrecy regarding the individual gender identity (Meyer, 2015). Experiencing GMS frequently in daily life or over long periods of time can contribute to allostatic load (Guidi et al., 2021) and has been linked to negative physiological (Hatzenbuehler & Pachankis, 2016) and mental health indicators (Dürrbaum et al., 2020; de Lange et al., 2022). Findings from a large-scale survey conducted by the European Union Agency for Fundamental Rights (2020) show that gender-diverse youth in Austria and in Europe in general experience various forms of GMS ranging from stigma and discrimination in family and school contexts to physical and sexual violence. In times of public health crises such as the COVID-19 pandemic, the experience of GMS adds additional strain, making gender-diverse adolescents and young adults a particularly vulnerable group for negative mental health outcomes, as evidenced by various literature. Thus, the need for effective interventions supporting adaptive coping during public health crises is high. However, longitudinal studies investigating the effectiveness of coping behavior and its real-time impact on stress and mental health in the daily lives of gender-diverse youth as well as examining direct comparisons to cisgender youth are sparse.

## **I.2. The COVID-19 Pandemic and Mental Health – State of the Research**

### ***I.2.1. Stress and Mental Health of Young People During COVID-19***

It became evident early on that adolescents and young adults were particularly burdened by the pandemic-related restrictions. In an effort to contain the spread of the disease, schools were closed and home schooling was established; universities switched to online lectures. Consequently, affected students had to adapt to distance learning; they experienced a loss of the in-person social interactions facilitated by the school context that are crucial for the development of social identity and autonomy (Lannegrand-Willems & Bosma, 2009) and that are also a source of social support. Although many social interactions instead moved to online platforms, a meta-analysis suggested that online social support is less effective for adolescent mental health than support provided in

person (Zhou & Cheng, 2022). In addition to the loss of this crucial social environment, affected students had to adapt their daily routines, leading to feelings of relief for some, but increased perceptions of stress for others. A qualitative study conducted with Austrian adolescents in spring 2021 revealed that after a year of pandemic-related restrictions, high school student concerns about their education and professional futures had increased, with school-related stress such as performance pressure and difficulties completing school-related projects being the most frequently mentioned stressor category (Jesser et al., 2022). A review of the impact of the early stages of the pandemic on mental health revealed that while some individuals were unaffected or even doing better psychologically than before the pandemic, the mental health of adolescents and young adults had been largely negatively impacted by the onset of the pandemic and the measures related to it (Manchia et al., 2022). Numerous international studies reported significant increases in stress and psychological symptoms among adolescents during the COVID-19 pandemic (Li et al., 2021; Orgilés et al., 2020; Ravens-Sieberer et al., 2021a). According to the COVID-19 and Psychological Health (COPSY) study (Ravens-Sieberer et al., 2021b), 83% of German children and adolescents felt psychologically burdened by the pandemic. High stress levels in young people were reported in various countries (Agarwal et al., 2021; Flaudias et al., 2020; Nocentini et al., 2021).

In Austria, the mental health of adolescents appeared to be significantly worse after a semester of home schooling in 2020 than it had been in 2018, and many high school students (Pieh et al., 2021) as well as apprentices (Dale et al., 2021) showed clinically relevant symptoms of depression, anxiety disorders, eating disorders, and insomnia. Moreover, after one semester of home schooling, 52.5% of Austrian high school students reported moderate stress levels and 36.5% reported high stress levels (Pieh et al., 2022). More concerning yet, after five surveys across the span of two years, the mental health of adolescents did not seem to have improved (Dale et al.,

2023). On the contrary, the prevalence of suicidal ideation increased from 35.3% in girls and 30.6% in boys in spring 2021, to 47.2% in girls and 33.5% in boys in fall 2021 (Dale et al., 2023). Perceived stress has been identified as a predictor for suicidal ideation (Chen & Kuo, 2020; Zhu et al., 2021), as have stressful life events including family stressors or academic stressors (Carballo et al., 2020), which increased during the COVID-19 pandemic due to measures such as home schooling. A meta-analysis published in 2022 revealed significant increases of anxiety and depressive symptoms in adolescents compared to before the pandemic (Wang et al., 2022). Increased stress levels compared to pre-pandemic times were reported for university students (e.g., Auerswald et al., 2014).

### ***1.1.3. The Effect of Gender***

Another risk factor for increased psychological distress and worse mental health during the pandemic was gender. Multiple studies have shown that women experienced greater negative mental health consequences during the pandemic than men did. A cross-sectional survey (2023) reported both gender and personality to be related to stress levels in the German population. A longitudinal study (Gniewosz et al., 2024) examining the relationship between stress and depressiveness in German adolescents found higher perceived stress to be associated with higher depressiveness, with female adolescents being more vulnerable to this effect. One particularly affected group during the pandemic were gender-diverse adolescents and young adults, often reporting significantly worse well-being and higher scores of negative mental health than their cisgender peers. For example, during spring 2021, while home schooling was in effect in Austria, three out of four surveyed gender-diverse youth reported high stress levels, compared to one out of three cisgender adolescents (Pieh et al., 2022). Even more alarming, the prevalence for suicidal ideation for gender-diverse participants was 91%, compared to 47.2% in female and 33.5% in male participants in fall 2021 (Dale et al., 2023).

### ***1.2.3. Overcoming These Challenges: Changes in Health Behaviors and Coping***

Studies conducted during the initial phase of the pandemic showed coping behavior to have substantial effects on mental health. For instance, a study conducted during the first lockdown with a sample representative for the UK population showed active coping and social support to be significantly associated with resilience, and resilience in turn to be negatively correlated with perceived stress. Alcohol and cigarette consumption on the other hand was negatively correlated with resilience and positively correlated with perceived stress (O'Rourke et al., 2021). Similarly, findings from a study conducted with a representative sample for the Austrian population during the first lockdown showed active coping and social support to positively predict increased well-being and negatively predict perceived stress, anxiety, depression, and insomnia; alcohol and cigarette consumption predicted higher perceived stress and worse mental health and well-being (Budimir et al., 2021).

Furthermore, in addition to fluctuations in stress levels and mental health symptoms, various studies have reported changes in health behaviors, such as diet, substance use, sleep, physical activity, and screen time throughout the pandemic (e.g., Ruiz et al., 2021). Building on the framework of the transactional stress model (Lazarus & Folkman, 1984), these changes in health behaviors can be understood as attempts to cope with the demands of the pandemic and its associated restrictions. As mentioned above, physical activity can have stress-buffering and protective effects on the mental health of adolescents. According to the WHO (WHO, 2020), meeting the physical activity recommendations for children and adolescents (of at least 60 minutes of moderate to vigorous physical activity a day and high-intensity aerobic physical activity at least three days per week) can benefit not only a variety of physical health indicators, but also mental health, such as a reduced risk of depression, and may even be comparable to pharmaceutical therapies in reducing symptoms of depression.

During the COVID-19 pandemic, exacerbated by measures such as lockdowns and social distancing, physical activity in children and adolescents (e.g., Caputo & Reichert, 2020; Rossi et al., 2021), as well as in university students (Haug et al., 2024), decreased significantly. A review revealed that more physically active adolescents generally reported better mental health scores and lower levels of stress during the pandemic than less active adolescents (Marconcin et al., 2022). Similarly, according to an Austrian study with aggregated data from over 7,000 adolescents, the risk for mental health symptoms such as depression, anxiety, and stress significantly decreased for individuals who exercised at least once a week and increased with more hours of screen time per day (Humer et al., 2022). A study conducted with Austrian apprentices during the pandemic showed that problematic alcohol consumption in adolescents had increased compared to pre-pandemic times and that apprentices with symptoms of anxiety or depression were twice as likely to show signs of problematic drinking (O'Rourke et al., 2022b). Furthermore, the health behaviors of adolescents during the pandemic differed between education types, with apprentices having engaged in more weekly exercise than high school students but showing higher signs of substance abuse (O'Rourke et al., 2022c).

On the one hand, these findings suggest that dysfunctional changes in health behaviors such as physical activity and screen time may have contributed to the development of psychological symptoms such as anxiety and depression in young people during the pandemic. On the other hand, the changes in these behaviors after the onset of the pandemic imply possible attempts at coping with the demands of the pandemic and therefore highlight potential approaches to supporting the mental health of young people during public health crises.

## **II. Summary and Research Aims**

As outlined above, adolescence and early adulthood are particularly vulnerable phases in life for the development of psychological disorders, partly due to heightened physiological stress reactivity. Chronic stress in the form of prolonged or repeated exposure to stressful situations without sufficient recovery phases can severely impact mental health. The COVID-19 pandemic, especially in the early stages, was a novel and unpredictable situation accompanied by the actual and perceived loss of resources and by significantly increased perceived stress and psychological symptoms among young people, with especially concerning rates among gender-diverse youth. To mitigate similar risks in future public health crises, effective, accessible, and low-cost interventions to increase the personal resources of vulnerable populations are essential. Health behaviors and coping strategies may be potential avenues for such interventions as they are easily implementable and may have stress-buffering effects. Study 1 examined potential moderating effects of health behaviors on the association between perceived stress and suicidal ideation in adolescents during spring 2021 in a large-scale online survey. Similarly, many studies in the early stages of the pandemic relied on cross-sectional designs, while longitudinal data remained scarce, limiting causal conclusions. Study 2 aimed to address this by investigating the trajectories of perceived stress over the course of one year and identifying potential risk factors and protective factors for perceived stress during this time, such as age and gender. Real-time data on how coping strategies influence perceived stress is still limited, particularly for gender-diverse youth. Study 3 aims to contribute to this research gap by analyzing the real-time effects of coping strategies on stress in cisgender youth and gender-diverse youth, providing valuable insights for potential future interventions.

To sum up, the studies included in this thesis aimed to examine risk factors and protective factors for chronic stress and subsequent mental health issues in adolescents and young adults,



focusing on two specific contexts: 1) chronic stress in the context of the COVID-19 pandemic, and 2) chronic stress in the form of gender minority stress.

Three separate studies were conducted, addressing the following open research questions:

- Do health behaviors (physical activity, phone usage, and problematic drinking behavior) moderate the relationship between perceived stress and suicidal ideation in adolescents during a public health crisis? (Study 1)
- What did the stress trajectory look like over the course of the COVID-19 pandemic, and was it moderated by sociodemographic factors such as age, gender, and education? (Study 2)
- How do cisgender youth and gender-diverse youth differ in their mental health? Which stressors do cisgender and gender-diverse youth experience in their daily lives and how do they cope with them? What are the real-time predictive effects of coping strategies on perceived stress and does gender moderate these effects? (Study 3)

In the following section, I present the studies addressing these research questions. These studies aimed to address the aforementioned research questions by employing multiple complementary research designs in various populations:

- 1) A large-scale cross-sectional online survey assessing moderating effects of health behaviors on the association between perceived stress and suicidal ideation in Austrian adolescents during the COVID-19 pandemic.
- 2) An EMA study using crowdsensing data in a sample of German adults, investigating linear and quadratic time trends of perceived stress over the course of the COVID-19 pandemic and the risk factors and protective factors associated with it.

- 3) A comprehensive mixed-methods EMA study addressing both between- and within-person effects in a sample of gender-diverse youth. This study investigated:
- a. baseline differences between cisgender youth and gender-diverse youth in mental health indicators, gender minority stress, and coping behaviors,
  - b. which specific stressors cisgender youth and gender-diverse youth face in their daily lives and how they cope with them on a daily basis, and
  - c. real-time predictive effects of coping strategies on perceived stress, as well as moderating effects of gender.

### **III. Summary of Manuscripts**

#### **III.1. Empirical Study 1**

As described above, adolescents and young adults were particularly burdened by the COVID-19 pandemic. Studies conducted after the onset of the pandemic showed an increase in mental health issues, such as anxiety, depression, and high levels of perceived stress, as well as changes in health behaviors, such as a decrease in physical activity and an increase in excessive phone use. Previous literature proposed that some health behaviors might have stress-buffering effects. To test whether these health behaviors could have protective effects on the mental health of adolescents experiencing high stress during the COVID-19 pandemic, in Study 1 of this dissertation (O'Rourke et al., 2023), I investigated the moderating effects of different health behaviors on the association between perceived stress and suicidal ideation in Austrian high school students. A total of 1,505 Austrian high school students aged 14 to 20 years (median age = 16; 77.9% female) filled out a cross-sectional online survey conducted with REDCap from September to November 2021. Perceived stress was measured with the Perceived Stress Scale (PSS10; Cohen et al., 1983), suicidal ideation was measured with item 9 of the PHQ-9 (Kroenke & Spitzer, 2002; Rossom et al., 2017), with a score of 0 indicating no suicidal ideation and a score of 1 or higher indicating suicidal ideation. Physical activity was measured assessing the days per week the participants were physically active, phone usage was measured as hours per day, and problematic drinking behavior was assessed using the CAGE questionnaire (Ewing, 1984). The prevalence of suicidal ideation, assessed in this sample was 47% for the female participants, 33.5% for the male participants, and 91% for the gender-diverse participants (Dale et al., 2023).

All three health behaviors significantly moderated the association between perceived stress and suicidal ideation, but effects were small. The moderation analyses revealed that higher physical activity ( $\Delta R^2 = 0.46\%$ ,  $p = 0.001$ ) and less time spent on the phone per day were associated with

less suicidal ideation at higher stress levels ( $\Delta R^2 = 0.66\%$ ,  $p = .001$ ). Signs of problematic drinking behavior were associated with higher suicidal ideation at higher stress levels ( $\Delta R^2 = 0.34\%$ ,  $p = 0.006$ ).

Although revealing only small effect sizes, these results are highly relevant from a public health perspective, as they suggest that some health behaviors may act as a buffer between perceived stress and suicidal ideation. In times of ongoing crises, such as the COVID-19 pandemic, low-threshold interventions to support mental health in vulnerable groups are urgently needed. Health behaviors such as meeting the daily recommended physical activity goals (Rodriguez-Ayllon et al., 2019) and avoiding smartphone overuse (Orben et al., 2022) are ideally suited as mechanisms of actions for such interventions, as they have been shown to support mental health, are low risk, and can be implemented autonomously by adolescents in their daily lives, even in the case of a lockdown or similar restrictions. However, the cross-sectional nature of this study does not allow for any causal inferences and RCTs testing interventions promoting health behaviors studies are needed to investigate these effects.

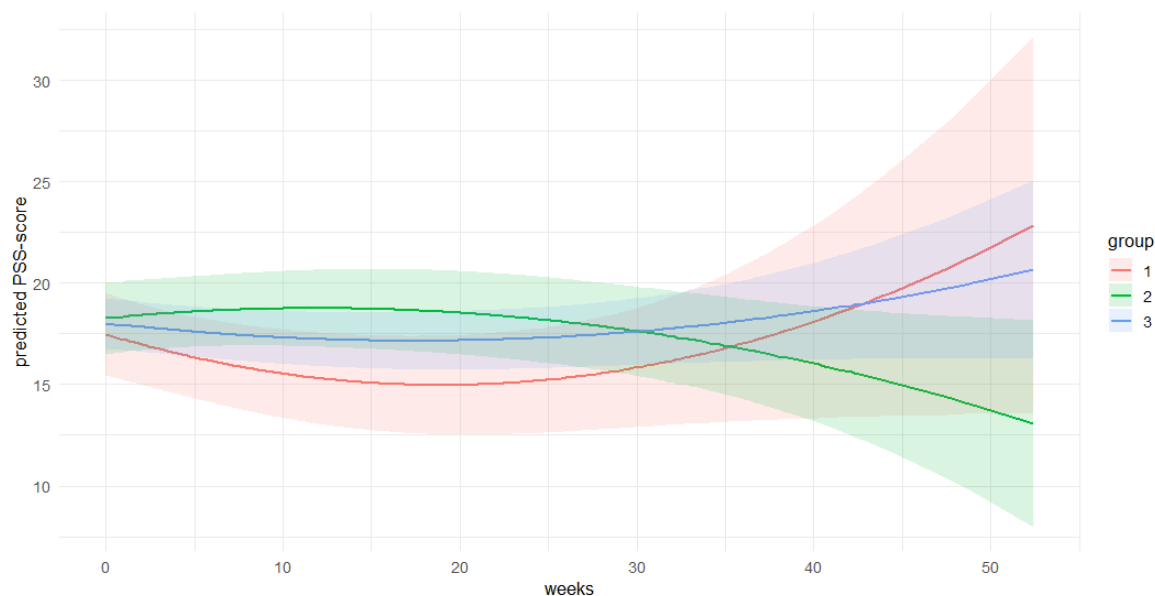
### **III.2. Empirical Study 2**

Study 2 of this doctoral thesis (O'Rourke et al., 2025) aimed to examine the trajectories of perceived stress levels over the course of a year throughout the COVID-19 pandemic for different sociodemographic groups and to identify possible risk factors and protective factors employing an EMA study in a sample of German adults participating in the stress study in crowdsensing digital health application CoronaHealth (Winter et al., 2025). A total of 288 German adults (66.5% female) aged 18 to 71 ( $M = 42.72$ ,  $SD = 13.48$ ), participated and were asked to fill in the Perceived Stress Scale (PSS-10; Cohen et al., 1983) on their mobile phones weekly from December 2020 to February 2022. This approach resulted in a total of 1,754 assessments, with participants making

6.18 assessments on average (min = 2, max = 28, SD = 5.64). Linear multilevel models were run to test the moderating effects of sociodemographic variables and experiences with Covid infection on the stress trajectories. In a first step, separate models were run for each predictor variable and in a second step all variables were included into one model to control for the effects of all other predictors. When controlling for all other predictors, perceived stress decreased slightly over time (estimate =  $-.35$ ,  $p = .009$ ). Older participants reported lower overall stress than younger participants (estimate =  $-1.17$ ,  $p = .019$ ). While none of the other tested moderating factors (gender, relationship status, education, restrictions, or COVID experiences) had significant main effects on perceived stress in the final model, the stress trajectories varied depending on education level and COVID experiences. Specifically, individuals with 11-12 years showed an inverse U-shaped stress trajectory (estimate =  $.01$ ,  $p = .028$ ). The stress trajectories according to years of education are illustrated in Figure 1.

**Figure 1**

*Predicted PSS scores over time according to education in years*

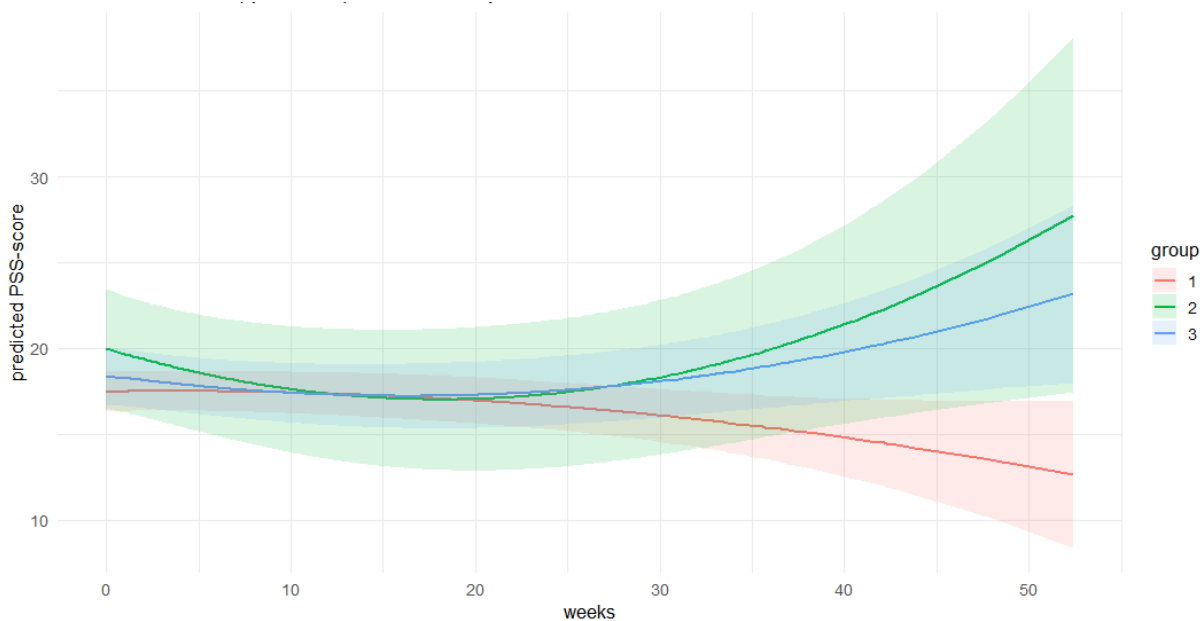


*Note:* 'up to 10 years' was coded as 1, '11-12 years' was coded as 2, '13+ years' was coded as 3

Divorced showed a U-shaped stress trajectory (estimate = .01,  $p = .010$ ), although the interaction with time was not significant anymore when controlling for all other predictors and thus needs to be interpreted with caution. The stress trajectories according to relationship status are illustrated in Figure 1.

## Figure 2

*Predicted PSS scores over time according to relationship status*



*Note:* 'partnered' was coded as 1, 'divorced' was coded as 2, 'single' was coded as 3

Participants whose relatives had recovered showed a linear reduction of stress over time (estimate = .28,  $p = .008$ ) as well as a stronger decrease of stress over time (estimate = -.01,  $p = .020$ ). Participants who had lost relatives to COVID showed an initial decrease in stress that slowed over time and then increased again (estimate = .01,  $p = .038$ ). Contrary to expectations, neither gender nor current restrictive measures had any meaningful effects on perceived stress trajectories in this sample. These results add to a growing number of studies identifying younger individuals as a vulnerable group during public health crises. While the gender-diverse participants in this sample

reported higher stress levels than the cisgender participants, they had to be excluded from direct analyses due to the small sample size ( $n=4$ ).

### **III.3. Empirical Study 3**

In Study 3 of this doctoral thesis, I specifically focused on gender-diverse adolescents and young adults. In this EMA study, I investigated between-person effects, examining baseline differences in mental health indicators, gender minority stress, and coping between cisgender and gender-diverse adolescent and young adults, as well as immediate within-person effects of coping strategies on perceived stress in the daily lives of cisgender and gender-diverse youth.

A total of 120 participants (65.8% gender diverse, 34.2% cisgender) aged 14 to 21 ( $M = 18.71$ ,  $SD = 1.28$ ) completed the baseline survey. Depressive symptoms were measured with the PHQ-9 (Kroenke & Spitzer, 2002) and suicidal ideation with the ninth item of the PHQ-9 (PHQ9; Rossom et al., 2017), with a score of 0 indicating no suicidal ideation and a score of 1 or higher indicating suicidal ideation. Perceived stress was measured using the PSS-10 (Cohen et al., 1983), Gender Minority Stress with a translated version of the Gender Minority Stress and Resilience Measure for Adolescence (GMSR-A; Hidalgo et al., 2019) and coping with the BriefCOPE (Carver, 1997; Knoll et al., 2005). Baseline analyses revealed that gender-diverse participants reported higher overall gender minority stress (all  $p < .001$ ), depressive symptoms ( $p = .044$ ,  $g = .39$ ), and suicidal ideation ( $p = .007$ ,  $OR = 2.85$ ), but not higher perceived stress than cisgender participants.

A total of 103 participants (72.8% gender diverse, 27.2% cisgender) remained for the EMA part of the study. Over the course of 14 days, participants reported three times per day 1) if they had experienced a stressful event, 2) how much stress this event caused them on a scale from 0-100, and 3) how they coped with this event, choosing from a list of 18 coping strategies. Thirteen of these coping strategies were derived from the BriefCOPE (Carver, 1997), four from the Trans

and Nonbinary Coping Measure (TNCM; Lindley & Budge, 2022) and listening to music was included as an additional strategy. Furthermore, 4) they were given a free-text option to describe the stressful event in more detail.

Qualitative content analysis (Mayring, 2010) of 494 participant-reported stressors (73.48% gender diverse, 26.53% cisgender) revealed the following nine main categories of stressors experienced by the participants during the study period: social interactions, school/university, daily hassles, mental health, gender minority stress, body-related stressors, public transportation, and sexual harassment. Gender-diverse participants reported more gender minority and social stress than cis participants, although these differences need to be interpreted with caution, as almost  $\frac{3}{4}$  of reported stress events were provided by gender-diverse participants. Lagged linear multilevel models were conducted to test the predictive within-person effects of coping on one assessment (t) or day (d) on perceived stress at the following assessment (t+1) or day (d+1). On the assessment level, results revealed that music listening as a coping strategy at one assessment significantly predicted lower stress at the next assessment for the total sample ( $p < .001$ ). When adding gender to the model, denial predicted lower stress at the next assessment for cisgender participants than for gender-diverse participants ( $p < .001$ ). On the aggregated day level, results revealed that behavioral disengagement predicted lower stress the next day for the total sample ( $p < .001$ ). Taking gender into account, venting predicted lower stress the next day for gender-diverse participants than for cisgender participants ( $p = .003$ ).

These results suggest some differences, but also similarities in 1) stressors experienced in daily life, 2) coping behaviors, and 3) the effectiveness of certain coping strategies between gender-diverse youth and cisgender youth. Furthermore, these results provide novel insights into real-time effects of coping on perceived stress in the daily life of young people.



## **IV. Discussion**

### **IV.1. Summary**

This dissertation aimed to investigate risk factors and protective factors for mental health in young people experiencing chronic stress. Two studies (Study 1 and Study 2) focused on a specific epochal-normative stressor; the COVID-19 pandemic. Findings from Study 1 suggest that health behaviors in the form of physical activity, phone use, and alcohol consumption can have buffering or intensifying effects on the relationship between perceived stress and suicidal ideation for adolescents in times of a public health crisis. Study 2 identified younger age as a sociodemographic risk factor for increased stress during the pandemic. Furthermore, it showed that perceived stress reduced in a sample of German adults from 2021 to 2022 and that relationship status, education, and close encounters with COVID infection affected the stress trajectory over time. Study 3 explicitly aimed to investigate relationships between perceived stress, coping strategies, and mental health in gender-diverse youth. This study provided insights into specific stressors experienced by gender-diverse youth in their day-to-day life and the coping behaviors employed to manage these stressful situations. Findings from Study 3 revealed that gender-diverse adolescents and young adults experiencing gender minority stress showed higher depressive symptoms and suicidal ideation than their cisgender peers. It also provided novel insights into immediate effects of coping strategies on perceived stress in daily life in both gender-diverse youth and cisgender youth and the varying effectiveness of certain coping strategies depending on gender identity. Music listening, behavioral disengagement, venting, and social support were identified as effective coping strategies, reducing subsequent stress more for gender-diverse youth; denial seemed to increase subsequent stress more for this group.

## IV.2. Integration

The three studies presented in this dissertation contribute to the literature on risk and protective factors influencing the mental health of young people facing chronic stress. Building on the theoretical frameworks of the Allostatic Load Model (McEwen, 2006), the Conservation of Resources Theory (Hobfoll, 1989), the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984), and the Gender Minority Stress Model (Meyer, 1995), the dissertation pursued two main objectives: to identify potential risk factors and protective factors for young people's mental health under conditions of chronic stress, and to explore mechanisms that may support these vulnerable populations during future public health crises. Table 1 provides an overview of the objectives, methodological approaches, and main findings of the three included articles.

**Table 1.**

*Overview of included articles.*

| Objective                                                                                                                                                                                                                         | Methodological Approach                                                                                                                            | Key Results                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Article 1: O'Rourke et al., 2023</b>                                                                                                                                                                                           |                                                                                                                                                    |                                                                                                                                                                                                                                                                      |
| Investigate potential moderating effects of <b>physical activity (PA)</b> , <b>phone usage (PU)</b> , and <b>problematic drinking (PD)</b> on the association between <b>perceived stress</b> and <b>suicidal ideation (SI)</b> . | Large-scale cross sectional online survey (n=1,505)<br>Moderation Analyses with SPSS Macro PROCESS                                                 | Small but significant moderating effects of PA, PU, and PD on the association of perceived stress and SI.<br><b>Higher PA → lower SI</b> at high stress levels.<br><b>Lower PU → lower SI</b> at high stress levels.<br><b>PD → higher SI</b> at high stress levels. |
| <b>Article 2: O'Rourke et al., 2025 (submitted for publication)</b>                                                                                                                                                               |                                                                                                                                                    |                                                                                                                                                                                                                                                                      |
| Examine the <b>time trend of perceived stress</b> over the course of one year during the pandemic and identify factors moderating these stress trajectories.                                                                      | Longitudinal EMA study (n=288; 1,754 assessments)<br>Stepwise hierarchical multilevel model approach testing linear and quadratic time trends in R | <b>Younger participants</b> reported <b>higher overall stress</b> than older participants. Education, relationship status, personal encounters with COVID infection moderated stress trajectories over time.                                                         |

| Article 3: O'Rourke et al., 2025 (submitted for publication)                                                                                                                                                                                                                                        |                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Investigate 1) baseline differences in gender minority stress (GMS) and mental health 2) stressors experienced in daily life and 3) momentary effects of coping strategies on perceived stress in daily life and the moderating effect of gender in a sample of cisgender and gender-diverse youth. | Mixed-methods EMA study<br>Baseline Differences<br>Lagged linear multilevel models in R | 1) <b>Higher</b> scores in <b>negative mental health</b> indicators in <b>gender-diverse youth</b> than in cisgender youth.<br>2) Stressors: social interactions, school, daily hassles, mental health, GMS, body, public transportation, and sexual harassment.<br>3) <b>Music listening, behavioral disengagement, and social support</b> predicted <b>lower subsequent stress</b> for all participants. Effectiveness of denial and venting depended on gender. |

Study 1 corroborated previous evidence on the stress buffering effects of health behaviors by demonstrating small but significant moderating effects of physical activity, phone use, and alcohol consumption on the relationship between perceived stress and suicidal ideation among adolescents during the COVID-19 pandemic. These findings highlight the potential of health behaviors as protective factors for adolescents experiencing substantial psychological strain in times of public health crises. This is particularly relevant given that such crises, including the COVID-19 pandemic, demand rapid, low-threshold, and cost-effective interventions capable of reaching large populations in real time to mitigate adverse mental health outcomes.

Study 2 identified younger age as a risk factor for increased perceived stress during the COVID-19 pandemic, adding to a large body of evidence with similar findings. Perceived stress decreased in this sample from January 2021 to January 2022. Younger individuals reported higher overall perceived stress than older participants. Moreover, education, relationship status and COVID experiences influenced the stress trajectories over time. Similarly, a large-scale study tracking mental health and quality of life in the German population over several time-points from

2020 to 2022 identified younger age, especially children and adolescents, female gender, and financial worries as risk factors for worse mental health and quality of life throughout the pandemic, while positive appraisal, cognitive flexibility, social support, self-efficacy, and institutional trust were identified as protective resilience factors (Stoffes-Winterling et al., 2025). Ahrens et al. (2021) found increased perceived stress, daily hassles, and loneliness during lockdown to be related to poorer mental health trajectories over time. Being in a relationship during the time of the lockdown may therefore have been a protective factor for mental health. However, early in the pandemic, Pieh et al. (2020) showed that while individuals with good relationship quality reported the overall best mental health, single individuals reported better mental health than individuals with poor relationship quality. Although we did not test for these factors specifically by age, it is notable that many of the factors that contribute to resilience in adults, such as self-efficacy or stable relationships, are rarely fully developed in youth. The lack of such resilience factors may contribute to the increased mental distress experienced by some youth during crises and deserves further investigation.

Study 3 provided important insights into between- and within-person effects of stress and coping in a population often neglected in mainstream studies, namely gender-diverse adolescents and young adults. Existing evidence reveals higher levels of psychological symptoms in gender-diverse adolescents than in cisgender adolescents, but direct comparisons of mental health according to gender are often restricted to male and female participants, excluding diverse participants. Studies describing gender minority stress and coping often employ cross-sectional designs, not allowing any causal conclusions of within-person effects of coping strategies on gender minority stress, and studies directly comparing coping strategies between cisgender and gender-diverse individuals are sparse. The qualitative results from Study 3 reaffirm the findings

reported by the European Union Agency for Fundamental Rights (2020), with gender-diverse youth reporting the most stressful situations in family and school/university contexts. Moreover, the EMA results add to the literature on coping and provide novel insights into the real-time effects of coping strategies on stress in the daily lives of gender-diverse youth. Previous studies have linked avoidant coping strategies with higher mental health symptoms in individuals facing minority stress (e.g., Budge et al., 2014; De Lange et al., 2022; Feinstein et al., 2017). Budge et al. (2014) further reported an association between the level of social support received and the type of coping strategies employed, with individuals receiving more social support employing more facilitative coping and individuals receiving less social support employing more avoidant coping. A study conducted with Romanian young adults during the COVID-19 pandemic (Leonti et al., 2023) found negative affect to increase the likelihood of avoidant coping, which in turn was associated with higher perceived stress. In line with these findings, gender-diverse participants in Study 3 reported significantly higher behavioral disengagement than cisgender participants at baseline in Study 3, indicating a tendency for avoidant coping. However, contrary to the negative effects of avoidant coping strategies reported in the aforementioned literature, behavioral disengagement on one day was related to lower subsequent stress the following day. These results suggest that behavioral disengagement may allow individuals facing gender minority stress a momentary shift in focus away from threatening situations toward other more constructive or pleasant activities, therefore reducing stress. Future studies should investigate such potential within-person chains in coping behavior over longer periods of time. More in line with this research on avoidant coping, denial predicted higher subsequent stress for gender-diverse participants than for cisgender participants, suggesting that for youth experiencing gender minority stress, denial may conflict with ongoing processes of identity affirmation and self-acceptance, potentially leading to more internal conflict by suppressing elicited emotions and delaying adaptive coping, therefore increasing perceived

stress. In contrast to avoidance-based coping strategies, active or engagement-focused coping has been found to decrease the negative mental health consequences of gender minority stress in some studies (e.g., De Lange et al., 2022; Szymanski & Gonzalez, 2020); other studies found no associations between problem-focused coping and psychological distress (e.g., Szymanski et al., 2008). In Study 3, no significant associations between active coping and subsequent stress were found. Socially supported coping strategies such as social support and venting, however, were associated with lower subsequent stress, which is in line with previous literature (Pflum et al., 2015). For gender-diverse adolescents, parental support may have particularly strong effects on mental health (Andrzejewski et al., 2021; McCurdy et al., 2023), suggesting that interventions incorporating parents of gender-diverse adolescents or educational campaigns targeted at parents may have strong protective effects on the mental health of gender-diverse adolescents and young adults in times of public health crises. Finally, music listening was found to be an effective coping strategy, predicting lower subsequent stress, which is in line with previous literature showing music listening to reduce both perceived stress and physiological stress markers (Linnemann et al., 2015). These findings emphasize the potential of music listening as yet another low-cost, low-threshold, low-effort intervention possibly reducing the effects of allostatic load in adolescents experiencing chronic stress.

The diverse methodological approaches used in this dissertation highlight the analyzed constructs from multiple perspectives and give a complementary overview on the examined topics. The cross-sectional nature of Study 1 allowed a first glimpse of potentially buffering effects of health behaviors on perceived stress and mental health in adolescents in the very specific temporal and societal context of the COVID-19 pandemic. Study 2 expanded on this by investigating the longitudinal trajectories of perceived stress and potentially moderating factors such as gender and

age throughout the pandemic. Study 3 focused on a specific vulnerable demographic group, gender-diverse adolescents and young adults and compared them with their cisgender peers, deepening the knowledge on how coping behaviors impact perceived stress in the daily lives of both gender-diverse youth and cisgender youth. Taken together, the findings identified risk factors and protective factors for chronic stress and mental health and might inform future interventions aimed at supporting vulnerable groups during public health crises.

### **IV.3. Limitations**

Several limitations need to be considered when interpreting the findings from this dissertation. First, the cross-sectional nature of Study 1 does not allow for any causal inferences. While the narrative-crisis model of suicide proposes the experience of stressful life events to increase the likelihood of suicidal ideation (Bloch-Elkouby et al., 2020), it is unclear whether perceived stress in Study 1 led to suicidal ideation or whether participants with higher suicidal ideation reported higher perceived stress. While the directionality of this effect cannot be confirmed in Study 1, the results nevertheless show small buffering effects of health behaviors on the association between perceived stress and suicidal ideation in adolescents. Another major limitation of this dissertation is the subjective assessment of all included constructs, introducing self-report bias. While the main focus of this dissertation was perceived stress, the assessment of biological markers of physiological stress systems, such as cortisol or alpha-amylase would have contributed to the understanding of allostatic load on mental health of young people during public health crises. Additionally, objective assessments of health behaviors such as physical activity or phone use through wearable trackers or applications may have added some precision and validity to these findings. Some limitations regarding sampling need to be addressed as well. Out of all 1,913 participants assessed in this dissertation, 1,397 were female, 382 were male, and 134 participants identified as gender diverse, skewing the results. Furthermore, of all participants assessed in Study

3, including the gender-diverse participants, 110 (91.75%) were assigned female sex at birth, potentially further skewing the results in some respects. Additionally, participants in Study 3 were explicitly informed that the study would be assessing gender minority stress, mental health, and coping in gender-diverse youth, therefore increasing the likelihood that the individuals agreeing to take part in the study were comfortable with openly talking about their gender experiences, introducing self-selection bias into the study. Qualitative findings suggest that trans women tend to experience higher levels of social stigma and lower social status than trans men (Verbeek et al., 2020), possibly explaining why we did not reach more trans women through our sampling strategy. The findings presented in this doctoral thesis may not be generalizable to populations outside of the German-speaking part of the world and populations with lower SES. Furthermore, Study 1 and Study 2 were conducted during the COVID-19 pandemic, potentially reflecting temporary patterns of stress, health behaviors, and coping in adolescents and young adults, thus, necessitating the findings to be interpreted with a specific temporal context in mind.

#### **IV.4. Conclusion and Implications**

Overall, the findings presented in this doctoral thesis add to the understanding of potential risk factors and protective factors for chronic stress and mental health consequences thereof and provide novel insights into potential mechanisms to help prevent drastic negative effects on the mental health of young people such as those observed during the COVID-19 pandemic. Using diverse methodological approaches, the studies included in this doctoral thesis investigated risk factors and protective factors for perceived stress in German-speaking countries. The findings clearly reveal both younger age (Study 2) and gender diversity (Study 3) as risk factors for heightened perceived stress during ongoing crises such as the COVID-19 pandemic. Furthermore, the findings show that health behaviors can have stress-buffering effects during ongoing crises (Study 1) and that certain coping strategies such as music listening, social support, and behavioral disengagement can have



short-term stress reducing effects in the daily lives of adolescents and young adults (Study 3). These findings can help inform interventions aimed at supporting the mental health of young people experiencing chronic stress in future times of high perceived stress such as the Covid-19 pandemic.

A meta-analysis covering 33 countries found higher coping flexibility to be related to better mental health outcomes during the COVID-19 pandemic (Chen et al., 2025). Instead of focusing on the distinction between different styles of coping strategies as either adaptive or maladaptive, future studies should investigate whether increasing overall coping flexibility in adolescents and young adults can have protective effects on mental health indicators. Also, the interactions between different coping strategies, such as active coping and music listening, warrants investigation in large samples. Furthermore, which specific coping strategies are employed to manage stressful situations seems to depend on the specific stressors experienced (Goreis et al., 2020). To untangle the dynamic links between specific stressors, coping behaviors, and stress outcomes more completely, it would be interesting for future studies to examine such individual within-person pathways between different stressors experienced, the specific strategies used to cope with them, and the effectiveness of these coping strategies for subsequent stress and mental health in more detail. Furthermore, the inclusion of biomarkers for physiological stress system activation (e.g., cortisol or alpha amylase) can expand the understanding of allostatic load and its effects on physiological health in populations experiencing gender minority stress and should be emphasized for future studies in this regard. This approach could furthermore provide causal evidence of the effects of different coping behaviors on physiological markers and both mental and physical health.

According to McEwen (2006), public health campaigns targeting allostatic load should focus on individual aspects, such as empowering individuals to pursue healthy lifestyles, including good sleep quality, healthy diet, and regular physical activity, and to avoid harmful behaviors like

smoking and alcohol consumption, and should also facilitate social support, an optimistic outlook on life, and good self-esteem. One such low-threshold, low-cost intervention, designed to support the mental health of adolescents during ongoing crises by increasing health behaviors, is SPARKY (Dale et al., 2023), an online randomized controlled trial aimed at increasing physical activity and reducing excessive phone use in at-risk adolescents and young adults.

This work contributes to a better understanding of risk factors and protective factors for the development of psychological symptoms in adolescents and young adults during ongoing crises. The findings highlight potential mechanisms for targeted interventions aimed at reducing the negative consequences of stress in young and vulnerable populations.

## Contribution of Authors

This dissertation includes three manuscripts. One manuscript was published in a peer-reviewed journal, one paper has been resubmitted after revision, and one paper has been submitted for peer-review. The three manuscripts, as well as the author contributions for each manuscript, are listed below.

1. **O'Rourke, T.**, Humer, E., Plener, P.L., Pieh, C., & Probst, T. (2023). Moderation effects of health behaviors on stress and suicidal ideation in adolescents: a cross-sectional survey during COVID-19. *Scientific Reports*, 13, 21376. <https://doi.org/10.1038/s41598-023-48972-y>

**Teresa O'Rourke** analyzed and interpreted the data and wrote and edited the manuscript. Elke Humer contributed to the conceptualization and design of the study, collected the data, and edited the manuscript. Paul Plener contributed to the conceptualization and design of the study and edited the manuscript. Christoph Pieh contributed to the conceptualization and design of the study, collected the data, and edited the manuscript. Thomas Probst contributed to the analysis and interpretation of the data and edited the manuscript.

2. **O'Rourke, T.**, Pryss, R., John, D., & Probst, T. (2023). Exploring the time trend of perceived stress during COVID-19: An Ecological Momentary Assessment study with the mHealth application CoronaHealth [Manuscript submitted for publication]

**Teresa O'Rourke** analyzed and interpreted the data and wrote and edited the manuscript. Rüdiger Pryss contributed to the conceptualization and design of the study as well as the data curation and

edited the manuscript. Dennis John contributed to the conceptualization of the study, helped with the data analysis, and edited the manuscript. Thomas Probst analyzed and interpreted the data and edited the manuscript.

3. **O'Rourke, T.**, Zach, L., Haider, K., Klinger, D., Nater, U. M., van Alebeek, H., Pieh, C., & Probst, T. (2025). How Transgender, Gender Diverse (TGD) and Cisgender Youth Cope with Daily Stress: Insights from an Ecological Momentary Assessment Study. [Manuscript submitted for publication]

**Teresa O'Rourke** conceptualized the study, contributed to the study design, collected, analyzed, and interpreted the data, and wrote and edited the manuscript. Lisa Zach contributed to the conceptualization and design of the study, helped with the curation, analysis, and interpretation of data, and edited the manuscript. Katja Haider contributed to the design of the study, assisted with the collection, analysis, and interpretation of the data, and edited the manuscript. Diana Klinger contributed to the conceptualization and design of the study, as well as to the data collection, and edited the manuscript. Urs M. Nater contributed to the design of the study and edited the manuscript. Hannah van Alebeek contributed to the analysis and interpretation of data and to the writing and editing of the manuscript. Thomas Probst contributed to the design of the study and the interpretation of data and edited the manuscript.

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## **Appendix: Included Publications**



# OPEN Moderation effects of health behaviors on stress and suicidal ideation in adolescents: a cross-sectional survey during COVID-19

Teresa O'Rourke<sup>1</sup>✉, Elke Humer<sup>1,2</sup>, Paul L. Plener<sup>3,4</sup>, Christoph Pieh<sup>1</sup> & Thomas Probst<sup>1,5</sup>

This cross-sectional online survey study investigated whether certain health behaviors moderated the relationship between perceived stress and suicidal ideation in Austrian adolescents during the COVID-19 pandemic. A total of 1505 14–20-year-old (median age = 16) high school students (77.9% female) filled out an online survey from September to November 2021. Perceived stress was measured with the PSS10, suicidal ideation with item 9 of the PHQ-9. The following health behaviors were assessed: Physical activity (days/week), phone use (hours/day), problematic drinking behavior (CAGE). All three health behaviors significantly moderated the relationship between perceived stress and suicidal ideation (all  $p < .05$ ), but effects were small. The moderation analyses revealed that higher physical activity and less time spent on the phone were associated with less suicidal ideation at higher stress levels. Showing signs of problematic drinking behavior was associated with higher suicidal ideation at higher stress levels. In conclusion, these results suggest that some health behaviors may be able to act as a buffer between perceived stress and suicidal ideation. However, more research is needed to confirm these potentially buffering effects.

The COVID-19 pandemic and the associated restrictions implemented to prevent an uncontrolled dissemination of the disease have disrupted the daily lives of people all over the world. The psychosocial consequences of these pandemic-related restrictions are becoming increasingly evident in the general population<sup>1</sup>, but particularly in children and adolescents<sup>2</sup>. Adolescence is characterized by crucial social and cognitive development<sup>3</sup>, which has been directly impacted by measures such as school closures and subsequent home-schooling. Schools constitute an important environment for adolescent development by providing context for peer-interactions essential for developing social identity and autonomy<sup>4</sup>. By having to adapt to distance learning, many adolescents not only experienced a loss of social contact with their peer-group, but both students and their parents also had to change daily routines, which resulted in many parents experiencing high levels of stress during the pandemic<sup>5</sup>. As consequences of these restrictions, many adolescents reported school-related stress, such as difficulties completing school projects and pressure to perform, increased interpersonal problems with family and friends, and worries about the future<sup>6</sup>. A study conducted in 2015 emphasized the multidimensionality of stressors in university students by identifying academic performance, pressure to succeed, and post-graduation plans as students most mentioned concerns even in non-pandemic times<sup>7</sup>. It is highly likely, that the pandemic-related restrictions have exacerbated these concerns for many students. After one semester of home-schooling in Austria, over 50% of 2884 surveyed high school students reported experiencing moderate stress levels, and one third reported experiencing high stress-levels<sup>8</sup>. Such an accumulation of stressors over time can exacerbate mental health symptoms<sup>9</sup>, which is especially worrisome in this age group, as adolescence already constitutes a vulnerable time for the development

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of mental health disorders<sup>10</sup>. For many individuals, adolescence and the transition to early adulthood constitutes a highly stressful time, with a meta-analysis from 2020 revealing an alarmingly high prevalence of stress, anxiety, and depression in university students<sup>11</sup>. The loss of social contacts through social distancing also brought with it a loss of a crucial coping strategy, namely social support, which has been linked to higher quality of life and well-being, as well as lower perceived stress, depressive symptoms, anxiety, and insomnia during COVID-19<sup>12</sup>. A lack of adaptive coping-strategies, on the other hand, has been associated with experiencing chronic stress<sup>13</sup> and may constitute a further risk factor for the development of mental disorders. Further risk factors for mental health problems can be adverse health behaviors, which have reportedly increased following the onset of the pandemic due to disruptions in daily life activities and the subsequent change in lifestyle<sup>14</sup>. For example, a study with more than 7000 Austrian adolescents reported a significant decrease of physical activity as well as a significant increase of mobile phone use compared to pre-pandemic data<sup>15</sup>. This is an alarming development, as an international study conducted at the beginning of the pandemic revealed significantly worse mental health indicators in individuals exhibiting negative changes in exercise behavior following pandemic-related restriction measures, in comparison to individuals adapting to restriction measures with positive changes in exercise behavior<sup>16</sup>. Another alarming change in health behavior after the onset of the pandemic was the consumption of drugs. In Austrian adolescents and young adults, the most used drugs are nicotine and alcohol<sup>17</sup>, followed by cannabis with a lifetime prevalence of 30–40%, and ecstasy, cocaine, and amphetamines with lifetime prevalences of around 6%<sup>18</sup>. Pre-pandemic data from the ESPAD study reveals that while only 15% of Austrian adolescents reported to have never consumed alcohol before, this number of abstinent adolescents has increased over the last decade<sup>19</sup>. However, post-pandemic data from a recent general population survey reveals that around 40% of 15–34-year-old Austrians increased their alcohol consumption during the first lockdown in March 2020<sup>15</sup>. These changes in drinking behavior were of short duration as alcohol consumption in this age group returned to base levels after a few months, which suggests that this was a way of coping with the demands of the first lockdown for this demographic group. While alcohol consumption as a coping strategy can have short-term stress-reducing effects<sup>20</sup>, it leads to detrimental physical and mental health outcomes in the long run<sup>21</sup>. In a study conducted during COVID-19 lockdown, alcohol consumption as a coping strategy positively predicted perceived stress, symptoms of depression, anxiety, and insomnia, and negatively predicted quality of life and well-being<sup>12</sup>.

An alarming development during the COVID-19 pandemic in Austria was an increase in suicidal ideation in adolescents, continuing even after restrictions had been lifted. While adolescents' suicidality did not seem to have been impacted by the onset of the COVID-19 pandemic or has seemingly even decreased during the pandemic in some countries such as Japan or New Zealand<sup>22</sup>, the prevalence of suicidal ideation in Austrian adolescents increased slightly from 35.3% in girls and 30.6% in boys in spring 2021, to 47.2% in girls and 33.5% in boys in autumn 2021<sup>23</sup>.

Perceived stress<sup>24,25</sup>, as well as stressful life events such as family stressors or academic stressors<sup>26</sup>, have been previously identified as predictors for suicidal ideation, and may have contributed to this development in some form. According to the Narrative-Crisis Model of suicide, experiencing stressful life events increases the likelihood of already vulnerable individuals of developing the Suicidal Crisis Syndrome, culminating in a sense of entrapment and little hope for the future, social withdrawal, affective disturbance, and hyperarousal<sup>27</sup>. The Suicidal Crisis Syndrome, in turn, has been linked to suicidal ideation as well as imminent suicidal behavior<sup>28</sup>. Taking this model into account, in a time of increased stress such as the COVID-19 pandemic, it is highly relevant to investigate potential protective factors for suicidal ideation. In this regard, health behaviors have been associated not only with physical health but mental health benefits as well. Physical activity, for example, may be such a protective factor for suicidal ideation, according to the findings of a meta-analysis<sup>29</sup>. Furthermore, multiple studies suggest a link between excessive phone use and suicidal ideation<sup>30</sup> as well as self-harm<sup>31</sup> in adolescents. Especially late-night phone use may be a risk factor for depression and suicidality in young people<sup>32</sup>. Chen et al.<sup>33</sup> identified a mediating effect of interpersonal problems, a common stressor, on the relationship between excessive phone use and suicidal behaviors as well as self-harm in adolescents. In their review, Carballo et al.<sup>26</sup> also identified alcohol use as a risk factor for suicidality. Both alcohol consumption as means of coping and heavy episodic drinking have been associated to increased suicidality in adolescents<sup>34</sup>.

In the present study, we aimed to examine whether the strength of the association between perceived stress and suicidal ideation is influenced by health behaviors. We, therefore, investigated three health behaviors (physical activity, mobile phone use, alcohol consumption) as moderators of the link between perceived stress and suicidal ideation.

The following research questions were addressed:

- RQ1 Does physical activity moderate the relationship between perceived stress and suicidal ideation?
- RQ2 Does phone usage moderate the relationship between perceived stress and suicidal ideation?
- RQ3 Does problematic drinking behavior moderate the relationship between perceived stress and suicidal ideation?

## Materials and methods

### Study design

A cross-sectional online survey was conducted from the 14th of September 2021 to the 14th of November 2021 via REDCap<sup>35</sup>, which is hosted at servers of the University for Continuing Education, Krems. Recruitment was conducted by school representatives, who posted a link to the online survey on various social media platforms, inviting Austrian high school students to participate. Participation in the study was voluntary. At the time of the survey, there was no lockdown in place and schools were fully open. Regular COVID-19 tests and FFP-2 masks outside of the classroom were required as protective measures in schools. To partake in the study, all participants

had to give electronic informed consent by agreeing to the data protection declaration and confirm that they were at least 14 years old, as the legal age of consent in Austria is 14. This study procedure was approved by the Ethics Committee of the University for Continuing Education Krems (protocol code EK GZ 41/2018–2021) as well as a data protection officer and conducted in accordance with the Declaration of Helsinki. Further studies have been published based on this dataset<sup>23</sup>.

## Materials

### Perceived stress

Perceived stress was measured with the reliable and validated Perceived Stress Scale (PSS-10)<sup>36</sup>. The PSS-10 is a widely used self-rating questionnaire containing 10 items on a 5-point Likert scale and scores ranging from 0 to 40. Scores from 0 to 13 indicate a low stress level, scores from 14 to 26 indicate a moderate stress level, and scores from 27 to 40 indicate a high stress level. The German version has been validated for individuals aged 14 to 90<sup>37</sup>. The Cronbach's  $\alpha$  for the PSS-10 in our sample was 0.861.

### Suicidal ideation

Suicidal ideation was assessed with the ninth item of the PHQ-9<sup>38,39</sup>: “Over the last two weeks, how often have you been bothered by thoughts that you would be better off dead or of hurting yourself in some way?” Possible answer options were not at all (0), several days (1), more than half the days (2), and nearly every day (3). A cut-off score of 1 is generally used to indicate suicidal ideation. The PHQ-9 has been shown to be a robust and age-independent predictor of suicide attempts and deaths<sup>39</sup>.

### Physical activity (Moderator 1)

To assess physical activity, participants were asked: “On how many of the last seven days have you been physically active for at least 60 min?” Possible answers ranged from 0 to 7 days.

### Phone usage (Moderator 2)

Smartphone usage was assessed by asking participants: “In a typical day, how much time do you spend—sitting or lying down—on your smartphone?” The following answers were possible: less than 1 h per day, 1–2 h per day, 3–4 h per day, 5–6 h per day, 7–8 h per day, more than 8 h per day.

### Problematic drinking behavior (Moderator 3)

Problematic drinking behavior was assessed using the validated and reliable screening questionnaire CAGE<sup>40,41</sup>. The CAGE consists of four yes/no questions regarding signs of alcoholism. Problematic drinking behavior is indicated when a cut-off of two or more questions have been answered with “yes”<sup>42</sup>.

## Statistics

To answer the three research questions, three moderation models were conducted using model 1 (one moderator) of the SPSS Macro Process. Using the Johnson-Neyman method, we tested for possible significance transition points within the observed range of the moderators. The first model tested the effect of physical activity on the relationship between perceived stress and suicidal ideation:

$$\text{Suicidal Ideation} = \beta_0 + \beta_1 \text{stress} + \beta_2 \text{physical activity} + \beta_3 \text{stress} \times \text{physical activity} + \varepsilon$$

The second model tested the effect of phone use on the relationship between perceived stress and suicidal ideation:

$$\text{Suicidal Ideation} = \beta_0 + \beta_1 \text{stress} + \beta_2 \text{phone use} + \beta_3 \text{stress} \times \text{phone use} + \varepsilon$$

The third model tested the effect of problematic alcohol consumption on the relationship between perceived stress and suicidal ideation:

$$\begin{aligned} \text{Suicidal Ideation} = & \beta_0 + \beta_1 \text{stress} + \beta_2 \text{problematic alcohol consumption} \\ & + \beta_3 \text{stress} \times \text{problematic alcohol consumption} + \varepsilon \end{aligned}$$

Gender and age were included as covariates in all 3 models. SPSS v28 was used for all analyses, all statistical tests were performed two-tailed, and the significance level was set to  $p < 0.05$ . To account for type-I error inflation due to multiple testing, an additional Bonferroni-adjusted significance level of  $p < 0.01666$  was calculated.

## Results

### Sample

Following the American Association for Public Opinion Research (AAPOR) reporting guidelines for nonprobability online samples<sup>43,44</sup>, we report that 62.31% of those who clicked on the survey link completed the entire survey, resulting in a 62.31% participation rate (ie, completion rate). In total, 1505 high school students with a mean age of 16.3 (SD = 1.4) completed the survey. 1173 (77.9%) out of these were female, 281 (18.7) male, and 51 (3.4%) reported diverse gender.

**Results for RQ1:** Does physical activity moderate the relationship between perceived stress and suicidal ideation?

A moderation analysis was run to determine whether the interaction between perceived stress and physical activity significantly predicts suicidal ideation. The overall model was significant,  $F(5, 1499) = 145.57, p < 0.001$ ,



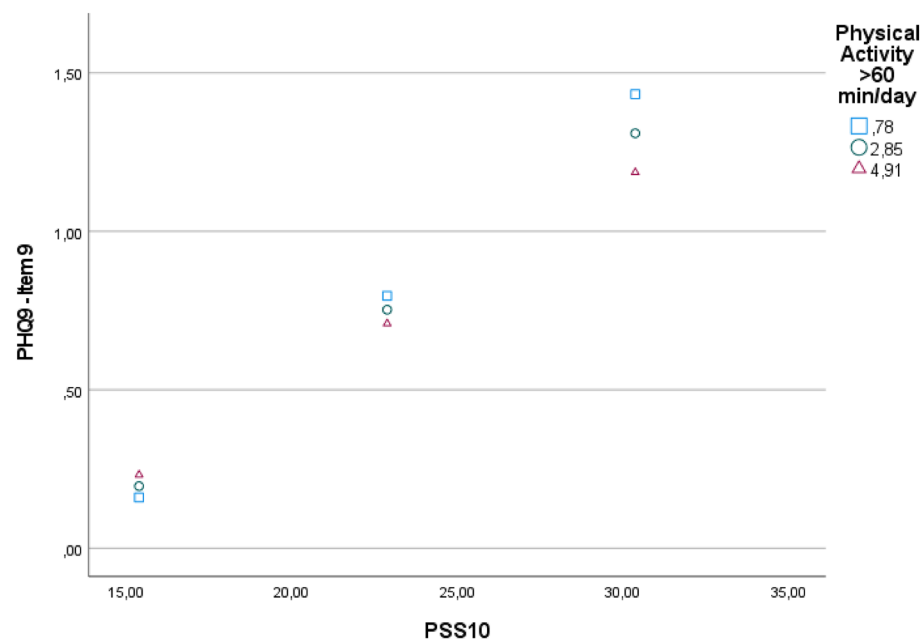
$R = 0.572$ , predicting 32.68% of the variance. All predictors were significant before Bonferroni-adjusting the significance level (perceived stress = 0.089,  $p < 0.001$ , 95% CI [0.080, 0.099]; physical activity = 0.074,  $p = 0.021$ , 95% CI [0.011, 0.137]), but the  $p$ -value of physical activity surpassed the Bonferroni-adjusted significance level of 0.01666. However, physical activity moderated the effect between perceived stress and suicidal ideation significantly,  $\Delta R^2 = 0.46\%$ ,  $F(1, 1499) = 10.32$ ,  $p = 0.001$ , 95% CI [-0.007, -0.002]. The R-Square change value indicates a small effect size. The interaction plot (Fig. 1) reveals that as stress levels increased, adolescents who were more physically active showed less suicidal ideation than less active adolescents. There were no statistical significance transition points within the observed range of the moderator found using the Johnson-Neyman method, as the effect was significant for all observed moderator values.

**Results for RQ2:** Does phone usage moderate the relationship between perceived stress and suicidal ideation?

A moderation analysis was run to determine whether the interaction between perceived stress and phone usage significantly predicts suicidal ideation. The overall model was significant,  $F(5, 1499) = 155.12$ ,  $p < 0.001$ ,  $R = 0.584$ , predicting 34.10% of the variance. Perceived stress (estimate = 0.039,  $p < 0.001$ , 95% CI [0.021, 0.057]) reached statistical significance before and after the Bonferroni-correction, while phone usage (estimate = -0.123,  $p = 0.052$ , 95% CI [-0.247, 0.001]) was not a significant predictor for suicidal ideation alone. However, physical activity moderated the effect between perceived stress and suicidal ideation significantly,  $\Delta R^2 = 0.66\%$ ,  $F(1, 1499) = 14.91$ ,  $p = 0.001$ , 95% CI [0.005, 0.015]. The R-Square change value indicates a small effect size. The interaction plot (Fig. 2) shows that at higher stress levels, adolescents who spent more time on their phones reported more suicidal ideation than those who spent less time on their phones. This effect becomes especially apparent at a high stress level, where adolescents who only spent 2 h per day on their phones did not meet the cut-off score for suicidal ideation ( $PHQ9 \geq 1$ ), while those who spent 3 or 5 h per day on their phone did show signs of suicidal ideation. There were no statistical significance transition points within the observed range of the moderator found using the Johnson-Neyman method, as the effect was significant for all observed moderator values.

**Results for RQ3:** Does problematic drinking behavior moderate the relationship between perceived stress and suicidal ideation?

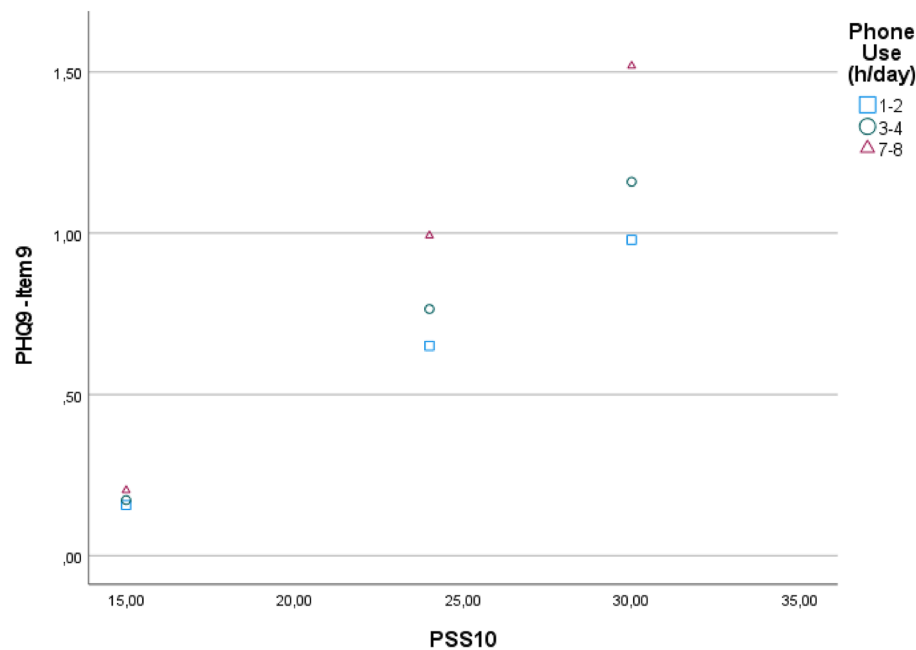
A moderation analysis was run to determine whether the interaction between perceived stress and problematic drinking behavior significantly predicts suicidal ideation. The overall model was significant,  $F(5, 1499) = 144.122$ ,  $p < 0.001$ ,  $R = 0.570$ , predicting 32.47% of the variance. All predictors were significant before Bonferroni-adjustment (perceived stress = 0.072,  $p < 0.001$ , 95% CI [0.065, 0.078], problematic alcohol consumption = -0.188,  $p = 0.028$ , 95% CI [-0.355, -0.021]), but the  $p$ -value of problematic alcohol consumption surpassed the Bonferroni-adjusted significance level of 0.01666. Problematic alcohol consumption moderated the effect between perceived stress and suicidal ideation significantly,  $\Delta R^2 = 0.34\%$ ,  $F(1, 1499) = 7.50$ ,  $p = 0.006$ , 95% CI [0.002, 0.016]. The R-Square change value indicates a small effect size. The interaction plot (Fig. 3) reveals that as stress levels increased, adolescents who showed signs of problematic drinking behavior ( $CAGE \geq 2$ ) reported higher suicidal ideation than those not meeting the criteria for problematic drinking behavior. There were no statistical significance transition points within the observed range of the moderator found using the Johnson-Neyman method, as the effect was significant for all observed moderator values.



Note.  $\square$  = 16<sup>th</sup> percentile,  $\circ$  = 50<sup>th</sup> percentile,  $\triangle$  = 84<sup>th</sup> percentile

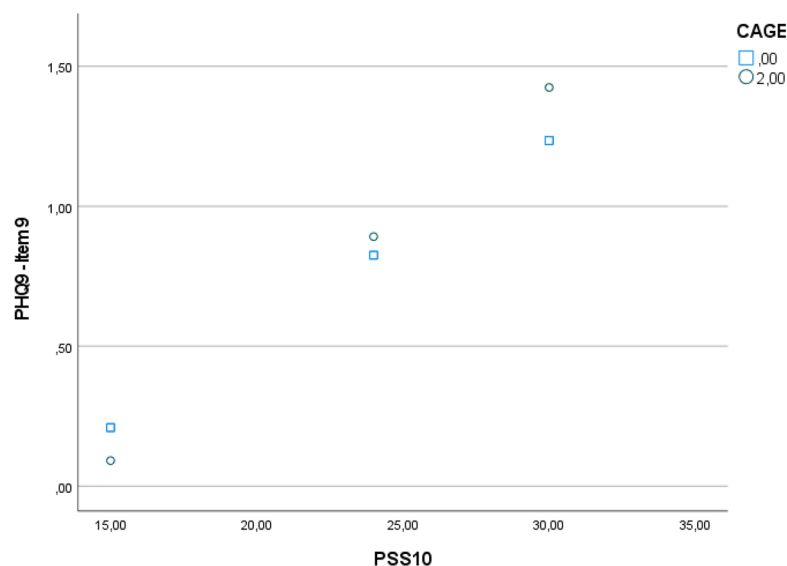
**Figure 1.** Moderation effect of physical activity on the relationship between perceived stress and suicidal ideation.





Note.  $\square$  = 16<sup>th</sup> percentile,  $\circ$  = 50<sup>th</sup> percentile,  $\triangle$  = 84<sup>th</sup> percentile

**Figure 2.** Moderation effect of phone usage on the relationship between perceived stress and suicidal ideation.



Note.  $\square$  = < cut-off score for problematic drinking behavior,  $\circ$  = > cut-off score for problematic drinking behavior

**Figure 3.** Moderation effect of problematic drinking behavior on the relationship between perceived stress and suicidal ideation.

## Discussion

Although neither physical activity, phone usage, nor problematic drinking behavior significantly predicted suicidal ideation on their own, all three health behaviors significantly moderated the relationship between perceived stress and suicidal ideation. Yet, the effects of the health behaviors were very small, indicating that the practical relevance of these results may be limited. Nevertheless, the results suggest that maintaining a healthy level of physical activity, spending little time on the phone, and reducing alcohol consumption may at least to a certain degree weaken the link between perceived stress and suicidal ideation. Based on the cross-sectional nature of this study, we cannot make any causal inferences on whether physical activity, phone usage, and problematic alcohol consumption influence stress or whether stress influences physical activity, phone usage, and problematic alcohol consumption. Nevertheless, the results suggest that the interplay between these health behaviors and stress has

an, albeit small, effect on suicidal ideation. From a public health perspective, the pandemic related restrictions highlighted the urgent need for low-threshold interventions and adaptive health behaviors may at least have supportive effects on adolescents' mental health during highly stressful times. Considering these results in the framework of the Narrative-Crisis Model of suicide<sup>27</sup>, physical activity may represent a protective factor for the development of the Suicidal Crisis Syndrome in vulnerable individuals experiencing stressful life events, while both excessive phone use and problematic alcohol consumption may represent risk factors in this regard. This is of particular interest, as the onset of the COVID-19 pandemic resulted in adverse changes in these health behaviors for a lot of young people<sup>17,45</sup>. Thus, focusing interventions and public health information on how to maintain a healthy lifestyle despite ongoing crises such as the COVID-19 pandemic, may pose an important factor for positive mental health change.

In line with the results of this study, under-exercising has been associated with higher stress levels and worse mental health, such as anxiety or depressive symptoms<sup>15</sup>, and greater amounts and higher intensities of physical activity generally seem to be more beneficial for physical and mental health<sup>46</sup>. However, not only the amount of time spent in physical activity is important, but the intensity as well. The World Health Organization guidelines for physical activity in children and adolescents recommend at least 60 min of moderate to vigorous physical activity daily for optimal health benefits<sup>47</sup>. A meta-analysis has identified beneficial effects of physical activity on mental health and suicidal ideation for adolescents, adults, and older adults alike<sup>29</sup>. Over-exercising, however, can be associated with health problems. It is well-known that over-exercising can be one symptom of eating disorders and poses a risk factor for developing an eating disorder<sup>48</sup>. Moreover, vigorous physical activity has been associated with higher accumulated concentrations of the stress-related hormone cortisol found in hair, compared to moderate physical activity<sup>49</sup>. In adolescents, over-exercising was linked to higher hair cortisol levels, compared to exercising the recommended amount<sup>50</sup>. While physical activity can be seen as a physical stressor, as it acutely increases circulating cortisol<sup>51</sup>, this does not necessarily correspond with an increase in subjectively perceived stress. On the contrary, higher physical activity has been linked to less perceived stress in adolescents<sup>52</sup>. Thus, a balanced approach to physical activity certainly is important for optimal physical and mental health. Adhering to the WHO physical activity guidelines, designed to facilitate a healthy lifestyle, is recommended and increasing adolescents' motivation and competency for regular physical activity may be a fruitful approach to support their mental health, especially during times of crises, such as the COVID-19 pandemic.

Mobile phone use may be a form of coping with stress for adolescents and has become particularly relevant during the COVID-19 pandemic, when social distancing was necessary and many options for leisure-time activities were restricted. While multiple studies have reported an association between excessive phone use and negative mental health outcomes, it is important to note that in the daily lives of adolescents, and even more so during ongoing crises such as the COVID-19 pandemic, smartphones are an essential means of communicating and sharing information with each other<sup>53</sup> and therefore may also hold potential for improving adolescents' psychosocial health, when used responsively. As loneliness and social isolation have also been associated with increased suicidal ideation<sup>25</sup>, this is an important factor to consider when developing mental health interventions for this age group. Additional important factors in this regard, besides time spent on the phone, may be the consumed content as well as the way in which this content is consumed by adolescents. Making mental health information available online in an accessible format and developing digitally available interventions may hold a high potential for reaching this specific age group<sup>54</sup>. However, fostering public health awareness of responsible smartphone use is crucial to prevent harmful consequences of excessive smartphone use in adolescents.

Alcohol consumption can be classified as a maladaptive coping strategy<sup>55</sup>, as it can potentially have dose-dependent short-term stress reducing effects, especially in highly stressful situations<sup>20</sup>, but can lead to physiological stress-system dysregulations in the long-term<sup>21</sup>. Moreover, not only has problematic alcohol use been associated to suicidality<sup>34</sup> and mental health problems such as depression and anxiety<sup>56</sup>. Considering the role of alcohol consumption in the relationship between stress and suicidal ideation, the duration of alcohol consumption seems critical. Responsible, short-term alcohol consumption should not increase suicidal ideation, but long-term use of alcohol to cope with stressful situations can exacerbate stress and mental health problems and in turn increase suicidal ideation. Chronic alcohol abuse also significantly increases overall mortality<sup>57</sup>, by increasing the risk of various cancers, liver disease, hypertension, and, especially relevant for younger people, also injuries and violence<sup>58</sup>. A systematic review on alcohol consumption in 15-to-19-year-olds suggests that reducing problematic alcohol consumption during adolescence might prevent negative long-term consequences of alcohol consumption for physical and mental health in later years, as well as harmful short-term consequences, such as injuries through accidents<sup>59</sup>.

For researchers and practitioners alike, it might be of interest to examine physical activity, phone usage, and problematic alcohol consumption as points of action in public health interventions targeting suicidality in adolescents suffering from the consequences of the COVID-19 pandemic, or other ongoing crises.

## Limitations

Some limitations to the study need to be considered when interpreting the results. Most importantly, the cross-sectional nature of the survey does not allow for any causal conclusions. Therefore, a longitudinal investigation of the effects proposed in this study is vital. Secondly, the online nature of the survey, although enabling the collection of a large sample, carries the potential to introduce self-selection bias. Adolescents without access to the internet could not be reached this way. The gender distribution was not representative of the Austrian population, with more girls taking part in the study than boys. Furthermore, only self-report measures of physical activity, phone usage, and stress were included, whereas accelerometric data could provide more objective measures of these variables. Suicidal ideation was only assessed with a single item question in PHQ 9 and not with a standardized questionnaire. Lastly, CAGE results from non-clinical samples should be interpreted cautiously<sup>40</sup>.

## Conclusions

Overall, these results suggest that some health behaviors may hold potential to attenuate the effect of stress on suicidal ideation, at least to a certain degree, while adverse health behaviors may even exacerbate it. However, as this cross-sectional design does not allow for any causal inferences, further exploration of these proposed relationships in longitudinal studies is necessary. Although revealing only small effects, these results seem highly relevant, not only from a public health perspective. Health behavior can be changed and should be actively promoted. Thus, evaluated low-threshold interventions to support adolescents' mental health during ongoing crises are urgently needed. Increasing physical activity, decreasing phone time or reducing alcohol consumption might be viable as such and should be investigated further in longitudinal studies. While systemic effort is necessary to prevent adverse developments in adolescent mental health in the future, taking action in one's everyday life by getting enough exercise, reducing phone use, and reducing alcohol intake may alleviate some of the impact of perceived stress on suicidal ideation and act as a protective factor for adolescents' mental health during ongoing crises.

## Data availability

The datasets used and analyzed during this study are available from the corresponding author on reasonable request.

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Conception and Design: C.P., E.H., P.L.P.; Acquisition of Data: C.P., E.H.; Analysis and Interpretation of Data: T.O., T.P.; Writing – original draft: T.O.; Writing – review and editing: C.P., E.H., P.L.P., T.P., T.O. All authors approved the final article.

## Competing interests

The authors declare no competing interests.

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**Title:** Exploring the time trend of perceived stress during COVID-19: An Ecological Momentary Assessment study with the mHealth application CoronaHealth

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## **Abstract**

The objectives of this study were to investigate the time trend of perceived stress during the COVID-19 pandemic in a sample of German adults and to identify possible moderating factors. An Ecological Momentary Assessment study with the mHealth application CoronaHealth was conducted with 288 participants from December 2020 to February 2022. Participants filled out the Perceived Stress Scale weekly. Linear multilevel models were conducted with R to test possible moderating effects of demographic factors as well as COVID-19 status on linear and quadratic time trends of stress during the COVID-19 pandemic. Perceived stress significantly decreased over time in the total sample. Younger age was significantly associated with increased stress at baseline. Education, relationship status and personal experiences with COVID-infection moderated stress trajectories over time. While perceived stress significantly reduced over time in the total sample, younger individuals seem to have experienced higher stress levels during the COVID-19 pandemic and certain variables impacted the stress trajectories over time. These findings provide real-time insights to the dynamics of perceived stress during the COVID-19 pandemic, highlight potential vulnerable populations at greater risk for negative mental health outcomes and demonstrate the potential of mHealth applications for mental health monitoring during public health crises.

**Keywords:** COVID-19, Digital Health, mHealth, Stress

## 1. Introduction

The COVID-19 pandemic and the related measures implemented to contain it, such as lockdowns and social distancing, led to uncertainty and significant changes in peoples' daily lives all over the globe. Where possible, home-office and home-schooling were implemented to reduce the spread of COVID-19. These measures not only necessitated sudden adaptations to daily routines but were often also accompanied with a loss of social contact, resulting in high levels of stress during the pandemic for both students and their parents (Fontenelle-Tereshchuk et al., 2021). The consequences of the COVID-19 pandemic on well-being and mental health have been becoming increasingly apparent (e.g.: Ammar et al., 2020; Brooks et al. 2020; Pieh et al., 2020; Shigemura et al., 2020). In Germany, indicators of mental health problems such as symptoms of depression and anxiety (Bäuerle et al., 2020) significantly increased after the start of the COVID-19 pandemic and have stayed at a high level since. While some studies reported an increase in mental health symptoms even after the first lockdown ended (Moradian et al., 2021), other studies reported a slight decrease of symptoms over time, although never reaching pre-pandemic levels (Mata et al, 2021).

While some studies depict an increase in perceived stress after the onset of the pandemic compared to pre-pandemic times (e.g. Peters et al., 2020), it seems to have stayed relatively low when compared to other countries. In an international survey conducted at the beginning of the pandemic (Adamson et al., 2020), German participants reported the lowest perceived stress scores compared to 10 other nationalities. In contrast to Peters et al. (2020), a longitudinal study conducted with German university students did not find a significant change in perceived stress from 2019 to 2020 but found perceived stress to be associated with preventive health behavior during the pandemic (Voltmer, 2021). In another longitudinal study conducted in Germany, higher perceived stress was linked to worse mental health during the COVID-19 pandemic (Ahrens et al., 2021). In

sum, longitudinal studies conducted in Germany have shown ambivalent results and inconsistent time trends of perceived stress during the COVID-19 pandemic. Thus, time trends of perceived stress during COVID-19 pandemic may vary between demographic groups in the general population.

While acute stress is an adaptive response to unpredictable changes in the environment, chronic stress can have detrimental effects not only on mental but also physical health (McEwen, 2017). Taking the vulnerability-stress model of psychopathology (Goh & Agius, 2010) into consideration, it is likely that already vulnerable individuals may be affected more severely by the COVID-19 pandemic. To implement effective measures of support for particularly vulnerable individuals, risk and protective factors for high stress levels during the pandemic first need to be identified. Indeed, although detrimental mental health consequences of the COVID-19 pandemic have been observed throughout the general population, certain demographic variables, particularly age, gender, education, and relationship status seem to increase perceived stress.

### Age

First, younger people seem to have suffered more severe mental health problems and reported higher stress levels during the pandemic than older people (Pieh et al., 2020), with children and adolescents representing a particularly affected group (Eigl et al., 2022).

### Gender and Sexual Orientation

Second, gender also seems to be highly related to mental health and perceived stress during the pandemic, with women seemingly being more burdened than men. An early systematic review of evidence from the first few months of the pandemic revealed female gender to be associated with a higher risk for psychiatric symptoms and low mental well-being (Vindegard et al., 2020). Moreover, a meta-analysis investigating the prevalence of mental health symptoms during the first



year of the pandemic found that women had significantly higher rates of mental health symptoms and perceived stress during the pandemic than men (Dragioti et al., 2021). Diverse or genderqueer individuals, as well as non-heterosexual individuals, an already vulnerable group faced with minority stress even during non-crisis times, reported high levels of perceived stress after the onset of the pandemic (Kneale & Bécaries, 2020), as well as higher scores of psychological symptoms than cisgendered individuals (e.g., Buspavanich et al., 2021; Dale et al., 2023).

### Education

Third, a higher education level may potentially be a protective factor for experiencing high stress levels during the pandemic (Kowal et al., 2020), as some jobs, which require a higher degree of education typically offer more job security. Alcover et al. (2020) reported not only a negative association between job insecurity and mental health, but also a buffering effect of social support on the mental health of individuals experiencing job insecurity and financial threat.

### Relationship status

Fourth, relationship status has been shown to be associated with perceived stress during COVID-19 pandemic. For example, in a Canadian study conducted with over 8000 participants, individuals in a relationship reported significantly lower perceived stress than single individuals (Nkire et al., 2022). Furthermore, single individuals reported higher stress levels than divorced or separated individuals, while widowed participants reported lower stress levels than all other groups (Nkire et al., 2022). While social support is an important coping strategy (Schwarzer & Knoll, 2007), opportunities to receive social support have been reduced for many people during the pandemic. Measures such as social distancing, home schooling and home office have decreased social contact outside of the home for many people. In a study conducted by Hendriksen et al. (2021), both individuals living alone and together with other people reported mood decreases during COVID-

19 lockdown, yet those living alone reported significantly higher increases in loneliness than those living together with other people. Another study conducted with health care workers found no association between living alone and mental health, while feelings of loneliness were associated with worse mental health outcomes (Cabello et al., 2021).

#### COVID status

Another important risk factor to consider is the COVID-19 disease itself. According to the above-mentioned meta-analysis (Dragioti et al., 2021), individuals currently infected with COVID-19 also had higher rates of mental health symptoms.

Many studies, especially in the beginning of the pandemic, assessed mental health and perceived stress cross-sectionally via online surveys, which can reach large samples, but are prone to recall bias. A low-threshold assessment method of high value for researchers, not only during the COVID-19 pandemic, is Ecological Momentary Assessment (EMA), which enables the measurement of longitudinal data in real time, preventing potential bias through retrospective assessments (Trull & Ebner-Priemer, 2009), and enabling the investigation of trajectories over time. Mhealth applications provide a solution of collecting psychological data such as perceived stress (Pryss et al. 2019) even during social distancing requirements and are more feasible than web-based surveys as they require less time investment from participants. Additionally, apps offer possibilities of interacting with participants and ways of monitoring (mental) health changes, that web-based surveys do not.

#### **Study Aims**

The aim of this study was to investigate the time trend of perceived stress during the COVID-19 pandemic in Germany using crowdsensing data and to identify possible moderating variables such as age, gender, relationship status, education, COVID-19 status, and operating system.

116 Based on the theoretical background, the following research questions (RQ) are addressed:

117 **RQ1:** Is there a time trend for perceived stress in the total sample?

118 **RQ2:**

119 a) Is perceived stress associated with restriction measures?

120 b) Does the time trend for perceived stress vary according to restriction measures?

121 **RQ3:**

122 a) Is perceived stress associated with age?

123 b) Does the time trend for perceived stress vary according to age?

124 **RQ4:**

125 a) Is perceived stress associated with gender?

126 b) Does the time trend for perceived stress vary according to gender?

127 **RQ5:**

128 a) Is perceived stress associated with relationship status?

129 b) Does the time trend for perceived stress vary according to relationship status?

130 **RQ6:**

131 a) Is perceived stress associated with education?

132 b) Does the time trend for perceived stress vary according to education?

133 **RQ7:**

134 a) Is perceived stress associated with personal covid status?

135 b) Does the time trend for perceived stress vary according to covid status?

136 **RQ8:**

137 a) Is perceived stress associated with the covid status of family members?

b) Does the time trend for perceived stress vary according to the covid status of family members?

## **2. Materials and Methods**

### **Study Design**

Data was collected from December 2020 to February 2022, using the study- and sensor-based mHealth application CoronaHealth (Beierle et al., 2021). The study was approved by institutional research ethics board and by a data protection official. After logging in to the app and providing informed consent, participants filled out a baseline questionnaire. They were then asked to fill out short follow-up questionnaires about their stress experience once a week and received feedback on their entries immediately after completing the questionnaires.

### **Sample**

Participants with only one assessment as well as all assessments less than 7 days apart were excluded. Due to the small number of participants with diverse gender ( $n=4$ ), these were excluded from the analyses as well. The final sample consisted of 284 participants (women: 66.5%, men: 33.5%) aged 18 to 71 ( $M = 42.72$ ,  $SD = 13.48$ ) and a total of 1754 assessments. Descriptive results for relationship status, education, personal COVID status, COVID status of a family member, and operating system are described in Table 1. An overview of entries assessed in each month is provided in Supplementary Table 1.

**Table 1**

Descriptives for Relationship Status, Education, Personal COVID Status, COVID Status of a Family Member, and Operating System.

|                                        | n (%)      |
|----------------------------------------|------------|
| <b>Relationship status</b>             |            |
| Partnered                              | 178 (62.7) |
| Divorced                               | 20 (7.0)   |
| Single                                 | 86 (30.3)  |
| Total                                  | 284 (100)  |
| <b>Education in years</b>              |            |
| ≤ 10 years                             | 58 (20.4)  |
| 11-12 years                            | 76 (26.8)  |
| 13+ years                              | 150 (52.8) |
| Total                                  | 284 (100)  |
| <b>Personal COVID status</b>           |            |
| Healthy                                | 272 (95.8) |
| Positive                               | 3 (1.1)    |
| Recovered                              | 9 (3.2)    |
| Total                                  | 284 (100)  |
| <b>COVID status of a family member</b> |            |
| Healthy                                | 225 (79.2) |
| Positive                               | 10 (3.5)   |
| Recovered                              | 49 (17.3)  |
| Total                                  | 284 (100)  |

**Measures***CoronaHealth*

The mHealth application CoronaHealth was developed by researchers from the University of Würzburg University, the University of Ulm, the Lutheran University of Applied Sciences in Nuremberg, and the University for Continuing Education Krems to assess physical and mental well-being during the COVID-19 pandemic (Beierle et al., 2021, Winter et al., 2025). It serves as a crowdsensing platform for implementing various questionnaire-based studies and collecting mobile sensor data.

### Perceived Stress Scale

Perceived stress was measured with the Perceived Stress Scale (PSS-10) (Cohen et al., 1983). The PSS-10 is a reliable and validated self-rating questionnaire with 10 items on a 5-point Likert scale and scores ranging from 0 to 40. Scores from 0-13 indicate a low perceived stress, scores from 14-26 indicate moderate perceived stress, and scores from 27-40 indicate high perceived stress. The German version has been validated for individuals aged 14 to 90 (Klein et al. 2016). Cronbach's alpha was  $\alpha = 0.98$  in the current sample.

### Other variables

Via the app, participants also provided demographic data such as age, gender, relationship status, and education. Additionally, participants were asked whether they were currently diagnosed with COVID-19 or whether they had a close family member currently diagnosed with COVID-19. The mobile phone operating system was assessed by the application not by self-report.

## **Statistics**

Linear multilevel models were conducted with R (R Core Team, 2022) using the lme4 and lmerTest packages to address the nested data structure. All statistical tests were 2-tailed, and the significance level was set to  $p < .05$ . The multilevel models had two levels: assessments as level 1 and individuals as level 2. The dependent variable was perceived stress in all models. All multilevel models were calculated with the full maximum likelihood estimation. The intercept was allowed to vary in these models (random intercept models). For all included variables, only categories with sufficient participants ( $\geq 20$ ) were analyzed. Since some categories fell below this cutoff, certain categories were combined to create new categories. For the variable "relationship status" the

193 categories married and living together (n=171), married living separately (n=6), and registered  
194 same-sex relationship (n=1) were combined to create the category *partnered*. The category  
195 widowed (n=2) was added to the category single (n=84). For the variable “education” the categories  
196 still in school (n=4), <7 years (n=1), 8-9 years (n=10), and 10 years (n=43) were combined to create  
197 the category  $\leq 10$  years. All categorical predictors were dummy coded with the following reference  
198 categories: ‘female’ for the effect of gender, ‘partnered’ for the effect of relationship status, <10  
199 years for the effect of education, ‘negative’ for the effect of COVID status, ‘no’ for the effect of  
200 loss of a relative to COVID. Since the PSS-10 assesses perceived stress regarding in the last 7 days,  
201 we excluded all assessments with less than 7 days apart. The time variable represented the  
202 cumulative number of weeks since each participant’s entry into the study (0 = study start, 1 = first  
203 week, 2 = second week, etc.). Both a linear and a quadratic time effect were included in the models,  
204 to account for potentially non-linear effects over the study duration. To test the effect of current  
205 restriction measures at the time of assessment, a variable accounting for current restrictions was  
206 coded as follows: 0 = no restrictions, 1 = light restrictions, 2 = moderate restriction and 3 = full  
207 lockdown. We investigated separate models to test the overall effects of each predictor on the stress  
208 trajectory. A full model containing all predictors was run and these results are provided in  
209 Supplementary Table 2. For RQ1, investigating the time trend of perceived stress, a multilevel  
210 model investigating the fixed effects of linear and quadratic time trends was conducted. For RQ2,  
211 the main effects of linear and quadratic time trends, restriction measures, and the interaction effects  
212 between time  $\times$  restrictions were included in the model. For RQ3, the main effects of linear and  
213 quadratic time, age and the interaction effects of time  $\times$  age were added to the model. Age was z-  
214 standardized. For RQ4, the main effects of time, gender and the interaction effects of time  $\times$  gender  
215 were added. For RQ5, the main effects of time, relationship status and the interaction effects of  
216 time\*relationship status were added. For RQ6, the main effects of time, education and the

interaction effects of time  $\times$  education were added. For RQ7, the main effects of time, personal covid status, and the interaction effects of time  $\times$  personal covid status were added. For RQ8, the main effects of time, covid status of a family member, and the interaction effects of covid status family member  $\times$  time were added. The ggplot2 package was used for data visualization.

### 3. Results

#### Results for RQ1 – Time Trend of Perceived Stress

Table 2 shows the results of the linear multilevel model investigating the time trend of perceived stress in the total sample. There was no significant main effect of time.

**Table 2**

*Effect of time on perceived stress*

| Parameter         | Estimate | SE  | <i>T</i> | <i>p</i> | 95% CI         |
|-------------------|----------|-----|----------|----------|----------------|
| Intercept         | 17.95    | .47 | 38.301   | <.001**  | [17.04, 18.88] |
| Time              | -.07     | .04 | -1.753   | .079     | [-.15, -.01]   |
| Time <sup>2</sup> | .00      | .00 | 1.140    | .254     | [-.00, .00]    |

Note: CI = confidence interval, \*  $p < .05$ , \*\*  $p < .001$

#### Results for RQ2 – Effect of Restriction Measures

Table 3 depicts the results of the multilevel model investigating if the trajectory of stress over time differed by restriction measures. There was no significant main effect of restriction measures and restriction measures did not significantly influence the stress trajectory over time.

**Table 3**

*Effect of time on perceived stress depending on restriction measures*

| Parameter          | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI         |
|--------------------|----------|------|----------|----------|----------------|
| Intercept          | 18.90    | 1.28 | 14.753   | <.001**  | [16.39, 21.41] |
| Time               | -.19     | .19  | -.990    | .322     | [-.56, .19]    |
| Time <sup>2</sup>  | .00      | .01  | .527     | .598     | [-.01, .02]    |
| Light restrictions | -.62     | 1.24 | -.500    | .617     | [-3.06, 1.82]  |



|                                                  |       |      |       |      |               |
|--------------------------------------------------|-------|------|-------|------|---------------|
| Moderate restrictions                            | -1.04 | 1.33 | -.786 | .432 | [-3.64, 1.56] |
| Lockdown                                         | -1.03 | 1.30 | -.794 | .427 | [-3.57, 1.51] |
| Time $\times$ light restrictions                 | .10   | .20  | .482  | .630 | [-.29, .48]   |
| Time $\times$ moderate restrictions              | .19   | .21  | .896  | .370 | [-.22, .60]   |
| Time $\times$ lockdown                           | -.03  | .23  | -.110 | .912 | [-.48, .43]   |
| Time <sup>2</sup> $\times$ light restrictions    | -.00  | .01  | -.353 | .724 | [-.02, .01]   |
| Time <sup>2</sup> $\times$ moderate restrictions | -.00  | .01  | -.531 | .595 | [-.02, .01]   |
| Time <sup>2</sup> $\times$ lockdown              | .00   | .01  | .213  | .832 | [-.01, .02]   |

Note: CI = confidence interval, \*  $p < .05$ , \*\*  $p < .001$

### Results for RQ3 – Effect of Age

Table 4 depicts the results of the multilevel model investigating if the trajectory of stress over time differed by age. With age included as a predictor in the model, the main effect of time reached statistical significance (estimate = -.08,  $p = .049$ ), with perceived stress decreasing linearly over time. Older participants reported significantly less perceived stress than younger participants at baseline (estimate = -1.19,  $p = .012$ ). The interaction between age and time did not reach statistical significance, meaning that age did not moderate the decline of perceived stress over time (main effect of time).

**Table 4**

*Effect of time on perceived stress depending on age*

| Parameter                      | Estimate | SE  | $T$    | $p$     | 95% CI         |
|--------------------------------|----------|-----|--------|---------|----------------|
| Intercept                      | 17.81    | .47 | 37.798 | <.001** | [16.89, 18.74] |
| Time                           | -.08     | .04 | -1.970 | .049*   | [-.16, -.00]   |
| Time <sup>2</sup>              | .00      | .00 | 1.274  | .203    | [-.00, .00]    |
| Age                            | -1.19    | .47 | -2.541 | .012*   | [-2.12, -.27]  |
| Age $\times$ time              | .08      | .04 | 1.802  | .072    | [-.01, .16]    |
| Age $\times$ time <sup>2</sup> | -.00     | .00 | -1.340 | .180    | [-.00, .00]    |

Note: CI = confidence interval, \*  $p < .05$ , \*\*  $p < .001$ , age was z-standardized

## Results for RQ4 – Effect of Gender

Table 5 summarizes the results of the multilevel model investigating if the trajectory of stress over time differed by gender (female vs. male). Neither the main effect of gender nor the male  $\times$  time interaction reached statistical significance.

**Table 5**

*Fixed effects of time trend of perceived stress depending on gender*

| Parameter                                | Estimate | SE  | <i>T</i> | <i>p</i> | 95% CI         |
|------------------------------------------|----------|-----|----------|----------|----------------|
| Intercept                                | 18.35    | .57 | 32.005   | <.001**  | [17.23, 19.48] |
| Time                                     | -.03     | .05 | -.698    | .485     | [-.13, .06]    |
| Time <sup>2</sup>                        | .00      | .00 | .034     | .973     | [-.00, .00]    |
| Gender (male)                            | -1.18    | .99 | -1.194   | .233     | [-3.13, .76]   |
| Gender (male) $\times$ time              | -.10     | .08 | -1.252   | .211     | [-.26, .06]    |
| Gender (male) $\times$ time <sup>2</sup> | .00      | .00 | 1.567    | .115     | [-.00, .00]    |

*Note:* CI = confidence interval, \*  $p < .05$ , \*\*  $p < .001$ , women were coded as 0, men as 1

## Results for RQ5 – Effects of Relationship Status

Table 6 summarizes the results of the multilevel model investigating if the trajectory of stress over time differed by relationship status. No relationship status category reached statistical significance. Both interaction effects of the divorced category with time (linear and quadratic) were significant. The interaction effect with the quadratic time variable and the single category was significant.

**Table 6**

*Effect of time on perceived stress depending on relationship status*

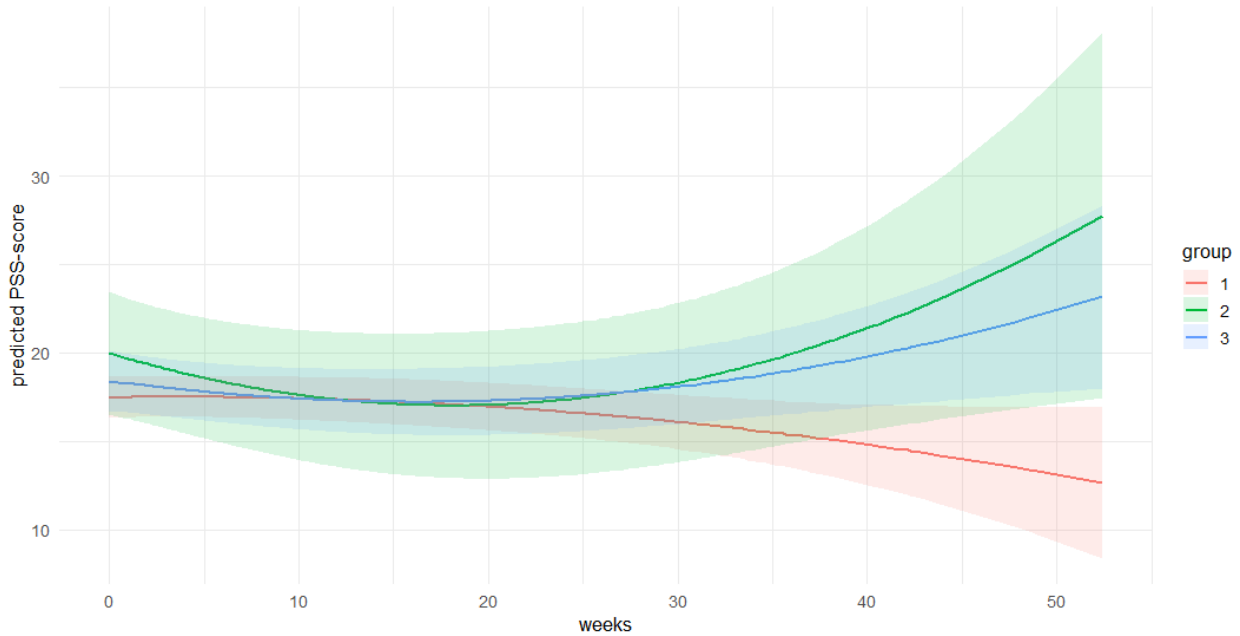
| Parameter                           | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI         |
|-------------------------------------|----------|------|----------|----------|----------------|
| Intercept                           | 17.48    | .59  | 29.570   | <.001**  | [16.32, 18.65] |
| Time                                | .01      | .05  | .289     | .772     | [-.08, .11]    |
| Time <sup>2</sup>                   | -.00     | .00  | -1.349   | .178     | [-.00, .00]    |
| Divorced                            | 2.32     | 1.85 | 1.352    | .177     | [-1.14, 6.15]  |
| Single                              | .95      | 1.04 | .912     | .363     | [-1.09, 2.99]  |
| Divorced $\times$ time              | -.34     | .16  | -2.129   | .033*    | [-.66, .03]    |
| Single $\times$ time                | -.16     | .09  | -1.892   | .059     | [-.33, .01]    |
| Divorced $\times$ time <sup>2</sup> | .01      | .00  | 2.562    | .010*    | [.00, .02]     |
| Single $\times$ time <sup>2</sup>   | .00      | .00  | 2.691    | .007*    | [.00, .01]     |

*Note:* CI = confidence interval, \*  $p < .05$ , \*\*  $p < .001$ , ‘partnered’ was coded as 1 in this model, ‘divorced’ as 2, and ‘single’ as 3

As illustrated in Figure 1, divorced and single participants showed U-shaped stress trajectories over the study period.

**Figure 1**

*Predicted PSS scores over time according to relationship status*



*Note: ‘partnered’ was coded as 1, ‘divorced’ was coded as 2, ‘single’ was coded as 3*

## Results for RQ6 – Effects of Education

Table 7 summarizes the results of the multilevel model investigating if the trajectory of stress over time differed by years of education. Both main effects of time (linear and quadratic) reached statistical significance. No main effect of education categories emerged, but both interaction effects of 11-12 years of education with time (linear and quadratic) reached statistical significance.

**Table 7**

*Effect of time on perceived stress depending on years of education*

| Parameter         | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI         |
|-------------------|----------|------|----------|----------|----------------|
| Intercept         | 17.48    | 1.04 | 16.782   | <.001**  | [15.43, 19.53] |
| Time              | -.27     | .10  | -2.631   | .009*    | [-.46, -.07]   |
| Time <sup>2</sup> | .01      | .00  | 2.197    | .028*    | [.00, .01]     |

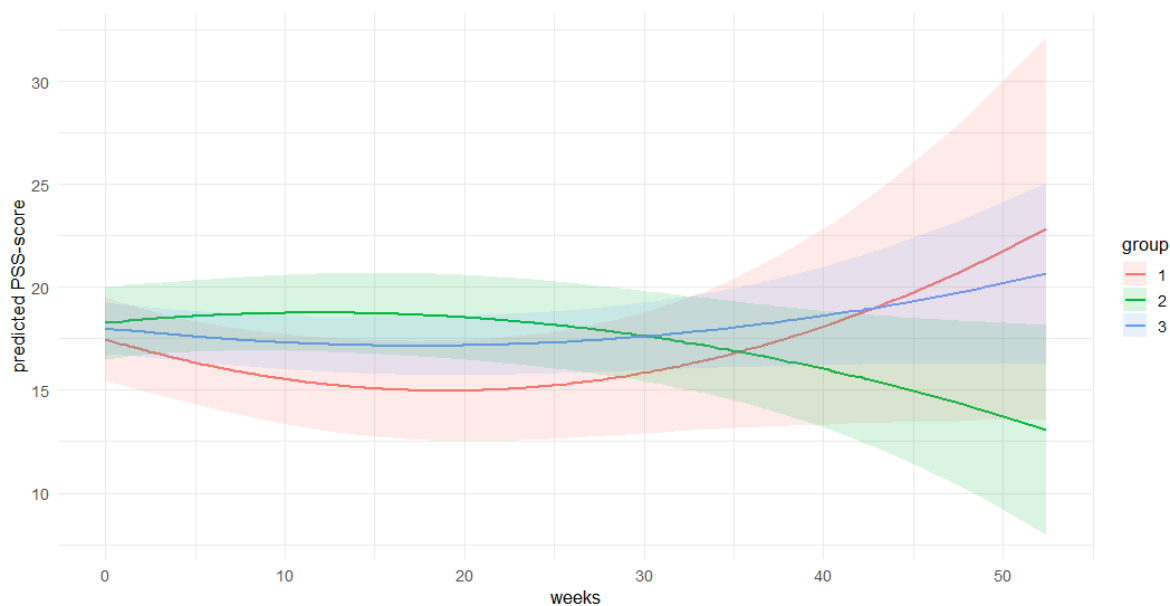
|                                 |      |      |        |       |               |
|---------------------------------|------|------|--------|-------|---------------|
| 11-12 years                     | .79  | 1.38 | .572   | .568  | [-1.92, 3.50] |
| 13+ years                       | .54  | 1.22 | .445   | .657  | [-1.86, 2.95] |
| 11-12 years × time              | .35  | .13  | 2.775  | .006* | [.10, .59]    |
| 13+ years × time                | .17  | .11  | 1.457  | .145  | [-.06, .39]   |
| 11-12 years × time <sup>2</sup> | -.01 | .00  | -2.778 | .006* | [-.02, -.00]  |
| 13+ years × time <sup>2</sup>   | -.00 | .00  | -1.170 | .242  | [-.01, .00]   |

Note: CI = confidence interval, \* p < .05, \*\* p < .001, 'up to 10 years' was coded as 1, '11-12 years' was coded as 2, and '13+ years' was coded as 3

As illustrated in Figure 2, participants with 11-12 years of education showed an inverse U-shaped stress trajectory over the study period.

## Figure 2

Predicted PSS scores over time according to education in years



Note: 'up to 10 years' was coded as 1, '11-12 years' was coded as 2, '13+ years' was coded as 3

## Results for RQ 7& 8 – Effects of COVID-19 Status

Tables 8 and 9 present the multilevel model results testing whether stress trajectories over time differed by participants' own COVID-19 diagnosis or by the COVID-19 status of a close relative at study entry. Neither being currently diagnosed with COVID-19 (see table 7) nor having a close family member currently diagnosed with COVID-19 (see table 8) was significantly associated with

perceived stress. Both interaction effects of having a recovered family member at study start with time (linear and quadratic) reached statistical significance.

**Table 8**

*Effect of time on perceived stress depending on personal COVID status*

| Parameter                     | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI         |
|-------------------------------|----------|------|----------|----------|----------------|
| Intercept                     | 17.97    | .48  | 37.829   | <.001**  | [17.04, 18.90] |
| Time                          | -.07     | .04  | -1.776   | .076     | [-.15, .01]    |
| Time <sup>2</sup>             | .00      | .00  | 1.147    | .252     | [-.00, .00]    |
| Positive                      | 7.12     | 4.85 | 1.473    | .142     | [-238, 16.66]  |
| Recovered                     | -2.03    | 2.71 | -.750    | .454     | [-7.36, 3.30]  |
| Positive × time               | .73      | 2.24 | .327     | .744     | [-3.66, 5.13]  |
| Recovered × time              | -.71     | .47  | -1.502   | .133     | [-1.64, .22]   |
| Positive × time <sup>2</sup>  | -.08     | .30  | -.271    | .786     | [.66, .50]     |
| Recovered × time <sup>2</sup> | .06      | .03  | 1.921    | .055     | [-.00, .12]    |

Note: CI = confidence interval, \* *p* < .05, \*\* *p* < .001, 'healthy' was coded as 0, 'currently positive' was coded as 1, and 'recovered' was coded as 2

**Table 9**

*Effect of time on perceived depending on a close relative's to COVID status*

| Parameter                     | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI         |
|-------------------------------|----------|------|----------|----------|----------------|
| Intercept                     | 17.87    | .52  | 34.158   | <.001**  | [16.84, 18.89] |
| Time                          | -.15     | .04  | -3.354   | <.001**  | [-.23, -.06]   |
| Time <sup>2</sup>             | .00      | .00  | 2.692    | .007*    | [.00, .01]     |
| Positive                      | 2.24     | 2.58 | .869     | .385     | [-2.83, 7.32]  |
| Recovered                     | .30      | 1.24 | .246     | .806     | [-2.13, 2.74]  |
| Positive × time               | .56      | .42  | 1.307    | ..191    | [-.27, 1.37]   |
| Recovered × time              | .30      | .10  | 3.071    | .002*    | [.11, .50]     |
| Positive × time <sup>2</sup>  | .00      | .02  | .228     | .820     | [-.03, .04]    |
| Recovered × time <sup>2</sup> | -.01     | .00  | -3.222   | .001*    | [-.02, -.00]   |

Note: CI = confidence interval, \* *p* < .05, \*\* *p* < .001, 'healthy' was coded as 0, 'currently positive' was coded as 1, and 'recovered' was coded as 2

#### 4. Discussion

While the effect of time did not reach statistical significance in the single model, the linear effect of time was significant when controlling for all other included variables (see Supplementary Table

2), indicating that perceived stress decrease from December 2020 to February 2022 in the total sample. This result corresponds to findings from other studies collecting data during the COVID-19 pandemic in Germany (e.g., Ochnik et al., 2022). Contextually, the result corresponds with the gradual lifting of lockdown restrictions after March 3<sup>rd</sup>, 2021. Other studies found contrasting results, reporting either an increase in perceived stress over the course of the pandemic (Peters et al., 2020) or no significant changes (Voltmer et al., 2021). These ambivalent results may stem from demographic differences of the samples and differing assessment periods. For instance, Peters et al. (2020) analyzed two measurement time points that were 1 to 5 years apart, while we assessed perceived stress longitudinally, over multiple time points in the span of a year. Moreover, both Peters et al. (2020) and Voltmer et al. (2021) analyzed the change of perceived stress from pre-pandemic times to after the onset of the pandemic, while all assessments in the current study were conducted during the COVID-19 pandemic.

Only age was significantly associated with overall perceived stress over time, with older participants reporting less perceived stress than younger participants, which is in line with the current research on the psychological effects of the pandemic on mental health. A meta-analysis of studies conducted during the first half year of the pandemic revealed young adults to have higher prevalences of anxiety, depression, sleep problems and suicidal ideation than older adults (Dragioti et al., 2021). Another meta-analysis comparing stress before and during the pandemic also found younger age to be associated to increased stress during the pandemic (Daniali et al., 2023). Both meta-analyses also found women to have reported higher stress levels and negative mental health throughout the pandemic, which we could not replicate in our study. One potential reason for this could be that our participants did not fill out the app in particularly high stress situations, reflected by the predominantly moderate stress levels reported in our sample. Neither education nor relationship status were associated with overall perceived stress, which may be due to the small

sample sizes of certain categories in these variables and the fact that some categories were merged. The ‘divorced’ category significantly interacted with the stress trajectory over time, with divorced participants showed a U-shaped stress trajectory in our sample. Single participants showed the same trajectory, but less pronounced, whereas partnered individuals showed an inverse U-shaped trajectory. Similarly, Nkire et al. (2021) found higher depressive symptoms in single and divorced individuals compared to partnered individuals during the pandemic. Divorced individuals may have had less access to social support during the pandemic, which might partially explain these results. While relationships can be a protective resource for mental health, relationship quality is a crucial moderator to consider in this regard. For example, in a study conducted during lockdown in Austria, single individuals reported higher perceived stress than individuals in a relationship with good relationship quality, but lower perceived stress than individuals in a relationship with poor relationship quality (Pieh et al., 2021). However, the significant interaction effect of relationship status disappeared when controlling for all other variables and thus has to be interpreted with caution. Years of education significantly impacted the stress trajectories as well, with individuals with 11-12 years of education showing an inverse U-shaped trajectory, with perceived stress initially increasing, but then decreasing over time. In comparison, both participants with up to 10 years and 13+ years showed U-shaped trajectories, with stress initially decreasing, but then increasing again over time.

Contrary to what we expected, current COVID-19 diagnoses of oneself or close family members were not significantly associated with perceived stress in this sample, but did significantly impact the stress trajectories over time. While a meta-analysis of studies conducted during the first year of the pandemic revealed currently infected individuals to have higher rates of stress than healthy individuals (Dragioti et al., 2021), our sample was collected during the second year of the pandemic, during which the COVID-19 vaccine was already approved and available for large parts

of the population, which may have influenced our results. For instance, Perez-Arce et al. (2021) have reported a short-term decrease in mental distress in individuals after receiving the first COVID-19 vaccination. Correspondingly, Agrawal et al. (2021) estimated a reduction of anxiety and depressive symptoms by 30% as a secondary benefit of COVID-19 vaccination. Disease severity may also play a role in this context, with high disease severity potentially increasing perceived stress while low disease severity may lead to lower perceived stress, leading to overall insignificant findings over time. This may also partially explain the curvilinear associations with perceived stress over time according to personal covid status (see supplementary material) or the covid status of close relatives in our sample. Koller et al. (2022) found both personal risk perception and perceived effectiveness of restriction measures to influence personal protective health behaviors during the pandemic. Personal risk perception and perceived effectiveness of collective measures may further depend on personal information seeking strategies and narratives reporting adverse effects of protective measures such as vaccines, which have varied greatly over the course of the Covid-19 pandemic (Betsch et al., 2011).

## **Limitations**

Some limitations to this study need to be considered when interpreting the results. First, the assessments were made in participants' everyday life settings, which increases ecological validity and generalizability of results, but decreases internal validity. Second, only a self-report measure was used to assess perceived stress. Combining such a subjective measure with accelerometric data or biomarkers could provide more insight into the stress experience in the future. COVID status, both personal and that of family members, were also assessed via self-report, and not validated through PCR-tests. Furthermore, the gender distribution was not representative, with almost twice as many women taking part in the study as men. The sample sizes of some subgroups were very



small, and therefore some categories of certain variables were combined, which may influence the results. It is also important to note that while the app-based assessment of data allowed for a large data pool, it is possible to have introduced some self-selection bias, as it required access to a mobile-phone over a prolonged period of time.

## **Conclusions**

Perceived stress significantly reduced over time in the total sample. Younger adults reported higher overall stress than older adults and education, relationship status and personal COVID-experiences impacted the stress trajectories over time. These findings emphasize the findings of various studies showing some individuals were more burdened than others during the COVID-19 pandemic and highlight the need for tailored public health measures to support these vulnerable groups in future crises and ideally prevent negative stress-related (mental) health outcomes. Moreover, the study demonstrates the potential of mHealth applications in monitoring mental health indicators during public health crises.

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**Supplementary Table 1**

Number of entries assessed in each month.

| <b>Date</b>    | <b>Entries (%)</b> |
|----------------|--------------------|
| December 2020  | 62                 |
| January 2021   | 202                |
| February 2021  | 165                |
| March 2021     | 188                |
| April 2021     | 189                |
| May 2021       | 187                |
| June 2021      | 130                |
| July 2021      | 117                |
| August 2021    | 73                 |
| September 2021 | 72                 |
| October 2021   | 98                 |
| November 2021  | 98                 |
| December 2021  | 78                 |
| January 2022   | 86                 |
| February 2022  | 9                  |
| <b>TOTAL</b>   | <b>1754</b>        |

**Supplementary Table 2**

Fixed effects of the full multilevel model investigating the time trends of perceived stress and moderating variables.

| Parameter                              | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI         |
|----------------------------------------|----------|------|----------|----------|----------------|
| Intercept                              | 17.14    | 1.38 | 12.438   | <.001**  | [14.43, 19.85] |
| Time                                   | -.35     | .13  | -2.605   | .009*    | [-.60, -.09]   |
| Time <sup>2</sup>                      | .01      | .00  | 1.518    | .129     | [-.00, .01]    |
| Age                                    | -1.17    | .50  | -2.366   | .019*    | [-2.15, -.19]  |
| Gender (men)                           | -.55     | 1.00 | -.545    | .586     | [-2.51, 1.42]  |
| Divorced                               | 2.73     | 1.86 | 1.467    | .143     | [-.93, 6.38]   |
| Single                                 | .29      | 1.06 | .272     | .786     | [-1.79, 2.37]  |
| 11-12 years ed.                        | .95      | 1.38 | .686     | .493     | [-1.77, 3.66]  |
| 13+ years ed.                          | .88      | 1.23 | .721     | .721     | [-1.53, 3.29]  |
| Positive                               | 6.01     | 5.06 | 1.187    | .236     | [-3.93, 15.95] |
| Recovered                              | -2.66    | 2.68 | -.992    | .322     | [-7.93, 2.61]  |
| Relative positive                      | 1.31     | 2.71 | .484     | .629     | [-4.01, 6.63]  |
| Relative recovered                     | .54      | 1.23 | .443     | .658     | [-1.87, 2.96]  |
| Light restrictions                     | .08      | .43  | .180     | .857     | [-.76, .91]    |
| Moderate restrictions                  | .28      | .50  | .571     | .568     | [-.69, 1.26]   |
| Lockdown                               | -.54     | .61  | -.883    | .377     | [-1.73, .66]   |
| Age × time                             | .06      | .05  | 1.412    | .158     | [-.03, .15]    |
| Gender × time                          | -.06     | .09  | -.643    | .520     | [-.23, .12]    |
| Divorced × time                        | -.20     | .16  | -1.195   | .232     | [-.52, .13]    |
| Single × time                          | -.03     | .09  | -.319    | .750     | [-.22, .15]    |
| 11-12 years × time                     | .36      | .13  | -1.195   | .007*    | [.10, .63]     |
| 13+ years ed. × time                   | .36      | .05  | 1.546    | .122     | [-.05, .41]    |
| Positive × time                        | .78      | 2.21 | .355     | .723     | [-3.55, 5.12]  |
| Recovered × time                       | -.78     | .47  | -1.664   | .096     | [-1.71, .14]   |
| Relative positive × time               | .51      | .43  | 1.206    | .228     | [-.32, 1.35]   |
| Relative recovered × time              | .31      | .10  | 2.935    | .003*    | [.10, .51]     |
| Age × time <sup>2</sup>                | -.00     | .00  | -.988    | .324     | [-.00, .00]    |
| Gender × time <sup>2</sup>             | .00      | .00  | 1.023    | .307     | [-.00, .01]    |
| Divorced × time <sup>2</sup>           | .01      | .00  | -1.470   | .142     | [-.00, .02]    |
| Single × time <sup>2</sup>             | .00      | .00  | 1.122    | .262     | [.00, .01]     |
| 11-12 years × time <sup>2</sup>        | -.01     | .00  | -2.205   | .028*    | [-.02, -.00]   |
| 13+ years ed. × time <sup>2</sup>      | -.00     | .00  | -1.260   | .208     | [-.01, .00]    |
| Positive × time <sup>2</sup>           | -.09     | .29  | -.291    | .771     | [-.66, .49]    |
| Recovered × time <sup>2</sup>          | .06      | .03  | 2.010    | .045*    | [.00, .12]     |
| Relative positive × time <sup>2</sup>  | .01      | .02  | .335     | .738     | [-.03, .04]    |
| Relative recovered × time <sup>2</sup> | -.01     | .00  | -2.768   | .006*    | [-.02, -.00]   |

Note: CI = confidence interval, \* *p* < .05, \*\* *p* < .001

# **How Transgender, Genderdiverse (TGD) and Cisgender Youth Cope With Daily Stress: Insights from an Ecological Momentary Assessment Study**

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# How Transgender, Gender Diverse (TGD) and Cisgender Youth Cope With Daily Stress: Insights from an Ecological Momentary Assessment Study

## Abstract

Transgender and gender diverse (TGD) youth face higher risks for mental health problems, partly due to gender minority stress (GMS). This study investigated differences in GMS, coping strategies, and mental health indicators between TGD and cis youth and explored immediate effects of coping strategies on stress in daily life. A 14-day Ecological Momentary Assessment (EMA) study was conducted using the mobile application ESMira. A baseline survey assessed GMS, perceived stress, depressive symptoms, and coping strategies. The EMA contained 3 daily prompts assessing the experience of stressful events, perceived stress, and employed coping strategies. 120 participants aged 14 to 21 ( $M=18.71$ ,  $SD=1.28$ ) were included in the baseline analysis and 103 participants in the EMA analysis. TGD participants reported higher GMS (all  $p<.001$ ), depressive symptoms ( $p=.044$ ,  $g = .39$ ), and suicidal ideation ( $p=.007$ ,  $OR = 2.85$ ), but not higher perceived stress than cis participants at baseline. Qualitative content analysis explored participant-reported stressors related to: Social interactions, education, daily life stress, mental health, GMS, body, public transportation and sexual harassment. Music listening at one assessment predicted lower stress at the next assessment ( $p<.001$ ). Denial predicted lower stress at the next assessment for cis than for TGD participants ( $p<.001$ ). Behavioral disengagement on one day predicted lower stress the next day ( $p<.001$ ). Venting predicted lower stress the next day for TGD in comparison to cis participants ( $p=.003$ ). Our results suggest differences between TGD and cis youth in exposure to GMS and provide novel insight into immediate effects of coping strategies on perceived stress in real-life.

**Keywords:** coping, gender minority stress, mental health, ecological momentary assessment

## Introduction

Adolescence is a stage in life that involves crucial social and cognitive development (Blakemore, 2012), while also being a vulnerable time for the development of mental health disorders (Blakemore, 2019). Studies show that for transgender and gender diverse (TGD) adolescents and young adults this vulnerability can be even more pronounced (e.g., Lefevor et al., 2019; Sares-Jäske et al., 2023; Scandurra et al., 2019). For instance, meta-analyses have shown that TGD youth are not only three times more likely to experience suicidal thoughts than their cis and heterosexual peers (Marshall et al., 2011), but also more likely to attempt suicide (Hatchell et al., 2021). In recent years, new insight has been provided by the “LGBTIQ+ Gesundheitsbericht 2022”-LGBTIQ+ Health Report 2022 from the Ministry of Social Affairs, Health, Care, and Consumer Protection (BMSGPK; Gaiswinkler et al., 2023). This large-scale study on the health of queer individuals in Austria showed TGD individuals had far higher prevalences of mental health disorders such as depression, burnout, PTSD, eating disorders or OCD than cisgender individuals. A recent meta-analysis (Klinger et al., 2024) on the mental health of non-binary youth revealed that adolescents and young adults identifying as non-binary report significantly worse general mental health than both their cisgender and transgender peers, with higher depressive and anxiety symptoms than cisgender individuals and rates of self-harm and suicidal ideation similar to transgender individuals.

One significant reason for this mental health disparity between TGD and cisgender adults and adolescents is the experience of gender minority stress (GMS) (Meyer, 1995) by TGD individuals. GMS as a concept includes distal stressors such as discrimination, victimization and rejection by others, and proximal stressors on a personal level such as expectations of discrimination, internalized stigma and consequently secrecy regarding gender identity (Meyer, 2015). The experience of these stressors, along with structural discrimination, has not only been linked to negative health indicators

(Hatzenbuehler & Pachankis, 2016), but can, according to gender minority stress theory (Meyer, 2003), also contribute to the development of mental health problems. Indeed, meta-analyses have linked the experience of GMS in TGD youth to negative mental health indicators (Dürrbaum et al., 2020) and more specifically to suicidal ideation and suicide attempts (de Lange et al., 2022). According to a large-scale survey conducted by the European Fundamental Rights Agency, TGD youth in Austria, as well as in Europe in general, experience various forms of GMS ranging from stigma, discrimination in family and school contexts to physical and sexual violence (European Union Agency for Fundamental Rights, 2020). Despite these specific gender minority stress factors potentially exacerbating mental health issues for TGD individuals, Meyer's (2015) GMS theory also includes specific protective factors such as community connection and pride, which may buffer the effects of the aforementioned stressors on mental health. Furthermore, TGD individuals have been shown to utilize unique coping strategies to manage gender-specific stressors, such as strategic avoidance, modulating their gender-presentation depending on specific contexts or intragroup prosocial behavior (Gorman et al., 2022). Successfully coping with stressful situations is necessary on a daily basis to prevent chronic stress and long-term negative mental and physical health (Cohen et al., 2007; Cohen et al., 2016). Whether a coping strategy is adaptive or maladaptive can vary from person to person and relies on both personal factors such as personal goals or beliefs and the situational context such as the predictability of a stressful experience or the time frame (Skinner et al., 2003). Additionally, existing literature proposes differences in coping between cisgender men and women (Tamres et al., 2002). Men seem to more commonly engage in more problem-focused or active coping strategies, while women more often seem to report emotion-focused coping strategies such as seeking social support to manage stressful situations (e.g., Brougham et al., 2009; O'Rourke et al., 2022). Evidence directly comparing coping between cisgender and TGD individuals is sparse. A study comparing resilience and coping in a small

sample of Indian transgender and cisgender individuals revealed a similar level of resilience in both samples, but a higher utilization of both avoidance and approach coping strategies in transgender individuals (Chauhan et al., 2024). A recent scoping review found a striking research gap regarding the mental health of LGBTQ adolescents in Austria (Siegel et al., 2022) and called for the inclusion of sexual orientation and non-binary gender identities in future mental health studies.

Based on this theoretical background, we hypothesized that, TGD individuals report higher gender minority stress (H1), perceived stress (H2), depressive symptoms (H3a), and suicidal ideation (H3b) than cisgender individuals and differ in their used coping strategies (H4). Next to these general differences between the two gender groups, we investigated time-dependent coping and stress links on 1) the immediate assessment-level and b) averaged from one day to the next and whether a specific coping strategy is more or less effective depending on the two gender groups, considering eighteen different coping strategies. Specifically, we pre-registered that H5a) higher reports of a given coping strategy at one *assessment* point (t) are associated with lower levels of stress at the next assessment (t+1) and that H5b) higher reports of a given coping strategy on one *day* (d) are associated with lower levels of stress on the next day (d+1). For both hypotheses (i.e., the assessment- and day-level), we hypothesized that the association between coping and stress depends on whether a participant self-identifies as cis or TGD (H6a and H6b).

## **Methods**

### ***Study Design***

A 14-day Ecological Momentary Assessment Study was conducted from the 9<sup>th</sup> of November 2023 to the 8<sup>th</sup> of October 2024 with the open-source mobile application ESMira (Lewetz & Stieger, 2023), created by the Karl Landsteiner University Krems. All collected data are stored on servers of the University for Continuing Education Krems. Recruitment was conducted in stages via



multiple channels. The first stage of recruitment was focused on sampling TGD participants via various queer organizations and queer reddit forums. In a second round of recruitment, Instagram ads targeting both TGD and cisgender adolescents and young adults were run. In the third stage of recruitment, participants were recruited via an outpatient clinic of the Department of Child and Adolescent Psychiatry at the Medical University of Vienna. To specifically recruit cis male participants, the study was advertised through a research course for psychology students at the University of Vienna. Participation in the study was voluntary. To be included, participants needed to be between the ages of 14 and 21. To take part in the study, participants had to give informed consent by signing the data protection and consent forms and confirm that they were at least 14 years old, as the legal age of consent in Austria is 14. After completing the baseline survey, notifications for the daily questionnaires were sent out via the ESMira app three times per day, at 7am, 1pm, and 7pm. These specific time points were chosen to allow school-aged individuals to participate in the study with as little interference with school commitments as possible. Participants were also able to add further assessments at any other time points. After completing participation in the study, the participants received an incentive of 20 EUR and in the case of the recruited psychology students, study credits. The study was funded by the Austrian National Union of Students (Österreichische Hochschüler\*innenschaft, ÖH) funds for queer and antiracist topics and thesis completion funds from the University of Vienna. The study procedure was preregistered after data collection but before data analysis on OSF registries (O'Rourke, Haider, Probst, & Nater, 2025) approved by the Ethics Committee of the University for Continuing Education Krems (protocol code EK GZ 52/2021-2024), the Ethics Committee of the Medical University of Vienna (no. 2183/2023), as well as a data protection officer and conducted in accordance with the Declaration of Helsinki.

## ***Measures***

### *Gender Minority Stress and Resilience*

To assess GMS and resilience at baseline, the validated Gender Minority Stress and Resilience Measure for Adolescence (GMSR-A; Hidalgo et al., 2019) was used. As the GMSR-A was not available in German yet, the English version was translated to German with forward-backward translation. The GMSR-A assesses distal stressors, proximal stressors, and resilience factors related to gender identity with a total of 58 items and 9 subscales. Distal stressors include Discrimination (5 items), Rejection (6 items), Victimization (7 items), and Non-Affirmation (6 items). Proximal stressors include Internalized Transphobia (8 items), Negative Future Expectations (9 items), and Non-Disclosure (5 items). Resilience factors include Pride (8 items) and Community Connectedness (5 items). Items in the subscales Discrimination, Rejection, and Victimization are scored in count response format with possible answers including “never” (0), “Yes, within the past year” (1), “Yes, before the past year” (1), and in four cases “does not apply to me”. If both “Yes, within the past year” and “Yes, before the past year” were checked, the counts were added together (2). All other items in the GMSR-A are scored on a 5-point Likert scale from “strongly disagree” (1) to “strongly agree” (5). Higher scores indicate higher agreement with the items, except for two items in the Community Connectedness subscale that have to be inverted. The internal consistencies for the subscales in the current sample were  $\alpha=.58$  for Discrimination,  $\alpha=.77$  for Rejection,  $\alpha=.69$  for Victimization,  $\alpha=.96$  for Non-Affirmation,  $\alpha=.92$  for Internalized Transphobia,  $\alpha=.95$  for Negative Future Expectations,  $\alpha=.87$  for Non-Disclosure,  $\alpha=.85$  for Pride, and  $\alpha=.83$  for Community Connectedness. As our sample included not only TGD, but also cis participants, we allowed participants to skip the items of the Pride subscale (“If the statement does not apply to you, you can skip it”), to avoid artificial statements from participants who could not

identify with the question asked. To further ensure that all participants engaged with the questionnaire as correctly as possible, an attention check item (“Please select “Fully agree” if you have read the question carefully”) was included in the questionnaire and participants who failed the attention check were excluded from the analysis. As the aim of this study was to compare GMS in TGD and cis participants, the resilience scales (Community Connectedness and Pride) were not included in the further analysis.

### *Perceived Stress*

The German Perceived Stress Scale (PSS-10; Klein et al., 2016) was used to measure perceived stress at baseline. The PSS-10 is a well-established, validated, and reliable self-rating questionnaire for the assessment of subjective stress (Cohen et al., 1983). It consists of 10 items scored on a 5-point Likert scale with scores ranging from 0 (“never”) to 4 (“very often”). Four items are reversed-coded before computing the sum score, with higher scores indicating higher perceived stress. As it is not a diagnostic tool, there are no standardized cut-offs, however cut-off scores for low (0-13), moderate (14-26) and high (27-40) stress-levels have been proposed (e.g., Swaminathan et al., 2016). The Cronbach’s  $\alpha$  for the PSS-10 in our sample was  $\alpha=.86$ .

### *Depressive Symptoms and Suicidal Ideation*

Depressive symptoms at baseline were assessed using the German Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001), which is not only validated for adults, but also for adolescents (Allgaier et al., 2012). It contains 9 items with a total sum score of 0 to 27. A cut-off of 11 is considered to indicate clinically relevant depressive symptoms in adolescents (<18), and 10 for adults. The Cronbach’s  $\alpha$  for the PHQ-9 was  $\alpha=.87$  in this study’s sample. Suicidal ideation was specifically operationalized with the ninth item of the PHQ-9 (PHQ9): “Over the last two weeks, how often have you been bothered by thoughts that you would be better off dead or hurting yourself

in some way?”. The responses are scored from 0 (“not at all”), 1 (“several days”), 2 (“more than half the days”), to 3 (“nearly every day”) and a cut-off score of 1 is proposed to indicate the presence of suicidal ideation. For this study suicidal ideation was coded as a categorical variable: A score of 0 was coded as no suicidal ideation, whereas a score of 1 or higher was coded as suicidal ideation. Previous literature has shown the PHQ9 item to robustly predict suicide attempts and deaths (Rossom et al., 2017).

### *Coping Strategies*

To assess coping strategies at baseline, the German version of the BriefCope (Knoll et al., 2005) was used. The BriefCope is a self-report questionnaire assessing 14 different coping strategies with 2 items each, added to form a sum score for each coping strategy. The items are scored on a four-point Likert scale ranging from “not at all” (1) to “very much” (4), with higher scores indicating higher agreement with the respective coping strategy. The Cronbach’s  $\alpha$  for the 14 coping strategies varied greatly in this sample. Four coping strategies had unacceptable internal consistencies (Distraction:  $\alpha=.35$ , Religion:  $\alpha=.42$ , Planning:  $\alpha=.42$ , Behavioral Disengagement:  $\alpha=.47$ ). Four coping strategies had poor to questionable internal consistencies (Denial:  $\alpha=.52$ , Venting:  $\alpha=.63$ , Acceptance:  $\alpha=.62$ , Self-blame:  $\alpha=.63$ ). Five strategies had internal consistencies ranging from acceptable to good (Positive Reframing:  $\alpha=.71$ , Humor:  $\alpha=.71$ , Emotional Support:  $\alpha=.75$ , Active Coping:  $\alpha=.75$ , Instrumental Support:  $\alpha=.85$ ). Only one coping strategy had an excellent internal consistency (Substance Use:  $\alpha=.91$ ).

### *Ecological Momentary Assessment*

To assess stress and coping over the 14-day study period, participants were asked 4 questions 3 times per day:

1. Did you experience a stressful event? (yes/no)

2. If you would like to describe in more detail what exactly caused you stress, you can do so here in a few words. (optional, free text)
3. How much did this event stress you? (Visual analogue scale (VAS) from 0-100)
4. How did you cope with this stressful event? Please indicate which of the following coping strategies you used and to what extent they applied to your situation.

To answer the fourth question, participants could choose from a list of eighteen coping strategies and then rate them on a VAS from 0-100: Distraction, Denial, Social Support, Behavioral Disengagement, Positive Reframing, Humor, Active Coping, Substance Use, Venting, Planning, Acceptance, Spirituality, Music, Social Activism, Hope, Strategic Gender Expression, Avoidance, and Secrecy (hiding your gender identity). Each coping strategy was assessed by one item. The coping strategies were derived from the fourteen strategies of the BriefCope and 4 additional ones were added as follows. TGD individuals often experience specific forms of gender-related stress and tend to utilize coping strategies that are not adequately represented in standard coping assessments. In order to capture coping strategies specific to TGD individuals, three coping skills (strategic gender expression, social activism, and hope) were included from the Trans and Nonbinary Coping Measure (TNCM; Lindley & Budge, 2022). Music listening was included as an additional coping strategy, partly based on feedback from TGD adolescents, partly on research revealing music listening to be an important stress-management tool for this age group (e.g., Miranda, 2019). Before the start of the study, all participants received a glossary (supplementary material A) explaining the included coping strategies. If a coping strategy was not selected, it was automatically coded as 0.

## *Statistics*

All tests were conducted using a two-tailed significance threshold of  $p < .05$ . To account for type-I error inflation due to multiple testing, Bonferroni-adjusted significance levels were calculated by dividing the original p-value of 0.05 through the number of computed tests per statistical analysis. SPSS v28 was used for analyses testing general differences between the two gender groups (TGD vs. cisgender) at baseline (H1-H4). Contrary to previous studies (Chavanduka et al., 2021; Poquiz et al., 2021), we assumed an ordinal scale level for the GMSR-A and thus tested differences in GMS (without the resilience scales Community Connectedness and Pride) with a non-parametric Mann-Whitney-U-test for independent groups (H1). Pearson's correlation coefficient (rank biserial correlation,  $r$ ) was used to estimate the effect sizes for each gender minority stress factor. Group differences in stress-levels based on the PSS-10 (H2), in depressive symptoms based on the PHQ-9 (H3a), and in coping strategies based on the subscales of the BriefCope (H4) were tested with independent samples t-tests and effect sizes were calculated using Hedge's  $g$ . Group differences in suicidal ideation (suicidal ideation vs. no suicidal ideation) were examined using a chi-squared test (H3b).

To test the momentary association between coping and stress (H5a-H6b), linear multilevel models were conducted with the lme4 and the lmerTest packages in R (R Core Team, 2022). Given the hierarchical data structure with multiple assessments (or days) nested within individuals, we used multilevel regression models with a random intercept for each participant. All hypotheses were tested while controlling for all other coping strategies assessed in the EMA and current stress-levels by including these variables as time-invariant covariates into the models. Thus, to test if a coping strategy used at a *given assessment* predicted stress at the *subsequent assessment* (H5a), all eighteen coping strategies and the stress-levels at timepoint  $t$  were included as fixed effects to predict stress at the timepoint  $t+1$ . To test if a coping strategy used at a *given day* predicted stress

on the *subsequent day* (H5b), the same model structure was used but with the use of coping strategies and stress-levels being averaged across the three daily assessments. Specifically, the eighteen coping strategies and stress-levels at day d were used to predict the stress-levels at d+1. To test whether the association between the use of a coping strategy at a given timepoint (or day) and stress-levels at the subsequent timepoint (or day) differed between TGD and cisgender (H6a and H6b), we included interactions between each coping strategy and a dummy-coded variable for the gender group (0 = cisgender, 1 = TGD) in both the assessment- (H5a) and day-level model (H5b). To isolate within-subject effects (e.g., whether using a specific coping strategy more than usual is associated with decreased stress levels) from between-subject differences (e.g., some participants may have generally lower stress levels and use certain strategy more or less frequently), the scores of the coping strategies on both the assessment- and day-level were person-mean centered. By that, positive values indicate above-average use of a coping strategy relative to the participant's own mean, while negative values indicate below-average use. The `ggplot2` package was used for data visualization. Additionally, an exploratory analysis of participant-reported stressors (EMA free-text item 2) was conducted with a qualitative content analysis.

## **Results**

### ***Sample***

In total, 133 participants completed the baseline questionnaire. Thirteen participants were removed from the original sample for the following reasons: Five test users were removed. Three participants (cis male, 20: n = 1, cis female, 18: n = 1, genderfluid, 20: n = 1) were removed for failing the attention check ("Please select \"Fully agree\" if you have read the question carefully."). Five participants were removed for not providing any sociodemographic data. This resulted in a

total of 120 participants aged 14 to 21 years ( $M = 18.71$ ,  $SD = 1.28$ ) who were included in the final baseline sample. The sociodemographic variables of the sample are described in table 1.

**Table 1.**

*Sociodemographic characteristics of the sample*

|                                     | <i>N (%)</i> |
|-------------------------------------|--------------|
| <b>Gender</b>                       |              |
| cis women                           | 35 (29.2)    |
| cis men                             | 6 (5)        |
| trans women                         | 1 (.8)       |
| trans men                           | 28 (23.3)    |
| trans*                              | 3 (2.5)      |
| non-binary                          | 26 (21.7)    |
| genderfluid                         | 7 (5.8)      |
| inter*                              | 1 (.8)       |
| agender                             | 5 (4.2)      |
| not sure                            | 2 (1.7)      |
| other                               | 6 (5)        |
| <b>Sex assigned at birth</b>        |              |
| female                              | 110 (91.7)   |
| male                                | 9 (7.5)      |
| other                               | 1 (.8)       |
| <b>Sexual orientation</b>           |              |
| heterosexual                        | 11 (9.2)     |
| homosexual                          | 8 (6.7)      |
| bisexual                            | 27 (22.5)    |
| pansexual                           | 18 (15)      |
| queer                               | 31 (25.8)    |
| asexual                             | 14 (11.7)    |
| other                               | 11 (9.2)     |
| <b>Current Education</b>            |              |
| no current education                | 18 (15)      |
| General secondary school (AHS)      | 19 (15.8)    |
| Vocational secondary school (BHS)   | 9 (7.5)      |
| Vocational school (Berufsschule)    | 6 (5)        |
| New middle school (NMS)             | 1 (.8)       |
| University of applied sciences (FH) | 13 (10.8)    |
| University                          | 34 (28.3)    |
| other                               | 20 (16.7)    |



## Baseline Results

*H1: TGD individuals experience more gender minority stress than cisgender individuals.*

TGD youth reported significantly higher scores in all GMS factors at baseline before and after Bonferroni-adjustment (see table 2). The effect sizes ( $r$ ) were large for all GMS factors, except for a medium effect size for Victimization.

**Table 2.**

*Comparison of gender minority stress in cis and TGD participants.*

|                              | group | <i>N</i> | Mean Rank | <i>U</i> | <i>Z</i> | <i>P</i> | <i>r</i> |
|------------------------------|-------|----------|-----------|----------|----------|----------|----------|
| Discrimination               | cis   | 41       | 34.84     | 567.500  | -6.186   | <.001**  | -0.57    |
|                              | TGD   | 79       | 73.82     |          |          |          |          |
| Rejection                    | cis   | 41       | 28.89     | 323.500  | -7.305   | <.001**  | -0.67    |
|                              | TGD   | 78       | 76.35     |          |          |          |          |
| Victimization                | cis   | 41       | 37.46     | 675.000  | -5.333   | <.001**  | -0.49    |
|                              | TGD   | 79       | 72.46     |          |          |          |          |
| Non-Affirmation              | cis   | 41       | 23.44     | 100.000  | -8.442   | <.001**  | -0.77    |
|                              | TGD   | 79       | 79.73     |          |          |          |          |
| Internalized Transphobia     | cis   | 41       | 24.82     | 156.500  | -8.132   | <.001**  | -0.74    |
|                              | TGD   | 79       | 79.02     |          |          |          |          |
| Negative Future Expectations | cis   | 41       | 26.65     | 231.500  | -7.723   | <.001**  | -0.71    |
|                              | TGD   | 79       | 78.07     |          |          |          |          |
| Non-Disclosure               | cis   | 41       | 25.05     | 166.000  | -8.108   | <.001**  | -0.74    |
|                              | TGD   | 79       | 78.90     |          |          |          |          |

Note: \*\*  $p < \text{Bonferroni-adjusted threshold of .007}$

*H2: TGD individuals experience more perceived stress than cisgender individuals.*

TGD participants ( $M = 24.77$ ,  $SD = 7.28$ ) did not report significantly higher perceived stress than cis participants ( $M = 23.93$ ,  $SD = 7.85$ ) on the PSS-10 ( $t(118) = -.59$ ,  $p = .558$ ,  $g = -.12$ ) at baseline.

*H3: TGD individuals experience higher depressive symptoms (a) and suicidal ideation (b) than cisgender individuals.*

At baseline, TGD participants ( $M = 14.20$ ,  $SD = 6.14$ ) reported significantly higher depressive symptoms than cis participants ( $M = 11.83$ ,  $SD = 5.87$ ) on the PHQ-9 ( $t(118) = -2.038$ ,  $p = .044$ ), with a mean difference of 2.37 points, and a small effect size ( $g = .39$ ). The prevalence of suicidal ideation was 39% in cis participants and 64.6% in TGD participants. TGD participants were more likely to report suicidal ideation than cis participants ( $\chi^2(1) = 7.136$ ,  $p = .007$ ). The odds ratio (OR) for suicidal ideation comparing cisgender and TGD participants was 2.85[1.30, 6.20].

*H4: TGD individuals report different coping strategies than cisgender individuals.*

The highest scoring coping strategies at baseline were Self-Blame, Planning, and Distraction for TGD participants and Planning, Distraction, and Self-Blame for cisgender participants, respectively (see Table 3). TGD individuals reported significantly higher scores in the coping strategy Behavioral Disengagement ( $p = .004$ ) before and after Bonferroni-adjustment, with a moderate effect size ( $g = -.507$ ). cisgender individuals reported significantly higher scores in Emotional Support ( $p = .025$ ), with a small effect size ( $g = .436$ ) and Religious Coping ( $p = .046$ ), with a small effect size ( $g = .444$ ), although these effects did not remain significant after Bonferroni correction. No other significant differences in coping strategies emerged.

**Table 3.**

*Differences in coping strategies between TGD and cis participants.*

|                   | TGD  |      | cis  |      | $T(df)$      | $p$   | Hedge's $g$ |
|-------------------|------|------|------|------|--------------|-------|-------------|
|                   | $M$  | $SD$ | $M$  | $SD$ |              |       |             |
| Distraction       | 5.42 | 1.42 | 5.27 | 1.36 | -.555 (118)  | .580  | -.106       |
| Active Coping     | 4.56 | 1.58 | 4.90 | 1.45 | 1.167 (118)  | .246  | .223        |
| Denial            | 3.28 | 1.33 | 3.63 | 1.53 | 1.320 (118)  | .190  | .252        |
| Substance Use     | 2.99 | 1.55 | 2.68 | 1.34 | -1.062 (118) | .291  | -.203       |
| Emotional Support | 4.66 | 1.64 | 5.37 | 1.56 | 2.278 (118)  | .025* | .436        |

|                          |      |      |      |      |                  |        |       |
|--------------------------|------|------|------|------|------------------|--------|-------|
| Instrumental Support     | 4.41 | 1.76 | 4.80 | 1.60 | 1.217 (118)      | .226   | .233  |
| Behavioral Disengagement | 3.81 | 1.49 | 3.12 | 1.03 | -2.967 (108.310) | .004** | -.507 |
| Venting                  | 4.20 | 1.63 | 4.51 | 1.63 | .988 (118)       | .325   | .189  |
| Positive Reframing       | 4.18 | 1.64 | 4.20 | 1.36 | .060 (118)       | .952   | .011  |
| Planning                 | 5.51 | 1.47 | 5.20 | 1.50 | -1.093 (118)     | .277   | -.209 |
| Humor                    | 4.80 | 1.74 | 4.41 | 1.60 | -1.174 (118)     | .243   | -.225 |
| Acceptance               | 4.91 | 1.47 | 4.88 | 1.72 | -.111 (118)      | .912   | -.021 |
| Religious Coping         | 2.42 | .810 | 2.85 | 1.24 | 2.042 (58.342)   | .046*  | .444  |
| Self-Blame               | 5.54 | 1.69 | 5.00 | 1.63 | -1.692 (118)     | .093   | -.324 |

Note: \* $p < .05$ , \*\*  $p < \text{Bonferroni-adjusted threshold of .004}$

### **EMA Results**

After removing all participants with fewer than 7 assessments, to have at least one daily assessment over the course of a week for each participant, 103 participants remained in the EMA sample, with a total of 4,081 assessments. Table 4 depicts the frequency of reported stress events and coping strategies across the study period, along with descriptives for experienced stress intensity and the extent to which an employed coping strategy was applied in a situation. The most often used coping strategies in the total sample were distraction (887 events), acceptance (850 events), and active problem solving (812 events).

**Table 4.**

*Descriptive Statistics of the total EMA assessments for Stress and Coping Strategies.*

|                          | N    | Min | Max | M     | SD    |
|--------------------------|------|-----|-----|-------|-------|
| Stress                   | 1206 | 1   | 100 | 53.21 | 26.75 |
| Distraction              | 887  | 1   | 100 | 46.25 | 32.26 |
| Denial                   | 631  | 1   | 100 | 29.66 | 30.16 |
| Social Support           | 707  | 1   | 100 | 38.18 | 32.63 |
| Behavioral Disengagement | 755  | 1   | 100 | 42.90 | 34.02 |
| Positive Reframing       | 608  | 1   | 100 | 31.00 | 28.16 |
| Humor                    | 583  | 1   | 100 | 28.51 | 28.90 |
| Active Coping            | 821  | 1   | 100 | 43.19 | 33.18 |
| Substance Use            | 400  | 1   | 100 | 10.45 | 21.77 |

|                   |     |   |     |       |       |
|-------------------|-----|---|-----|-------|-------|
| Venting           | 666 | 1 | 100 | 32.24 | 31.64 |
| Planning          | 665 | 1 | 100 | 38.31 | 32.82 |
| Acceptance        | 850 | 1 | 100 | 47.01 | 30.63 |
| Spirituality      | 366 | 1 | 100 | 6.34  | 16.32 |
| Music             | 686 | 1 | 100 | 47.42 | 36.68 |
| Social Activism   | 391 | 1 | 100 | 14.22 | 25.59 |
| Hope              | 655 | 1 | 100 | 36.87 | 30.20 |
| Gender Expression | 436 | 1 | 100 | 21.32 | 31.01 |
| Avoidance         | 508 | 1 | 100 | 33.91 | 31.61 |
| Secrecy           | 464 | 1 | 100 | 29.34 | 37.49 |

### ***Stressors***

In total, the optional free text item “If you would like to describe in more detail what exactly caused you stress, you can do so here in a few words.” resulted in 494 responses. Of these, 363 responses (73,48%) came from TGD participants and 131 (26,52) from cis participants. A qualitative content analysis (Hsieh & Shannon, 2005) of the reported stressors resulted in 9 main categories of stressors: Social Interactions (153), Education/Work (148), Daily Life Stress (93), Mental Health (85), Gender Minority Stress (54), Public Transportation/Traffic (43), Body (43), Sexual Harassment (16), and Other (64). Each category comprised multiple subcategories and some responses were allocated to multiple categories. For a detailed description of all subcategories and exemplary responses, see Supplementary Material B.

### ***Multilevel-Models***

*H5a: Coping at one assessment predicts stress at the following assessment.*

Table 5 depicts the results of the linear multilevel model investigating the predictive effects of coping strategies at one assessment point (t) on stress at the next assessment (t +1), while controlling for current stress at t. Listening to music as a coping strategy at one assessment

significantly predicted lower stress at the next assessment ( $p < .001$ ). Active Coping ( $p = .043$ ) and Venting ( $p = .025$ ) were also associated with lower subsequent stress; however, unlike listening to music, these effects did not remain significant after Bonferroni correction.

**Table 5.**

*Fixed effects of the multilevel model investigating the predictive effects of coping strategies on stress at the following assessment.*

| Parameter                | Estimate | SE   | T      | p       | 95% CI         |
|--------------------------|----------|------|--------|---------|----------------|
| Intercept                | 13.88    | 1.20 | 11.521 | <.001** | [11.51, 16.37] |
| Stress                   | .14      | .02  | 6.018  | <.001** | [-.09, .19]    |
| Distraction              | -.03     | .02  | -1.265 | .206    | [-.08, .02]    |
| Denial                   | .02      | .03  | .787   | .431    | [-.04, .08]    |
| Social Support           | -.00     | .03  | -.050  | .960    | [-.05, .05]    |
| Behavioral Disengagement | .02      | .02  | .707   | .480    | [-.03, .07]    |
| Positive Reframing       | -.01     | .04  | -.203  | .839    | [-.08, .06]    |
| Humor                    | -.01     | .03  | -.157  | .875    | [-.07, .06]    |
| Active Coping            | -.05     | .02  | -2.026 | .043*   | [-.10, -.00]   |
| Substance Use            | .05      | .06  | .769   | .442    | [-.07, .16]    |
| Venting                  | -.07     | .03  | -2.242 | .025*   | [-.13, -.01]   |
| Planning                 | -.04     | .03  | -1.448 | .148    | [-.10, .01]    |
| Acceptance               | .00      | .03  | .012   | .990    | [-.05, .05]    |
| Spirituality             | -.02     | .08  | -.253  | .801    | [-.18, .14]    |
| Music                    | -.09     | .02  | -3.858 | <.001** | [-.13, -.04]   |
| Social Activism          | -.00     | .05  | -.010  | .992    | [-.10, .10]    |
| Hope                     | .06      | .03  | 1.781  | .075    | [-.01, .12]    |
| Gender expression        | .03      | .04  | .736   | .462    | [-.05, .12]    |
| Avoidance                | -.04     | .03  | -1.136 | .256    | [-.10, .03]    |
| Secrecy                  | -.01     | .03  | -.332  | .740    | [-.08, .05]    |

Note: CI = confidence interval, \*  $p < .05$ , \*\*  $p < \text{Bonferroni-adjusted threshold of .0125}$

*H6a: Gender moderates the association between coping and stress at the following assessment.*

Table 6 depicts the results of the linear multilevel model investigating the predictive effects of coping strategies at one assessment point, gender, and the interaction effects of gender and coping on stress at the next assessment. Stress levels at one assessment significantly predicted stress levels

at the next assessment ( $p < .001$ ), indicating that participants with higher (or lower) stress at one assessment tended to report higher (or lower) stress at the subsequent assessment. This temporal stability in stress levels was weaker for TGD participants than for cis participants ( $p = .014$ ), although this effect did not remain significant after Bonferroni correction. Denial as a coping strategy at one assessment significantly predicted lower stress at the following assessment ( $p = .002$ ), both before and after Bonferroni adjustment. Planning ( $p = .042$ ) and music listening ( $p = .027$ ) at one assessment significantly predicted lower stress at the next assessment before Bonferroni adjustment, but not afterwards.

**Table 6.**

*Fixed effects of the multilevel model investigating the predictive effects of coping strategies and gender diversity on stress at the following assessment.*

| Parameter                | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI        |
|--------------------------|----------|------|----------|----------|---------------|
| Intercept                | 11.68    | 2.15 | 5.442    | <.001**  | [7.47, 16.04] |
| Gender Diversity (GD)    | 2.96     | 2.55 | 1.157    | .250     | [-2.11, 7.99] |
| Stress                   | .24      | .05  | 5.268    | <.001**  | [.15, .34]    |
| Distraction              | .04      | .04  | .992     | .321     | [-.04, .13]   |
| Denial                   | -.17     | .05  | -3.163   | .002**   | [-.28, -.07]  |
| Social Support           | -.06     | .05  | -1.282   | .200     | [-.15, .03]   |
| Behavioral disengagement | -.04     | .05  | -.778    | .437     | [-.14, .06]   |
| Positive Reframing       | .05      | .06  | .826     | .409     | [-.08, .17]   |
| Humor                    | -.01     | .06  | -.100    | .921     | [-.12, .11]   |
| Active Coping            | -.06     | .04  | -1.376   | .169     | [-.14, .02]   |
| Substance Use            | .10      | .09  | 1.076    | .282     | [-.08, .28]   |
| Venting                  | -.07     | .05  | -1.366   | .172     | [-.18, .03]   |
| Planning                 | -.11     | .05  | -2.034   | .042*    | [-.21, -.00]  |
| Acceptance               | .01      | .05  | .260     | .795     | [-.08, .10]   |
| Spirituality             | .02      | .18  | .135     | .893     | [-.32, .37]   |
| Music                    | -.10     | .04  | -2.206   | .027*    | [-.19, -.01]  |
| Social Activism          | -.03     | .08  | -.301    | .764     | [-.19, .14]   |
| Hope                     | .09      | .06  | 1.874    | .138     | [-.03, .21]   |
| Gender Expression        | .03      | .13  | .268     | .789     | [-.21, .28]   |
| Avoidance                | -.02     | .07  | -.250    | .803     | [-.15, .12]   |
| Secrecy                  | .13      | .15  | .908     | .364     | [-.16, .42]   |
| GD*Stress                | -.13     | .05  | -2.467   | .014*    | [-.24, -.03]  |

|                                |      |     |        |         |              |
|--------------------------------|------|-----|--------|---------|--------------|
| GD*Distraction                 | -.10 | .05 | -1.978 | .048*   | [-.21, -.00] |
| GD*Denial                      | .28  | .07 | 4.259  | <.001** | [.15, .41]   |
| GD*SocialSupport               | .08  | .06 | 1.495  | .135    | [-.03, .20]  |
| GD*Behavioral<br>disengagement | .07  | .06 | 1.185  | .236    | [-.04, .18]  |
| GD*Positive Reframing          | -.07 | .08 | -.974  | .330    | [-.22, .07]  |
| GD*Humor                       | .01  | .07 | .085   | .932    | [-.14, .15]  |
| GD*Active Coping               | .01  | .05 | .127   | .900    | [-.09, .11]  |
| GD*Substance Use               | -.11 | .12 | -.937  | .349    | [-.35, .12]  |
| GD*Venting                     | .01  | .07 | .164   | .870    | [-.12, .14]  |
| GD*Planning                    | .09  | .06 | 1.452  | .147    | [-.03, .21]  |
| GD*Acceptance                  | -.03 | .05 | -.487  | .626    | [-.13, .08]  |
| GD*Spirituality                | -.06 | .20 | -.325  | .746    | [-.45, .33]  |
| GD*Music                       | .01  | .05 | .276   | .783    | [-.09, .12]  |
| GD*Social Activism             | .06  | .11 | .558   | .577    | [-.15, .27]  |
| GD*Hope                        | -.05 | .07 | -.718  | .473    | [-.19, .09]  |
| GD*Gender Expression           | .01  | .13 | .038   | .970    | [-.26, .27]  |
| GD*Avoidance                   | -.03 | .08 | -.344  | .731    | [-.18, .13]  |
| GD*Secrecy                     | -.14 | .15 | -.942  | .346    | [-.44, .15]  |

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*Note:* CI = confidence interval, \*  $p < .05$ , \*\*  $p < \text{Bonferroni-adjusted threshold of } .0125$

The negative interaction effect between Distraction and gender (see Figure 1) indicated that using Distraction as a coping strategy at one assessment predicted lower subsequent stress for TGD participants compared to cis participants. This effect did however not remain significant after Bonferroni correction.

**Figure 1.**

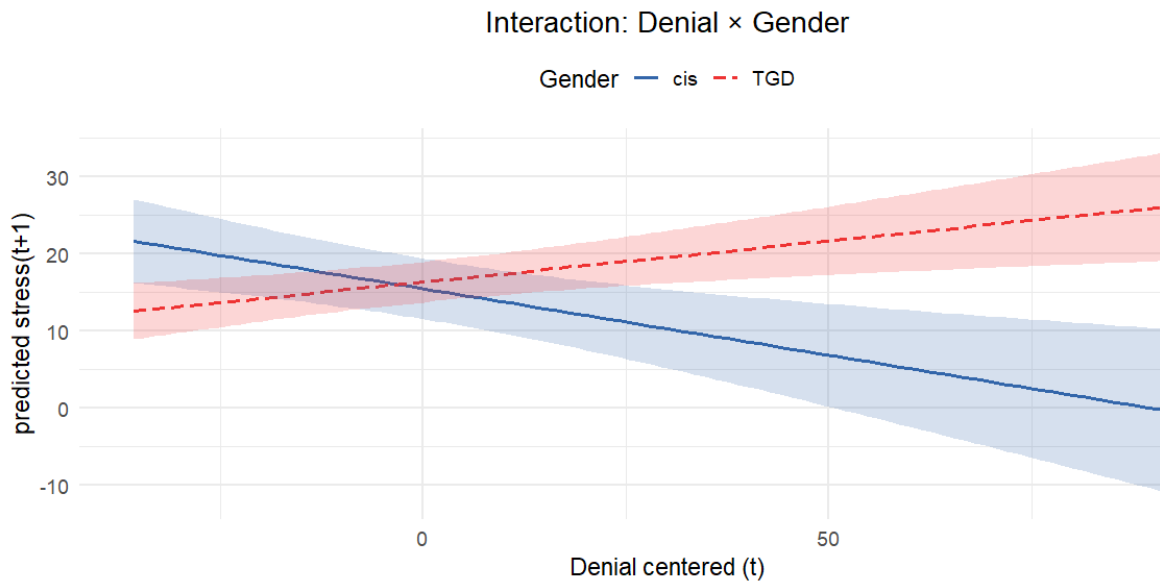
*Interaction Effect of Distraction and Gender*



The positive interaction effect between Denial and gender remained significant after Bonferroni correction. As illustrated in Figure 2, Denial at one assessment predicted lower stress at the next assessment for cisgender participants than for TGD participants.

**Figure 2.**

*Interaction Effect of Denial and Gender*





*H5b: Coping on one day predicts stress the following day.*

Table 7 depicts the results of the linear multilevel model investigating the predictive effects of coping strategies on one day  $d$  on stress the following day  $d+1$  when controlling for stress at day  $d$ . Stress levels on one day significantly predicted stress levels the following day ( $p < .001$ ). Behavioral disengagement ( $p < .001$ ) and music listening ( $p = .003$ ) as a coping strategy on one day significantly predicted lower stress the next day before and after Bonferroni adjustment. Social Support ( $p = .019$ ) and Venting ( $p = .031$ ) both significantly predicted lower stress the next day before Bonferroni-adjustment, but the  $p$ -values exceeded the Bonferroni-adjusted significance level. Social Activism ( $p = .047$ ) on one day significantly predicted higher stress the next day before Bonferroni-adjustment but also surpassed the Bonferroni-corrected significance level.

**Table 7.**

*Fixed effects of the multilevel model investigating the predictive effects of coping strategies (daily average) at day  $d$  on stress (daily average) at the following day  $d+1$ .*

| Parameter                | Estimate | SE  | <i>T</i> | <i>p</i> | 95% CI       |
|--------------------------|----------|-----|----------|----------|--------------|
| Intercept                | 4.02     | .44 | 9.064    | <.001**  | [2.32, 5.47] |
| Stress                   | .73      | .02 | 43.629   | <.001**  | [.66, .82]   |
| Distraction              | -.01     | .02 | -.511    | .609     | [-.05, .03]  |
| Denial                   | -.04     | .03 | -1.394   | .164     | [-.09, .02]  |
| Social Support           | -.05     | .02 | -2.343   | .019*    | [-.10, -.01] |
| Behavioral disengagement | -.12     | .02 | -5.950   | <.001**  | [-.17, -.08] |
| Positive Reframing       | .01      | .03 | .353     | .724     | [-.05, .07]  |
| Humor                    | -.02     | .03 | -.689    | .491     | [-.07, .04]  |
| Active Coping            | -.04     | .02 | -1.784   | .075     | [-.08, .01]  |
| Substance Use            | .08      | .05 | 1.578    | .115     | [-.02, .18]  |
| Venting                  | -.06     | .03 | -2.156   | .031*    | [-.11, -.00] |
| Planning                 | -.03     | .02 | -1.234   | .217     | [-.08, .02]  |
| Acceptance               | -.02     | .02 | -.930    | .352     | [-.06, .02]  |
| Spirituality             | .11      | .07 | 1.632    | .103     | [-.02, .25]  |
| Music                    | -.06     | .02 | -2.983   | .003**   | [-.10, -.02] |
| Social Activism          | .09      | .04 | 1.983    | .047*    | [.00, .17]   |
| Hope                     | -.02     | .03 | -.755    | .450     | [-.08, .03]  |
| Gender expression        | -.05     | .04 | -1.504   | .133     | [-.12, .02]  |

|           |     |     |       |      |             |
|-----------|-----|-----|-------|------|-------------|
| Avoidance | .05 | .03 | 1.762 | .078 | [-.01, .10] |
| Secrecy   | .01 | .03 | .460  | .645 | [-.04, .07] |

Note: CI = confidence interval, \*  $p < .05$ , \*\*  $p < \text{Bonferroni-adjusted threshold of } .0125$

*H6b: Gender moderates the association between coping on one day and stress the following day.*

Table 8 shows the results of the linear multilevel model investigating the predictive effects of coping strategies on one day (d), gender, and the interaction effects of gender and coping on stress the following day (d+1) when controlling for stress at day d. Stress levels on one day significantly predicted stress levels the next day ( $p < .001$ ). Social Support ( $p = .001$ ) and Behavioral Disengagement ( $p < .001$ ) on one day both significantly predicted lower stress the next day before and after Bonferroni-adjustment.

Table 8. Fixed effects of the multilevel model investigating the predictive effects of coping strategies and gender diversity on stress the following day.

| Parameter                | Estimate | SE   | <i>T</i> | <i>p</i> | 95% CI        |
|--------------------------|----------|------|----------|----------|---------------|
| Intercept                | 3.94     | .84  | 4.703    | <.001**  | [2.07, 6.06]  |
| Gender Diversity (GD)    | .51      | 1.00 | .510     | .614     | [-1.53, 2.51] |
| Stress                   | .72      | .03  | 22.555   | <.001**  | [.63, .81]    |
| Distraction              | -.04     | .04  | -1.089   | .276     | [-.12, .04]   |
| Denial                   | -.08     | .05  | -1.731   | .084     | [-.17, .01]   |
| Social Support           | -.13     | .04  | -3.285   | .001*    | [-.20, -.05]  |
| Behavioral disengagement | -.15     | .04  | -3.493   | <.001**  | [-.23, -.06]  |
| Positive Reframing       | .02      | .05  | .279     | .780     | [-.09, .12]   |
| Humor                    | .03      | .05  | .567     | .570     | [-.07, .13]   |
| Active Coping            | -.04     | .04  | -1.047   | .295     | [-.11, .03]   |
| Substance Use            | .13      | .08  | 1.683    | .093     | [-.02, .28]   |
| Venting                  | .07      | .05  | 1.456    | .146     | [-.03, .17]   |
| Planning                 | -.06     | .04  | -1.469   | .142     | [-.15, .02]   |
| Acceptance               | .02      | .04  | .510     | .610     | [-.06, .10]   |
| Spirituality             | -.07     | .16  | -.426    | .670     | [-.39, .25]   |
| Music                    | -.07     | .04  | -1.654   | .098     | [-.14, .01]   |
| Social Activism          | .07      | .06  | 1.151    | .250     | [-.05, .20]   |
| Hope                     | .05      | .05  | .922     | .356     | [-.05, .15]   |
| Gender Expression        | .04      | .10  | .445     | .656     | [-.15, .24]   |

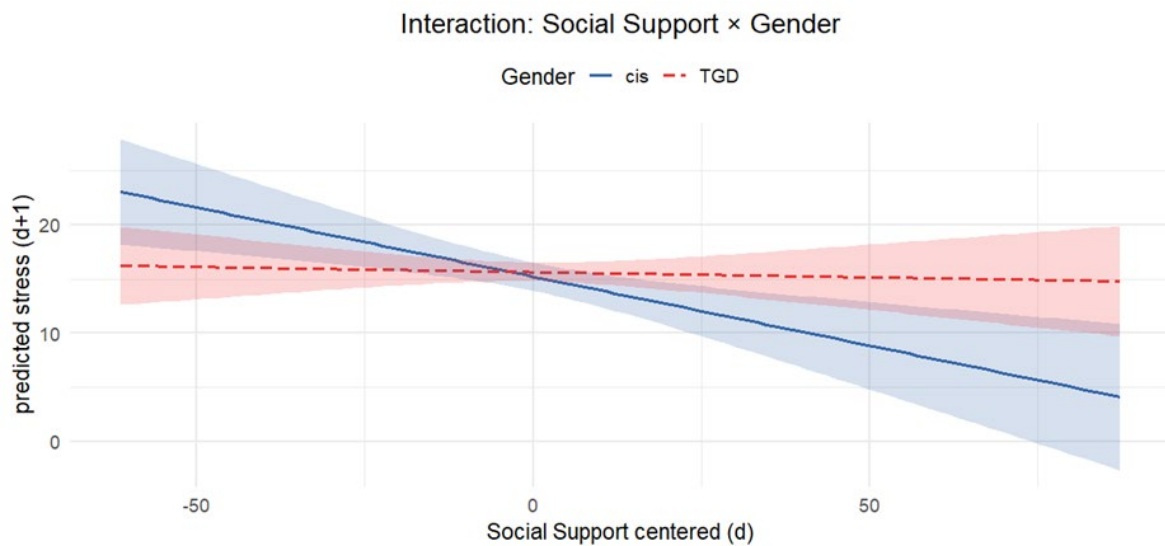
|                                |      |     |        |        |              |
|--------------------------------|------|-----|--------|--------|--------------|
| Avoidance                      | .01  | .06 | .236   | .813   | [-.10, .13]  |
| Secrecy                        | .05  | .16 | .327   | .743   | [-.26, .36]  |
| GD*Stress                      | -.01 | .04 | -.155  | .877   | [-.08, .07]  |
| GD*Distraction                 | .04  | .05 | .880   | .379   | [-.05, .13]  |
| GD*Denial                      | .07  | .06 | 1.264  | .206   | [-.04, .18]  |
| GD*SocialSupport               | .12  | .05 | 2.423  | .015*  | [.02, .21]   |
| GD*Behavioral<br>disengagement | .03  | .05 | .653   | .514   | [-.06, .13]  |
| GD*Positive Reframing          | -.00 | .07 | -.026  | .979   | [-.13, .13]  |
| GD*Humor                       | -.07 | .06 | -1.103 | .270   | [-.19, .05]  |
| GD*Active Coping               | -.00 | .04 | -.002  | .998   | [-.09, .09]  |
| GD*Substance Use               | -.10 | .10 | -.989  | .323   | [-.30, .10]  |
| GD*Venting                     | -.17 | .06 | -3.002 | .003** | [-.29, -.06] |
| GD*Planning                    | .05  | .05 | .852   | .394   | [-.06, .15]  |
| GD*Acceptance                  | -.05 | .05 | -1.160 | .246   | [-.15, .04]  |
| GD*Spirituality                | .24  | .18 | 1.332  | .183   | [-.11, .56]  |
| GD*Music                       | .02  | .05 | .366   | .715   | [-.07, .20]  |
| GD*Social Activism             | .02  | .09 | .266   | .790   | [-.15, .20]  |
| GD*Hope                        | -.09 | .06 | -1.429 | .153   | [-.21, .03]  |
| GD*Gender Expression           | -.12 | .11 | -1.074 | .283   | [-.33, .10]  |
| GD*Avoidance                   | .06  | .07 | .978   | .328   | [-.06, .28]  |
| GD*Secrecy                     | -.04 | .16 | -.243  | .808   | [-.36, .28]  |

*Note:* CI = confidence interval, \*  $p < .05$ , \*\*  $p < \text{Bonferroni-adjusted threshold of } .0125$

The positive interaction effect between Social Support and gender (see Figure 3) was significant before Bonferroni-adjustment ( $p = .015$ ), meaning that Social Support as a coping strategy on one day predicted lower stress for cis participants (see significant main effect of Social Support in Table 8) than for TGD participants. However, the  $p$ -value of this interaction effect surpassed the Bonferroni-adjusted significance threshold.

**Figure 3.**

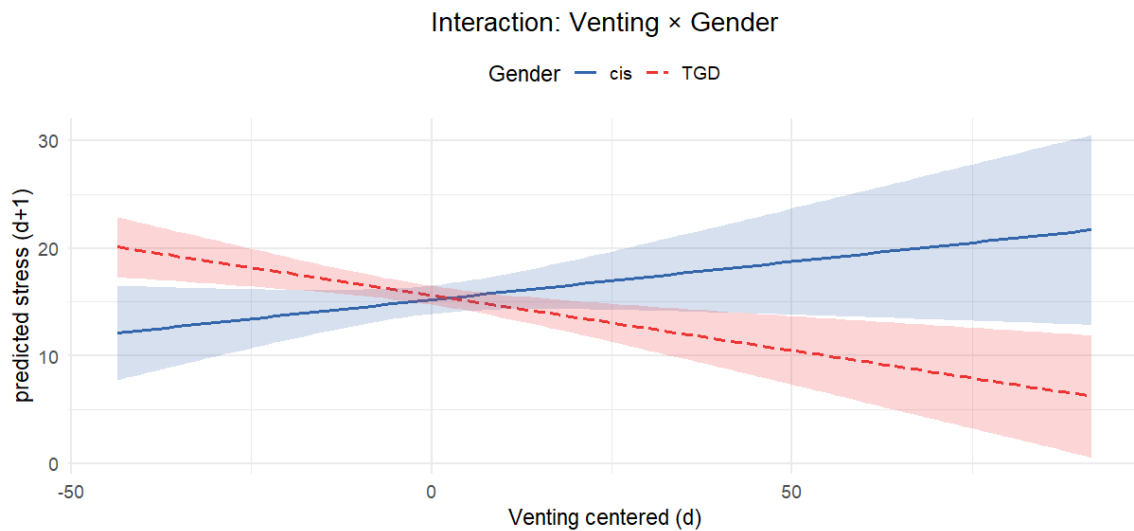
Interaction Effect of Social Support and Gender



The interaction effect between Venting and gender (see Figure 4) was significant before and after Bonferroni-adjustment ( $p=.003$ ). The interaction was negative, meaning that Venting as a coping strategy on one day predicted lower stress for TGD participants compared to cis participants.

**Figure 4.**

Interaction Effect of Venting and Gender



## **Discussion**

The present study investigated differences in GMS, mental health indicators, and coping strategies in TGD and cisgender adolescents and young adults. Using an EMA design, we furthermore explored the predictive effects of coping strategies on perceived stress in real-life and possible moderating effects of gender.

### ***Baseline Findings***

As hypothesized, TGD adolescents and young adults reported significantly higher GMS than their cisgender peers. They did not, however, report significantly higher perceived stress. Based on previous literature (e.g., McElroy, et al., 2016), as well as the heightened GMS factors in the TGD sample, we expected TGD participants to report higher perceived stress than the cisgender participants. In line with our hypothesis, TGD participants reported significantly higher depressive symptoms and suicidal ideation than cisgender individuals. These results correspond with existing literature, linking high rates of depressive symptoms and suicidal ideation in TGD populations (e.g., Kohnepoushi et al., 2023; Pellicane & Ciesla, 2022) to the experience of gender minority stress and revealing significantly higher depressive symptoms and suicidal ideation in genderqueer individuals than in cis individuals (Levefor et al. 2019).

The results also revealed some differences in coping between TGD and cisgender participants. TGD individuals reported significantly higher scores in Behavioral Disengagement. Cisgender participants reported higher scores in Emotional Support and Religious Coping, although these effects did not remain significant after Bonferroni-adjustment and should thus be interpreted with caution.

### ***EMA Findings – Stressors***

Almost  $\frac{3}{4}$  of assessed stressors were reported by TGD participants, with only around  $\frac{1}{4}$  reported by cis participants. The majority of participant-reported stressors were related to social interactions, school/university, or daily life stress, followed by mental health concerns, other stressors, gender minority stress, body-related concerns, public transportation, and finally sexual harassment. As most of the data was collected during exam season, the high amount of stress events related to school and university was to be expected. The surprisingly high number of stress events related to public transportation can be explained by the ongoing train strikes in Germany at the time data collection. Some stress-events could be allocated to multiple categories, which suggests some intersectionality in the stressors TGD adolescents face in everyday life. For example, the response “A teacher used my deadname again, even though he knew better... in front of the whole class.” was allocated both to the school category as well as the gender minority stress category and illustrates that in addition to performance pressure, some TGD individuals may also experience gender-specific victimization in the school context.

### ***EMA Findings – Predictive Effects of Coping Strategies on Stress***

Investigating the predictive effects of coping strategies used at one assessment on stress at the following assessment, only listening to music as a coping strategy significantly predicted lower stress at the next assessment. This result is in line with previous literature showing music listening as a relaxation strategy in everyday life to reduce both subjective stress and momentary cortisol levels (Linnemann et al., 2015).

The effect of certain coping strategies depended on whether a participant belonged to the TGD or cisgender group. Denial predicted lower stress at the next assessment in cisgender participants. However, it seemed to have contrary effects for TGD participants, increasing stress

for this group compared to cisgender participants. For TGD youth, denial may conflict with ongoing processes of identity affirmation and self-acceptance. Suppressing or distancing oneself from emotionally relevant or identity-related experiences might intensify internal conflict or delay necessary coping processes, leading to increased stress. Distraction was the most reported coping strategy and seemed to reduce stress from one assessment point to the slightly for TGD individuals, while it seemed to increase stress at the next assessment for the cisgender participants. This effect, however, did not remain significant after Bonferroni-correction and should therefore be interpreted with caution. For TGD youth, distraction might offer a brief reprieve from pervasive minority stressors such as misgendering or discrimination, thus slightly reducing momentary stress. For cisgender youth, who are less likely to experience identity-based stress, distraction may reflect a more general form of emotional avoidance.

Looking at the effects of coping on one day on stress the following day, behavioral disengagement and music listening predicted lower stress the following day. The effects of certain coping strategies on stress the next day again depended on which gender group the participants belonged to. Social Support on one day predicted lower stress the next day. The interaction effect between Social Support and Gender suggested that social support on one day predicted lower stress for cis participants but slightly higher stress the next day for TGD participants. This interaction effect was marginally not significant anymore after Bonferroni-adjusting the p-value and should also be interpreted with caution. For TGD individuals, the effectiveness of seeking social support, especially when dealing with gender specific stress, may highly depend on who they are seeking social support from. Having to educate their interaction partner on their gender-specific experiences may not only buffer the effectiveness of social support but may place additional strain on the individual seeking support (Gorman et al., 2022). This reinforces the importance, especially for (mental) health care providers, to educate themselves about gender-specific topics.

Venting, or living out one's emotions, as a coping strategy predicted significantly lower stress the following day in TGD individuals compared to cis participants. For cisgender youth, venting may reflect a dysregulated form of emotional expression that is not accompanied by meaningful processing or resolution, thereby amplifying stress. In contrast, for gender diverse youth, venting may serve a more adaptive role: it could facilitate connection with affirming peers, support identity expression, or function as a release of accumulated minority stress. As such, the same behavior may carry different emotional consequences depending on the social context and the individual's lived experience.

Our results suggest certain differences in 1) the types of stressors experienced, 2) the coping strategies utilized, and 3) the effectiveness of certain coping strategies in successfully reducing stress for TGD and cis youth. As suggested in previous literature (Freese et al., 2017), health care providers should foster functional coping strategies, such as providing effective social support and reduce dysfunctional coping strategies such as denial, to promote mental health in TGD individuals. Thus, it seems crucial to encourage education on gender-specific topics to enable professionals working with adolescents to provide effective support and safe environments for TGD individuals and thus reduce some of the additional burden on TGD individuals.

### ***Limitations***

Some limitations to this study need to be considered when interpreting the results. Suicidal ideation was only assessed with a single item question (PHQ9). It is important to note that the sample for this study consisted of substantially more gender diverse participants than cisgender participants due to oversampling. Moreover, cisgender and TGD participants were not matched to each other. However, the two groups did not significantly differ from each other in age or education. It has to be noted as well, that due to the small sizes of the individual sub-samples, transgender and non-



binary participants were grouped together for the analyses, although differences in gender minority between these two groups have been previously reported (Chavanduka et al., 2021). The imbalance in sex assigned at birth further limits the generalizability of results, with the majority of participants being assigned female sex at birth. Furthermore, many of the cis participants identified as not heterosexual, which could have influenced the results, as queer individuals also face more forms of discrimination than heterosexual individuals. In the EMA part of the study, coping strategies were not assessed with validated questionnaires, but with singular self-report items on a VAS scale. Although we provided the participants with information material explaining the different coping strategies assessed, we could not control whether the reported coping strategies reflected the actually utilized coping strategies by the participants. The majority of analyzed stressors were reported by TGD participants, which influences the interpretation of the qualitative results.

## ***Conclusion***

Our findings provide novel insight into immediate effects of coping strategies utilized by TGD and cisgender youth on perceived stress in real-life. Additionally, they highlight again the intersectional burden on TGD youth of experiencing not only everyday life stress such as pressure to perform in school, but also gender-specific stressors such as being misgendered by a teacher. To promote mental health in TGD youth, it is necessary to support the development of adaptive coping strategies and effective support networks. Education about LGBTQI+ topics for health care providers is crucial to reduce the systematic experience of gender minority stress of gender diverse adolescents and young adults. A tailored approach in the treatment of gender diverse youth, taking the individual experience of TGD adolescents and young adults, as well as differences in the effectiveness of certain coping strategies into account, seems warranted.

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### Supplementary Material

- Supplementary Material A: Glossary of Coping Strategies
- Supplementary Material B: Reported Stressors



## Glossary of included terms

The list below provides you with an overview of the meaning of some terms used in the questionnaires. If you don't understand something while filling out a questionnaire, you can simply open the list and look it up again.

### Coping Strategies

#### Acceptance

... means that after a stressful event, you accept that it happened without actively wanting to change anything.

#### Active Coping

... means that in a stressful situation, you actively try to change something about your situation or problem.

#### Avoidance

... means that you avoid certain actions or activities that are stressful for you (e.g., avoiding conversations or interactions with certain people, postponing tasks, avoiding stressful places or situations).

In terms of your gender identity, this can mean **avoiding gender-specific activities** (e.g., sports or social clubs) or **cisgender or heterosexual spaces** (e.g., bars or clubs) or **gender-specific spaces** (e.g., gyms, restrooms, changing rooms); that you **avoid traveling to conservative countries** where you feel that trans\*, inter\*, and/or non-binary people are not welcome, or that you avoid places where you feel that **binary gender norms** (i.e., male and female) or expectations are enforced.

#### Behavioral Disengagement

... means that you withdraw during or after a stressful event and no longer engage with it.

#### Distraction

... means that during or after a stressful situation, you try to distract yourself with other activities (e.g., work or television) in order to take your mind off things.

#### Denial

... means that during or after a stressful event, you cannot or do not want to accept that it happened to you, or you convince yourself that it is not true.

#### Hope

... means maintaining positive expectations (e.g., about the future) in stressful situations. For example, you focus on positive events or solutions instead of dwelling on the negative aspects of the stressful situation. Hope does not mean denying reality or ignoring serious problems but rather thinking positively and constructively.



In terms of your gender identity, this can mean, for example, that you imagine yourself being more **confident in your gender presentation**, that you focus on the hope that your **gender identity** will be **accepted** by others in your life (e.g., friends, coworkers, family) in the future, that you will one day be generally **accepted as trans\*, inter\*, and/or non-binary**, or that other people will **recognize your gender** in the future. It can also mean **thinking about future social transition steps** (e.g., changing your name, clothing, pronouns).

### Humor

... means that during or after a stressful event, you make jokes about it or take the situation with humor.

### Planning

... means that before or during a stressful event, you think about the problem at hand and come up with a plan on how to best deal with it.

### Positive Reframing

... means that during or after a stressful event, you try to find something good in what has happened to you or try to see it from a positive perspective.

### Religion/Spirituality

... means that during or after a stressful event, you try to find solace in your faith, pray, meditate, or perform any other spiritual ritual to cope with your stress.

### Secrecy (regarding your identity)

... means that you **avoid discussing your trans\*, inter\*, and/or non-binary identity with other people** or revealing it to them, or that you **only talk about it with selected individuals**.

### Social Activism

... means that you participate in social and/or political activities to cope with stress, for example by campaigning for social justice, change, or a specific cause. This can mean joining demonstrations or protests, participating in charitable projects or volunteer work, or educational and awareness-raising activities.

In terms of your gender identity, social activism can mean participating in **trans\*, inter\*, or non-binary support projects** (e.g., medical care, supply runs), **volunteering with organizations** that support trans\*, inter\*, and/or non-binary people, participating in **demonstrations** to increase the visibility of the community, or **wearing accessories** that **indicate your pronouns**.

### Social Support

... means that in stressful situations, you seek support from your social environment, i.e. from friends, family, schoolmates or work colleagues. Social support can take many forms, e.g. listening, comforting, giving advice, providing practical help or information. However, social support can also come from you and be intended for others.

In terms of gender identity, social support can manifest itself in **being there for other trans\*, inter\*, and/or non-binary people** (e.g., by supporting their feelings during transition processes), talking to

them about your **social transition** (e.g., your name change, changes in clothing style, or pronouns), or how you have dealt with **conversations about gender identity**. It can also mean talking to them specifically about your **transition**.

### Strategic Gender Expression

... means changing the way you **move your body** (e.g., gait, gestures, sitting) to conform to traditional gender stereotypes. It can also mean using **different pronouns** that seem more comfortable to other people or **dressing in a traditionally gender-stereotypical manner**. It can also mean that you **use more masculine/feminine behaviors**. You make these changes so that you are **(not) perceived as trans\*, inter\*, and/or non-binary**.

### Substance Use

... means that during or after a stressful event, you turn to alcohol or other drugs to calm yourself down and cope with your stress.

### Venting

... means that during or after a stressful event, you openly show your emotions and do not try to suppress them. For example, you openly show that you are feeling bad or angry.

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Body</b> <ul style="list-style-type: none"> <li>• <b>Physical Discomfort</b> (20) – e.g.: “I can't do anything because of period pain, even walking seems incredibly exhausting.”</li> <li>• <b>Weight and Looks</b> (23) – e.g.: “Shopping for pants after gaining weight.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Daily Life Stress</b> <ul style="list-style-type: none"> <li>• <b>Daily life stress</b> (2) – e.g.: „Just daily life stress.”</li> <li>• <b>Household chores</b> (8) – e.g.: “Was grocery shopping.”</li> <li>• <b>Loud noises</b> (9) – e.g.: “Loud cafeteria – overstimulated.”</li> <li>• <b>TV/Media</b> (2) – e.g.: “Confrontation with graphic images.”</li> <li>• <b>Organization</b> (16) – e.g.: “Planning of a choir event.”</li> <li>• <b>Overwhelm</b> (16) – e.g.: “Woke up and was overwhelmed with tasks.”</li> <li>• <b>Time management</b> (30) – e.g.: “Time pressure.”</li> <li>• <b>Leisure time stress</b> (10) – e.g.: “Escape Room.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Education/Work</b> <ul style="list-style-type: none"> <li>• <b>School/University</b> (137) e.g.: “School + performance pressure.”</li> <li>• <b>Work</b> (11) – e.g.: “Work stress, full shop.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Gender Minority Stress</b> <ul style="list-style-type: none"> <li>• <b>Discrimination</b> (2) – e.g.: “Due to my ongoing therapy and my queerness, I was rejected for the volunteer service I would have liked to do.”</li> <li>• <b>Victimization</b> (9) – e.g.: “While dancing disco fox, I was forced to dance in the man’s position”</li> <li>• <b>Gender Dysphoria</b> (12) – e.g. “I am afraid of gaining weight which would further distance my body from my gender identity”</li> <li>• <b>Deadnaming</b> (4) – e.g.: “A teacher used my deadname again, even though he knew better... in front of the whole class”</li> <li>• <b>Misgendering</b> (8) – e.g.: “My grandmother stresses me out, she doesn’t understand my trans identity and has misgendered me again, my mother doesn’t have my back.”</li> <li>• <b>Coming Out</b> (3) – e.g.: “Coming out as trans to the local priest”</li> <li>• <b>Activism</b> (6) – e.g.: “A friend wrote to me because he had been misgendered by his cisgender friend, and I got involved by lightly criticizing his friend for it.”</li> <li>• <b>Negative Expectations</b> (8) – e.g.: “Picking up my library card, fear of incomprehension.”</li> <li>• <b>Non-Disclosure</b> (2) – e.g.: “Not telling my friend that I wore a binder.”</li> </ul> |
| <b>Mental Health</b> <ul style="list-style-type: none"> <li>• <b>Mental Strain</b> (60) – e.g.: “Panic attack.”</li> <li>• <b>Sleep</b> (25) – e.g.: “My sleep stressed me today, because I had a bad dream.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Public Transportation and Traffic</b> <ul style="list-style-type: none"> <li>• <b>Flying</b> (9) – e.g.: “Security check at the airport.”</li> <li>• <b>Public Transportation</b> (31) – e.g.: “The train was delayed so I had to check for another connection”</li> <li>• <b>Driving lessons</b> (3) – e.g.: “Driving lessons.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Sexual Harassment</b> <ul style="list-style-type: none"> <li>• <b>Sexual harassment</b> (7) – e.g.: “Cat calling.”</li> <li>• <b>Fear at night</b> (9) – e.g.: “Walking home alone at night as a woman.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Social Interactions</b> <ul style="list-style-type: none"> <li>• <b>Family</b> (36) – e.g.: “Family celebration.”</li> <li>• <b>Friends</b> (16) – e.g.: “Time with friends.”</li> <li>• <b>Romantic Relationships</b> (9) – e.g.: “There was a tense situation with my partner.”</li> <li>• <b>Disagreements</b> (11) – e.g.: “Disagreement between classmates.”</li> <li>• <b>Doctors</b> (11) – e.g.: “Dentist appointment.”</li> <li>• <b>Crowds</b> (10) – e.g.: “Extremely full train station.”</li> <li>• <b>Other Social Interactions</b> (60) – e.g.: “Phone call with internship.”</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Other Stressors</b> (64) – e.g.: “Training my dog.”                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |