Sleep, Physical Activity, and Mental Health Among Sexual-Minority, Transgender, and Gender-Diverse Youth

by

Brian Timothy Gillis, LMFT

A dissertation submitted to the Graduate Faculty of
Auburn University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

Auburn, Alabama
August 5, 2023

Keywords: sleep, physical activity, mental health, LGBTQ+, youth, health equity

Approved by

Mona El-Sheikh, Ph.D., Chair, Leonard Peterson & Co., Inc. Professor of
Human Development & Family Science
Stephen A. Erath, Ph.D., Professor of Human Development & Family Science
Ben Hinnant, Ph.D., Associate Professor of Human Development & Family Science
Joshua R. Novak, Ph.D., LMFT, Associate Professor of Human Development & Family Science

Abstract

In the face of legislation that curtails the rights and wellbeing of sexual- and gender-minority (SGM) youth, developmental science has a responsibility to investigate SGM health and its protective factors. Sleep is a bellwether of health, indicating how well individuals and communities are doing. Given this, the two studies of this dissertation sought to understand the nature of sleep among SGM youth – how it compares to non-SGM peers, how it functions as a risk and protective factor for mental health, and what behaviors could promote SGM sleep. Using data from the Adolescent Brain Cognitive Development Study, the following measures were obtained for youth at age 12: SGM status by self-report, sleep by objective actigraphy, minority stress (past 12-month discrimination) by self-report, mental health (internalizing symptoms and externalizing behaviors) by parent report, and physical activity by accelerometry. Study I focused on sexual-minority (SM) youth. In models adjusted for sociodemographic characteristics and internalizing (anxious/depressive) symptoms, SM youth had shorter sleep duration, later sleep timing, and more irregularity in sleep duration and timing compared to non-SM peers. However, they also had fewer wake minutes during the night, indicative of better sleep quality. Sleep quality, then, emerged as a moderator of relations between discrimination and externalizing behaviors. For SM youth with fewer wake minutes, there was no relationship between discrimination and externalizing (aggressive/rule-breaking) behaviors, suggestive of a protective role for sleep quality. Sleep did not moderate associations between discrimination and internalizing symptoms. Study II focused on gender-minority (GM) youth. In unadjusted models, GM youth had shorter sleep duration but better sleep quality than non-GM youth, and in models adjusted for sociodemographic variables and internalizing symptoms, GM youth had later sleep timing and more irregularity in duration and timing. Physical activity emerged as a moderator of

relations between GM status and sleep duration: at higher levels of physical activity, there was no difference in sleep duration between GM and non-GM youth, suggesting that physical activity could protect GM youth from insufficient sleep. Physical activity did not serve a similar function for sleep quality, timing, or regularity. Across studies, findings increase our understanding of sleep in the lives of SGM youth.

Acknowledgements

For Carissa.

And Mark.

To count the number of people who helped me to arrive at this moment would be impossible. However, I have tremendous gratitude for the individuals and communities who provided support, encouragement, and love just when I needed it.

So, thank you –

To my parents, who pray constantly for my wellbeing.

To my sweet sister, who believed in me more than I could believe in myself.

To Mona, whose spoken and unspoken support helped me to feel that my research questions were valuable, worthwhile, and on the right track. I have learned so much from you about how to ask questions and communicate their answers.

To my lab siblings and partners in crime, especially Ekjyot and Olivia, who made our work fun along the way. And Parsons, who read literature and helped me to think through the "why" and "how" of these studies.

To Stephen, who took on extra summer reading this year.

To Ben, who kept the stats on track.

To Josh, for excellent committee service.

To Connor, Mac, June, Jules, and Newtie, for keeping me sane off campus.

To Kyle, for righting the ship.

To Rob, whose guidance provided a firm foundation at the beginning of the program.

To Margaret, who frustrated and delighted me, and gave me confidence.

To Scott, whose quiet mentorship makes me feel accepted.

To DaJuandra and Kara, for listening ears.

And to all other fellow students and faculty for friendship, laughs, and camaraderie.

Table of Contents

Abstract 2

Acknowledgements 4

List of Tables 6

List of Figures 9

List of Abbreviations 10

Chapter 1: General Introduction 11

Chapter 2: Introduction to Study I 26

Chapter 3: Method of Study I 37

Chapter 4: Results of Study I 44

Chapter 5: Discussion of Study I 50

Chapter 6: Introduction to Study II 60

Chapter 7: Method of Study II 71

Chapter 8: Results of Study II 77

Chapter 9: Discussion of Study II 83

Chapter 10: General Discussion 92

References 98

Tables 136

Figures 168

Appendix: Measures 176

List of Tables

Table 1.1: Descriptive Statistics of Continuous Variables in Study I 136

Table 1.2: Differences in Sleep Actigraphy and Mental Health by Sex Assigned at Birth 137

Table 1.3: Differences in Sleep Duration and Quality by Ethnicity and Race 138

Table 1.4: Differences in Sleep Schedule and Regularity by Ethnicity and Race 139

Table 1.5: Correlations Among Continuous Variables in Study I 140

Table 1.6: Differences in Sleep Actigraphy and Mental Health by Discrimination Experience Among Sexual-Minority Youth 141

Table 1.7: Mean Comparisons of Sleep Actigraphy Between Sexual-Minority and Non-Sexual-Minority Youth 142

Table 1.8: Sleep Minutes as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 143

Table 1.9: Sleep Efficiency as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 144

Table 1.10: Wake After Sleep Onset as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 145

Table 1.11: Sleep Latency as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 146

Table 1.12: Sleep Midpoint as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 147

Table 1.13: Variability in Sleep Minutes as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 148

Table 1.14: Variability in Sleep Midpoint as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth 149

Table 2.1: Descriptive Statistics of Continuous Variables in Study II 150

Table 2.2: Differences in Physical Activity and Sleep Actigraphy by Sex Assigned at Birth ... 151

Table 2.3: Differences in Physical Activity by Ethnicity and Race 152

Table 2.4: Correlations Among Continuous Variables in Study II 153

Table 2.5: Differences in Physical Activity by Transgender or Gender-Diverse Status 154

Table 2.6: Mean Comparisons of Sleep Actigraphy Between Transgender and Gender-Diverse and Non-Transgender and Gender-Diverse Youth 155

Table 2.7: Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Duration 156

Table 2.8: Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Quality 157

Table 2.9: Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Schedule 158

Table 2.10: Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Regularity 159

Table 2.11: Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Duration 160

Table 2.12: Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Quality 161

Table 2.13: Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Schedule 162

Table 2.14: Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Regularity 163

Table 2.15: Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Duration.. 164

Table 2.16: Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Quality.. 165

Table 2.17: Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Schedule 166

Table 2.18: Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Regularity 167

List of Figures

Figure 1.1: Sleep Minutes as a Moderator of Relations Between Sexual-Minority Discrimination and Aggressive Behavior 168

Figure 1.2: Sleep Efficiency as a Moderator of Relations Between Sexual-Minority Discrimination and Rule-Breaking Behavior........ 169

Figure 1.3: Wake After Sleep Onset as a Moderator of Relations Between Sexual-Minority Discrimination and Aggressive Behavior 170

Figure 1.4: Wake After Sleep Onset as a Moderator of Relations Between Sexual-Minority Discrimination and Rule-Breaking Behavior........ 171

Figure 2.1: Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Minutes 172

Figure 2.2: Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Minutes 173

Figure 2.3: Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Latency........ 174

Figure 2.4: Steps as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Minutes........ 175

List of Abbreviations

ABCD Study = Adolescent Brain Cognitive Development Study

GM = gender minority

HPA = hypothalamic–pituitary–adrenal

MANCOVA = multivariate analysis of covariance

METs = metabolic equivalents of task

MST = minority stress theory

MVPA = moderate-to-vigorous physical activity

NIH = National Institutes of Health

SES = socioeconomic status

SGM = sexual or gender minority

SM = sexual minority

TGD = transgender or gender diverse

var. = variability

WASO = wake after sleep onset

Chapter 1: General Introduction

In October 2021 the American Academy of Pediatrics, together with peer societies of health professionals, declared a national emergency on youth mental health and called for policymakers to take actions to support the socioemotional wellbeing of children and adolescents in the wake of the COVID-19 pandemic (American Academy of Pediatrics, 2021). Two months later, the U.S. Surgeon General responded with an advisory to stakeholders who could help address what has since become known as a youth mental health crisis (Office of the Surgeon General, 2021). At the center of the response was youth themselves, with a call for children and adolescents to attend to their "body and mind" through sleep and physical activity (among other recommendations; Office of the Surgeon General, 2021, p. 15). The Surgeon General further recognized a role for the research community, encouraging the use of novel methods, such as collecting data through wearable technology, and asking for research on health inequities affecting "at-risk youth populations, such as…sexual- and gender-minority [SGM] youth" (Office of the Surgeon General, 2021, p. 38). In echoing this call to address SGM health inequities, the Substance Abuse and Mental Health Services Administration (2023) has elicited research "that focuses on the ways [SGM] youth are thriving" (p. 59). It is within the context of this crisis – and this responsibility of researchers to locate sources of support for youth – that this dissertation is situated. The following two studies seek to contribute to our understanding of ways that youth from a marginalized group can have agency over their own health through ordinary behaviors that may have extraordinary influence.

Contextualizing Sexual- and Gender-Minority Health

Sexual-minority (SM) youth are those who identify as lesbian, gay, bisexual, pansexual, asexual, queer, or a host of other specific orientations that differ from strictly heterosexual or

mixed-sex sexual or romantic interests (Zaza et al., 2016). Gender-minority (GM) youth have a gender identity that differs from the gender considered to be congruent with their sex assigned at birth; GM individuals are sometimes referred to as transgender and gender-diverse (TGD) in developmental and health literatures (Thorne et al., 2019). Together, SGM youth account for nearly 10% of the U.S. population between ages 13 and 17 (Conron, 2020). This includes 1.92 million youth who identify as sexual minorities (Conron, 2020) and at least 300,000 who identify as transgender (Herman et al., 2022). Despite significant gains in public support for SM rights such as same-sex marriage (Gallup, 2023) and GM protections against housing and workplace discrimination (Parker et al., 2022), marginalization continues to occur (Fish, 2020; Fish & Russell, 2022). In 2021 and 2022, more than 300 bills were introduced in U.S. state legislatures to reduce access to gender-affirming healthcare and limit GM youths' access to school spaces and activities (Nakajima & Jin, 2022). While 85% of such bills were unsuccessful (Nakajima & Jin, 2022), they garnered considerable media attention and led to the spread of harmful misinformation (Pang et al., 2022). Approximately 70% percent of SGM youth report experiences of discrimination (Price-Feeney et al., 2020), and 36% of SGM adolescents report being victimized (Williams et al., 2021). Surveillance data show that SM youth are two times (Johns et al., 2020) and GM youth are five times (Johns et al., 2019) more likely to report feeling unsafe at school than non-SGM peers. Both SM and GM youth are two times more likely to be bullied at school or online than their peers (Johns et al., 2019; Johns et al., 2020). Observational data reflect similar trends: pooled estimates from a recent meta-analysis showed that risk for victimization was three times more likely for SGM youth than their non-SGM peers (Williams et al., 2021).

The cost of marginalization is high. SGM youth have higher prevalence rates than non-SGM individuals on nearly every indicator of mental illness (Fish et al., 2020; Russell & Fish, 2016), including internalizing symptoms of depression and anxiety (Adelson et al., 2016), externalizing behaviors like substance use (especially use of illicit drugs; Johns et al., 2019; Mereish, 2019), and impaired academic achievement (Fenaughty et al., 2019). Of gravest concern, GM youth in the U.S. are six times more likely to attempt suicide than non-GM peers (Johns et al., 2019), while SM youth are four times more likely than their non-SM counterparts (Johns et al., 2020). Due to gaps in health equity between SGM and non-SGM individuals, the Office of Management and Budget has identified SGMs as a U.S. Health Disparity Population (Alvidrez et al., 2019).

Such health inequities have been linked to marginalization (Halliwell, 2018; Williams et al., 2022). Discrimination accounts in part for the disparity in suicide attempts between GM and non-GM youth (Price-Feeney et al., 2020). Experiences of victimization are correlated with suicide risk (Bouris et al., 2016; Hatchel et al., 2021) and temporally precede depressive symptoms (Hatchel et al., 2018). Evidence suggests that victimization on the basis of one's identity (e.g., discrimination attributed to one's SGM status) may have a stronger relationship to depression, anxiety, and substance use than victimization without a specific cause (Earnshaw et al., 2016; Goldbach & Gibbs, 2017). This association is stronger still for identities that are more strongly held by youth, including SGM status (Goldbach & Gibbs, 2017). Further, the association between victimization and depressive symptoms is more robust in adolescence than later developmental periods (Birkett et al., 2015).

Theoretical and Conceptual Frameworks

The relationship between marginalization and health can be understood through the lens of minority stress theory (MST; Brooks, 1981; Meyer, 1995, 2003, 2015; Frost & Meyer, 2023). At its core, MST suggests that individuals with marginalized identities have psychological demands over and above those of all people. Such demands are the result of experiences of prejudice, vigilance from the anticipation of prejudice, and internalized negative self-valuation following prejudice (Meyer, 2003). Meyer posits that minority stress is unique (i.e., that it occurs in addition to general stress), chronic (i.e., that it is related to widespread social norms that are unlikely to change in the short term), and social (i.e., that sources of stress are located outside of the individual; Meyer, 2003).

From its inception (Brooks, 1981), MST has included the idea that there is variability in the effects of minority stress because some individuals demonstrate resilience in the presence of adversity (Frost & Meyer, 2023; Meyer, 1995, 2003, 2015). In earlier writings, Meyer described such resilience processes as coping (Meyer, 1995), yet he later carefully added that there are aspects of general stress and resilience models that apply to MST (Meyer, 2003). These include the specification of both group and individual "stress-ameliorating processes" (Meyer, 2003, p. 6). Group resilience can be observed through affiliation with one's community, which can be protective against stigma and discrimination (Meyer, 2015). Individual resilience is seen in resources available at the personal level, including biological factors and "usual activities" or everyday behaviors in which individuals engage (Dohrenwend, 2000; Meyer, 2003). When we consider activities through time use, we see that adolescents spend more than one-third of their lives in either sleep or physical movement (Brown et al., 2021; Randler et al., 2019), suggesting

that by time use alone, sleep and physical activity may be considered important everyday behaviors that could ameliorate minority stress.

Sameroff's unified theory of development (2010) provides further context for understanding the relationship between minority stress and youth development. The unified theory describes a dialectical exchange between individuals and their environments with attention to contextual and regulation models (Sameroff, 2010). The contextual model explains that youth are situated within multiple, interconnected systems comprised of homes, neighborhoods, schools, cities, states, and the broader culture. For SGM youth, such systems are the places where minority stress occurs. The regulation model articulates an increasing level of self-regulation that is common for individuals as they advance from childhood to adulthood, and which includes biological, psychological, and social facets. Sameroff (2010) describes sleep as a regulatory process that requires – and blends – the biological, psychological, and social together, suggesting that sleep is a lens through which to observe youth development. Sameroff (2010) further highlights transactions or interactions between contextual and regulatory models, suggesting that regulation can moderate the developmental processes set in motion by context.

Sleep and Physical Activity

Sleep is a key bioregulatory process that plays a vital role in nearly every aspect of wellbeing (Matricciani et al., 2019). For mental health, sleep supports emotion processing and regulation (Simon et al., 2020); over time, sufficient sleep is associated with lower levels of both internalizing symptoms and externalizing behaviors among youth (Kelly et al., 2022; Van Veen et al., 2021). For physiological processes, sleep assists in the functioning of the immune, endocrine, metabolic, and nervous systems (Zoccoli & Amici, 2020). For cognitive functioning, sleep aids in memory consolidation (Born & Wilhelm, 2012), improves working memory

(Matricciani et al., 2019), and increases cognitive efficiency (Short et al., 2018). In short, it is difficult for any individual to be "doing well" without sleeping well (Walker, 2017).

Sleep has multiple dimensions (Buysse, 2014; Meltzer et al., 2021), each of which has unique effects on child development. Longer *sleep duration*, higher *sleep quality* (that is, fewer nighttime awakenings), earlier sleep *timing*, and more *regularity* (or consistency) in sleep duration and timing are all generally better for youth with regard to mental and physical health and academic functioning (Becker et al., 2017; Matricciani et al., 2019; Spruyt, 2019). While such trends are fairly consistent in the literature, only a few parameters have specific guidelines associated with them, such as recommendations that youth obtain eight-to-ten hours of sleep per night, go to bed no later than 9:00pm, fall asleep close to 30-60 minutes of the same time each night, and remain sleep for at least 85% of the night (Allen et al., 2016; Hirshkowitz et al., 2015; Mindell et al., 2009; Ohayon et al., 2017).

Beyond its main effects, sleep plays an influential role in moderating the relationship between minority stress and youth development. For example, under conditions of longer, better-quality, or more consistent-length sleep, relations among racial/ethnic or general discrimination and mental health are diminished (El-Sheikh et al., 2016; El-Sheikh, Zeringue, et al., 2022; Wang & Yip, 2020; Yip, 2015). These findings suggest that sleep could be an individual resilience factor consistent with Meyer's (2003, 2015) conceptualization of stress amelioration. This places sleep within a broader resilience framework (Rutter, 1987) in which a promotive factor buffers stress, alleviating its expected negative effect (Luthar et al., 2000; Masten, 2001). (Sleep would be a *promotive* rather than a *protective* factor, as promotive factors theoretically confer advantages across both low- and high-risk contexts, while protective factors function in the context of risk; Sameroff, 2010). Conversely, shorter or poorer-quality sleep has been shown

to strengthen the relationship between discrimination and symptoms of mental illness (El-Sheikh et al., 2016; El-Sheikh, Zeringue, et al., 2022; Yip, 2015). Such a condition is consistent with multiplicative risk (Evans et al., 2013) and diathesis–stress (Sameroff, 1983) models. Both describe the deleterious influence of multiple risk factors functioning together, in slightly different ways. Multiplicative risk (also called cumulative risk), is often aggregated as an additive effect (e.g., the effect of two risk factors compared to the effect of one risk factor; Evans et al., 2013). Yet it also can be operationalized as an interactive effect to test moderation (e.g., Yip, 2015). Diathesis–stress is a specific type of multiplicative risk process in which the influence of an existing or initial context of risk (e.g., being mistreated due to one's identity) is amplified by a stressor (e.g., insufficient sleep), increasing the vulnerability to a negative outcome (El-Sheikh, Zeringue, et al., 2022; Sameroff, 1983). Both of these observed moderating functions of sleep in the context of minority stress – resilience and risk – are part of a larger literature showing that sleep can buffer or exacerbate the effects of other stressors, including peer victimization (Tu et al., 2015), attachment insecurity (El-Sheikh & Kelly, 2017), family conflict (El-Sheikh et al., 2014), and socioeconomic adversity (Bagley & El-Sheikh, 2013; Gillis et al., 2023). Of note, the role of sleep to moderate associations between discrimination and mental health has not been examined for sleep timing or regularity in timing.

Physical activity, a key health behavior, seems to play a similarly wide-reaching role in supporting multiple domains of development. At higher levels, physical activity supports emotion regulation (Lubans et al., 2016) and is associated with lower levels of depressive and anxious symptoms, as well as acting-out behaviors among youth (Biddle et al., 2019; Spruit et al., 2016). It further supports immune, endocrine, metabolic, and nervous system functioning (Fleshner, 2005; Hackney & Lane, 2015; Vrijkotte et al., 2015). Along with these important

aspects of bioregulatory health, physical activity also supports longer and better-quality sleep (Gerber et al., 2014; Kalak et al., 2012; Philbrook & El-Sheikh, 2016). Cognitively, physical activity improves memory and strengthens performance (Biddle et al., 2019; Lubans et al., 2016).

Like sleep, physical activity has been shown to moderate associations between stress and youth development. In studies examining environmental stressors such as family conflict and negative life events, the association between stress and mental illness symptoms is attenuated under conditions of more physical activity (Norris et al., 1992; Sigfusdottir et al., 2011). The inverse also was observed – under conditions of less physical activity, a stronger relationship between stress and mental health was apparent. This suggests, again like sleep, that *more* physical activity can play a promotive role for youth facing stress, while *less* physical activity can increase risk, supportive of both resilience and multiplicative risk/diathesis–stress frameworks.

Taken together, sleep and physical activity provide a tremendous window into youth development, and their assessment by objective methods is easier now than ever before. Over the last decade, the use of consumer wearable technology has proliferated, offering the public insight into their sleep and physical activity at the touch of a button (Chinoy et al., 2021). Sensing technology and coding algorithms have become increasingly accurate in the estimation of sleep/wake periods and energy expenditure compared to gold-standard research instruments in the fields of sleep and kinesiology (Bagot et al., 2018).

The Present Studies

The present dissertation is comprised of two studies using data from the Adolescent Brain Cognitive Development (ABCD) Study, a longitudinal National Institutes of Health (NIH)

investigation offering unprecedented insight into the lives of youth in the U.S. In ABCD's third wave of data collection (two-year follow-up to baseline), more than 4,000 youth wore actigraphs/accelerometers to contribute objective information on their sleep and physical activity. The sample had adequate representation of SGM individuals, including 211 SM and 91 GM adolescents, making ABCD the first nationally representative study of SGM youth sleep and physical activity using objective measurement (Bagot et al., 2018; Calzo & Blashill, 2018). Although SGM youth are frequently sampled together in studies of health (Russell & Fish, 2016), the current studies disaggregated data to examine the health of SM youth separately from GM youth. This is so that researchers, clinicians, and service providers seeking information on factors contributing to the health of one part of the community versus another can benefit from differentiation between groups.

Study I begins with a comparison of sleep between SM and non-SM ("straight") youth. To date, such differences among youth have been examined only from self-report (i.e., subjective) questionnaires. Surveillance data from the Youth Risk Behavior Survey showed that SM youth reported sleeping less at night than non-SM peers in 2015 (Dai et al., 2020; Kann et al., 2016). Large-scale population studies in China (Huang et al., 2018) and Korea (Seo et al., 2015) have revealed similar patterns. Huang et al. (2018) also found SM youth in China reported taking longer to fall asleep and woke more during the night than non-SM peers. While a very useful start, such self-reports of sleep are only the tip of the iceberg toward a comprehensive understanding of SM sleep health (Meltzer et al., 2021; Millar et al., 2019). Study I advances this literature by examining SM-to-non-SM mean differences in objective sleep duration, quality, timing, and regularity. Sleep duration refers to the average length of sleep obtained each night. Sleep quality addresses the relative fragmentation and consolidation of sleep, a function of time

spent awake during the night. Sleep timing considers whether sleep falls earlier or later in the night. In contrast to the duration, quality, and timing, which are represented by means across nights, sleep regularity (also called consistency) examines variability of a sleep parameter across nights. Pursuant to a literature showing the importance of regularity in sleep duration and timing (Becker et al., 2017; Bei et al., 2016), the present study includes these two types of regularity (i.e., regularity in sleep duration and timing).

In a similar fashion, Study II begins with a comparison of GM youths' sleep to that of non-GM ("cisgender") peers. Just one known study has reported such comparisons, finding that GM youth were half as likely to report sleeping 8–10 hours per night than non-GM youth, and twice as likely to report having poor-quality sleep using a single-item dichotomized rating of sleep quality (Levenson et al., 2021). Study II extends this literature by investigating GM sleep along dimensions of duration, quality, timing, and regularity examined objectively with actigraphs.

Following these initial examinations of SM and GM youth sleep, each study assesses resilience and risk in the context of minority stress. In Study I, minority stress was operationalized as past-year discrimination on the basis of sexual orientation, a common assessment of discrimination (Schmitt et al., 2014). Because discrimination was attributed to SM status, only SM youth were included in this portion of analyses. Multiple dimensions of sleep were tested as moderators of relations between discrimination and mental health. Previous studies support the hypothesis that under conditions of more-optimal sleep (e.g., longer, better-quality), the association between discrimination and mental health would be lessened (El-Sheikh, Zeringue, et al., 2022; Wang & Yip, 2020), consistent with Meyer's (2003, 2015) conceptualization of resilience in the context of minority stress, as well as a resilience framework

more broadly (Rutter, 1987). Conversely, as previously found (El-Sheikh et al., 2016; Yip, 2015), less-optimal sleep was expected to strengthen relations between discrimination and negative mental health outcomes by conferring multiplicative risk (Evans et al., 2013).

Study II's examination of resilience and risk took a different approach, testing physical activity as a factor promoting sleep equity for GM youth, as well as a risk factor widening sleep inequities. This approach assumed the presence of minority stress without modeling it directly; Meyer (2015) suggested that having an SGM status implies minority stress, even when it is not observed. Interaction models tested physical activity as a moderator of the association between GM status and each sleep parameter independently. It was expected that under conditions of higher physical activity, this relationship would be weakened, providing evidence that physical activity could mitigate sleep inequities for GM youth. A similar role for physical activity has already been established among racially minoritized youth (Gillis et al., 2021). Under conditions of less physical activity, it was expected that the association between GM status and sleep would be strengthened, suggesting that low physical activity may increase risk of sleep disturbances among GM youth.

In both studies, sleep was measured objectively using accelerometry from FitBit Charge HR devices. Prior to the ABCD Study, NIH commissioned a pilot study to ensure the validity of this instrument (Wing et al., 2017), finding it to be valid in measuring sleep parameters relative to both polysomnography and research-grade actigraphs, and in estimating physical activity relative to electrocardiograms and calorimeters (Bagot et al., 2018), thus bolstering the trustworthiness of a consumer-grade wearable for research. In ABCD, participants wore FitBit devices for up to 21 consecutive days, a length of time exceeding the more-common assessment

periods of seven to 14 days (Ancoli-Israel et al., 2015; Meltzer et al., 2012), thereby providing more-than-sufficient data about youth sleep in this sample.

The sleep field recommends that multiple facets be examined to obtain a comprehensive picture of sleep (Sadeh & El-Sheikh, 2015). Accordingly, four dimensions were considered across both studies: duration, quality, timing, and regularity. The first three (duration, quality, and timing) were indexed by means of various sleep parameters across nights of assessment. Duration was represented by *sleep minutes* (the number of minutes an individual is asleep between their nightly sleep onset and their morning wake [the full length of which can be referred to as the sleep period], exclusive of minutes in which they are awake). Quality was be represented by *sleep efficiency* (the percentage of the sleep period spent in sleep, calculated by dividing sleep minutes by the total number of minutes in the sleep period), *wake after sleep onset* (the number of minutes an individual is awake during the sleep period), and *sleep latency* (the number of minutes spent trying to fall asleep). Timing was indexed by a single variable, *sleep midpoint* (the clock time halfway between sleep onset and wake); this allowed us to see if an adolescent generally had an earlier or later sleep period. Regularity was reflected by examining relative consistency in sleep duration and timing across nights of assessment through *variability in sleep minutes* and *variability in sleep midpoint* across nights of data collection (each one calculated by intra-individual standard deviation divided by intra-individual mean for sleep minutes and midpoint across nights, respectively; Snedecor & Cochran, 1989). Each sleep variable was examined continuously in order to best reflect the full range of sleep in the population and to maximize variability (Aiken & West, 1991).

Like sleep, physical activity has various dimensions and was represented with multiple parameters, consistent with recommendations (Hills et al., 2014). Overall intensity of physical

activity was represented by average *metabolic equivalents of task per minute*, a common unit for comparing activity levels across individuals based on energy expenditure (Maher & Olds, 2011). Time spent in intense physical activity was represented by *average number of minutes of moderate-to-vigorous physical activity*, a level typically associated with physical activity that is done intentionally as compared to physical activity done in the course of daily activity (Hills et al., 2014). A third parameter, *average number of daily steps*, quantified physical movement without respect to intensity (Diaz et al., 2015), allowing us to see variability in physical activity even among youth with overall low intensity of activity including activity that takes place in the course of daily tasks.

Early adolescence is an ideal time to examine both sleep and physical activity, in part due to significant changes from childhood that occur in each (Crowley et al., 2018; Hyde et al., 2013). With puberty, the homeostatic pressure that initiates sleep builds up more slowly in the body, at the same time that the internal circadian rhythm becomes delayed, resulting in later bedtimes – and frequently, given the inflexibility of school schedules – a shorter window of time for sleep to occur (Crowley et al., 2018). Physical activity similarly declines from childhood to adolescence, as afterschool leisure time decreases and as physical activity largely constricts from recreational free play to scheduled sports involvement (Hyde et al., 2013). Yet the "punctuation" of leaving childhood and entering adolescence is importantly met with another change: increasing autonomy (Sameroff, 2010). Parents exert decreasingly less control over bedtime (Russo et al., 2007; Short et al., 2013), while adolescents gain increasing decision-making in time use during afterschool hours and on weekends (Hyde et al., 2013), the primary hours for physical activity outside of school-based physical education.

Early adolescents' newfound autonomy has vital implications for their development. It means that youth have *agency* over sleep and physical activity, and suggests that each may be *modifiable* (Hosker et al., 2019). Having agency over modifiable behaviors gives youth control over factors associated with their wellbeing and increases self-efficacy, a well-documented protective mechanism (Rutter, 1987). Participation in decision-making about activities affecting health is shown to be psychologically beneficial for youth (Rith-Najarian et al., 2016). Further, and very importantly, this may allow youth to counterbalance health inequities associated with SGM identities. At the same time, such findings would be tempered by structural constraints, such as lack of access to and safety in gender-affirmed locker rooms, which can work against SGM youth's participation in physical activity (Greenspan et al., 2019).

Health equity research has begun to shine light on biological factors and everyday behaviors that function as processes of resilience, including sleep and physical activity (El-Sheikh, Zeringue, et al., 2022; Gillis et al., 2021). The present studies extend such an evidence base to SGM youth, consistent with a strengths-based approach to the study of SGM health (Colpitts & Gahagan, 2016). Key aspects of this dissertation represent "firsts" in the literature. These studies are the first to examine SGM sleep through objective assessment, responding to a call in the literature for actigraphic assessment of SGM sleep (Millar et al., 2019) and building on previous descriptions of sleep duration and quality among SGM youth using self-reported data. The novelty of this work is further extended by investigating the timing or regularity of sleep in SGM youth relative to straight and cisgender peers. These two sleep dimensions that are gaining increasing attention as we learn more about their influence on youth development beyond sleep duration and quality (Becker et al., 2017; Matricciani et al., 2019), yet they have not been investigated previously among SGM youth, even by self-report. Finally, moderation

models probe sleep and physical activity as promotive factors specifically for SGM youth, with the aim of classifying them as behavioral levers that can be utilized to improve health equity. This goal – identifying promotive behaviors that reduce inequities between SGM and non-SGM youth – is the most important contribution that this dissertation hopes to make (National Academies of Sciences, Engineering, and Medicine, 2022).

Chapter 2: Introduction to Study I

Sleep, Discrimination, and Mental Health Among Sexual-Minority Youth

Sexual-minority (SM) youth – those who identify as lesbian, gay, or bisexual in sexual or romantic interests (Zaza et al., 2016) – are gaining increasing attention in the sleep literature (Butler et al., 2020; Millar et al., 2019; Patterson & Potter, 2019). While evidence suggests that SM individuals on average obtain shorter (Dai et al., 2020) and poorer-quality sleep (Li et al., 2017) compared to non-SM ("straight") peers, other important dimensions of pediatric sleep, such as sleep timing and regularity (Meltzer et al., 2021), remain to be investigated. The urgency to do so is based on the frequent minority stress and discrimination to which SM youth are exposed (Williams et al., 2021). Sleep holds tremendous promise to protect the wellbeing of SM youth, given the role of sleep in strengthening equity for marginalized youth generally (Hale et al., 2020), and given an expanding literature pointing to the promotive effects of sleep in the context of minority stress, including experiences of discrimination (Wang & Yip, 2020). This study sought to compare the sleep of SM youth to non-SM peers in early adolescence, focusing on four key sleep dimensions: duration, quality, timing, and regularity. Then, among SM youth, sleep was examined as a moderator of relations between discrimination and mental health.

Sleep Among Sexual-Minority Youth

Sleep is multifaceted (Meltzer et al., 2021). Its dimensions include average duration (length of sleep), quality (indexed by the portion of the night spent in sleep, as well as the length of time it takes to fall asleep), and timing (whether the sleep period falls earlier or later in the night), as well as regularity or variability in these facets across nights. For a comprehensive assessment of sleep, it is necessary to include multiple dimensions (Sadeh & El-Sheikh, 2015). Actigraphy – estimation of sleep and wake on the basis of movement as measured by a wrist-

worn device – allows us to capture multiple dimensions simultaneously and to do so in a non-invasive manner that examines sleep in the context of natural (i.e., home) environments (Sadeh, 2015). This ability – to study sleep in context – has opened up the literature to investigations of sleep among varying groups of people based on development and identity, such as comparing trends in sleep across ages (Boatswain-Jacques et al., 2023; Randler et al., 2019) and studying sleep among marginalized populations (El-Sheikh, Gillis, et al., 2022; Yip et al., 2020).

To that end, a small but growing literature is beginning to elucidate the nature of sleep among SM youth (Butler et al., 2020; Patterson & Potter, 2019). In general, patterns across studies suggest that SM youth have shorter sleep duration and poorer sleep quality relative to non-SM peers (Patterson & Potter, 2019). Dai et al. (2020) found that SM high school students in the U.S. were more likely than non-SM peers to report sleeping five or fewer hours per night on average on the 2015 Youth Risk Behavior Survey. From the same sample, Kann et al. (2016) reported that SM students were less likely than their non-SM peers to obtain eight or more hours of sleep on typical school nights. An analysis of data from the 2015 School-Based Chinese Adolescents Health Survey found that SM youth in grades 7–12 had significantly lower self-reported sleep quality than non-SM students (Huang et al., 2018). Among the same sample, SM youth reported taking longer to fall asleep (sleep latency), sleeping for fewer minutes, sleeping a shorter percentage of the night (sleep efficiency), having more sleep problems or disturbances, more frequently needing to take medication to induce sleep, and having more daytime sleepiness, all on average in comparison to non-SM peers (Li et al., 2017). Finally, data from the Eighth Korea Youth Risk Behavior Web-based Survey in 2012 found that significantly more bisexual boys (but not gay or lesbian youth) believed they did not sleep enough compared to non-SM peers at ages 12–18 (Seo et al., 2015). Among studies described here, a predominant pattern

emerged in which SM youth report shorter and poorer-quality sleep relative to non-SM adolescents across multiple sleep dimensions. However, several opportunities to advance this literature are apparent. First, the two existing studies of SM youth sleep in the U.S. have relied on the same sample and wave of national surveillance data (the 2015 Youth Risk Behavior Survey; Dai et al., 2020; Kann et al., 2016). Second, no publication has examined the sleep of SM youth using actigraphy as an objective measurement. Studies to date have asked individuals to report on their sleep duration and quality; while such reports are useful to identify trends at the population level, adolescents are known to significantly overestimate both sleep duration and quality compared to actigraphic measurement (Short et al., 2012), thus necessitating an actigraphic assessment of SM youth sleep.

Discrimination and Mental Health

Discrimination occurs when persons are viewed or treated negatively as the result of belonging to or being perceived to belong to a socially defined group (Krieger, 2014). Experiences of discrimination have a negative influence on mental health (Schmitt et al., 2014; Wilson & Cariola, 2020). Discrimination has relations with *internalizing symptoms* of depression and anxiety, both cross-sectionally and longitudinally, with pooled effect sizes in the moderate range (Greene et al., 2006; Schmitt et al., 2014). Such associations appear to be stronger for youth than adults (Schmitt et al., 2014). Youth who reported discrimination were three times more likely to have depressive symptoms compared to their peers who do not experience discrimination (Coker et al., 2009). Although less studied than internalizing symptoms, relations between discrimination and *externalizing behaviors* also have been examined in the literature. Among early adolescents – the same developmental stage investigated in the present study – youth who experienced discrimination were twice as likely than their peers to exhibit behaviors

indicative of oppositional-defiant and conduct disorders (Coker et al., 2009), and were more likely to exhibit subclinical delinquent behaviors and aggression (Bogart et al., 2013). Similar findings have been observed for middle and late adolescents, among whom negative peer experiences were associated with a composite of rule-breaking and aggressive behavior (Williams et al., 2005). Discrimination is further linked across time in adolescence to substance use (Fuller-Rowell et al., 2012). A majority of studies in this literature have been of general discrimination (i.e., being harassed, threatened, or treated less well than others) and racial/ethnic discrimination. Although limited research has examined discrimination on the basis of sexual identity, findings are consistent with general and racial/ethnic discrimination: for SM youth, discrimination has been linked with depressive symptoms (Almeida et al., 2009; Russell & Fish, 2016; Wilson & Cariola, 2020) and delinquency (Goldbach et al., 2014).

Several potential mechanisms may link discrimination with poorer mental health outcomes among youth. One predominant factor is rumination, a maladaptive response to stress characterized by sustained focus on negative thoughts (Hatzenbuehler & Pachankis, 2016; Wang & Yip, 2020). Experiences of discrimination are linked with same-day rumination (Hatzenbuehler et al., 2009; Wang & Yip, 2020), which in turn is linked over time with internalizing symptoms (Hatzenbuehler et al., 2008) and externalizing behaviors (du Pont et al., 2018). Another potential explanatory mechanism is vigilance; discrimination can increase vigilance, or alertness against potential threats, which predicts depressive symptoms over time (Hatzenbuehler & Pachankis, 2016). Emotion dysregulation is another pathway (Hatzenbuehler et al., 2008) – stress exposures can lead to lower emotion regulation, which in turn is related to aggressive behavior (Herts et al., 2012). This process may occur through impairment of the anterior cingulate cortex and prefrontal cortex (Berger & Sarnyai, 2015), as well as the

hypothalamic–pituitary–adrenal (HPA) axis (Berger & Sarnyai, 2015), which regulates the body's response to stress through the release of hormones (Hatzenbuehler & Pachankis, 2016). In adolescence, diminished HPA activity is associated with both internalizing symptoms and externalizing behaviors (Kuhlman et al., 2018).

Sleep as a Moderator of Relations Between Discrimination and Mental Health

Direct associations between multiple dimensions of sleep and mental health are well demonstrated among youth (Spruyt, 2019). Shorter sleep duration (Shochat et al., 2014), poorer sleep quality (Matricciani et al., 2019), later sleep timing (Barclay et al., 2011; Díaz-Morales, 2016; Jankowski, 2016), and sleep irregularity (Becker et al., 2017) are associated with depressive and anxious symptoms and behavior problems. Beyond main effects, sleep has been shown to moderate associations between stress and mental health among youth. Multiple dimensions of sleep have been demonstrated to moderate associations between experiences of discrimination and mental health in childhood and adolescence (El-Sheikh, Gillis, et al., 2022). In such studies to date, both general discrimination (that is, not related specifically to SM status) and racial/ethnic discrimination in the U.S. have been examined. While experiences of discrimination are heterogeneous between individuals and among marginalized groups, these investigations suggest that sleep may play a role in mitigating or exacerbating relations between discrimination and mental health for SM youth.

Among a sample of late adolescents, general discrimination was associated with depressive and anxious symptoms for girls with fewer average sleep minutes measured by actigraphs, while girls with longer sleep had no association between discrimination and internalizing symptoms, indicating a buffering effect for sleep duration in the context of discrimination (El-Sheikh, Zeringue, et al., 2022). For both girls and boys, more-frequent

discrimination was associated with depressive and anxious symptoms and rule-breaking behavior among youth with more variability in sleep minutes across a week of actigraphic measurement, while more consistent sleep weakened the association between discrimination and negative outcomes (El-Sheikh, Zeringue, et al., 2022). Among a different sample of adolescents, a similar pattern was observed: general discrimination was associated with externalizing behaviors, while the relationship was attenuated among youth with longer actigraphy-based sleep duration (El-Sheikh et al., 2016).

In studies examining racial/ethnic discrimination, sleep duration and quality were found to moderate associations between experiences of discrimination and internalizing symptoms (Wang & Yip, 2020; Yip, 2015). Specifically, in a daily-association study of actigraphy, adolescents who slept longer or had less nighttime waking following discrimination experiences showed greater use of active coping strategies like seeking social support and problem-solving the next day, which in turn predicted better mood and fewer somatic complaints (Wang & Yip, 2020). Across a three-year longitudinal study of a different sample, discrimination predicted growth in depressive symptoms for youth with lower self-reported sleep quality, yet, for adolescents with higher sleep quality, the rise in depressive symptoms leveled off after two years, and then began to decrease (Yip, 2015). These studies provide evidence that sleep could serve as a moderator of associations between discrimination and mental health among SM youth, consistent with a growing literature on risk and protective factors for SM health (Russell & Fish, 2016).

Sleep is known to influence mental health through the same mechanisms that discrimination is associated with mental health. Longer nighttime sleep duration has been shown to predict less rumination the following day in the context of discrimination (Wang & Yip,

2020), perhaps suggestive that long sleep could attenuate the association between discrimination and poorer mental health for SM youth, while shorter sleep might strengthen this relationship. Additionally, longer and better-quality sleep improves emotion regulation (Palmer & Alfano, 2017), which could disrupt the otherwise-observed association between stressors and maladjustment through the pathway of emotion dysregulation (Herts et al., 2012), while shorter sleep erodes emotion regulation among youth (Baum et al., 2014; Robinson et al., 2018). Furthermore, short or poor-quality sleep is associated with greater activation of the HPA axis in response to stress, while longer and better-quality sleep is related to more-optimal HPA functioning (Philbrook et al., 2021; van Dalfsen & Markus, 2018). Taken together, these pathways suggest that better sleep could lessen the effect of discrimination on mental health by providing youth with enhanced ability to regulate emotions and mitigate physiological stress.

Theoretical and Conceptual Frameworks

Minority stress theory (Brooks, 1981) posits that stressors on the basis of sexual identity negatively impact mental health through three processes: discrimination, vigilance to guard against discrimination, and an internalized negative view of oneself (Meyer, 2003). Discrimination is characterized as a distal factor in which an external force – an expressed negative viewpoint from another person or institution – detracts from the wellbeing of an SM individual (Meyer, 2003). Such experiences not only stigmatize individuals, undermining their sense of belonging, but also can contribute to negative self-evaluation (Meyer, 2003). Goldbach and Gibbs (2017) extended the applicability of minority stress theory to adolescents, finding that all aspects of the theory in its original form are relevant to the lives of youth. Further, adolescence is a salient developmental stage for examining the influence minority stress among SM youth as they are working through tasks of both general and sexual identity development

(Goldbach & Gibbs, 2017; Russell & Fish, 2019). Minority stress theory has been employed in the SM youth sleep literature to contextualize findings related to sleep inequities (Butler et al., 2020; Huang et al., 2018; Li et al., 2017; Patterson & Potter, 2019); that is, to suggest why, or through what mechanism, SM youth may have shorter or poorer-quality sleep relative to non-SM peers. In the current study, minority stress theory places SM youth within a potential context of risk, and further helps to frame our understanding of discrimination's influence on mental health.

Yet the effects of stressors are only part of minority stress theory – it also includes processes that mitigate stress (Goldbach & Gibbs, 2017; Meyer, 2003, 2015). A rich literature on resilience (Rutter, 1987; Rutter, 1993) helps us to understand the stress-reducing factors proposed by minority stress theory. Resilience is observed when a condition of risk is not associated with a negative outcome because of the presence of a promotive factor (Sameroff, 2010). Sleep is an important promotive factor for marginalized youth (El-Sheikh, Gillis, et al., 2022), and it is proposed as a mechanism to strengthen equity among groups (Hale et al., 2020). For SM youth in particular, the identification of resilient contexts is a necessary addition to a literature that has its roots in the investigations of deficits (Colpitts & Gahagan, 2016; Meyer, 2015). In our study, this might be seen for an individual who reports an experience of discrimination but still has high-quality sleep; if such an individual also has fewer symptoms of mental health problems, then we would posit that resilience has occurred.

Yet not all youth who experience discrimination are able to maintain high-quality sleep; some may have poorer-quality sleep. Such a condition – under which discrimination interacts with suboptimal sleep – can be understood within multiplicative risk and diathesis–stress frameworks. Multiplicative risk (sometimes also called cumulative risk) occurs when one risk factor interacts with another to increase the likelihood of a negative outcome (Evans et al., 2013).

Multiplicative risk models are frequently employed in investigations of youth development and mental health (Sameroff, 2000) and have been used to understand moderation effects of sleep in the context of risk, including discrimination (El-Sheikh, Zeringue, et al., 2022). Similarly, diathesis–stress (Sameroff, 1983) occurs when risk from an existing condition is amplified by a second risk factor. In this study, the interactive effect of discrimination *and* poor-quality sleep would be expected to have a greater influence on mental health than discrimination or poor-quality sleep on their own.

The Present Study

The present study had three aims. The first was to compare the sleep of SM and non-SM adolescents using a large, national dataset that has not previously been used to examine the sleep of SM youth. In accordance with recommendations in the pediatric sleep literature (Meltzer et al., 2021; Sadeh & El-Sheikh, 2015), a broad assessment of sleep was undertaken to encompass sleep duration, quality, timing, and regularity. Duration was represented by *sleep minutes*. Quality was indicated by *sleep efficiency*, *wake after sleep onset*, and *sleep latency*. Timing was measured through *sleep midpoint*, which reflects whether the sleep period falls earlier or later in the night. Regularity – the consistency of sleep duration and timing across nights – was represented by *variability in sleep minutes* and *variability in sleep midpoint*. Based on existing literature, it was expected that SM youth would have shorter sleep duration, lower sleep efficiency, more wake after sleep onset, and longer latency relative to non-SM youth (Li et al., 2017; Patterson & Potter, 2019). While the present study was the first to assess sleep timing and regularity in SM youth, SM youth were expected to have later sleep timing and more variability in sleep duration and timing, consistent with a literature showing the same pattern for ethnically and racially minoritized youth (Guglielmo et al., 2018). Such a finding also would be consistent

with observations of shorter sleep duration and poorer sleep quality among SM youth (Li et al., 2017; Patterson & Potter, 2019).

The remaining two aims of the present study were addressed with a subsample comprised of SM youth from the same large, national dataset. A subsample of SM youth was used because the discrimination measure was specific to SM status and because a growing literature recognizes the importance of investigating within-group differences of developmental outcomes in order to better understand processes of resilience and risk (El-Sheikh, Gillis, et al., 2022). The second aim examined the direct associations between discrimination on the basis of SM status and multiple dimensions of youth mental health – internalizing symptoms and externalizing behaviors. Consistent with minority stress theory (Frost & Meyer, 2023; Meyer, 2003) and existing literature (Russell & Fish, 2016; Wilson & Cariola, 2020), it was anticipated that discrimination would be associated with both internalizing symptoms and externalizing behaviors among SM youth. The third aim examined sleep as a moderator of these associations. It was expected that more-optimal sleep would lower risk for negative mental health outcomes among SM youth who experienced discrimination, in line with a resilience framework (Rutter, 1987). Conversely, less-optimal sleep may represent higher risk in accordance with multiplicative risk (Evans et al., 2013) and diathesis–stress (Sameroff, 1983) frameworks. Such patterns of protection and vulnerability are not mutually exclusive (Luthar et al., 2000) and have been observed in other investigations of interactions between stressors and mental health (El-Sheikh, Zeringue, et al., 2022; Tu et al., 2015; Yip, 2015).

The study makes a novel contribution to the literature in several ways. First, it builds on previous investigations of SM adolescent sleep by analyzing actigraphy of SM youth, which has yet to be done (Millar et al., 2019). Second, analyses provide information on several sleep

parameters that have not been examined among SM youth, even by self-report: sleep timing and regularity. Third, such novel sleep parameters are examined as potential promotive and risk factors for SM youth mental health in the context of discrimination, a research question that has not been addressed in the literature. Importantly, the results of such analyses could elucidate conditions under which SM youth are protected from negative developmental outcomes, which might be utilized in future intervention programs (Blake et al., 2017), in clinical work (Novak & Gillis, 2022), and in other service settings where SM youth are helped (Martos et al., 2017).

Chapter 3: Method of Study I

Participants

A total of 11,875 youth living near 21 data-collection sites around the United States were recruited into the ABCD Study at ages 9–10 for wide-ranging baseline assessments of biopsychosocial functioning and development beginning in 2016 (Garavan et al., 2018; Karcher & Barch, 2021). Participants were primarily recruited through public and private elementary schools using probability sampling to approximate the demographic composition of all U.S. 9- and 10-year-olds with regard to sex, race, ethnicity, family income, and household composition (Garavan et al., 2018; Thompson et al., 2019). All families had to have at least one parent who was fluent in English or Spanish. Youth were excluded from participation if they had severe sensory, developmental, or physical health impairments or were unable to undergo magnetic resonance imaging, a key source of data for the larger study (Thompson et al., 2019).

Data for the present study were collected at a single timepoint between September 2018 and January 2020, two years after baseline, when youth were ages 10–13. At this timepoint, 4,369 participants contributed data on their sleep using FitBit devices. Participants were retained in analyses if they contributed at least five nights of data in the same week (Meltzer et al., 2022; see more below under Measures), resulting in an analytic sample of $N = 2{,}979$ youth (M age = 11.96 years, $SD = 7.80$ months; 51.19% were assigned male sex at birth, and 48.81% assigned female sex at birth). The mode of parent-reported pubertal status was mid-puberty (40.39%); other youth were in pre-puberty (14.36%), early puberty (27.67%), late puberty (17.27%), or post-puberty (0.31%). Parents reported that 61.29% of youth were non-Hispanic White, 16.07% were multiracial or multiethnic, 12.23% were Hispanic, Latino, or Latina, 7.08% were non-Hispanic Black, 2.66% were of Asian descendent, and 0.20% were American Indian or Alaska

Native; a smaller remainder of participants did not specify a racial identity. On the basis of income-to-needs ratio (described under Measures), 20.97% of youth were from families living at or near the poverty line, 14.06% were lower middle class, and 64.96% were middle class and above.

A subsample of youth were identified as sexual minorities (*n* = 211; see below under Measures). SM youth had a mean age of 11.99 years (*SD* = 7.34 months) and a mode pubertal status of mid-puberty; 83.89% were assigned female sex at birth, and 16.11% were assigned male sex at birth. SM participants were 59.52% non-Hispanic White, 23.81% multiracial or multiethnic, 11.90% Hispanic, Latino, or Latina, 3.33% non-Hispanic Black, 0.95% Asian, and 0.49% another race. The families of SM youth were primarily middle class and above (68.00%); 19.50% lived in or near poverty, and 12.50% were lower middle class.

Procedures

Procedures for the ABCD Study were approved by the institutional review board of University of California, San Diego. Secondary data analysis was deemed exempt by the Auburn University institutional review board. Auburn University signed a Data Use Certification to obtain access to the National Institute of Mental Health Data Archive. Only procedures related to this dissertation study are described here. Parents provided consent, and youth assented to participation. During a laboratory visit at one of 21 data-collection sites, parents and youth completed questionnaires using iPads with guidance as necessary from trained research assistants (Blashill & Calzo, 2019; Karcher & Barch, 2021). Parents provided information about youth demographics and mental health, while youth provided information about their SM status and experiences of discrimination. Youth wore FitBit devices at home for up to three weeks (*M* = 12.46 nights, *SD* = 5.78 nights) to measure sleep (Nelson et al., 2022).

Measures

SM Status

Youth were coded as sexual minorities if they answered *Yes* or *Maybe* to the question "Are you gay or bisexual?" in accordance with prior studies (Blashill & Calzo, 2019). SM status was coded as: 1 = *SM*, 0 = *Non-SM*.

Sleep

Objective indicators of sleep duration, quality, timing, and regularity were measured by FitBit Charge HR devices and extracted using Fitabase (Small Steps Labs, San Diego, CA). FitBit uses accelerometry to estimate periods of wake and sleep in 30-second intervals. Sleep duration was measured by average nightly *sleep minutes* (the number of minutes that a participant is determined to be asleep between sleep onset and wake). Sleep quality was indicated by three parameters: *sleep efficiency* (*sleep minutes* divided by the number of minutes between sleep onset and wake, multiplied by 100), *wake after sleep onset* (WASO; the average number of minutes determined to be awake between sleep onset and wake), and *sleep latency* (the number of minutes from the time a participant was determined to be in bed and sleep onset). Sleep timing was indicated by the average *midpoint* between sleep onset and wake. Sleep regularity was indexed by *variability in sleep minutes* and *variability in sleep midpoint* (calculated as intra-individual *SD*/*M* of the respective sleep parameter, with higher numbers indicating more variability [Snedecor & Cochran, 1989]). Sleep minutes and WASO were provided directly from Fitabase, along with timing variables (first minute a participant was determined to be in bed, sleep onset, and wake) that were used to calculate other variables. Sleep efficiency and latency were calculated in a manner consistent with a study that validated the use of FitBit Charge HR devices in comparison to polysomnography (de Zambotti et al., 2015),

along with recommendations in the field (Fekedulegn et al., 2020). Sleep midpoint (Randler et al., 2019) and variability (Kelly et al., 2022) were calculated in a manner consistent with others in the field. Participants' sleep data were included if they had at least five nights of actigraphic measurement, in accordance with best practices in the field (Meltzer et al., 2012).

Discrimination

Youth responded to the question, "In the past 12 months, have you felt discriminated against because someone thought you were gay, lesbian, or bisexual?" (1 = *Yes*, 0 = *No*). Single-item measures of discrimination are established in the literature as accurate representations of such experiences (Almeida et al., 2009) and are a common method of assessment in the field (Schmitt et al., 2014).

Mental Health

Parents reported on the mental health of SM youth over the previous six months using the well-established and widely adopted Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001), which surveys a diverse range of symptoms and behaviors that youth may experience. The CBCL is validated in community samples to detect sub-clinical levels of adjustment problems (Bilenberg, 1999; Döpfner et al., 1994), but also has clinical and borderline-clinical thresholds that may indicate serious instances of mental illness (Achenbach & Rescorla, 2001). The measure had strong test-retest reliability (indicated by Pearson's r) and internal consistency (indicated by Cronbach's alpha) in a norming sample of school-age children (Achenbach & Rescorla, 2001). Three syndrome scales were used in the present study to cover both internalizing symptoms and externalizing behaviors: *anxious/depressive symptoms*, *aggressive behavior*, and *rule-breaking behavior*. The anxious/depressive scale was comprised of 13 items ($\alpha = 0.90$), such as "Feels worthless or inferior" and "Fears going to school." The aggressive

behavior scale had 17 items (α = 0.94), including “Destroys things belonging to his/her family members or others” and “Threatens people.” The rule-breaking behavior scale had 15 items (α = 0.92), including “Breaks rules at home, school, or elsewhere” and “Lying or cheating.” See the Appendix for a full list of items. For each item, parents respond with 0 if the symptom was *Not True* for their child, 1 if it was *Somewhat or Sometimes True*, and 2 if it was *Very True or Often True*. Responses were summed for each scale and converted to *T* scores, which are normed for age and sex assigned at birth (Achenbach & Rescorla, 2001). Small percentages of SM youth exceeded cutoffs for clinical or borderline-clinical ($T \geq 65$) levels of anxious/depressive symtpoms (11.85%), aggressive behavior (5.21%), and rule-breaking behavior (4.27%).

Controls

At the time of in-person data collection, one parent reported each youth’s sex assigned at birth (*female* or *male*), pubertal status, race, household income, and size of household. Pubertal status was reported through secondary sex characteristics on the widely used Pubertal Developmental Scale (Petersen et al., 1988). Household income and size were used to compute family income-to-needs ratio, a commonly used measure of socioeconomic status (SES; Diemer et al., 2013), calculated by dividing family income by the federal poverty threshold for their household size (U.S. Department of Commerce, 2019). During in-person data collection, staff measured each participant’s waist circumference in inches using measuring tape, which is a valid estimate of approximate body adiposity in youth (Bixler et al., 2009). Sleep is known to vary systemically by sex assigned at birth, puberty, race, SES, and adiposity (Bixler et al., 2009; El-Sheikh, Gillis, et al., 2022; Guglielmo et al., 2018; Lucien et al., 2021; Storfer-Isser et al., 2012); therefore, demographic and health variables were covaried in analyses. In tests of mean differences in sleep between SM and non-SM youth, anxious/depressive symptoms was utilized

as an additional control because anxious/depressive symptoms are associated with each sleep parameter under consideration in adolescence (Kelly et al., 2022); this is a common covariate in studies of SM sleep (Butler et al., 2020).

Plan of Analysis

Standard data preparation procedures were completed in SPSS 29 (International Business Machines Corporation, Armonk, NY) to examine central tendency and distribution in each main study variable. Extreme outliers, identified by Mahalanobis distance, were trimmed to the next-highest observed value to improve normality in continuous independent variables (i.e., sleep; Kline, 2011). A total of 86 observations were trimmed (6 for sleep minutes, 2 for sleep efficiency, 3 for WASO, 17 for sleep latency, 11 for sleep midpoint, 13 for variability in sleep minutes, and 34 for variability in sleep midpoint); trimmed observations accounted for 0.41% of sleep data. Toward the investigation of aim 1, a first set of analyses examined mean differences in sleep parameters between SM and non-SM youth using multivariate analysis of covariance (MANCOVA). Three models were examined: an unadjusted baseline model with no covariates; a model adjusted for sex assigned at birth, pubertal status, race, family income, and waist circumference; and a model adjusted for these same covariates plus anxious/depressive symptoms.

For aim 2, moderation analyses were performed in mPlus 8.1 (Muthén & Muthén, Los Angeles, CA) utilizing a subsample comprised of all SM youth with sleep data (n = 211). Path analyses tested relations of discrimination, sleep, and the interaction of Discrimination x Sleep with mental health, in independent models for each sleep parameter and each mental health outcome. Each model controlled for sex assigned at birth, pubertal status, race, family income, and waist circumference. Several additional steps were taken to aid interpretation of findings.

For significant interaction effects, the association between discrimination and mental health was plotted at prototypical conditional values of sleep, ± 1 *SD* from the mean. The Model Constraint command was used to test whether simple slopes differed significantly from 0, to test whether predicted means at conditional values differed significantly from the sample mean (i.e., grandmean) of each outcome, and to identify regions of significance. Predicted means were compared to one another and to sample mean in units of *SDs*. R^2s were calculated to determine sizes of significant effects (Sullivan & Feinn, 2012).

Chapter 4: Results of Study I

Preliminary Analyses

Across SM and non-SM groups, youth obtained 7 hours and 31 minutes of sleep per night average (Table 1.1). Across parameters, sleep varied by sociodemographic characteristics. In the full sample, individuals assigned female at birth had longer and more-efficient sleep, awoke fewer minutes of the night, had later sleep midpoint, and had more variability in sleep minutes and midpoint compared to youth assigned male at birth (Table 1.2). Sleep also varied by ethnicity and race (Tables 1.3–1.4). On average, non-Hispanic Asian youth had lower sleep efficiency than youth from all other ethnicities and races, as well as higher WASO than Hispanic, Black, and multiethnic/multiracial youth. Asian and non-Hispanic White youth had higher WASO and earlier sleep midpoint than Hispanic youth and less variability in sleep minutes than multiracial/multiethnic youth. Non-Hispanic Black youth had fewer sleep minutes, higher sleep efficiency, less WASO, and more variability in sleep minutes than all other youth, as well as later sleep midpoint than Asian, White, and multiethnic/multiracial youth and more variability in sleep midpoint than Hispanic, Asian, and White youth. No ethnic/racial differences were observed in sleep latency.

More advanced pubertal status was associated with fewer sleep minutes, higher sleep efficiency, less WASO, longer sleep latency, later sleep midpoint, and more variability in sleep minutes and midpoint (Table 1.5). Youth from families with lower income had fewer sleep minutes, higher efficiency, less WASO, later sleep midpoint, and more variability in sleep minutes and midpoint.

Among SM youth, anxious/depressive symptoms and rule-breaking behavior did not vary by sex assigned at birth, but individuals assigned male at birth had more aggressive behavior

than those assigned female at birth (Table 1.2). Mental health did not vary by pubertal status, family income, or waist circumference (Table 1.5). In general sleep was not associated with mental health, but more variability in sleep midpoint was moderately correlated with more aggressive and rule-breaking behavior. SM youth who experienced discrimination in the past 12 months had greater variability in sleep minutes and midpoint than SM youth who did not experience discrimination (Table 1.6); other sleep variables and mental health indices did not vary by discrimination.

Mean Comparisons of SM and Non-SM Youth Sleep

On average, SM youth slept 8.33 fewer minutes per night, had 0.32% more efficient sleep, woke 2.69 fewer minutes per night, had a sleep midpoint 22 minutes later, and had greater variability in sleep minutes and midpoint (0.02 and 0.01, respectively) compared to non-SM youth (Table 1.7). All such differences were consistent across unadjusted models and models adjusted for sex assigned at birth, pubertal status, race, family income, waist circumference, as well as models that were additionally adjusted for anxious/depressive symptoms. Sleep latency did not differ between SM and non-SM youth in either model.

Relations Between Discrimination and Mental Health Among SM Youth

Across models controlling for sex assigned at birth, pubertal status, race, family income and waist circumference, discrimination was not independently associated with anxious/depressive symptoms, aggressive behavior, or rule-breaking behavior (Tables 1.8–1.14).

Sleep as a Moderator of Relations Between Discrimination and Mental Health Among SM Youth

Sleep Minutes

Among SM youth, sleep minutes was not associated with anxious/depressive symptoms, aggressive behavior, and rule-breaking behavior (Table 1.8). Further, sleep minutes did not moderate the association between anxious/depressive symptoms or rule-breaking behavior. However, the relationship between discrimination and aggressive behavior was moderated by sleep minutes. For SM youth with shorter sleep, equivalent to 6 hours and 42 minutes on average per night, discrimination was unrelated to aggressive behavior (Figure 1.1). Among SM youth with longer sleep, equivalent to 8 hours and 4 minutes, a positive association between discrimination and aggressive behavior was observed. Among youth who experienced discrimination, longer-sleeping youth displayed 0.54 *SD* more aggressive behavior than shorter-sleeping SM youth, a level that was 0.32-*SD* higher than the sample mean for all youth, $\Delta\chi^2$ (1) = 22.50, $p < .001$, while shorter-sleeping youth had aggressive behavior below the sample mean, $\Delta\chi^2$ (1) = 11.73, $p < .001$, a 0.22-*SD* difference. Analysis of regions of significance showed that the relationship between discrimination and aggressive behavior was non-significant below 7.91 hours per night; 79.62% of SM youth ($n = 168$) fell in this range. The interaction of Discrimination x Sleep Minutes accounted for 3.30% of the variance in aggressive behavior.

Sleep Efficiency

Sleep efficiency was not associated with anxious/depressive symptoms, aggressive behavior, or rule-breaking behavior (Table 1.9). Sleep efficiency was not a moderator of relations between anxious/depressive symptoms or aggressive behavior. Sleep efficiency was observed to moderate the association between discrimination and rule-breaking behavior. Among

SM youth with lower sleep efficiency, equivalent to 87.24%, a positive slope was observed, while the relationship between discrimination and rule-breaking behavior was non-significant for SM youth with higher sleep efficiency, equivalent to 90.70%. For youth who experienced discrimination, those with less-efficient sleep exhibited 0.55-*SD* more rule-breaking behavior than youth with more-efficient sleep and 0.41-*SD* more than the sample mean of all SM youth, $\Delta\chi^2$ (1) = 34.53, $p < .001$ (Figure 1.2). SM youth who experienced discrimination and had higher sleep efficiency showed rule-breaking scores below the sample mean, $\Delta\chi^2$ (1) = 10.38, $p < .01$, a 0.40-*SD* difference. The relationship between discrimination and rule-breaking behavior was non-significant for SM youth with sleep efficiency of 88.04% or above; 72.51% (n = 153) of SM youth were in this region. The interaction of Discrimination x Sleep Efficiency explained 2.90% of the variance in rule-breaking behavior.

WASO

Direct relations between WASO and mental health were not observed (Table 1.10). However, WASO emerged as a moderator of relations between discrimination and both indicators of externalizing behavior, aggression and rule breaking. The relationship between discrimination and aggressive behavior was positive for SM youth with more minutes of WASO (66.90 minutes) but was not significantly different from zero for SM youth with less WASO (43.78 minutes; Figure 1.3). Among youth who experienced discrimination, those with a higher level of wake minutes had a predicted mean of aggressive behavior that was 0.63 *SD* greater than youth with fewer wake minutes and 0.36 *SD* above the sample mean for all SM youth, $\Delta\chi^2$ (1) = 28.31, $p < .001$. Aggressive behavior for SM youth who experienced discrimination *and* had less WASO was 0.27 *SD* below the sample mean, $\Delta\chi^2$ (1) = 16.72, $p < .001$. For SM youth, the association between discrimination and aggressive behavior was non-significant at 65.61 minutes

per night or less; 81.04% of the SM youth sample (n = 171) were in this region. The interaction of Discrimination x WASO accounted for 2.70% of the variance in aggressive behavior.

As with aggressive behavior, a positive association between discrimination and rule-breaking was observed only under the condition of more WASO (Figure 1.4). For SM youth who faced discrimination, rule-breaking behavior for those with more WASO was 0.82 *SD* more than their peers with less WASO and 0.50 *SD* above the sample mean, $\Delta\chi^2$ (1) = 51.99, $p < .001$. SM youth who reported discrimination but had less WASO exhibited rule-breaking behavior 0.32 *SD* below the sample mean, $\Delta\chi^2$ (1) = 21.56, $p < .001$, a 0.31-*SD* difference. The relationship between discrimination and rule-breaking behavior was non-significant for SM youth who woke for 59.64 minutes or less; 66.35% of the sample (n = 140) fell in this region. The interaction of Discrimination x WASO explained 4.60% of the variance in rule-breaking behavior.

Sleep Latency

Sleep latency was not associated with anxious/depressive symptoms, aggressive behavior, or rule-breaking behavior (Table 1.11). Further, sleep latency did not moderate associations between discrimination and mental health.

Sleep Midpoint

Sleep midpoint was not independently associated with mental health and did not function as a moderator of relations between discrimination and mental health (Table 1.12).

Variability in Sleep Minutes

No relationship between observed between variability in sleep minutes and anxious/depressive symptoms, aggressive behavior, and rule-breaking behavior, neither did variability in sleep minutes moderate such relations (Table 1.13).

Variability in Sleep Midpoint

Greater variability in sleep midpoint was associated with higher aggressive behavior and more rule-breaking behavior (Table 1.14), accounting for 2.80% and 2.60% of the variance in aggressive behavior and rule-breaking behavior, respectively. Variability in sleep midpoint not related to anxious/depressive symptoms. Associations between discrimination and mental health were not moderated by variability in sleep midpoint.

Chapter 5: Discussion of Study I

A growing literature of self-report data has established that SM youth have shorter and poorer-quality sleep compared to non-SM youth (Butler et al., 2020; Dai et al., 2020; Kann et al., 2016). This study extends that literature by testing such differences using actigraphy. Because sleep has a vital role in maintaining all aspects of health and well-being (Matricciani et al., 2019), it is important that we understand its nature especially in contexts where sleep may be threatened. Such is the case for the sleep of SM youth, which exists in the context of their developmental stage and marginalized identities. Regarding the former, adolescence is a period of tremendous change in sleep, as circadian timing becomes delayed while time constraints remain ever-present, such as school responsibilities and the temptation (or pressure) of social-media use into late evening hours (Crowley et al., 2018). Short sleep during the week is often sought to be made-up for on weekends, causing even more irregularity in sleep duration and timing (Boatswain-Jacques et al., 2023). The result of this so-called “perfect storm” is that adolescence is the developmental stage when individuals are most likely to have unmet sleep needs (Crowley et al., 2018). SM youth may experience an “even more perfect” storm, as experiences of marginalization are associated with sub-optimal sleep (Fuller-Rowell et al., 2023; Guglielmo et al., 2018).

As hypothesized, in comparison to their non-SM counterparts, SM youth had shorter sleep duration, later sleep timing, and less regularity in duration and timing. The finding of shorter sleep duration corroborates with actigraphy what has previously been found with self-report data in surveillance surveys (Butler et al., 2020). Because self-report sleep data from youth can be biased (Short et al., 2012), it is important to obtain verification using objective measurement when possible. Actigraphy further allows us to quantify exactly how much shorter

the sleep of SM youth is on average – in this sample, 8 fewer minutes per night. While such a difference for a single night may have few consequences, the cumulative risk of brief sleep loss over time is substantial and accounts for individual differences in mental health and cognitive abilities among youth (Gruber et al., 2012; Sadeh et al., 2003).

Our observation that SM youth have later sleep timing and less regularity in duration and timing is novel and of concern given the role of sleep schedule and consistency in youth development. Sleep is just one of the body's numerous functions that are patterned along a 24-hour rhythm (Haspel et al., 2020). While most of these, such as cortisol, blood pressure, and body temperature, are autonomically modulated to rise and fall at predictable times throughout the day, sleep is the one circadian process that we can intentionally interrupt by changing our sleep-wake behaviors to stay awake later on some days and waking earlier on others. Shifting sleep to a later schedule, and varying times of sleep and wake from day to day, impairs other circadian processes that are patterned by sleep and wake cycles (Haspel et al., 2020). Unsurprisingly, later sleep timing and irregularity in duration and timing are associated with poorer academic performance, depressive and anxious symptoms, aggressive and delinquent behaviors, obesity, diminished immune functioning, and hypertension, even in adolescence (Becker et al., 2017; Fuligni et al., 2018; Matricciani et al., 2019; Morales-Ghinaglia & Fernandez-Mendoza, 2023; Shochat et al., 2014). Given that adolescence is already a time of later and less-regular sleep (Crowley et al., 2018), it is all the more serious that SM youth have even later and more irregular sleep than other youth. Across dimensions, findings of less-optimal sleep for SM youth are consistent with minority stress theory (Goldbach & Gibbs, 2017) in that a developmental outcome is systematically different for members of a marginalized group.

Contrary to hypotheses, SM youth had fewer wake minutes during the night, as well as very slightly higher sleep efficiency in unadjusted models that did not control for sociodemographic factors. This finding may be understood by the fact that sleep duration and WASO sometimes vary as functions of one another. For example, an individual who sleeps for four hours has fewer wake minutes during the night than an individual who sleeps for eight hours, but this does not mean that the person who slept for four hours had "better" sleep (Carskadon et al., 2001). Thus, SM youth in our sample could have fewer minutes of WASO because their sleep duration is shorter. However, it also is the case that sleep minutes and WASO do not have to covary; a longer-sleeping individual with high WASO could sleep for a shorter percentage of the night than a shorter-sleeping individual with less WASO, and this is why the field recognizes sleep efficiency as an important indicator of sleep quality (Ancoli-Israel et al., 2015). While SM youth have shorter sleep duration, they seem to wake less during night, thus giving them a slight advantage when it comes to sleep quality. This is the first study to document higher-quality sleep for SM individuals (Patterson & Potter, 2019). While SM youth may perceive themselves to have more sleep problems in subjective reports (Huang et al., 2018; Li et al., 2017), their actigraphy does not reflect this.

It is fitting, then, that in models examining relations of discrimination, sleep, and mental health among SM youth, a consistent pattern emerged for sleep quality as a moderator for relations between discrimination and externalizing behaviors. Consistent with hypotheses, under conditions of better-quality sleep (represented by higher efficiency or fewer wake minutes during the sleep period), there was no relationship between discrimination and externalizing behaviors, demonstrating a protective effect. A similar pattern has been observed among ethnically and racially minoritized youth (El-Sheikh, Zeringue, et al., 2022), and is characterized as a

protective-stabilizing pattern of resilience (Luthar et al., 2000) because aggressive and rule-breaking behaviors were consistent across both high (discrimination) and low (no discrimination) levels of risk for youth with high-quality sleep. This pattern is consistent with the concept of resilience under the context of minority stress (Meyer, 2015). High-quality sleep may function as a stress-ameliorating process that counterbalances the stress of discrimination.

Another pattern was observed across the same models: SM youth who experienced discrimination *and* had poor-quality sleep were at elevated risk for externalizing behaviors. This finding of dual risk also was consistent with both hypotheses and prior literature examining interactions of discrimination and sleep quality among ethnically and racially minoritized youth (El-Sheikh, Zeringue, et al., 2022). This pattern can be described as vulnerable-reactive (Luthar et al., 2000) because increased risk for externalizing behavior was conferred only under the condition of both discrimination and poor sleep quality. This pattern is consistent with the multiplicative risk framework, a model that guided the design and hypotheses of this study. Multiplicative risk suggests that several risk factors can function in tandem to jeopardize youth development by taxing physiological and psychological systems (Evans et al., 2013).

At the physiological level, discrimination represents a stressor (Grasser & Jovanovic, 2022). When the body experiences stress, multiple systems work together to mount a response through a process called allostasis that helps the body to cope with the stressor and then return to its normal state, homeostasis (McEwen, 1998). Two such systems are the autonomic nervous system, which controls cardiovascular and respiratory activity, and the HPA, which regulates hormones like cortisol. Repeated or prolonged (i.e., chronic) activation of these systems diminishes their effectiveness and efficiency over time, such that they may underperform when needed or may fail to turn off after a stressor is removed (McEwen, 1998). This condition of

“wear and tear,” referred to as allostatic load, is an essential link between stress and wellbeing (Gunnar & Quevedo, 2007; McEwen, 1998), including children’s mental health (El-Sheikh & Hinnant, 2011). Allostatic load is linked with difficulties in emotion regulation, which can cause youth to act out behaviorally (Dich et al., 2017). While tentative because it was not measured in this study, poor sleep may exacerbate the association between discrimination and externalizing behavior by contributing to allostatic load. Like discrimination, insufficient sleep impairs the functioning of neural connectivity in the body’s stress-response system (Robinson et al., 2018), undermining its ability to efficiently activate and deactivate when confronted with threats like discrimination (Grasser & Jovanovic, 2022). Such impairment, in turn, links sleep with poorer emotion regulation (Palmer & Alfano, 2017). SM youth who face discrimination *and* have poor sleep thus experience a double hit to their regulatory abilities.

Though also speculative, interactions between discrimination and sleep can further be interpreted in light of cross-domain effects (Evans et al., 2013). Discrimination primarily occurs outside of the home (though not exclusively), while sleep occurs inside the home. Thus, an SM adolescent could experience discrimination during a school day or at an afterschool activity, but then come home to an environment that allows them to sufficiently regulate, including through sleep, such that they are able to recover from the stress caused by discrimination (Wang & Yip, 2020). This represents the protective function of high-quality sleep. Conversely, an adolescent could experience discrimination at school and then come home to an environment that does not allow their bioregulatory system to return to homeostasis, which could be reflected in or worsened by poor sleep, thereby contributing to allostatic load and maladjustment.

Several additional study findings ran contrary to hypotheses. Sleep duration moderated the relationship between discrimination and externalizing behaviors in an unexpected pattern:

discrimination was associated with problem behaviors only in the context of longer sleep, while shorter sleep was protective against externalizing behaviors in the context of discrimination. This finding could align with the proposed idea that shorter, higher-quality sleep is adaptive for SM youth (as shorter sleep comes with fewer wake minutes), while longer sleep could come with more wake minutes, which was a risk factor for SM youth facing discrimination in this study. Next, only sleep duration and quality, but not timing or regularity, moderated the association between discrimination and externalizing behaviors. One partial explanation may be the fact that SM youth on average had later and more-irregular sleep compared to non-SM youth; therefore, protection from these sleep dimensions may not have been available to SM youth (though a pattern of risk still would have been expected). While the literature did not support differential hypotheses for each sleep parameter, other studies of interactions between discrimination and sleep have found similar discrepancies across sleep dimensions. For example, sleep regularity, but not duration or quality, moderated the association between discrimination and rule-breaking behavior in a study of adolescents (El-Sheikh, Zeringue, et al., 2022). Likewise, sleep quality but not duration moderated the link between discrimination and support-seeking behaviors (Wang & Yip, 2020). Such differential findings are not surprising given that the various sleep parameters examined are related yet discrete constructs (Meltzer et al., 2021); therefore, we do not always see consistent effects across them, especially in moderation analyses.

Additionally, contrary to expectations, sleep was not found to moderate associations between discrimination and internalizing symptoms. This finding is inconsistent with previous literature, where sleep had a moderating role for depression (El-Sheikh et al., 2016; Yip, 2015) and anxiety (El-Sheikh et al., 2016; El-Sheikh, Zeringue, et al., 2022) in the context of discrimination. It may be the case that for SM youth, relations between discrimination and

internalizing symptoms are moderated by external factors, such as peer and family support (Russell & Fish, 2016), that counterbalance discrimination in explicit ways, such as through verbal messages of support. Additionally, previous literature on the conjoint influence of discrimination and sleep on internalizing symptoms examined depression and anxiety independently of one another (El-Sheikh et al., 2016; El-Sheikh, Zeringue, et al., 2022). Our internalizing measure did not separate out these two dimensions, potentially leading to the differential findings. Sample characteristics including SM status and our measurement of discrimination based on SM status, rather than racial/ethnic or general discrimination, could further account for inconsistencies between our findings and previous literature.

Finally, several anticipated main effects also were not observed in the study: discrimination and most sleep parameters were not directly associated with internalizing symptoms and externalizing behaviors among SM youth. Regarding discrimination and mental health, while such main effects have been well-established in the literature (Almeida et al., 2009; Russell & Fish, 2016; Wilson & Cariola, 2020), several risk and protective factors have been found to moderate this association, including family (Freitas et al., 2016) and peer (Matijczak et al., 2021) support and religious participation (Thamrin et al., 2021). Thus, it could be that direct associations between discrimination and mental health among SM youth were not observed in this study because those relationships were moderated by other unmeasured factors. The same is true for associations between sleep and mental health. While an ample literature shows that suboptimal sleep is a risk factor for mental health problems among youth generally (Becker et al., 2017; Matricciani et al., 2019; Spruyt, 2019), many factors are known to moderate this association. These are as wide-ranging as physical activity (Gillis & El-Sheikh, 2019), SES (El-Sheikh et al., 2010), and interparental conflict (Lemola et al., 2012). Such moderation may have

contributed to a lack of main effects in this study. It should be noted that studies linking sleep to mental health among youth have been predominated by non-SM samples, but there is no reason to expect that sleep would not be associated with mental health among SM youth, especially given that such linkages have been demonstrated for SM adults (Butler et al., 2020).

This study is limited in its examination of concurrent associations between discrimination, sleep, and mental health, which prohibits conclusions regarding causality in relationships among variables. Additionally, the sample was weighted disproportionately on two key sociodemographic variables relative to the U.S. population: family income sex and assigned at birth. In the present study, the full sample of youth skewed toward higher family income, while the sample of SM youth alone had an overrepresentation of individuals assigned female. Though the ABCD Study took all appropriate steps to ensure that the full sample was representative of U.S. youth on sociodemographic characteristics at the time of recruitment, including SES (Garavan et al., 2018), the uneven distribution of family income may have been due to sampling bias, as urban areas near study sites had median family incomes higher than the U.S. median due to local cost of living (Heeringa & Berglund, 2020). Regarding the assigned sex distribution among SM youth, it may have been the case that more individuals assigned female at birth are comfortable disclosing their sexual identity at ages 10–13 compared to individuals assigned male at birth. Generalizability of results could be impacted, especially given that youth sleep and mental health are known to vary by both family income and assigned sex (El-Sheikh et al., 2020; Gillis et al., 2023); however, both variables were included in models as covariates, and all findings reported were over-and-above associations of income and sex with outcomes. Finally, generalizability may be limited additionally due to the self-selecting nature of sexual identity disclosure. Unlike age, sex assigned at birth, race/ethnicity, and family income,

representation of SM status was not part of the ABCD Study's recruitment. Therefore, the data are not considered representative of all SM youth in the U.S.; rather, the SM sample is comprised of youth who felt safe identifying as lesbian, gay, or bisexual at age 10–13 on a survey administered by the federal government.

Future work drawing on multiple waves of data could allow us to examine differences between SM and non-SM youth in their trajectories of sleep duration, quality, timing, and regularity across adolescence. Such work would add greatly to our understanding of sleep health equity for SM youth. Sleep and its trajectories also could then be examined as moderators of the prospective association between minority stress and developmental outcomes. As ABCD is a longitudinal investigation of youth development, subsequent waves of data will be forthcoming that should enable such analyses. Additionally, the present study examined only mental health as an indicator of SM youth development associated with discrimination, though other developmental domains also are related to discrimination, including cognitive and academic performance, positive outcomes (such as self-esteem, affect, mood, and life satisfaction), and physical health (Greene et al., 2006; Schmitt et al., 2014; Wang & Yip, 2020). Future investigations may consider sleep as a moderator of relations between SM-based discrimination and these domains of development. Finally, other health behaviors such as physical activity and nutrition could be examined as moderators of associations between discrimination and development, in an effort to illuminate other behaviors that SM youth can utilize to protect their own health.

In sum, the findings of this study fit within a larger literature examining sleep in the lives of marginalized youth. As with other minoritized groups, SM youth had overall less-optimal sleep: shorter duration, later timing, and less regularity in duration and timing. Yet, another

finding – that SM youth seemed to have slightly better sleep quality – pointed to a protective role for sleep in the context of marginalization: for SM youth facing discrimination, sleep quality was protective against behavioral problems. Taken together, these two sets of findings suggest that when other sleep dimensions are stressed, sleep quality may emerge as a type of "saving grace" for marginalized youth, helping to reduce the risks associated with minority stress. This finding emphasizes the importance of high-quality sleep for youth development, especially in the context of discrimination among SM youth.

Chapter 6: Introduction to Study II

Physical Activity as a Promotive Factor Against Sleep Disturbances for Transgender and Gender-Diverse Youth

Transgender and gender-diverse (TGD) youth are more likely than non-TGD peers to report shorter sleep duration and poorer sleep quality (Levenson et al., 2021). Even in non-clinical samples, sleep disturbances in adolescence can interfere with key developmental domains, including academic performance, psychosocial adjustment, and physical health (Chaput et al., 2016; Matricciani et al., 2019; Spruyt, 2019). Given increased risk of impairment to each of these domains for TGD youth in the context of minority stress (Connolly et al., 2016; Hafeez et al., 2017; Poteat et al., 2014), it is incumbent upon researchers to identity promotive factors that protect the wellbeing of TGD youth (Colpitts & Gahagan, 2016; Stieglitz, 2010). Physical activity is one such promotive factor that is associated with longer (Philbrook & El-Sheikh, 2016) and better-quality (Kalak et al., 2012) sleep among adolescents and that has been shown to decrease inequities in sleep for historically minoritized individuals (Gillis et al., 2021). The present study examines physical activity as a moderator of relations between TGD status and sleep.

TGD Youth and Sleep Inequities

TGD Status

Transgender or gender-diverse references a wide array of individuals whose gender varies from their sex assigned at birth, or whose gender does not align with the strict dichotomy of female/male or feminine/masculine (Rosenthal, 2016; Thorne et al., 2019). There is rich diversity among individuals in this group. *Transgender* describes persons whose gender identity differs from their sex assigned at birth. Some transgender (or *trans* for short) individuals alter the

presentation of their gender (such as through name, pronouns, clothing, and physical appearance, among many other expressions of gender) so that their gender is fully embodied for themselves and accurately understood by others. Like all persons, trans individuals' genders might be masculine, feminine, both, or neither. The latter experiences – having aspects of both feminine and masculine genders, or of understanding oneself as not having a gender – are represented by the term *gender diverse*, which is also referred to as *gender-expansive*, *gender-minority,* or *genderqueer* (Thorne et al., 2019). Reflective of having a gender that crosses dichotomous female/male categories, some gender-diverse individuals describe their gender as *nonbinary*. Recent population-level data estimates that approximately five percent of U.S. individuals in the U.S. born between 1993 and 2004 identify as a gender other than the one they were assigned at birth, including about two percent who identify as transgender and three percent who are nonbinary (Pew Research Center, 2022).

Dimensions of Sleep

A rich literature on sleep health recognizes the multidimensionality of sleep (Buysse, 2014; Meltzer et al., 2021; Sadeh, 2015). Sleep can have long or short *duration*, better or worse *quality*, and earlier or later *timing*. Each of these can have more or less *regularity* or variability over a period of time. In this study, the phrase *sleep disturbance* is used as a broad term to describe what is generally considered less-optimal sleep in any of the four dimensions: short sleep duration, poor-quality sleep, late sleep timing, or less regularity (Matricciani et al., 2019). Dimensions of sleep are distinct from one another, yet they are related, and at times operate in tandem with one another (El-Sheikh et al., 2019). Therefore, researchers are advised to consider multiple sleep parameters in their studies (Sadeh & El-Sheikh, 2015). A reliable and valid way to assess sleep objectively is through the use of an actigraph, a small device that can be worn on the

wrist and which uses changes in activity to define periods of sleep or wake (Fekedulegn et al., 2020; Sadeh, 2015). This enables the identification of a number of important sleep parameters (Ancoli-Israel et al., 2015). Sleep duration is defined by *sleep minutes* (the number of minutes scored as sleep from onset to wake excluding periods of wakefulness). Sleep quality can be operationalized as *sleep efficiency* (percentage of sleep minutes from onset to wake that are identified as sleep), *wake after sleep onset* (WASO; the number of minutes that are coded as wake between sleep onset and offset), and *sleep latency* (the number of minutes between the first sleep attempt and the onset of sleep; in other words, how long it takes to fall asleep). Sleep timing can be identified by *sleep midpoint* (the clock time midway between sleep onset and offset). Sleep regularity can be measured by the relative *variability in sleep minutes* and *variability in sleep midpoint* across multiple nights (intraindividual *SD/M*; a coefficient of variability across nights of consideration; Snedecor & Cochran, 1989). These parameters are well-recognized in the literature (Meltzer et al., 2021).

Relations between TGD Status and Sleep

Studies of sleep among TGD youth are rare (Butler et al., 2020; Patterson & Potter, 2019). In fact, only one known study to date has isolated a TGD youth sample to examine sleep inequities against a non-TGD, non-sexual minority (SM) comparison group (Levenson et al., 2021). Using self-reported sleep duration and a single-item dichotomized rating of sleep quality, Levenson and colleagues (2021) found that TGD youth were half as likely to report getting enough sleep (defined as 8–10 hours per night on average) and twice as likely to report poor-quality sleep compared to non-TGD peers.

Other studies have examined sleep among TGD adults. Gender-diverse individuals reported very short sleep duration (fewer than 5 hours per night by self-report) at higher rates

than non-TGD sexual minority individuals (Dai & Hao, 2019). For TGD individuals, lower self-reported sleep quality is associated with lower health-related quality of life (Auer et al., 2017). In qualitative studies, TGD adults have indicated their sleep quality has been negatively impacted by symptoms of anxiety and depression, feelings of anatomical dysphoria, and negative thoughts related to society's perception of their gender identity (Harry-Hernandez et al., 2020).

Consequences of Sleep Disturbances in Childhood

Sleep is a key indicator of overall wellbeing (Hale et al., 2020), and sleep disturbances are harmful to child development in the areas of cognitive/academic functioning, psychosocial adjustment, and physical health (Beebe, 2011; Chaput et al., 2016; Matricciani et al., 2019; Shochat et al., 2014; Spruyt, 2019). Experimental studies of youth have demonstrated that brief sleep restriction by one hour per night for a week is associated with less-efficient attentional processing (Dutil et al., 2018), and that sleep restriction down to four hours in a single night impairs limbic activity, reduces cognitive processing abilities, and reduces communication between the cognitive and emotional centers of the brain, leading to poorer decision-making skills (Robinson et al., 2018). By contrast, sleep extension by 30 minutes per night is associated with improvements (that is, reductions) in emotional lability and impulsive behavior (Gruber et al., 2012), as well as improvements in working memory and reaction times (Sadeh et al., 2003). In cross-sectional and longitudinal studies, sleep disturbances are present among youth experiencing impairments to attention, memory, executive function, and overall cognitive performance (Short et al., 2018); internalizing symptoms of depression and anxiety (Baddam et al., 2018); externalizing behavior problems like delinquency and substance use (Shochat et al., 2014); and markers of physical illness such as lower ratings of general health, greater somatic complaints, higher body adiposity, and cardiometabolic risk factors (Chaput et al., 2016;

Matricciani et al., 2019; Shochat et al., 2014). Across developmental stages, chronic sleep problems from early childhood and adolescence are predictive of overall general health quality in young adulthood controlling for health in childhood (Reidy et al., 2016), and sleep problems in middle childhood are associated with depressive and anxious symptoms and delinquent behaviors in late adolescence, controlling for childhood adjustment and concurrent sleep problems in adolescence (Shimizu et al., 2021). These studies of experimental, correlational, and longitudinal associations demonstrate the wide-ranging effects of sleep on child and adolescent development and underscore the importance of protecting sleep among youth.

Physical Activity

Relations between Physical Activity and Sleep

Direct effects linking physical activity with sleep are mixed, yet findings point to positive relations between physical activity and sleep health. For instance, among youth and young adults on average, more physical activity is associated with longer sleep duration (Gerber et al., 2014) and shorter sleep latency (that is, falling asleep faster; Kalak et al., 2012). Among adults, better self-reported sleep quality is associated with more minutes of combined light, moderate, and intense physical activity as measured by a FitBit device (Bisson et al., 2019). Although tests of daily associations between physical activity and sleep have often failed to demonstrate a temporal direction of effects between daytime physical activity and subsequent nighttime sleep (Mead et al., 2019), meta-analyses have estimated small-to-moderate effect sizes linking *mean* physical activity with *mean* sleep (Driver & Taylor, 2000).

Moderating Role of Physical Activity

While no studies have examined physical activity as a moderator of relations between TGD status and sleep, a small literature has demonstrated that physical activity can be protective

against negative developmental outcomes in other contexts. For example, among a racially minoritized group, Black youth in the U.S. were observed to sleep less than White youth, yet this difference was mitigated by more-frequent involvement in physical activity (Gillis et al., 2021). In other contexts, Sigfusdottir (2011) found that, among youth exposed to family conflict, physically active adolescents reported lower levels of depressive symptoms than more-sedentary peers. Similarly, in an intervention study, higher levels of physical activity were associated with decreases in symptoms of maladjustment for youth with high perceived stress (Norris et al., 1992). Together these studies demonstrate the potential for physical activity to moderate associations between a contextual factor (in this case, TGD status) and a key developmental health outcome (sleep). Importantly, existing moderation studies have relied on self-reported physical activity. The present study extends this literature through its use of multiple objective indicators of physical activity.

Objective Measurement of Physical Activity

Similar to sleep, patterns of physical activity can be accurately captured through the use of a wrist-worn accelerometer (Bagot et al., 2018; Wing et al., 2017). In combination with a photoplethysmographic heart rate monitor, units of time (usually 30 seconds or one minute) can be categorized by intensity of physical activity relative to rest (Bagot et al., 2018; Dominick et al., 2016). The number of *steps* taken per day also can be estimated (Diaz et al., 2015). In pediatric and adult populations, FitBit devices have been shown to have good correspondence with objective energy expenditure (Diaz et al., 2015; Wing et al., 2017), intensity of physical activity measured by established research-grade accelerometers (Wing et al., 2017), and observation of steps by researchers (Diaz et al., 2015; Dominick et al., 2016).

Theoretical and Conceptual Frameworks

Three theoretical and conceptual frameworks provide context for understanding inequities in sleep health between TGD and non-TGD youth: gender minority stress theory, resilience framework, and multiplicative risk/diathesis–stress models. Gender minority stress, an extension of minority stress theory (Flentje et al., 2020; Meyer, 2003), describes two dimensions by which having TGD status may have adverse effects on physical health (Tan et al., 2020; Testa et al., 2015). External (or distal) stressors include potential for discrimination or non-acceptance based on having a gender identity that does not fit within society's expectation of dichotomous female–male gender. Internal (or proximal) stressors include whether and how disclosure of one's gender identity, a lack of agency regarding disclosure, and negative emotions such as anxiety that may accompany decisions around gender expression (Testa et al., 2015). For TGD youth, non-affirmation of gender – that is, being misgendered through name, pronouns, or nouns of address (e.g., *sir*) – connects the external to the internal; if one's gender is understood incorrectly by another, internal stress increases. Experiences of minority stress, in turn, have been linked to negative health outcomes, including self-reported shorter and lower-quality sleep (Caceres et al., 2022; Eom et al., 2022; Flentje et al., 2020). Although gender minority stress was not measured in the present study, it was used as a guiding theory to understand the potential for TGD to have different health outcomes than non-TGD peers. Gender minority stress theory has previously been used in the literature to account for associations between TGD status and sleep disturbances (Kolp et al., 2020).

It is important to acknowledge that there are individual differences following stressors, in that some children experience a negative downstream consequence following exposure to risk, while others do not (Rutter, 1993). For those who do not, it is theorized that they are protected by

mechanisms or processes that ameliorate a stressor (Meyer, 2015; Rutter, 1987). Such a phenomenon, characterized as resilience, is highlighted especially when a promotive factor interrupts or counterbalances a risk process (Luthar et al., 2000; Masten, 2001). The uncovering of resilient promotive factors is especially important in research involving TGD youth, as much of the early research in this field was deficit-based (Colpitts & Gahagan, 2016). Physical activity is one such potential promotive factor given its role in ameliorating risk for youth (Gillis et al., 2021; Norris et al., 1992; Sigfusdottir et al., 2011). At a neurobiological level, physical activity helps the brain in its response to stress by promoting neurotransmitters that alleviate depressive symptoms (Pedersen, 2019) and by supporting emotion regulation via cortical thickening (Wu et al., 2022). At the psychosocial level, accomplishment-based physical activity could strengthen self-efficacy, which further mitigates mood-related symptomology and negative self-valuation (Ryan, 2008). Because gender minority stressors convey disempowering and negative messages about oneself that have a direct effect on sleep (Caceres et al., 2022), physical activity could play a role in interrupting this process by increasing one's sense of agency and self-esteem while mitigating against low mood. Importantly, the presence of such a resiliency process can be inferred even when minority stress is not operationalized (Meyer, 2003). Translated to the current study, a TGD child "beating the odds" and having sleep that is on average not different from a non-TGD peer could be viewed as resilient even though the "stress" of TGD status is not measured.

Additionally, some children experience a second stressor in the context of an initial risk factor. This phenomenon, characterized as cumulative or multiplicative risk (Evans et al., 2013) and as diathesis–stress (Sameroff, 1983), accounts for the effects of multiple risk factors in the life of a child. It suggests that risk of a negative outcome is increased through the interaction of

multiple risks, and that initial risks can be exacerbated by secondary stressors (Luthar et al., 2000). In this study, such dual risk may occur for TGD individuals who obtain low levels of physical activity – a type of double jeopardy in which a marginalized identity status interacts with behavior to increase risk of a negative health outcome (Tan et al., 2020).

The Present Study

The present study had two primary aims. The first was to examine mean differences in sleep between TGD and non-TGD youth in early adolescence. Toward a more comprehensive assessment of sleep (Sadeh & El-Sheikh, 2015), the first aim utilized a total of seven sleep parameters tapping into four dimensions of sleep: duration (indexed by *sleep minutes*), quality (indexed by *sleep efficiency*, *WASO*, and *sleep latency*), timing (indexed by *sleep midpoint*), and regularity (indexed by *variability in sleep minutes* and *variability in sleep midpoint over the week).* Based on scant available literature, TGD youth were expected to have shorter sleep duration and poorer sleep quality than non-TGD peers (Levenson et al., 2021). No specific hypotheses were made about differences in sleep timing or regularity given the paucity of existing literature linking TGD status to these sleep dimensions.

A second aim was to examine physical activity as a moderator of relations between TGD status and sleep health inequities, responsive to a call in the literature to identify factors that are promotive of sleep among TGD individuals (Butler et al., 2020). Toward a more comprehensive assessment of physical activity (Hills et al., 2014), we used three indicators of physical activity averaged across all days of assessment. (1) *Average METs per minute* represented overall intensity of physical activity. (2) *Average number of minutes per day spent in moderate or vigorous physical activity* provided a quantification of intense physical activity. (3) *Average number of steps per day* were a quantification of cumulative physical activity irrespective of

intensity. These are well-acknowledged indicators of physical activity from objective measurements (Hills et al., 2014). Based on previous literature demonstrating protective effects of physical activity (Gillis et al., 2021), it was expected that under conditions of greater physical activity, the association between TGD status and sleep would be attenuated. This would be consistent with a resilience framework in which an expected difference on the basis of a marginalized identity is not observed under the condition of a promotive factor (Colpitts & Gahagan, 2016). At lower levels of physical activity, it was hypothesized that the association between TGD status and sleep would be accentuated. Such a finding would be in line with previous research showing that a sleep disturbance was most pronounced among members of a minoritized group who obtained less physical activity (Gillis et al., 2021), and further would be consistent with multiplicative risk (Evans et al., 2013) and diathesis–stress (Sameroff, 1983) frameworks.

Finally, the study is the first of its kind to utilize objective indicators of both physical activity and sleep in the study of TGD health inequities. It is timely in that record numbers of youth now identify as having TGD status (Pew Research Center, 2022), and that sleep disturbances have broad and important downstream consequences (Spruyt, 2019). The study is responsive to calls in the literature for elucidation of factors that protect the sleep of TGD youth (Butler et al., 2020) and of conditions under which TGD individuals thrive more generally (Wilson & Cariola, 2020). The NIH agenda for sleep research calls for integrative science that elucidates consequences of sleep health inequities, as well as work that points to potential interventions to attenuate differences between minoritized populations and others (National Heart, Lung, and Blood Institute, 2021). This agenda builds on a call previously made in the report of a workshop on sleep health disparities hosted by the NIH, which indicated the need to

understand protective factors of sleep health (Jackson et al., 2020). Finally, this study considers a modifiable behavior – physical activity – that helps to place the health of TGD youth in their own hands at a time of increasing autonomy in early adolescence. Findings may be incorporated into prevention and intervention efforts focused on TGD youth health.

Chapter 7: Method of Study II

Participants

For the full ABCD Study, a sample of approximately 11,875 youth were recruited through elementary schools located near data-collection sites around the United States, which were primarily large research universities (Thompson et al., 2019). Families were included if at least one parent and the youth spoke English or Spanish fluently. Youth were excluded if they had a severe impairment to their development that could invalidate results on key study measures, or if they were unable to participate in magnetic resonance imaging. Like similar large cohort studies, probability sampling was used to recruit a sample with demographic characteristics that resembled the population of the U.S. (Garavan et al., 2018).

Youth were ages 9–10 at the time of baseline data collection beginning in 2016. The present study, with a cross-sectional design, uses data from the two-year follow-up (September 2018 to January 2020), which was the first wave at which a large number of youth (approximately 4,300) were given FitBit devices for anthropomorphic data collection. The analytic sample for the current investigation was comprised of 2,979 youth who had at least 5 nights of sleep data from the same week (Meltzer et al., 2012; see Measures). Youth in the analytic sample ranged in age between 10.08 and 13.58 years (*M* age = 11.96 years, *SD* = 7.80 months); 51.19% were assigned male at birth, and 48.81% assigned female sex at birth). Participants had a mode parent-reported pubertal status of mid-puberty (40.39%); 14.36% were in pre-puberty, 27.67% in early puberty, 17.27% in late puberty, and 0.31% post-puberty. Parents indicated that 19.38% of youth were Hispanic, Latino, or Latina, and 79.42% were non-Hispanic. Non-Hispanic racial identities included White (61.29%), Black (7.08%), Asian (2.665), and American Indian or Alaska Native (0.20%); 16.07% of youth were multiracial or multiethnic.

Most youth (64.96%) were middle class or above based on income-to-needs ratio (see Measures); 20.97% were from families living at or near the poverty line, and 14.06% were lower middle class.

Procedure

The University of California, San Diego Study institutional review board approved study procedures for ABCD. Analysis of secondary data for the current study was considered exempt from human-subjects protocol by the Auburn University institutional review board. A Data Use Certification was signed by Auburn University to obtain data access from the National Institute of Mental Health Data Archive. Procedures related only to the current study are described here. Youth assented to their participation, and parents provided consent. Families visited a research laboratory at one of 21 sites around the country to completed questionnaires on digital tablets (Blashill & Calzo, 2019; Karcher & Barch, 2021). Parents provided information regarding family demographics, and youth reported on their gender identity. Youth wore a Fitbit Charge HR at home continuously for 21 days to provide objective assessments of physical activity and sleep (Nelson et al., 2022).

Measures

TGD Status

Youth were coded as being TGD (1 = *Yes*, 0 = *No*) if they met one or more of the following conditions: if they answered *Yes* or *Maybe* to the question, "Are you transgender?;" if they responded *Not at all*, *A little*, or *Somewhat* to the question, "How much do you feel like [your sex assigned at birth]?;" or if they responded *Totally*, *Mostly*, or *Somewhat* to the question, "How much do you feel like [the dichotomous sex opposite to your sex assigned at birth]?" Such a multi-step approach – sex assigned at birth in relation to aspects of current, self-affirmed

gender identity is in line with recommendations in of the field (Calzo & Blashill, 2018; Heidari et al., 2016; Patterson et al., 2017).

Physical Activity

Objective physical activity data were gathered using FitBit Charge HR devices. Three indicators of physical activity were extracted by Fitabase (Small Steps Labs, San Diego, CA). Average daily *metabolic equivalents of task (METs) per minute* (METs/minute) and average number of daily minutes spent in *moderate-to-vigorous physical activity* (MVPA) are established measures of intensity of physical activity (Maher & Olds, 2011). Average number of daily *steps* is a commonly understood measure of physical activity (Diaz et al., 2015; Franzen-Castle et al., 2017).

Sleep

Sleep data were collected by FitBit Charge HR devices and scored and extracted by Fitabase. Sleep duration was measured by *sleep minutes* (the average number of minutes determined to be asleep from sleep onset to wake). Measures of sleep quality included *sleep efficiency* (the quotient of sleep minutes divided by the number of minutes from onset to wake, represented as a percentage), *WASO* (the number of wake minutes between onset and wake), and *sleep latency* (the average nightly minutes from first minute in bed until sleep onset). Sleep timing was indicated by the average *midpoint* or middle minute (clock time) between sleep onset and wake. Sleep regularity was indexed by *variability in sleep minutes* (intra-individual *SD/M* of sleep minutes for each individual; Snedecor & Cochran, 1989) and *variability in sleep midpoint* (*SD*/*M* of sleep midpoint for each individual) over the weeks of sleep assessment. Sleep minutes, WASO, time in bed, sleep onset, and wake were generated by Fitabase and are consistent with definitions used in a study validating the Fitbit Charge HR device against polysomnography (de

Zambotti et al., 2015). Sleep efficiency and latency were calculated in a manner consistent with the same study (de Zambotti et al., 2015) and with best practices (Fekedulegn et al., 2020). The calculations for sleep midpoint and for variability in minutes and midpoint are commonly used in the field (Becker et al., 2017; Randler et al., 2019). Sleep data were included for participants with at least five nights of FitBit wear, consistent with best practices in the field (Meltzer et al., 2012). Participants had on average 12.46 nights of wear (*SD* = 5.78 nights).

Controls

Youths' sex assigned at birth (*female* or *male*), pubertal status, race, family income, and size of household were reported by a parent at the time of data collection. The widely used Pubertal Developmental Scale (Petersen et al., 1988) was used to collect pubertal status through the assessment of milestones in the development of physical secondary sex characteristics. A common indicator of SES, family income-to-needs ratio (Diemer et al., 2013), was calculated by dividing family income by the federal poverty threshold for a given household size (U.S. Department of Commerce, 2019). Research staff obtained each participants' waist circumference in inches using a measuring tape during in-person data collection; this is a valid estimate of body adiposity among youth (Bixler et al., 2009). Parents' reported on youth anxious/depressive symptoms using the 13-item anxious/depressive syndrome scale of the Child Behavior Checklist (see Appendix for full measure; Achenbach & Rescorla, 2001). Covariates were included in analyses due to systemic variation in sleep by each variable (Bixler et al., 2009; El-Sheikh, Gillis, et al., 2022; Guglielmo et al., 2018; Kelly et al., 2022; Lucien et al., 2021; Storfer-Isser et al., 2012).

Plan of Analysis

Preliminary data analysis were performed in SPSS 29 (International Business Machines Corporation, Armonk, NY). Measures of central tendency and distribution were examined. Mahalanobis distance was used to identify extreme outliers in continuous independent variables (i.e., physical activity parameters). Twenty-six observations (4 for METs/minute, 19 for MVPA, and 3 for steps) were trimmed to the next-highest observation to strengthen normality (Kline, 2011); trimmed observations accounted for 0.30% of physical activity data. To carry out the first aim of the study, a multivariate analysis of covariance evaluated whether means of each sleep variable differed between groups of TGD and non-TGD youth in three steps. An unadjusted model compared mean differences without covariates; an initial adjusted model controlled for sex assigned at birth, pubertal status, race, family income, and waist circumference; and an additional adjusted model used the same covariates along with anxious/depressive symptoms in order to account for differences in sleep that may be accounted for by mental health concerns (Kelly et al., 2022). Other analyses of TGD sleep have utilized a similar sequential set of controls (Levenson et al., 2021).

For the second aim of the study, moderation analyses were conducted in Mplus 8.1 (Muthén & Muthén, Los Angeles, CA). Interaction terms representing the product of TGD Status x Physical Activity were created for each measure of physical activity. Sleep variables were regressed independently onto each interaction term, controlling for sex assigned at birth, pubertal status, race, family income, and waist circumference. All exogenous variables were mean-centered in analyses. Significant interactions were plotted at one *SD* above and below the mean, and simple slopes were estimated in Mplus using the Model Constraint command. Differences in predicted means were evaluated through chi-square difference testing from intercepts (i.e.,

grandmeans). Regions of significance were calculated in Mplus. Magnitudes of effects were characterized through conventional effect sizes (Sullivan & Feinn, 2012) and through the distance of prototypical-value predicted means from the sample mean in units of *SD*s.

Chapter 8: Results of Study II

Preliminary Analyses

Across both TGD and non-TGD youth, on average adolescents obtained 36 minutes of moderate-to-vigorous physical activity each day and walked 9,644 steps (Table 2.1). Youth slept 7.51 hours per night (sleep minutes) and woke for an additional 58 minutes per night (WASO) on average. Youth took approximately 7 minutes to fall asleep, and the average midpoint of sleep was 3:14am. Importantly, some indicators of sleep and physical activity varied by demographic characteristics. Across the full sample of TGD and non-TGD youth, those assigned male at birth were more physically active than those assigned female at birth on each parameter of physical activity (Table 2.2). Compared to youth assigned male at birth, individuals assigned female at birth had longer sleep duration and better sleep quality (higher efficiency and fewer wake minutes), but later sleep schedule and more variability in sleep duration and schedule; youth did not differ in sleep latency by sex assigned at birth. Hispanic youth were less physically active than other youth, including fewer minutes of MVPA than White adolescents and fewer steps than non-Hispanic Asian, non-Hispanic White, and multiethnic/multiracial youth; no ethnic or racial groups differed in METs/minute (Table 2.3).

Youth with more advanced puberty were less physically active across all indicators and had less-optimal sleep across multiple indicators, including shorter sleep duration, taking longer to fall sleep, a later sleep schedule, and more variability in sleep duration and schedule; they did, however, have better sleep quality (higher efficiency and fewer wake minutes; Table 2.4). Compared to higher-SES youth, lower-SES adolescents were less physically active across all indicators and had less-optimal sleep across multiple parameters, including shorter sleep duration, later sleep schedule, and more variability in sleep duration and schedule; however,

lower-SES youth had better sleep quality. Physical activity variables were strongly associated with one another. In addition, across all physical activity indicators, more physical activity was associated with falling asleep faster and earlier and having more regularity in sleep duration and schedule; more physical activity also was associated with lower sleep efficiency and more wake minutes during the night. Correlations among sleep variables were small-to-large. Notably, longer sleep duration was associated with poorer sleep quality (lower efficiency and more wake minutes), earlier sleep schedule, and more-regular sleep. Earlier sleep schedule was associated with more regularity. TGD youth were less physically active than non-TGD youth by each indicator of physical activity (Table 2.5).

Mean Comparisons of TGD and Non-TGD Youth Sleep

TGD youth slept for 7.29 hours per night on average, which was 13.67 fewer minutes than non-TGD youth. TGD individuals had 2.50 fewer wake minutes during the night, had a sleep midpoint that was 16 minutes later in the night, and had greater variability in sleep minutes (a 0.03 difference) and midpoint (a .01 difference) in comparison to TGD youth (Table 2.6). In models adjusted for sex assigned at birth, pubertal status, race, family income, waist circumference, and anxious/depressive symptoms, three sleep differences remained: TGD youth continued to have later sleep midpoint, more variability in sleep minutes, and more variability in sleep midpoint. Sleep efficiency and sleep latency did not vary between TGD and non-TGD youth in either unadjusted or adjusted models.

Main Effects of TGD Status on Sleep

In models controlling for sex assigned at birth, pubertal status, race, family income, and waist circumference, TGD status was not associated with any sleep parameter (Tables 2.7–2.18).

METs/Minute

Main Effects of METs/Minute on Sleep

METs/minute were not associated with any sleep parameter (Tables 2.7–2.10).

METs/Minute as a Moderator of Relations between TGD Status and Sleep

METs/minute moderated the association between TGD status and sleep minutes (Table 2.7). As demonstrated by simple slope analyses, under conditions of more METs/minute (1 *SD* above the mean), there was no association between TGD status and sleep minutes (Figure 2.1). TGD youth with higher METs/minute slept 19.87 more minutes per night than TGD youth with lower METs/minute, a difference of 0.53 *SD*, and 4.06 minutes longer than the mean for all youth, a 0.11-*SD* difference, $\Delta\chi^2$ (1) = 32.30, $p < .001$. At lower METs/minute (1 *SD* below the mean), a significant relationship between TGD status and sleep minutes was observed, with TGD youth sleeping 15.81 fewer minutes per night on average than the mean for all youth, a difference of 0.42 *SD*, $\Delta\chi^2$ (1) = 538.45, $p < .001$. Among TGD youth, individuals with more METs/minute slept 19.86 more minutes per night than youth with lower METs/minute, a difference of 0.53 *SD*s. Analysis of regions of significance showed that the relationship between TGD status and sleep minutes was non-significant for youth who obtained an average of 1.99 METs/minute or higher each day; 38.89% of TGD youth were in this region. The interaction of TGD Status x METs/Minute accounted for 0.1% of the variance in sleep minutes.

METs/minute did not moderate associations between TGD status and sleep efficiency, WASO, latency, midpoint, variability in sleep minutes, or variability in sleep midpoint (Tables 2.8–2.10).

MVPA

Main Effects of MVPA on Sleep

Average daily minutes of MVPA were unassociated with sleep minutes (Table 2.11), negatively associated with sleep efficiency (Table 2.12), positively associated with WASO, negatively associated with sleep latency, negatively associated with sleep midpoint (Table 2.13), negatively associated with variability in sleep minutes (Table 2.14), and unassociated with variability in sleep midpoint.

MVPA as a Moderator of Relations between TGD Status and Sleep

MVPA moderated relations between TGD status and sleep minutes (Table 2.11). At greater MVPA (1 *SD* above the mean, or an average of 65.78 minutes per day), there was no association between TGD status and sleep minutes (Figure 2.2). Among TGD youth, those with greater MVPA slept 16.69 minutes longer than those with less MVPA, a 0.45-*SD* difference, a sleep duration that did not differ from the sample mean, $\Delta\chi^2$ (1) = 0.59, $p = .44$. With less MVPA (1 *SD* below the mean, or an average of 6.60 minutes per day), the association between TGD status sleep minutes was negative, with TGD individuals sleeping 15.94 fewer minutes per night than the sample mean, a difference of 0.43 *SD*, $\Delta\chi^2$ (1) = 542.68, $p < .001$. The relationship between TGD status and sleep minutes was non-significant for youth who obtained at least 35.96 minutes of MVPA per day on average; 25.56% of TGD youth had this level of physical activity or above. The interaction of TGD Status x MVPA explained for 0.1% of the variance in sleep minutes.

MVPA also moderated relations between TGD status and sleep latency (Table 2.12). Simple slope analyses showed that under the condition of more minutes of MVPA, the association between TGD status and sleep latency was non-significant (Figure 2.3). TGD youth

with greater MVPA took 1.25 minutes longer than the sample mean to fall asleep, $\Delta\chi^2$ (1) = 184.57, $p < .001$, a 0.26-*SD* difference. Under the condition of fewer MVPA minutes, sleep latency was negatively associated with TGD status. TGD youth with less MVPA fell asleep 2.32 minutes faster than TGD youth with greater MVPA, a 0.47-*SD* difference, and 1.25 minutes faster than the mean for all youth, a $\Delta\chi^2$ (1) = 146.09, $p < .001$, a difference of 0.26 *SD*. Regions of significance showed that there was no relationship between TGD status and sleep latency for youth who had 15.46 or more minutes of MVPA each day on average; 54.44% of TGD youth were in this range. The interaction of TGD Status x MVPA accounted for 0.2% of the variance in sleep latency.

MPVA did not moderate associations between TGD status and sleep efficiency, WASO, midpoint, variability in sleep minutes, or variability in sleep midpoint (Tables 2.12–2.14).

Steps

Main Effects of Steps on Sleep

More average daily steps were negatively associated with fewer sleep minutes (Table 2.15), lower sleep efficiency (Table 2.16), shorter sleep latency, earlier sleep midpoint (Table 2.17), less variability in sleep minutes (Table 2.18), and more variability in sleep midpoint. Steps were unassociated with WASO (Table 2.16).

Steps as a Moderator of Relations between TGD Status and Sleep

Steps moderated relations between TGD status and sleep minutes (Table 2.15). At 12,700 average steps (a number equivalent to 1 *SD* above the mean for the full sample), sleep minutes did not vary by TGD status (Figure 2.4). TGD youth who took more steps did not differ from the sample mean in their sleep minutes, $\Delta\chi^2$ (1) = 1.32, $p = .25$, but slept 13.79 minutes longer per night than TGD who took fewer steps, a difference of 0.37 *SD*. Under conditions of fewer steps

(6,589, or 1 *SD* below the mean), a negative slope was observed. TGD youth with fewer steps slept 14.29 fewer minutes per night than the sample mean, a 0.38-*SD* difference, $\Delta\chi^2$ (1) = 445.97, $p < .001$. The relationship between TGD status and sleep minutes was non-significant for youth who took at least 9,517 steps each day on average; 31.11% of TGD youth were in this range. The interaction of TGD Status x Steps explained for 0.1% of the variance in sleep minutes.

Steps did not moderate associations between TGD status and sleep efficiency, WASO, latency, midpoint, variability in sleep minutes, or variability in sleep midpoint (Tables 2.16–2.18).

Chapter 9: Discussion of Study II

Sleep is unique among health behaviors. It is critical, compulsory, and quick-acting as a catalyst for wellbeing. As a bioregulatory function, it affects nearly every biological process in the body, including cellular growth, metabolism, and the production of enzymes and hormones that drive organ function (Cirelli & Tononi, 2008; Haspel et al., 2020). Unfortunately, systemic differences in sleep become pathways through which health inequities are mediated between groups of people (Hale et al., 2020). This study placed sleep health equity at the forefront of two aims: to examine differences in multiple dimensions of sleep between TGD and non-TGD youth, and to identify factors that promote the sleep of TGD youth.

As hypothesized, TGD youth slept 14 fewer minutes per night on average than non-TGD youth in unadjusted models. This difference adds up to more than an hour and a half of less sleep over the course of a week, and six and a half hours over the course of a month – nearly equivalent to a full night of sleep. On a daily basis, sleep deprivation has been linked to changes in neurological connectivity affecting emotion regulation (Robinson et al., 2018) and cognition (Dutil et al., 2018). Sleep loss also has an impact on neuroendocrine function affecting glucose and hunger (Leproult & Van Cauter, 2009) and on cardiometabolic regulation (Quist et al., 2016). Thus, accumulated sleep debt in TGD youth could have a negative influence on their mental health, academic performance, and physical well-being (Matricciani et al., 2019). This finding based on objective measures of sleep is consistent with a previous study showing that TGD youth had fewer self-reported hours of sleep per night, as well as higher odds of feeling they do not get enough sleep, in comparison to non-TGD youth (Levenson et al., 2021).

Contrary to previous literature in which TGD youth were more likely than non-TGD peers to subjectively rate their sleep quality as poor (Levenson et al., 2021), TGD youth in this

sample had slightly better sleep quality, as indicated by fewer wake minutes during the night in unadjusted models. It is not uncommon to observe discrepancies between objective and subjective ratings of sleep quality (El-Sheikh et al., 2019). Nevertheless, it may be the case that in the context of short sleep duration, better sleep quality emerges as an adaptation for TGD youth. Previous work has shown that high-quality sleep has a compensatory role that offsets the association between short sleep duration and negative developmental outcomes (El-Sheikh et al., 2019; Meijer et al., 2010).

Notably, after controlling for sociodemographic variables and internalizing symptoms, differences in sleep duration and quality based on TGD status were no longer evident. In Levenson ‘s (2021) study of TGD youth, a difference in sleep duration was attenuated by similar controls. It is important to consider that the inclusion of covariates in tests of mean differences aims to reduce the amount of unexplained variance in dependent variables before testing differences related to the variable of interest, thus removing confounding explanations for such differences. In this case, TGD-related disparities in sleep duration and quality were not observed after accounting for sex assigned at birth, pubertal status, race, family income, waist circumference, and anxious/depressive symptoms. This does not mean that TGD youths' sleep duration and quality do not differ from non-TGD youth (indeed, mean differences were observed), but rather may suggest that differences in sleep may be due in part to sociodemographic characteristics and mental health. In our sample TGD youth had lower family income, higher waist circumference, and more anxious/depressive symptoms, consistent with other samples (Fornander et al., 2022; Price-Feeney et al., 2020). Each of these variables are associated with sleep in adolescence (Buckhalt, 2011; Kelly et al., 2022; Morrissey et al., 2020). It may be the case that TGD/non-TGD differences in sleep are driven by factors such as SES,

adiposity, and mental health, which vary systemically among TGD populations (Fornander et al., 2022; Price-Feeney et al., 2020).

Given a lack of published data related to sleep timing and regularity among TGD youth, specific hypotheses about relations between TGD status and these sleep parameters were not formulated. However, inequities in timing and regularity were observed and remained significant even after controlling for sociodemographic variables and internalizing symptoms. Compared to non-TGD participants, TGD youth had a later sleep midpoint, indicative of falling asleep and waking at later times, and less regularity in the duration and timing of their sleep. Timing and regularity are key dimensions of sleep because they are the gears on which multiple homeostatic circadian processes turn, including blood pressure, body temperature, and stress response (Haspel et al., 2020). An established literature on sleep timing has shown that later sleep and wake times in adolescence are associated with a host of physical health concerns, including poorer lipid and glucose profiles and higher body adiposity, blood pressure, and inflammation (Matricciani et al., 2019; Morales-Ghinaglia & Fernandez-Mendoza, 2023; Quist et al., 2016). A growing literature has identified similar findings for sleep irregularity, which is night-to-night variation in sleep timing and duration beyond mean times (Becker et al., 2017). The 24-hour rhythm reflected in and maintained by sleep underpins our most basic biology (Haspel et al., 2020). Irregularity in sleep patterns, characterized by inconsistency in sleep duration from night to night, or fluctuations in wake times across days, can result in circadian disturbances that affect more than just sleep/wake cycles.

The second aim of this study sought to identify protective factors for the sleep of TGD youth. Supportive of hypotheses, physical activity moderated relations between TGD status and sleep duration in a consistent pattern across all three measures of physical activity. Under

conditions of higher METs/minute, more MVPA, or more steps, TGD status was unrelated to sleep duration. This is indicative of a protective-stabilizing role (Luthar et al., 2000) for physical activity; among those who were more physically active, there was no observed difference in sleep duration between TGD and non-TGD youth. Assuming that the disparity in sleep duration for TGD youth is due to the presence of gender minority stress, it may be the case that physical activity interrupts this pathway. It could do so in several ways. Physical activity may increase one's sense of agency and control through perceptions of self-competence (Lubans et al., 2016). It may improve mood, both momentarily by releasing endorphins and neurotransmitters such as dopamine and serotonin (Paluska & Schwenk, 2000), and long-term by alleviating depressive symptoms (McPhie & Rawana, 2015) and enhancing neurological structures supporting emotion regulation (Valkenborghs et al., 2019). It also can alter one's physical appearance (Lubans et al., 2016), which is a mechanism that can be used to increase gender euphoria (Smith, 2023). The identification of a factor that mitigates sleep inequities is responsive to multiple NIH recommendations (Jackson et al., 2020; National Heart, Lung, and Blood Institute, 2021), and it situates this study within a public health literature that is seeking to strengthen sleep health equity (Hale et al., 2020). Furthermore, this finding is consistent with a previous study showing that physical activity ameliorates differences in sleep duration among historically minoritized youth (Gillis et al., 2021), and it supports the notion that physical activity serves as a resilience factor in the context of gender minority stress (Meyer, 2015; Tan et al., 2020; Testa et al., 2015).

In the same models, a pattern of risk was also observed, consistent with hypotheses. TGD youth who exhibited lower METs/minute, engaged in less moderate-to-vigorous physical activity, or took fewer steps had shorter sleep duration compared to both TGD youth with higher physical activity levels and non-TGD youth regardless of their physical activity levels.

Interestingly, however, the predicted sleep duration for TGD youth with low physical activity was not substantially lower than the mean of sleep duration for all TGD youth. This could be interpreted in one of two ways. First it *could* indicate that low physical activity does not confer an additional risk for short sleep beyond the risk otherwise associated with TGD status. (Although, it should be noted, that TGD status does not directly cause insufficient short sleep; rather the social environment inhabited by marginalized youth is thought to create circumstances that disrupt sleep [Butler et al., 2020; Levenson et al., 2021]). Alternatively, it could imply that the increased risk of short sleep among TGD youth is partially driven by lower levels of physical activity within this population. While speculative, the latter explanation has more support, as TGD youth in the sample were less physically active than non-TGD youth across all three indicators of physical activity. Regardless of how we interpret this pattern, the key finding remains the same: low physical activity is associated with shorter sleep duration among TGD youth. This pattern aligns with the vulnerable-reactive interaction effect in which vulnerability for a negative outcome is observed only in the context of greater risk (Luthar et al., 2000). This also is consistent with multiplicative risk (Evans et al., 2013) and diathesis–stress (Sameroff, 1983) frameworks, as well as previous findings for racially minoritized youth (Gillis et al., 2021).

An additional interaction pattern emerged for moderation of the relationship between TGD status and sleep latency by MVPA. Youth with more MVPA had average sleep latency regardless of TGD status, while TGD youth with less MVPA had shorter sleep latency (predicted $M = 5.64$ minutes). Sleep latencies around 5 minutes or less can be indicative of insufficient sleep (Shen et al., 2006), which aligns with the finding that TGD youth with lower MVPA also had shorter sleep duration. Importantly, however, not all recommendations for appropriate sleep

latency times recognize <5 minutes as a critical cutoff (Ohayon et al., 2017). Nevertheless, TGD youth with higher physical activity exhibited average sleep latency.

Several findings did not support hypotheses. Specifically, relations between TGD status and other sleep parameters – including sleep efficiency, timing, and regularity – were not moderated by physical activity. This may be due to a lack of specificity in the data regarding the timing of physical activity. Previous work has found that MVPA between 9:00am and 6:00pm is associated with poorer sleep efficiency, while MVPA after 6:00pm is not (Pesonen et al., 2011). Additionally, physical activity and sleep efficiency have a reciprocal relationship; within-person analyses have isolated temporal associations and found that physical activity is related to same-night sleep efficiency, and that sleep efficiency is related to next-day physical activity (Pesonen et al., 2011). This further contributes to the complexity of relations between physical activity and sleep quality. Regarding timing and regularity in particular, time use is another factor: one study revealed differential associations between physical activity and sleep and wake times on weekdays versus weekends (Adam et al., 2007). This may be due to the scheduling of physical activity on different days, which further confounds the relationship between physical activity and sleep (Allen et al., 2016).

A significant limitation to this study's findings is that physical activity, while promotive of sleep duration among TGD youth, comes with serious personal and structural barriers for TGD individuals (Greenspan et al., 2019). Gender dysphoria can limit the extent to which TGD youth feel comfortable engaging in physical movement because dysphoria is associated with lower body satisfaction and because clothing made for exercise is often gendered (Gilani et al., 2021). Moreover, exclusion from sports teams and gender-affirmed locker rooms and bathrooms, as well as lack of safety within these spaces, may hinder TGD youth's engagement in physical

activity (Barrera et al., 2022; Greenspan et al., 2019; Kosciw et al., 2020; Kulick et al., 2019; Wernick et al., 2017). However, despite facing these barriers, over half of TGD youth report high motivation to be physically active (Gilani et al., 2021). From the present study, some hope may be taken from the fact that step counts were promotive of sleep. Unlike higher METs/minute and MVPA, which are often achieved through intentional bouts of more-intense physical activity through sports and workouts, steps can be gained irrespective of intensity (Maher & Olds, 2011). Thus, even lighter forms of non-sport physical activity – or disruptions to longer bouts of sedentary behavior – could be protective for TGD youth. Furthermore, 26–39% of TGD youth in the sample had physical activity levels that were protective against sleep duration inequities; this suggests that even though barriers to TGD physical activity are substantial, some TGD youth are able to obtain sufficient physical activity to mitigate health disparities.

Several future directions are indicated by this work. The present study found low physical activity to be a risk factor for TGD youth but did not explicitly investigate length or bouts of sedentary behavior as a potential moderator of relations between TGD status and sleep. Future studies could examine whether more-sedentary TGD youth are at heightened risk of experiencing sleep disturbances. Alternative models also could be explored. As mentioned earlier, TGD youth in this sample had lower family income, higher body adiposity, and poorer mental health, all of which have been associated with sleep disturbances. Future work could examine whether these factors mediate the association between TGD status and sleep outcomes. Given the links between TGD status and physical activity, and between physical activity and sleep, it also may be the case that lower levels of physical activity play an indirect role in linking TGD status to sleep.

Strengths of this study include its examination of objective sleep in a sample of TGD youth, which represents a first in the literature. Such objective data about TGD sleep is needed to

fully understand the multiple dimensions of pediatric sleep beyond that which has been measured through self-report (Butler et al., 2020; Millar et al., 2019). In addition to sleep, this study further illuminated differences in physical activity between TGD and non-TGD youth. Investigations of TGD adolescents' physical activity have been scarce (A. Bishop et al., 2020), and are especially pertinent given the spread of legislative action restricting sport participation for trans youth (Barrera et al., 2022). While parents and medical providers of TGD youth are likely to understand if TGD youth wish not to be – or cannot be – involved in school-based physical activity, findings of this study highlight the importance of physical activity for TGD youth. Finally, this study utilized a multi-question approach to identify TGD status, which aligns with recommendations (Calzo & Blashill, 2018; Heidari et al., 2016; Patterson et al., 2017). The approach was inclusive of non-transgender gender-diverse youth, such as those who did not identify as trans but had experiences of feeling like a gender different from the one commonly aligned to their sex assigned at birth.

This study is limited by characteristics of its sample. Across all youth, mean family income was higher than the U.S. population (Heeringa & Berglund, 2020). Given that nearly all sleep parameters were correlated with family income in the sample – consistent with other studies (Sosso et al., 2021) – generalizability across income gradients may be limited. This is additionally confounded by the fact that income gradients for sleep vary by race in the U.S. (Johnson et al., 2019). Pubertal status was another limiting sample characteristic. TGD youth were more pubertally advanced than non-TGD youth (*M* difference = 0.35 pubertal stages), likely due to an overrepresentation of individuals assigned female at birth among TGD youth, as endogenous female puberty begins earlier than natal male puberty (Walvoord, 2010). Pubertal status may have influenced the results for sleep duration in aim 1, as sleep duration decreases

with pubertal advancement (Boatswain-Jacques et al., 2023). However, sleep timing and regularity also vary with pubertal change (Boatswain-Jacques et al., 2023; Randler et al., 2019), and TGD/non-TGD differences were observed even after accounting for pubertal status. Finally, the larger study from which data were drawn did not survey the use of gonadotropin-releasing hormone agonists for pubertal suppression. However, recent work has not found significant changes in sleep following the initiation of exogenous gender-affirming hormone therapy (Morssinkhof et al., 2023).

Findings from this study may provide new reasons for physicians, mental health professionals, and others working with TGD populations in clinical settings to talk with youth about their sleep and physical activity. Though TGD youth have shorter, later, and more irregular sleep than non-TGD youth on average, individual differences point to protective behaviors. Physical activity is a health behavior that TGD youth can utilize to reduce their risk for short sleep. Conversations with youth can highlight the importance of sleep for their daily functioning and long-term health and should seek to identify physical activities that TGD youth feel safe doing.

Chapter 10: General Discussion

In the last decade of the 20th century and first decade of the 21st century, considerable advances were made for the visibility and inclusion of SGM individuals in the U.S (Fish & Russell, 2022; Russell & Fish, 2019). Some changes were tangible, such as marriage equality and non-discrimination laws, while others were more subtle, like the acceptability of same-sex affection on network television (Russell & Fish, 2019). This seemingly led to more people coming out and, importantly, to coming out at earlier ages, with averages now in middle adolescence (M. D. Bishop et al., 2020; Russell & Fish, 2019). While such advances have seemed desirable for many, they have not led to marked improvements in health equity for SGM youth (Porta et al., 2018; Stuart-Maver et al., 2021). At least two major forces may continue to drive SGM health disparities. First, most visibly today, some social progress is being rolled back in states around the country (Cunningham et al., 2022). While forward-moving legislation has focused on adult populations, "backlash" legislation is focused on youth, including laws that restrict youth privacy, prevent the teaching of gender and sexuality development and the teaching of human rights history, block access to healthcare, and exclude youth from school activities (Nakajima & Jin, 2022). The recent rise in anti-SGM legislation is associated with increases in symptoms of mental health problems for SGM youth (Cunningham et al., 2022; Fields & Wotipka, 2022).

Second, SGM youth today find themselves at the center of a "developmental collision" as they navigate two simultaneous processes: adolescent identity development and SGM identity development (Russell & Fish, 2019). For all youth, adolescence is a time of growing awareness of oneself and one's social position, navigating interpersonal dynamics in school, home, and social domains, while undergoing significant physical and psychological changes. For SGM

youth, this normative experience dovetails with a separate normative process of coming into one's own as an SGM individual. This experience includes awareness of one's unique sexual and/or gender identity; exploration, acceptance, and/or rejection of it; and iterative decisions about what to disclose and how and to whom (Russell & Fish, 2019). GM youth are faced with the additional task of deciding how best to express their gender so that it can be understood accurately by others, which often is met with resistance from caregivers (Pullen Sansfaçon et al., 2022). Decisions of disclosure and expression for both SM and GM youth are made with safety in mind, and the stakes are high, as SGM youth are victimized three times as much non-SGM peers (Williams et al., 2021).

Thus, the SGM youth who contributed data to the ABCD Study, and to this dissertation, are at a unique moment in their lives and in the history of their community, as the push and pull of political progress and social backlash intersects with multiple confluent developmental processes. This is the social and intrapersonal context in which the studies presented here sought to learn something about one key aspect of SGM youths' health: their sleep. Sleep is a sort of bellwether for physical and mental wellbeing. When sleep is too short, is of poor quality, or is improperly or inconsistently timed, health suffers (Spruyt, 2019). Because suboptimal sleep is a risk factor for obesity, high blood pressure, insulin resistance, depression, anxiety, and substance use (Matricciani et al., 2019), we can learn a lot about an individual's – or a community's – vulnerability to illness by studying their sleep.

In line with a broader literature showing persistent disparities for SGM wellbeing (Russell & Fish, 2019), SGM youth across both studies of this dissertation had less-optimal sleep than their peers, including shorter sleep duration, later sleep timing, and less regularity in duration and timing. These studies are the first in the field to demonstrate short sleep duration for

SGM youth using actigraphy, and the first to identify later sleep schedule and less regularity by any assessment method. These findings provide additional evidence that sleep is at risk in the SGM community (Butler et al., 2020; Patterson & Potter, 2019), a fact that may spur parents, physicians, mental health providers, and researchers to find ways to promote sleep among SGM populations, especially youth. Fortunately, sleep duration, schedule, and regularity lend themselves well to intervention, as they share one underlying behavior: bedtimes. Early bedtimes across nights would promote longer sleep duration, earlier sleep timing, and greater regularity (Bartel et al., 2015; Campbell et al., 2023) for SGM youth. Though many factors work against nightly early bedtimes for youth (Crowley et al., 2018), this represents a singular behavior change with substantial effects, as longer, earlier, and regular sleep promotes wellness across physical and mental health domains (Matricciani et al., 2019).

Despite the confirmation of sleep inequities for SGM youth, other findings in the present studies provide hope. Sleep quality emerged as a potential source of resilience. SM youth had slightly higher sleep quality than non-SM youth, while GM youth had sleep quality that was not worse than non-GM peers; both findings stand in contrast to earlier work showing poorer self-reported sleep quality for SGM youth (Butler et al., 2020; Levenson et al., 2021). It may be the case that under the condition of suboptimal sleep in other dimensions (shorter duration, later timing, less regularity), sleep quality functions as a compensatory mechanism (El-Sheikh et al., 2019).

Furthermore, in moderation analyses, consistent patterns emerged across multiple measures of the same constructs – sleep quality (across two indicators) was protective against externalizing behaviors (indexed across two dimensions) in the context of discrimination for SM youth, while physical activity (across three parameters) was protective against short sleep

duration for GM youth. Consistency across modes of assessment enhances clarity of patterns and is a strength of this project. At the same time, neither sleep nor physical activity functioned as a moderator in all hypothesized cases, which may be a function of the complex, multi-determined development of mental health and sleep outcomes.

These studies surveyed seven parameters representing four dimensions of sleep: duration, quality, timing, and regularity. Yet pediatric sleep health – a conceptualization of what is needed from sleep in order for youth to thrive – has additional dimensions, including subjective quality (i.e., satisfaction), alertness/daytime sleepiness, and sleep hygiene behaviors (Meltzer et al., 2021). These dimensions were unstudied in this project and could be targets for future research. Though several studies have reported lower subjective quality for SGM youth (e.g., Huang et al., 2018), only one has examined daytime sleepiness (Li et al., 2017), and none has investigated sleep hygiene behaviors among SGM youth (Butler et al., 2020; Patterson & Potter, 2019).

An additional key aspect of pediatric sleep – social jetlag (Wittmann et al., 2006) – also was not captured in an explicit way by this project. Beginning as early as age 5, and increasing until age 17, it is common for youth to have different sleep schedules on weeknights versus weekends (Randler et al., 2019). While weekdays are often driven by school schedules and more-rigidly enforced bedtimes, weekends represent a period of "free sleep" in which youth might stay awake later and sleep in later; by adolescence, this results in longer sleep on weekends (Boatswain-Jacques et al., 2023; Randler et al., 2019). Though this behavior is normative in the sense that most youth engage in this pattern to some degree, extreme amounts – differences in sleep timing of two hours of more between weeknights and weekends – have deletrious effects on physical and mental health (Henderson et al., 2019; Malone et al., 2016). In the present studies, differences between weekday and weekend sleep would have accounted for a

portion of the variance in two parameters – variability in sleep minutes and variability in sleep midpoint. However, such differences were not examined as discrete variables. Given that SGM youth had significantly greater variability by both of these indicators of sleep regularity, future work should examine whether SGM youth have greater social jetlag in childhood and adolescence compared to their non-SGM peers.

Finally, it is acknowledged that the approach taken here to understand the landscape of SGM youth sleep utilized comparisons to non-SGM individuals. While this approach illuminated meaningful differences in key areas of sleep health inequity across the dimensions of sleep duration, timing, and regularity, it also unwittingly contributed to a heterosexual-, cisgender-centric viewpoint by basing non-SGM health as the norm by which SGM health was evaluated. While non-SGM sleep was equivalent to the mean in these studies because of the large number of non-SGM youth who were sampled, more equitable approaches could be considered in the future. A research strategy informed by targeted universalism (Toppin, 2021), for example, could compare the sleep of SGM youth to universal sleep recommendations in order to evaluate if SGM youth are sleeping sufficienctly. Such an approach has been undertaken in the study of self-reported sleep duration among SGM youth (Kann et al., 2016). However, to extend this across all dimensions of pediatric sleep health would require strong evidence and consensus around what is "good enough" in every dimension of sleep health, something our literature does not yet support (Allen et al., 2016). Sleep duration and quality recommendations are fairly well-defined (Hirshkowitz, 2015; Ohayon et al., 2017), but the evidence supporting recommendations for sleep timing and regularity is much less established (Allen et al., 2016), preventing a targeted universalism approach to comprehensive sleep health at this time.

To conclude by way of reflection, as a marriage and family therapist working with SGM youth, I have often been struck that many problems they experience are determined by other people in their lives, such as parents, pastors, peers, and lawmakers. Therefore, the therapeutic process too frequently becomes one of coping with difficult situations until the child or adolescent arrives at a better future. It was from this context that the research questions of my dissertation arose, in an effort to identify behaviors within youths' control that they could utilize to promote their own health. In other words, this project sought to locate agency that SGM youth could use to combat health disparities. While such an effort does not remove the responsibility of parents, pastors, friends, and lawmakers to ensure the safety of all youth, it does bring SGM youth to the table, allowing them to have a say in their own mental and physical health by focusing on their sleep and physical activity. Study I showed that optimal sleep is protective of mental health, while Study II demonstrated that engagement in physical activity is associated with more-optimal sleep. These findings contribute to our understanding of the interconnectedness of health domains and point to potential levers of change for the wellbeing of SGM youth.

References

Achenbach, T. M., & Rescorla, L. (2001). *ASEBA school-age forms & profiles*. ASEBA.

Adam, E. K., Snell, E. K., & Pendry, P. (2007). Sleep timing and quantity in ecological and family context: A nationally representative time-diary study. *Journal of Family Psychology*, *21*(1), 4-19. https://doi.org/10.1037/0893-3200.21.1.4

Adelson, S. L., Stroeh, O. M., & Ng, Y. K. W. (2016). Development and mental health of lesbian, gay, bisexual, or transgender youth in pediatric practice. *Pediatric Clinics*, *63*(6), 971-983. https://doi.org/10.1016/j.pcl.2016.07.002

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interactions*. Sage.

Allen, S. L., Howlett, M. D., Coulombe, J. A., & Corkum, P. V. (2016). ABCs of SLEEPING: A review of the evidence behind pediatric sleep practice recommendations. *Sleep Medicine Reviews*, *29*, 1-14. https://doi.org/10.1016/j.smrv.2015.08.006

Almeida, J., Johnson, R. M., Corliss, H. L., Molnar, B. E., & Azrael, D. (2009). Emotional distress among LGBT youth: The influence of perceived discrimination based on sexual orientation. *Journal of Youth and Adolescence*, *38*(7), 1001-1014. https://doi.org/10.1007/s10964-009-9397-9

Alvidrez, J., Castille, D., Laude-Sharp, M., Rosario, A., & Tabor, D. (2019). The National Institute on Minority Health and Health Disparities research framework. *American Journal of Public Health*, *109*(S1), S16-S20. https://doi.org/10.2105/AJPH.2018.304883

American Academy of Pediatrics. (2021). *AAP-AACAP-CHA Declaration of a National Emergency in Child and Adolescent Mental Health*. Retrieved September 13, 2022 from

https://www.aap.org/en/advocacy/child-and-adolescent-healthy-mental-development/aap-aacap-cha-declaration-of-a-national-emergency-in-child-and-adolescent-mental-health/

Ancoli-Israel, S., Martin, J. L., Blackwell, T., Buenaver, L., Liu, L., Meltzer, L. J., Sadeh, A., Spira, A. P., & Taylor, D. J. (2015). The SBSM guide to actigraphy monitoring: Clinical and research applications. *Behavioral Sleep Medicine*, *13*(sup1), S4-S38. https://doi.org/10.1080/15402002.2015.1046356

Auer, M. K., Liedl, A., Fuss, J., Nieder, T., Briken, P., Stalla, G. K., Hildebrandt, T., Biedermann, S. V., & Sievers, C. (2017). High impact of sleeping problems on quality of life in transgender individuals: A cross-sectional multicenter study. *PLoS One*, *12*(2), e0171640. https://doi.org/10.1371/journal.pone.0171640

Baddam, S. K., Canapari, C. A., Van Noordt, S. J., & Crowley, M. J. (2018). Sleep disturbances in child and adolescent mental health disorders: A review of the variability of objective sleep markers. *Medical Sciences*, *6*(2), 46. https://doi.org/10.3390/medsci6020046

Bagley, E. J., & El-Sheikh, M. (2013). Familial risk moderates the association between sleep and zBMI in children. *Journal of Pediatric Psychology*, *38*(7), 775-784. https://doi.org/10.1093/jpepsy/jst031

Bagot, K., Matthews, S., Mason, M., Squeglia, L. M., Fowler, J., Gray, K., Herting, M., May, A., Colrain, I., & Godino, J. (2018). Current, future and potential use of mobile and wearable technologies and social media data in the ABCD study to increase understanding of contributors to child health. *Developmental Cognitive Neuroscience*, *32*, 121-129. https://doi.org/10.1016/j.dcn.2018.03.008

Barclay, N. L., Eley, T. C., Maughan, B., Rowe, R., & Gregory, A. M. (2011). Associations between diurnal preference, sleep quality and externalizing behaviours: A behavioural

genetic analysis. *Psychological Medicine*, *41*(5), 1029-1040. https://doi.org/10.1017/S0033291710001741

Barrera, E., Millington, K., & Kremen, J. (2022). The medical implications of banning transgender youth from sport participation. *JAMA Pediatrics*, *176*(3), 223-224. https://doi.org/10.1001/jamapediatrics.2021.4597

Bartel, K. A., Gradisar, M., & Williamson, P. (2015). Protective and risk factors for adolescent sleep: A meta-analytic review. *Sleep Medicine Reviews*, *21*, 72-85. https://doi.org/10.1016/j.smrv.2014.08.002

Baum, K. T., Desai, A., Field, J., Miller, L. E., Rausch, J., & Beebe, D. W. (2014). Sleep restriction worsens mood and emotion regulation in adolescents. *Journal of Child Psychology and Psychiatry*, *55*(2), 180-190. https://doi.org/10.1111/jcpp.12125

Becker, S. P., Sidol, C. A., Van Dyk, T. R., Epstein, J. N., & Beebe, D. W. (2017). Intraindividual variability of sleep/wake patterns in relation to child and adolescent functioning: A systematic review. *Sleep Medicine Reviews*, *34*, 94-121. https://doi.org/10.1016/j.smrv.2016.07.004

Beebe, D. W. (2011). Cognitive, behavioral, and functional consequences of inadequate sleep in children and adolescents. *Pediatric Clinics of North America*, *58*(3), 649-665. https://doi.org/10.1016/j.pcl.2011.03.002

Bei, B., Wiley, J. F., Trinder, J., & Manber, R. (2016). Beyond the mean: A systematic review on the correlates of daily intraindividual variability of sleep/wake patterns. *Sleep Medicine Reviews*, *28*, 108-124. https://doi.org/10.1016/j.smrv.2015.06.003

Berger, M., & Sarnyai, Z. (2015). "More than skin deep": Stress neurobiology and mental health consequences of racial discrimination. *Stress*, *18*(1), 1-10. https://doi.org/10.3109/10253890.2014.989204

Biddle, S. J., Ciaccioni, S., Thomas, G., & Vergeer, I. (2019). Physical activity and mental health in children and adolescents: An updated review of reviews and an analysis of causality. *Psychology of Sport Exercise*, *42*, 146-155. https://doi.org/10.1016/j.psychsport.2018.08.011

Bilenberg, N. (1999). The Child Behavior Checklist (CBCL) and related material: Standardization and validation in Danish population based and clinically based samples. *Acta Psychiatrica Scandinavica*, *100*, 2-52. https://doi.org/10.1111/j.1600-0447.1999.tb10703.x

Birkett, M., Newcomb, M. E., & Mustanski, B. (2015). Does it get better? A longitudinal analysis of psychological distress and victimization in lesbian, gay, bisexual, transgender, and questioning youth. *Journal of Adolescent Health*, *56*(3), 280-285. https://doi.org/10.1016/j.jadohealth.2014.10.275

Bishop, A., Overcash, F., McGuire, J., & Reicks, M. (2020). Diet and physical activity behaviors among adolescent transgender students: School survey results. *Journal of Adolescent Health*, *66*(4), 484-490. https://doi.org/10.1016/j.jadohealth.2019.10.026

Bishop, M. D., Fish, J. N., Hammack, P. L., & Russell, S. T. (2020). Sexual identity development milestones in three generations of sexual minority people: A national probability sample. *Developmental Psychology*, *56*(11), 2177. https://doi.org/10.1037/dev0001105

Bisson, A. N. S., Robinson, S. A., & Lachman, M. E. (2019). Walk to a better night of sleep: Testing the relationship between physical activity and sleep. *Sleep Health*, *5*(5), 487-494. https://doi.org/10.1016/j.sleh.2019.06.003

Bixler, E. O., Vgontzas, A. N., Lin, H.-M., Liao, D., Calhoun, S., Vela-Bueno, A., Fedok, F., Vlasic, V., & Graff, G. (2009). Sleep disordered breathing in children in a general population sample: Prevalence and risk factors. *Sleep*, *32*(6), 731-736. https://doi.org/10.1093/sleep/32.6.731

Blake, M. J., Sheeber, L. B., Youssef, G. J., Raniti, M. B., & Allen, N. B. (2017). Systematic review and meta-analysis of adolescent cognitive–behavioral sleep interventions. *Clinical Child and Family Psychology Review*, *20*, 227-249. https://doi.org/10.1007/s10567-017-0234-5

Blashill, A. J., & Calzo, J. P. (2019). Sexual minority children: Mood disorders and suicidality disparities. *Journal of Affective Disorders*, *246*, 96-98. https://doi.org/10.1016/j.jad.2018.12.040

Boatswain-Jacques, A.-F., Dusablon, C., Cimon-Paquet, C., YuTong Guo, É., Ménard, R., Matte-Gagné, C., Carrier, J., & Bernier, A. (2023). From early birds to night owls: A longitudinal study of actigraphy-assessed sleep trajectories during the transition from pre- to early adolescence. *Sleep*, zsad127. https://doi.org/10.1093/sleep/zsad127

Bogart, L. M., Elliott, M. N., Kanouse, D. E., Klein, D. J., Davies, S. L., Cuccaro, P. M., Banspach, S. W., Peskin, M. F., & Schuster, M. A. (2013). Association between perceived discrimination and racial/ethnic disparities in problem behaviors among preadolescent youths. *American Journal of Public Health*, *103*(6), 1074-1081. https://doi.org/10.2105/AJPH.2012.301073

Born, J., & Wilhelm, I. (2012). System consolidation of memory during sleep. *Psychological Research*, *76*(2), 192-203. https://doi.org/10.1007/s00426-011-0335-6

Bouris, A., Everett, B. G., Heath, R. D., Elsaesser, C. E., & Neilands, T. B. (2016). Effects of victimization and violence on suicidal ideation and behaviors among sexual minority and heterosexual adolescents. *LGBT Health*, *3*(2), 153-161. https://doi.org/10.1089/lgbt.2015.0037

Brooks, V. R. (1981). *Minority stress and lesbian women*. Free Press.

Brown, D. M., Kwan, M. Y., Arbour-Nicitopoulos, K. P., & Cairney, J. (2021). Identifying patterns of movement behaviours in relation to depressive symptoms during adolescence: A latent profile analysis approach. *Preventive Medicine*, *143*, 106352. https://doi.org/10.1016/j.ypmed.2020.106352

Buckhalt, J. A. (2011). Insufficient sleep and the socioeconomic status achievement gap. *Child Development Perspectives*, *5*(1), 59-65. https://doi.org/10.1111/j.1750-8606.2010.00151.x

Butler, E. S., McGlinchey, E., & Juster, R. P. (2020). Sexual and gender minority sleep: A narrative review and suggestions for future research. *Journal of Sleep Research*, *29*(1), e12928. https://doi.org/10.1111/jsr.12928

Buysse, D. J. (2014). Sleep health: Can we define it? Does it matter? *Sleep*, *37*(1), 9-17. https://doi.org/10.5665/sleep.3298

Caceres, B. A., Jackman, K. B., Belloir, J., Dworkin, J., Dolezal, C., Duncan, D. T., & Bockting, W. O. (2022). Examining the associations of gender minority stressors with sleep health in gender minority individuals. *Sleep Health*, *8*(2), 153-160. https://doi.org/10.1016/j.sleh.2021.10.006

Calzo, J. P., & Blashill, A. J. (2018). Child sexual orientation and gender identity in the Adolescent Brain Cognitive Development Cohort Study. *JAMA Pediatrics*, *172*(11), 1090-1092. https://doi.org/10.1001/jamapediatrics.2018.2496

Campbell, I. G., Cruz-Basilio, A., Figueroa, J. G., & Bottom, V. B. (2023). Earlier bedtime and its effect on adolescent sleep duration. *Pediatrics*, e2022060607. https://doi.org/10.1542/peds.2022-060607

Carskadon, M. A., Acebo, C., & Seifer, R. (2001). Extended nights, sleep loss, and recovery sleep in adolescents. *Archives Italiennes de Biologie*, *139*(3), 301-312. https://doi.org/10.4449/aib.v139i3.505

Chaput, J.-P., Gray, C. E., Poitras, V. J., Carson, V., Gruber, R., Olds, T., Weiss, S. K., Connor Gorber, S., Kho, M. E., & Sampson, M. (2016). Systematic review of the relationships between sleep duration and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S266-S282. https://doi.org/10.1139/apnm-2015-0627

Chinoy, E. D., Cuellar, J. A., Huwa, K. E., Jameson, J. T., Watson, C. H., Bessman, S. C., Hirsch, D. A., Cooper, A. D., Drummond, S. P., & Markwald, R. R. (2021). Performance of seven consumer sleep-tracking devices compared with polysomnography. *Sleep*, *44*(5), zsaa291. https://doi.org/10.1093/sleep/zsaa291

Cirelli, C., & Tononi, G. (2008). Is sleep essential? *PLoS Biology*, *6*(8), e216. https://doi.org/10.1371/journal.pbio.0060216

Coker, T. R., Elliott, M. N., Kanouse, D. E., Grunbaum, J. A., Schwebel, D. C., Gilliland, M. J., Tortolero, S. R., Peskin, M. F., & Schuster, M. A. (2009). Perceived racial/ethnic discrimination among fifth-grade students and its association with mental health.

American Journal of Public Health, *99*(5), 878-884. https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2008.144329

Colpitts, E., & Gahagan, J. (2016). The utility of resilience as a conceptual framework for understanding and measuring LGBTQ health. *International Journal for Equity in Health*, *15*(60), 1-8. https://doi.org/10.1186/s12939-016-0349-1

Connolly, M. D., Zervos, M. J., Barone II, C. J., Johnson, C. C., & Joseph, C. L. (2016). The mental health of transgender youth: Advances in understanding. *Journal of Adolescent Health*, *59*(5), 489-495. https://doi.org/10.1016/j.jadohealth.2016.06.012

Conron, K. J. (2020). *LGBT youth population in the United States*. The Williams Institute. https://williamsinstitute.law.ucla.edu/wp-content/uploads/LGBT-Youth-US-Pop-Sep-2020.pdf

Crowley, S. J., Wolfson, A. R., Tarokh, L., & Carskadon, M. A. (2018). An update on adolescent sleep: New evidence informing the perfect storm model. *Journal of Adolescence*, *67*, 55-65. https://doi.org/10.1016/j.adolescence.2018.06.001

Cunningham, G. B., Watanabe, N. M., & Buzuvis, E. (2022). Anti-transgender rights legislation and internet searches pertaining to depression and suicide. *PLoS One*, *17*(12), e0279420. https://doi.org/10.1371/journal.pone.0279420

Dai, H., & Hao, J. (2019). Sleep deprivation and chronic health conditions among sexual minority adults. *Behavioral Sleep Medicine*, *17*(3), 254-268. https://doi.org/10.1080/15402002.2017.1342166

Dai, H., Ingram, D. G., & Taylor, J. B. (2020). Hierarchical and mediation analysis of disparities in very short sleep among sexual minority youth in the US, 2015. *Behavioral Sleep Medicine*, *18*(4), 433-446. https://doi.org/10.1080/15402002.2019.1607738

de Zambotti, M., Baker, F. C., & Colrain, I. M. (2015). Validation of sleep-tracking technology compared with polysomnography in adolescents. *Sleep*, *38*(9), 1461-1468. https://doi.org/10.5665/sleep.4990

Díaz-Morales, J. F. (2016). Anxiety during adolescence: Considering morningness-eveningness as a risk factor. *Sleep and Biological Rhythms*, *14*(2), 141-147. https://doi.org/10.1007/s41105-015-0032-8

Diaz, K. M., Krupka, D. J., Chang, M. J., Peacock, J., Ma, Y., Goldsmith, J., Schwartz, J. E., & Davidson, K. W. (2015). Fitbit: An accurate and reliable device for wireless physical activity tracking. *International Journal of Cardiology*, *185*, 138-140. https://doi.org/10.1016/j.ijcard.2015.03.038

Dich, N., Doan, S. N., & Evans, G. W. (2017). In risky environments, emotional children have more behavioral problems but lower allostatic load. *Health Psychology*, *36*(5), 468-476. http://doi.org/10.1037/hea0000459

Diemer, M. A., Mistry, R. S., Wadsworth, M. E., López, I., & Reimers, F. (2013). Best practices in conceptualizing and measuring social class in psychological research. *Analyses of Social Issues and Public Policy*, *13*(1), 77-113. https://doi.org/10.1111/asap.12001

Dohrenwend, B. P. (2000). The role of adversity and stress in psychopathology: Some evidence and its implications for theory and research. *Journal of Health and Social Behavior*, *41*(1), 1-19. https://doi.org/10.2307/2676357

Dominick, G. M., Winfree, K. N., Pohlig, R. T., & Papas, M. A. (2016). Physical activity assessment between consumer-and research-grade accelerometers: A comparative study in free-living conditions. *JMIR mHealth and uHealth*, *4*(3), e6281. https://doi.org/10.2196/mhealth.6281

Döpfner, M., Schmeck, K., Berner, W., Lehmkuhl, G., & Poustka, F. (1994). Reliability and factorial validity of the Child Behavior Checklist--An analysis of a clinical and field sample. *Zeitschrift fur Kinder-und Jugendpsychiatrie*, *22*(3), 189-205. https://europepmc.org/article/med/7975921

Driver, H. S., & Taylor, S. R. (2000). Exercise and sleep. *Sleep Medicine Reviews*, *4*(4), 387-402. https://doi.org/10.1053/smrv.2000.0110

du Pont, A., Rhee, S. H., Corley, R. P., Hewitt, J. K., & Friedman, N. P. (2018). Rumination and psychopathology: Are anger and depressive rumination differentially associated with internalizing and externalizing psychopathology? *Clinical Psychological Science*, *6*(1), 18-31. https://doi.org/10.1177/2167702617720747

Dutil, C., Walsh, J. J., Featherstone, R. B., Gunnell, K. E., Tremblay, M. S., Gruber, R., Weiss, S. K., Cote, K. A., Sampson, M., & Chaput, J.-P. (2018). Influence of sleep on developing brain functions and structures in children and adolescents: A systematic review. *Sleep Medicine Reviews*, *42*, 184-201. https://doi.org/10.1016/j.smrv.2018.08.003

Earnshaw, V. A., Bogart, L. M., Poteat, V. P., Reisner, S. L., & Schuster, M. A. (2016). Bullying among lesbian, gay, bisexual, and transgender youth. *Pediatric Clinics of North America*, *63*(6), 999-1010. https://doi.org/10.1016/j.pcl.2016.07.004

El-Sheikh, M., Gillis, B. T., Saini, E. K., Erath, S. A., & Buckhalt, J. A. (2022). Sleep and disparities in child and adolescent development. *Child Development Perspectives*, *16*(4), 200-207. https://doi.org/10.1111/cdep.12465

El-Sheikh, M., & Hinnant, J. B. (2011). Marital conflict, respiratory sinus arrhythmia, and allostatic load: Interrelations and associations with the development of children's

externalizing behavior. *Development and Psychopathology*, *23*(3), 815-829. https://doi.org/10.1017/S0954579411000320

El-Sheikh, M., & Kelly, R. J. (2017). Family functioning and children's sleep. *Child Development Perspectives*, *11*(4), 264-269. https://doi.org/10.1111/cdep.12243

El-Sheikh, M., Kelly, R. J., Buckhalt, J. A., & Hinnant, J. B. (2010). Children's sleep and adjustment over time: The role of socioeconomic context. *Child Development*, *81*(3), 870-883. https://doi.org/10.1111/j.1467-8624.2010.01439.x

El-Sheikh, M., Saini, E. K., Gillis, B. T., & Kelly, R. J. (2019). Interactions between sleep duration and quality as predictors of adolescents' adjustment. *Sleep Health*, *5*(2), 180-186. https://doi.org/10.1016/j.sleh.2018.11.004

El-Sheikh, M., Shimizu, M., Philbrook, L. E., Erath, S. A., & Buckhalt, J. A. (2020). Sleep and development in adolescence in the context of socioeconomic disadvantage. *Journal of Adolescence*, *83*, 1-11. https://doi.org/10.1016/j.adolescence.2020.06.006

El-Sheikh, M., Tu, K. M., Erath, S. A., & Buckhalt, J. A. (2014). Family stress and adolescents' cognitive functioning: Sleep as a protective factor. *Journal of Family Psychology*, *28*(6), 887-896. https://doi.org/10.1037/fam0000031

El-Sheikh, M., Tu, K. M., Saini, E. K., Fuller-Rowell, T. E., & Buckhalt, J. A. (2016). Perceived discrimination and youths' adjustment: Sleep as a moderator. *Journal of Sleep Research*, *25*(1), 70-77. https://doi.org/10.1111/jsr.12333

El-Sheikh, M., Zeringue, M. M., Saini, E. K., Fuller-Rowell, T. E., & Yip, T. (2022). Discrimination and adjustment in adolescence: The moderating role of sleep. *Sleep*, *45*(1), zsab215. https://doi.org/10.1093/sleep/zsab215

Eom, Y.-J., Lee, H., Kim, R., Choo, S., Yi, H., & Kim, S.-S. (2022). Discrimination keeps transgender people awake at night: A nationwide cross-sectional survey of 583 transgender adults in South Korea. *Sleep Health*, *8*(6), 580-586. https://doi.org/10.1016/j.sleh.2022.06.012

Evans, G. W., Li, D., & Whipple, S. S. (2013). Cumulative risk and child development. *Psychological Bulletin*, *139*(6), 1342-1396. https://doi.org/10.1037/a0031808

Fekedulegn, D., Andrew, M. E., Shi, M., Violanti, J. M., Knox, S., & Innes, K. E. (2020). Actigraphy-based assessment of sleep parameters. *Annals of Work Exposures and Health*, *64*(4), 350-367. https://doi.org/10.1093/annweh/wxaa007

Fenaughty, J., Lucassen, M. F., Clark, T., & Denny, S. (2019). Factors associated with academic achievement for sexual and gender minority and heterosexual cisgender students: Implications from a nationally representative study. *Journal of Youth and Adolescence*, *48*, 1883-1898. https://doi.org/10.1007/s10964-019-01124-w

Fields, X., & Wotipka, C. M. (2022). Effect of LGBT anti-discrimination laws on school climate and outcomes for lesbian, gay, and bisexual high school students. *Journal of LGBT Youth*, *19*(3), 307-329. https://doi.org/10.1080/19361653.2020.1821276

Fish, J. N. (2020). Future directions in understanding and addressing mental health among LGBTQ youth. *Journal of Clinical Child & Adolescent Psychology*, *49*(6), 943-956. https://doi.org/10.1080/15374416.2020.1815207

Fish, J. N., Baams, L., & McGuire, J. K. (2020). Sexual and gender minority mental health among children and youth. In E. D. Rothblum (Ed.), *The Oxford handbook of sexual and gender minority mental health* (pp. 229-243). Oxford University Press.

Fish, J. N., & Russell, S. T. (2022). The paradox of progress for sexual and gender diverse youth. *Current Opinion in Psychology*, *48*, 101498. https://doi.org/10.1016/j.copsyc.2022.101498

Flentje, A., Heck, N. C., Brennan, J. M., & Meyer, I. H. (2020). The relationship between minority stress and biological outcomes: A systematic review. *Journal of Behavioral Medicine*, *43*(5), 673-694. https://doi.org/10.1007/s10865-019-00120-6

Fleshner, F. (2005). Physical activity and stress resistance: Sympathetic nervous system adaptations prevent stress-induced immunosuppression. *Exercise and Sport Sciences Reviews*, *33*(3), 120-126. https://journals.lww.com/acsm-essr/Fulltext/2005/07000/Physical_Activity_and_Stress_Resistance_.00004.aspx

Fornander, M. J., Roberts, T., Egan, A. M., & Moser, C. N. (2022). Weight status, medication use, and recreational activities of treatment-naïve transgender youth. *Childhood Obesity*, *18*(4), 228-236. https://doi.org/10.1089/chi.2021.0155

Franzen-Castle, L., Dunker, T., Chai, W., & Krehbiel, M. (2017). Fitbit and Fitabase technology: Tracking and evaluating youth physical activity. *The Journal of Extension*, *55*(2), 5. https://tigerprints.clemson.edu/joe/vol55/iss2/5

Freitas, D. F., D'Augelli, A. R., Coimbra, S., & Fontaine, A. M. (2016). Discrimination and mental health among gay, lesbian, and bisexual youths in Portugal: The moderating role of family relationships and optimism. *Journal of GLBT Family Studies*, *12*(1), 68-90. https://doi.org/10.1080/1550428X.2015.1070704

Frost, D. M., & Meyer, I. H. (2023). Minority stress theory: Application, critique, and continued relevance. *Current Opinion in Psychology*, *51*, 101579. https://doi.org/10.1016/j.copsyc.2023.101579

Fuligni, A. J., Arruda, E. H., Krull, J. L., & Gonzales, N. A. (2018). Adolescent sleep duration, variability, and peak levels of achievement and mental health. *Child Development*, *89*(2), e18-e28. https://doi.org/10.1111/cdev.12729

Fuller-Rowell, T. E., Cogburn, C. D., Brodish, A. B., Peck, S. C., Malanchuk, O., & Eccles, J. S. (2012). Racial discrimination and substance use: Longitudinal associations and identity moderators. *Journal of Behavioral Medicine*, *35*, 581-590. https://doi.org/10.1007/s10865-011-9388-7

Fuller-Rowell, T. E., Saini, E. K., & El-Sheikh, M. (2023). Social class discrimination during adolescence as a mediator of socioeconomic disparities in actigraphy-assessed and self-reported sleep. *Sleep Medicine*. https://doi.org/10.1016/j.sleep.2023.05.021

Gallup. (2023). *LGBT rights*. Retrieved February 14, 2023 from https://news.gallup.com/poll/1651/gay-lesbian-rights.aspx

Garavan, H., Bartsch, H., Conway, K., Decastro, A., Goldstein, R., Heeringa, S., Jernigan, T., Potter, A., Thompson, W., & Zahs, D. (2018). Recruiting the ABCD sample: Design considerations and procedures. *Developmental Cognitive Neuroscience*, *32*, 16-22. https://doi.org/10.1016/j.dcn.2018.04.004

Gerber, M., Brand, S., Herrmann, C., Colledge, F., Holsboer-Trachsler, E., & Pühse, U. (2014). Increased objectively assessed vigorous-intensity exercise is associated with reduced stress, increased mental health and good objective and subjective sleep in young adults. *Physiology & Behavior*, *135*, 17-24. https://doi.org/10.1016/j.physbeh.2014.05.047

Gilani, M., Wallach, P., & Kyriakou, A. (2021). Levels of physical activity and barriers to sport participation in young people with gender dysphoria. *Journal of Pediatric Endocrinology and Metabolism*, *34*(6), 747-753. https://doi.org/10.1515/jpem-2021-0007

Gillis, B. T., & El-Sheikh, M. (2019). Sleep and adjustment in adolescence: Physical activity as a moderator of risk. *Sleep Health*, *5*(3), 266-272. https://doi.org/10.1016/j.sleh.2019.02.001

Gillis, B. T., Hinnant, J. B., Erath, S. A., & El-Sheikh, M. (2023). Relationship between family income and trajectories of adjustment in adolescence: Sleep and physical activity as moderators. *Journal of Adolescence*, *95*(3), 494-508. https://doi.org/10.1002/jad.12131

Gillis, B. T., Shimizu, M., Philbrook, L. E., & El-Sheikh, M. (2021). Racial disparities in adolescent sleep duration: Physical activity as a protective factor. *Cultural Diversity and Ethnic Minority Psychology*, *27*(1), 118-122. http://dx.doi.org/10.1037/cdp0000422

Goldbach, J. T., & Gibbs, J. J. (2017). A developmentally informed adaptation of minority stress for sexual minority adolescents. *Journal of Adolescence*, *55*, 36-50. https://doi.org/10.1016/j.adolescence.2016.12.007

Goldbach, J. T., Tanner-Smith, E. E., Bagwell, M., & Dunlap, S. (2014). Minority stress and substance use in sexual minority adolescents: A meta-analysis. *Prevention Science*, *15*, 350-363. https://doi.org/10.1007/s11121-013-0393-7

Grasser, L. R., & Jovanovic, T. (2022). Neural impacts of stigma, racism, and discrimination. *Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*, *7*(12), 1225-1234. https://doi.org/10.1016/j.bpsc.2022.06.012

Greene, M. L., Way, N., & Pahl, K. (2006). Trajectories of perceived adult and peer discrimination among Black, Latino, and Asian American adolescents: Patterns and psychological correlates. *Developmental Psychology*, *42*(2), 218. https://doi.org/10.1037/0012-1649.42.2.218

Greenspan, S. B., Griffith, C., & Watson, R. J. (2019). LGBTQ+ youth's experiences and engagement in physical activity: A comprehensive content analysis. *Adolescent Research Review*, *4*, 169-185. https://doi.org/10.1007/s40894-019-00110-4

Gruber, R., Cassoff, J., Frenette, S., Wiebe, S., & Carrier, J. (2012). Impact of sleep extension and restriction on children's emotional lability and impulsivity. *Pediatrics*, *130*(5), e1155-e1161. https://doi.org/10.1542/peds.2012-0564

Guglielmo, D., Gazmararian, J. A., Chung, J., Rogers, A. E., & Hale, L. (2018). Racial/ethnic sleep disparities in US school-aged children and adolescents: A review of the literature. *Sleep Health*, *4*(1), 68-80. https://doi.org/10.1016/j.sleh.2017.09.005

Gunnar, M., & Quevedo, K. (2007). The neurobiology of stress and development. *Annual Review of Psychology*, *58*, 145-173. https://doi.org/10.1146/annurev.psych.58.110405.085605

Hackney, A. C., & Lane, A. R. (2015). Exercise and the regulation of endocrine hormones. *Progress in Molecular Biology and Translational Science*, *135*, 293-311. https://doi.org/10.1016/bs.pmbts.2015.07.001

Hafeez, H., Zeshan, M., Tahir, M. A., Jahan, N., & Naveed, S. (2017). Health care disparities among lesbian, gay, bisexual, and transgender youth: A literature review. *Cureus*, *9*(4). https://doi.org/10.7759/cureus.1184

Hale, L., Troxel, W., & Buysse, D. J. (2020). Sleep health: An opportunity for public health to address health equity. *Annual Review of Public Health*, *41*, 81-99. https://doi.org/10.1146/annurev-publhealth-040119-094412

Halliwell, P. (2018). The psychological & emotional effects of discrimination within the LGBTQ, transgender, & non-binary communities. *Thomas Jefferson Law Review*, *41*, 222-237. https://heinonline.org/HOL/P?h=hein.journals/tjeflr41&i=240

Harry-Hernandez, S., Reisner, S. L., Schrimshaw, E. W., Radix, A., Mallick, R., Callander, D., Suarez, L., Dubin, S., Khan, A., & Duncan, D. T. (2020). Gender dysphoria, mental health, and poor sleep health among transgender and gender nonbinary individuals: A qualitative study in New York City. *Transgender Health*, *5*(1), 59-68. https://doi.org/10.1089/trgh.2019.0007

Haspel, J. A., Anafi, R., Brown, M. K., Cermakian, N., Depner, C., Desplats, P., Gelman, A. E., Haack, M., Jelic, S., & Kim, B. S. (2020). Perfect timing: Circadian rhythms, sleep, and immunity—An NIH workshop summary. *JCI insight*, *5*(1). https://doi.org/10.1172/jci.insight.131487

Hatchel, T., Espelage, D. L., & Huang, Y. (2018). Sexual harassment victimization, school belonging, and depressive symptoms among LGBTQ adolescents: Temporal insights. *American Journal of Orthopsychiatry*, *88*(4), 422. https://doi.org/10.1037/ort0000279

Hatchel, T., Polanin, J. R., & Espelage, D. L. (2021). Suicidal thoughts and behaviors among LGBTQ youth: Meta-analyses and a systematic review. *Archives of Suicide Research*, *25*(1), 1-37. https://doi.org/10.1080/13811118.2019.1663329

Hatzenbuehler, M. L., McLaughlin, K. A., & Nolen-Hoeksema, S. (2008). Emotion regulation and internalizing symptoms in a longitudinal study of sexual minority and heterosexual adolescents. *Journal of Child Psychology and Psychiatry*, *49*(12), 1270-1278. https://doi.org/10.1111/j.1469-7610.2008.01924.x

Hatzenbuehler, M. L., Nolen-Hoeksema, S., & Dovidio, J. (2009). How does stigma “get under the skin”? The mediating role of emotion regulation. *Psychological Science*, *20*(10), 1282-1289. https://doi.org/10.1111/j.1467-9280.2009.02441.x

Hatzenbuehler, M. L., & Pachankis, J. E. (2016). Stigma and minority stress as social determinants of health among lesbian, gay, bisexual, and transgender youth: Research evidence and clinical implications. *Pediatric Clinics of North America*, *63*(6), 985-997. https://doi.org/10.1016/j.pcl.2016.07.003

Heeringa, S. G., & Berglund, P. A. (2020). A guide for population-based analysis of the Adolescent Brain Cognitive Development (ABCD) Study baseline data. *BioRxiv*. https://doi.org/10.1101/2020.02.10.942011

Heidari, S., Babor, T. F., De Castro, P., Tort, S., & Curno, M. (2016). Sex and gender equity in research: Rationale for the SAGER guidelines and recommended use. *Research Integrity and Peer Review*, *1*, 2. https://doi.org/10.1186/s41073-016-0007-6

Henderson, S. E., Brady, E. M., & Robertson, N. (2019). Associations between social jetlag and mental health in young people: A systematic review. *Chronobiology International*, *36*(10), 1316-1333. https://doi.org/10.1080/07420528.2019.1636813

Herman, J. L., Flores, A. R., & O'Neill, K. K. (2022). *How many adults and youth identify as transgender in the United States?* The Williams Institute. https://williamsinstitute.law.ucla.edu/wp-content/uploads/Trans-Pop-Update-Jun-2022.pdf

Herts, K. L., McLaughlin, K. A., & Hatzenbuehler, M. L. (2012). Emotion dysregulation as a mechanism linking stress exposure to adolescent aggressive behavior. *Journal of Abnormal Child Psychology*, *40*, 1111-1122. https://doi.org/10.1007/s10802-012-9629-4

Hills, A. P., Mokhtar, N., & Byrne, N. M. (2014). Assessment of physical activity and energy expenditure: An overview of objective measures. *Frontiers in Nutrition*, *1*, 5. https://doi.org/10.3389/fnut.2014.00005

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., Ware, J. C., & Adams Hillard, P. J. (2015). National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. *Sleep Health*, *1*(1), 40-43. https://doi.org/10.1016/j.sleh.2014.12.010

Hirshkowitz, M., Whiton, K., Albert, S. M., Alessi, C., Bruni, O., DonCarlos, L., Hazen, N., Herman, J., Adams Hillard, P. J., Katz, E. S., Kheirandish-Gozal, L., Neubauer, D. N., O'Donnell, A. E., Ohayon, M., Peever, J., Rawding, R., Sachdeva, R. C., Setters, B., Vitiello, M. V., & Ware, J. C. (2015). National Sleep Foundation's updated sleep duration recommendations: Final report. *Sleep Health*, *1*(4), 233-243. https://doi.org/10.1016/j.sleh.2015.10.004

Hosker, D. K., Elkins, R. M., & Potter, M. P. (2019). Promoting mental health and wellness in youth through physical activity, nutrition, and sleep. *Child and Adolescent Psychiatric Clinics*, *28*(2), 171-193. https://doi.org/10.1016/j.chc.2018.11.010

Huang, Y., Li, P., Lai, Z., Jia, X., Xiao, D., Wang, T., Guo, L., & Lu, C. (2018). Role of sleep quality in mediating the relationship between sexual minority status and suicidal behavior among Chinese adolescents. *Psychology Research and Behavior Management*, *11*, 607-615. https://doi.org/10.2147/PRBM.S186586

Hyde, A. L., Maher, J. P., & Elavsky, S. (2013). Enhancing our understanding of physical activity and wellbeing with a lifespan perspective. *International Journal of Wellbeing*, *3*(1), 98-115. https://doi.org/10.5502/ijw.v3i1.6

Jackson, C. L., Walker, J. R., Brown, M. K., Das, R., & Jones, N. L. (2020). A workshop report on the causes and consequences of sleep health disparities. *Sleep*, *43*(8), zsaa037. https://doi.org/10.1093/sleep/zsaa037

Jankowski, K. S. (2016). Morningness-eveningness and depressive symptoms: Test on the components level with CES-D in Polish students. *Journal of Affective Disorders*, *196*, 47-53. https://doi.org/10.1016/j.jad.2016.02.015

Johns, M. M., Lowry, R., Andrzejewski, J., Barrios, L. C., Demissie, Z., McManus, T., Rasberry, C. N., Robin, L., & Underwood, J. M. (2019). Transgender identity and experiences of violence victimization, substance use, suicide risk, and sexual risk behaviors among high school students—19 states and large urban school districts, 2017. *Morbidity and Mortality Weekly Report*, *68*(3), 67-71. https://doi.org/10.15585/mmwr.mm6803a3

Johns, M. M., Lowry, R., Haderxhanaj, L. T., Rasberry, C. N., Robin, L., Scales, L., Stone, D., & Suarez, N. A. (2020). Trends in violence victimization and suicide risk by sexual identity among high school students—Youth Risk Behavior Survey, United States, 2015–2019. *Morbidity and Morality Weekly Report—Supplements*, *69*(1), 19-27. https://doi.org/10.15585/mmwr.su6901a3

Johnson, D. A., Jackson, C. L., Williams, N. J., & Alcántara, C. (2019). Are sleep patterns influenced by race/ethnicity – a marker of relative advantage or disadvantage? Evidence to date. *Nature and Science of Sleep*, *11*, 79-95. https://doi.org/10.2147/NSS.S169312

Kalak, N., Gerber, M., Kirov, R., Mikoteit, T., Yordanova, J., Pühse, U., Holsboer-Trachsler, E., & Brand, S. (2012). Daily morning running for 3 weeks improved sleep and psychological functioning in healthy adolescents compared with controls. *Journal of Adolescent Health*, *51*(6), 615-622. https://doi.org/10.1016/j.jadohealth.2012.02.020

Kann, L., Olsen, E. O. M., McManus, T., Harris, W. A., Shanklin, S. L., Flint, K. H., Queen, B., Lowry, R., Chyen, D., & Whittle, L. (2016). Sexual identity, sex of sexual contacts, and health-related behaviors among students in grades 9–12—United States and selected sites, 2015. *Morbidity and Mortality Weekly Report: Surveillance Summaries*, *65*(9), 1-202. https://www.jstor.org/stable/24805814

Karcher, N. R., & Barch, D. M. (2021). The ABCD study: Understanding the development of risk for mental and physical health outcomes. *Neuropsychopharmacology*, *46*(1), 131-142. https://doi.org/10.1038/s41386-020-0736-6

Kelly, R. J., Zeringue, M. M., & El-Sheikh, M. (2022). Adolescents' sleep and adjustment: Reciprocal effects. *Child Development*, *93*(2), 540-555. https://doi.org/10.1111/cdev.13703

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). Guilford Press.

Kolp, H., Wilder, S., Andersen, C., Johnson, E., Horvath, S., Gidycz, C. A., & Shorey, R. (2020). Gender minority stress, sleep disturbance, and sexual victimization in transgender and gender nonconforming adults. *Journal of Clinical Psychology*, *76*(4), 688-698. https://doi.org/10.1002/jclp.22880

Kosciw, J. G., Clark, C. M., Truong, N. L., & Zongrone, A. D. (2020). *The 2019 National School Climate Survey: The experiences of lesbian, gay, bisexual, transgender, and queer youth in our nation's schools. A report from GLSEN*. ERIC. https://doi.org/https://eric.ed.gov/?id=ED608534

Krieger, N. (2014). Discrimination and health inequities. *International Journal of Health Services*, *44*(4), 643-710. https://doi.org/10.2190/HS.44.4.b

Kuhlman, K. R., Geiss, E. G., Vargas, I., & Lopez-Duran, N. (2018). HPA-axis activation as a key moderator of childhood trauma exposure and adolescent mental health. *Journal of Abnormal Child Psychology*, *46*(1), 149-157. https://doi.org/10.1007/s10802-017-0282-9

Kulick, A., Wernick, L. J., Espinoza, M. A. V., Newman, T. J., & Dessel, A. B. (2019). Three strikes and you're out: Culture, facilities, and participation among LGBTQ youth in sports. *Sport, Education and Society*, *24*(9), 939-953. https://doi.org/10.1080/13573322.2018.1532406

Lemola, S., Schwarz, B., & Siffert, A. (2012). Interparental conflict and early adolescents' aggression: Is irregular sleep a vulnerability factor? *Journal of Adolescence*, *35*(1), 97-105. https://doi.org/10.1016/j.adolescence.2011.06.001

Leproult, R., & Van Cauter, E. (2009). Role of sleep and sleep loss in hormonal release and metabolism. In S. Loche, M. Cappa, L. Ghizzoni, M. Maghnie, & M. O. Savage (Eds.), *Pediatric neuroendocrinology* (Vol. 17, pp. 11-21). Karger. https://doi.org/https://doi.org/10.1159/000262524

Levenson, J. C., Thoma, B. C., Hamilton, J. L., Choukas-Bradley, S., & Salk, R. H. (2021). Sleep among gender minority adolescents. *Sleep*, *44*(3), zsaa185. https://doi.org/10.1093/sleep/zsaa185

Li, P., Huang, Y., Guo, L., Wang, W., Xi, C., Lei, Y., Luo, M., Pan, S., Deng, X., & Zhang, W.-h. (2017). Is sexual minority status associated with poor sleep quality among adolescents? Analysis of a national cross-sectional survey in Chinese adolescents. *BMJ Open*, *7*(12), e017067. https://doi.org/10.1136/bmjopen-2017-017067

Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., Kelly, P., Smith, J., Raine, L., & Biddle, S. (2016). Physical activity for cognitive and mental

health in youth: A systematic review of mechanisms. *Pediatrics*, *138*(3), e20161642. https://doi.org/10.1542/peds.2016-1642

Lucien, J. N., Ortega, M. T., & Shaw, N. D. (2021). Sleep and puberty. *Current Opinion in Endocrine and Metabolic Research*, *17*, 1-7. https://doi.org/10.1016/j.coemr.2020.09.009

Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, *71*, 543-562. https://doi.org/10.1111/1467-8624.00164

Maher, C. A., & Olds, T. S. (2011). Minutes, MET minutes, and METs: Unpacking socio-economic gradients in physical activity in adolescents. *Journal of Epidemiology & Community Health*, *65*(2), 160-165. http://dx.doi.org/10.1136/jech.2009.099796

Malone, S. K., Zemel, B., Compher, C., Souders, M., Chittams, J., Thompson, A. L., Pack, A., & Lipman, T. H. (2016). Social jet lag, chronotype and body mass index in 14–17-year-old adolescents. *Chronobiology International*, *33*(9), 1255-1266. https://doi.org/10.1080/07420528.2016.1196697

Martos, A. J., Wilson, P. A., & Meyer, I. H. (2017). Lesbian, gay, bisexual, and transgender (LGBT) health services in the United States: Origins, evolution, and contemporary landscape. *PLoS One*, *12*(7), e0180544. https://doi.org/10.1371/journal.pone.0180544

Masten, A. S. (2001). Ordinary magic: Resilience processes in development. *American Psychologist*, *56*(3), 227-238. https://doi.org/10.1037//0003-066X.56.3.227

Matijczak, A., McDonald, S. E., Tomlinson, C. A., Murphy, J. L., & O’Connor, K. (2021). The moderating effect of comfort from companion animals and social support on the relationship between microaggressions and mental health in LGBTQ+ emerging adults. *Behavioral Sciences*, *11*(1), 1. https://doi.org/10.3390/bs11010001

Matricciani, L., Paquet, C., Galland, B., Short, M., & Olds, T. (2019). Children's sleep and health: A meta-review. *Sleep Medicine Reviews*, *46*, 136-150. https://doi.org/10.1016/j.smrv.2019.04.011

McEwen, B. S. (1998). Stress, adaptation, and disease: Allostasis and allostatic load. *Annals of the New York Academy of Sciences*, *840*, 33-44.

McPhie, M. L., & Rawana, J. S. (2015). The effect of physical activity on depression in adolescence and emerging adulthood: A growth-curve analysis. *Journal of Adolescence*, *40*, 83-92. https://doi.org/10.1016/j.adolescence.2015.01.008

Mead, M. P., Baron, K., Sorby, M., & Irish, L. A. (2019). Daily associations between sleep and physical activity. *International Journal of Behavioral Medicine*, *26*(5), 562-568. https://doi.org/10.1007/s12529-019-09810-6

Meijer, A. M., Reitz, E., Dekovic, M., van den Wittenboer, G. L., & Stoel, R. D. (2010). Longitudinal relations between sleep quality, time in bed and adolescent problem behaviour. *Journal of Child Psychology and Psychiatry*, *51*(11), 1278-1286. https://doi.org/10.1111/j.1469-7610.2010.02261.x

Meltzer, L. J., Montgomery-Downs, H. E., Insana, S. P., & Walsh, C. M. (2012). Use of actigraphy for assessment in pediatric sleep research. *Sleep Medicine Reviews*, *16*(5), 463-475. https://doi.org/10.1016/j.smrv.2011.10.002

Meltzer, L. J., Williamson, A. A., & Mindell, J. A. (2021). Pediatric sleep health: It matters, and so does how we define it. *Sleep Medicine Reviews*, *57*, 101425. https://doi.org/10.1016/j.smrv.2021.101425

Mereish, E. H. (2019). Substance use and misuse among sexual and gender minority youth. *Current Opinion in Psychology*, *30*, 123-127. https://doi.org/10.1016/j.copsyc.2019.05.002

Meyer, I. H. (1995). Minority stress and mental health in gay men. *Journal of Health and Social Behavior*, 38-56. https://doi.org/10.2307/2137286

Meyer, I. H. (2003). Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: Conceptual issues and research evidence. *Psychological Bulletin*, *129*(5), 674. http://dx.doi.org/10.1037/0033-2909.129.5.674

Meyer, I. H. (2015). Resilience in the study of minority stress and health of sexual and gender minorities. *Psychology of Sexual Orientation and Gender Diversity*, *2*(3), 209-213. https://doi.org/10.1037/sgd0000132

Millar, B. M., Goedel, W. C., & Duncan, D. T. (2019). Sleep health among sexual and gender minorities. In D. T. Duncan, I. Kawachi, & S. Redline (Eds.), *The social epidemiology of sleep* (pp. 187-204). Oxford University Press.

Mindell, J. A., Meltzer, L. J., Carskadon, M. A., & Chervin, R. D. (2009). Developmental aspects of sleep hygiene: Findings from the 2004 National Sleep Foundation Sleep in America Poll. *Sleep Medicine*, *10*, 771-779. https://doi.org/10.1016/j.sleep.2008.07.016

Morales-Ghinaglia, N., & Fernandez-Mendoza, J. (2023). Sleep variability and regularity as contributors to obesity and cardiometabolic health in adolescence. *Obesity*, *31*(3), 597-614. https://doi.org/10.1002/oby.23667

Morrissey, B., Taveras, E., Allender, S., & Strugnell, C. (2020). Sleep and obesity among children: A systematic review of multiple sleep dimensions. *Pediatric Obesity*, *15*(4), e12619. https://doi.org/10.1111/ijpo.12619

Morssinkhof, M. W., Wiepjes, C. M., Bosman, B. W., Kinds, J., Fisher, A. D., Greenman, Y., Kreukels, B. P., T'Sjoen, G., van der Werf, Y. D., & den Heijer, M. (2023). Sex hormones, insomnia, and sleep quality: Subjective sleep in the first year of hormone use in transgender persons. *Sleep Medicine*, *107*, 316-326. https://doi.org/10.1016/j.sleep.2023.04.028

Nakajima, K., & Jin, C. H. (2022). Bills targeting trans youth are growing more common — and radically reshaping lives. *NPR*. https://www.npr.org/2022/11/28/1138396067/transgender-youth-bills-trans-sports

National Academies of Sciences, Engineering, and Medicine. (2022). *Reducing inequalities between LGBTQ adolescents and cisgender, heterosexual adolescents*. National Academies Press. https://doi.org/10.17226/26383

National Heart, Lung, and Blood Institute,. (2021). *National Institutes of Health sleep research plan*. Retrieved September 17, 2022 from https://www.nhlbi.nih.gov/all-publications-and-resources/2021-nih-health-sleep-research-plan

Nelson, B. W., Flannery, J. E., Flournoy, J., Duell, N., Prinstein, M. J., & Telzer, E. (2022). Concurrent and prospective associations between fitbit wearable-derived RDoC arousal and regulatory constructs and adolescent internalizing symptoms. *Journal of Child Psychology and Psychiatry*, *63*(3), 282-295. https://doi.org/10.1111/jcpp.13471

Norris, R., Carroll, D., & Cochrane, R. (1992). The effects of physical activity and exercise training on psychological stress and well-being in an adolescent population. *Journal of Psychosomatic Research*, *36*(1), 55-65. https://doi.org/10.1016/0022-3999(92)90114-H

Novak, J. R., & Gillis, B. T. (2022). A primer on sleep for MFTs: Implications and practical considerations. *Journal of Marital and Family Therapy*, *48*(2), 543-559. https://doi.org/10.1111/jmft.12528

Office of the Surgeon General. (2021). *Protecting Youth Mental Health: The U.S. Surgeon General's Advisory*. Retrieved September 13, 2022 from https://www.hhs.gov/sites/default/files/surgeon-general-youth-mental-health-advisory.pdf

Ohayon, M., Wickwire, E. M., Hirshkowitz, M., Albert, S. M., Avidan, A., Daly, F. J., Dauvilliers, Y., Ferri, R., Fung, C., Gozal, D., Hazen, N., Krystal, A., Lichstein, K., Mallampalli, M., Plazzi, G., Rawding, R., Scheer, F. A., Somers, V., & Vitiello, M. V. (2017). National Sleep Foundation's sleep quality recommendations: First report. *Sleep Health*, *3*(1), 6-19. https://doi.org/10.1016/j.sleh.2016.11.006

Palmer, C. A., & Alfano, C. A. (2017). Sleep and emotion regulation: An organizing, integrative review. *Sleep Medicine Reviews*, *31*, 6-16. https://doi.org/10.1016/j.smrv.2015.12.006

Paluska, S. A., & Schwenk, T. L. (2000). Physical activity and mental health. *Sports Medicine*, *29*(3), 167-180. https://doi.org/10.2165/00007256-200029030-00003

Pang, K. C., Hoq, M., & Steensma, T. D. (2022). Negative media coverage as a barrier to accessing care for transgender children and adolescents. *JAMA Network Open*, *5*(2), e2138623. https://doi.org/10.1001/jamanetworkopen.2021.38623

Parker, K., Horowitz, J. M., & Brown, A. (2022). *Americans' complex views on gender identity and transgender issues*. Pew Research Center. Retrieved February 14, 2023 from https://www.pewresearch.org/social-trends/2022/06/28/americans-complex-views-on-gender-identity-and-transgender-issues/

Patterson, C. J., & Potter, E. C. (2019). Sexual orientation and sleep difficulties: A review of research. *Sleep Health*, *5*(3), 227-235. https://doi.org/10.1016/j.sleh.2019.02.004

Patterson, J. G., Jabson, J. M., & Bowen, D. J. (2017). Measuring sexual and gender minority populations in health surveillance. *LGBT Health*, *4*(2), 82-105. https://doi.org/10.1089/lgbt.2016.0026

Pedersen, B. K. (2019). Physical activity and muscle–brain crosstalk. *Nature Reviews Endocrinology*, *15*(7), 383-392. https://doi.org/10.1038/s41574-019-0174-x

Pesonen, A.-K., Sjöstén, N. M., Matthews, K. A., Heinonen, K., Martikainen, S., Kajantie, E., Tammelin, T., Eriksson, J. G., Strandberg, T., & Räikkönen, K. (2011). Temporal associations between daytime physical activity and sleep in children. *PLoS One*, *6*(8), e22958. https://doi.org/10.1371/journal.pone.0022958

Petersen, A. C., Crockett, L., Richards, M., & Boxer, A. (1988). A self-report measure of pubertal status: Reliability, validity, and initial norms. *Journal of Youth and Adolescence*, *17*(2), 117-133. https://doi.org/10.1037/0012-1649.40.6.1188

Pew Research Center. (2022). *American Trends Panel*. https://www.pewresearch.org/wp-content/uploads/2022/06/trans-pop-estimate-SR-topline_final.pdf

Philbrook, L. E., & El-Sheikh, M. (2016). Associations between neighborhood context, physical activity, and sleep in adolescents. *Sleep Health*, *2*(3), 205-210. https://doi.org/10.1016/j.sleh.2016.05.008

Philbrook, L. E., Shimizu, M., Erath, S. A., Hinnant, J. B., & El-Sheikh, M. (2021). Longitudinal associations between adolescents' sleep and adjustment: Respiratory sinus arrhythmia as a moderator. *Developmental Psychobiology*, *63*(S1), e22220. https://doi.org/10.1002/dev.22220

Porta, C. M., Watson, R. J., Doull, M., Eisenberg, M. E., Grumdahl, N., & Saewyc, E. (2018). Trend disparities in emotional distress and suicidality among sexual minority and heterosexual Minnesota adolescents from 1998 to 2010. *Journal of School Health*, *88*(8), 605-614. https://doi.org/10.1111/josh.12650

Poteat, V. P., Scheer, J. R., & Mereish, E. H. (2014). Factors affecting academic achievement among sexual minority and gender-variant youth. In L. S. Liben & R. S. Bigler (Eds.), *Advances in child development and behavior: The role of gender in educational contexts and outcomes* (Vol. 47, pp. 261-300). https://doi.org/https://doi.org/10.1016/bs.acdb.2014.04.005

Price-Feeney, M., Green, A. E., & Dorison, S. (2020). Understanding the mental health of transgender and nonbinary youth. *Journal of Adolescent Health*, *66*(6), 684-690. https://doi.org/10.1016/j.jadohealth.2019.11.314

Pullen Sansfaçon, A., Medico, D., Gelly, M., Kirichenko, V., & Suerich-Gulick, F. (2022). Blossoming child, mourning parent: A qualitative study of trans children and their parents navigating transition. *Journal of Child and Family Studies*, *31*(7), 1771-1784. https://doi.org/10.1007/s10826-021-02178-w

Quist, J. S., Sjödin, A., Chaput, J.-P., & Hjorth, M. F. (2016). Sleep and cardiometabolic risk in children and adolescents. *Sleep Medicine Reviews*, *29*, 76-100. https://doi.org/10.1016/j.smrv.2015.09.001

Randler, C., Vollmer, C., Kalb, N., & Itzek-Greulich, H. (2019). Breakpoints of time in bed, midpoint of sleep, and social jetlag from infancy to early adulthood. *Sleep Medicine*, *57*, 80-86. https://doi.org/10.1016/j.sleep.2019.01.023

Reidy, B. L., Raposa, E. B., Brennan, P. A., Hammen, C. L., Najman, J. M., & Johnson, K. C. (2016). Prospective associations between chronic youth sleep problems and young adult health. *Sleep Health*, *2*(1), 69-74. https://doi.org/10.1016/j.sleh.2015.11.005

Rith-Najarian, L. R., Daleiden, E. L., & Chorpita, B. F. (2016). Evidence-based decision making in youth mental health prevention. *American Journal of Preventive Medicine*, *51*(4), S132-S139. https://doi.org/10.1016/j.amepre.2016.05.018

Robinson, J. L., Erath, S. A., Kana, R. K., & El-Sheikh, M. (2018). Neurophysiological differences in the adolescent brain following a single night of restricted sleep – A 7T fMRI study. *Developmental Cognitive Neuroscience*, *31*, 1-10. https://doi.org/10.1016/j.dcn.2018.03.012

Rosenthal, S. M. (2016). Transgender youth: Current concepts. *Annals of Pediatric Endocrinology & Metabolism*, *21*(4), 185-192. https://doi.org/10.6065/apem.2016.21.4.185

Russell, S. T., & Fish, J. N. (2016). Mental health in lesbian, gay, bisexual, and transgender (LGBT) youth. *Annual Review of Clinical Psychology*, *12*, 465-487. https://doi.org/10.1146/annurev-clinpsy-021815-093153

Russell, S. T., & Fish, J. N. (2019). Sexual minority youth, social change, and health: A developmental collision. *Research in Human Development*, *16*(1), 5-20. https://doi.org/10.1080/15427609.2018.1537772

Russo, P. M., Bruni, O., Lucidi, F., Ferri, R., & Violani, C. (2007). Sleep habits and circadian preference in Italian children and adolescents. *Journal of Sleep Research*, *16*(2), 163-169. https://doi.org/10.1111/j.1365-2869.2007.00584.x

Rutter, M. (1987). Psychosocial resilience and protective mechanisms. *American Journal of Orthopsychiatry*, *57*(3), 316-331. https://doi.org/10.1111/j.1939-0025.1987.tb03541.x

Rutter, M. E. (1993). Resilience: Some conceptual considerations. *Journal of Adolescent Health*, *14*(8), 626-631. https://doi.org/10.1016/1054-139X(93)90196-V

Ryan, M. P. (2008). The antidepressant effects of physical activity: Mediating self-esteem and self-efficacy mechanisms. *Psychology & Health*, *23*(3), 279-307. https://doi.org/10.1080/14768320601185502

Sadeh, A. (2015). III. Sleep assessment methods. *Monographs of the Society for Research in Child Development*, *80*(1), 33-48. https://doi.org/10.1111/mono.12143

Sadeh, A., & El-Sheikh, M. (2015). XI. Sleep and development: Conclusions and future directions. *Monographs of the Society for Research in Child Development*, *80*(1), 177-181. https://doi.org/10.1111/mono.12151

Sadeh, A., Gruber, R., & Raviv, A. (2003). The effects of sleep restriction and extension on school-age children: What a difference an hour makes. *Child Development*, *74*(2), 444-455. https://doi.org/10.1111/1467-8624.7402008

Sameroff, A. (2010). A unified theory of development: A dialectic integration of nature and nurture. *Child Development*, *81*(1), 6-22. https://doi.org/10.1111/j.1467-8624.2009.01378.x

Sameroff, A. J. (1983). Development systems: Contexts and evolution. In W. Kessen (Ed.), *Handbook of child psychology: History, theory, and methods* (Vol. 1, pp. 237-294). Wiley.

Sameroff, A. J. (2000). Developmental systems and psychopathology. *Development & Psychopathology*, *12*(3), 297-312. https://doi.org/10.1017/S0954579400003035

Schmitt, M. T., Branscombe, N. R., Postmes, T., & Garcia, A. (2014). The consequences of perceived discrimination for psychological well-being: A meta-analytic review. *Psychological Bulletin*, *140*(4), 921-948. https://doi.org/10.1037/a0035754

Seo, D.-i., Jun Sung, D., & So, W.-Y. (2015). Differences in perceived health status outcomes among heterosexual, homosexual (gay or lesbian) and bisexual Korean adolescents. *Universitas Psychologica*, *14*(1), 339-344. https://doi.org/10.11144/Javeriana.upsy14-1.dphs

Shen, J., Barbera, J., & Shapiro, C. M. (2006). Distinguishing sleepiness and fatigue: Focus on definition and measurement. *Sleep Medicine Reviews*, *10*(1), 63-76. https://doi.org/10.1016/j.smrv.2005.05.004

Shimizu, M., Zeringue, M. M., Erath, S. A., Hinnant, J. B., & El-Sheikh, M. (2021). Trajectories of sleep problems in childhood: Associations with mental health in adolescence. *Sleep*, *44*(3), zsaa190. https://doi.org/10.1093/sleep/zsaa190

Shochat, T., Cohen-Zion, M., & Tzischinsky, O. (2014). Functional consequences of inadequate sleep in adolescents: A systematic review. *Sleep Medicine Reviews*, *18*(1), 75-87. https://doi.org/10.1016/j.smrv.2013.03.005

Short, M. A., Blunden, S., Rigney, G., Matricciani, L., Coussens, S., Reynolds, C. M., & Galland, B. (2018). Cognition and objectively measured sleep duration in children: A systematic review and meta-analysis. *Sleep Health*, *4*(3), 292-300. https://doi.org/10.1016/j.sleh.2018.02.004

Short, M. A., Gradisar, M., Lack, L. C., Wright, H., & Carskadon, M. A. (2012). The discrepancy between actigraphic and sleep diary measures of sleep in adolescents. *Sleep Medicine*, *13*(4), 378-384. https://doi.org/10.1016/j.sleep.2011.11.005

Short, M. A., Gradisar, M., Lack, L. C., Wright, H. R., Dewald, J. F., Wolfson, A. R., & Carskadon, M. A. (2013). A cross-cultural comparison of sleep duration between US and Australian adolescents: The effect of school start time, parent-set bedtimes, and extracurricular load. *Health Education & Behavior*, *40*(3), 323-330. https://doi.org/10.1177/1090198112451266

Sigfusdottir, I. D., Asgeirsdottir, B. B., Sigurdsson, J. F., & Gudjonsson, G. H. (2011). Physical activity buffers the effects of family conflict on depressed mood: A study on adolescent girls and boys. *Journal of Adolescence*, *34*(5), 895-902. https://doi.org/10.1016/j.adolescence.2011.01.003

Simon, E. B., Vallat, R., Barnes, C. M., & Walker, M. P. (2020). Sleep loss and the socio-emotional brain. *Trends in Cognitive Sciences*, *24*(6), 435-450. https://doi.org/10.1016/j.tics.2020.02.003

Smith, K. (2023). Gender dysphoria vs. gender euphoria. In *Gender: Reflections and Intersections*. BCcampus. https://pressbooks.bccampus.ca/gri1/chapter/__unknown__-16/

Snedecor, G. W., & Cochran, W. G. (1989). *Statistical methods* (8th ed.). Iowa State University Press.

Sosso, F. A. E., Holmes, S. D., & Weinstein, A. A. (2021). Influence of socioeconomic status on objective sleep measurement: A systematic review and meta-analysis of actigraphy studies. *Sleep Health*, *7*(4), 417-428. https://doi.org/10.1016/j.sleh.2021.05.005

Spruit, A., Assink, M., van Vugt, E., van der Put, C., & Stams, G. J. (2016). The effects of physical activity interventions on psychosocial outcomes in adolescents: A meta-analytic review. *Clinical Psychology Review*, *45*, 56-71. https://doi.org/10.1016/j.cpr.2016.03.006

Spruyt, K. (2019). A review of developmental consequences of poor sleep in childhood. *Sleep Medicine*, *60*, 3-12. https://doi.org/10.1016/j.sleep.2018.11.021

Stieglitz, K. A. (2010). Development, risk, and resilience of transgender youth. *Journal of the Association of Nurses in AIDS Care*, *21*(3), 192-206. https://doi.org/10.1016/j.jana.2009.08.004

Storfer-Isser, A., Patel, S. R., Babineau, D. C., & Redline, S. (2012). Relation between sleep duration and BMI varies by age and sex in youth age 8–19. *Pediatric Obesity*, *7*(1), 53-64. https://doi.org/10.1111/j.2047-6310.2011.00008.x

Stuart-Maver, S. L., Foley Nicpon, M., Stuart-Maver, C. I., & Mahatmya, D. (2021). Trends and disparities in suicidal behaviors for heterosexual and sexual minority youth 1995–2017. *Psychology of Sexual Orientation and Gender Diversity*, *10*(2), 279–291. https://doi.org/10.1037/sgd0000525

Substance Abuse and Mental Health Services Administration. (2023). *Moving beyond change efforts: Evidence and action to support and affirm LGBTQI+ youth*. Center for Substance Abuse Prevention.

Sullivan, G. M., & Feinn, R. (2012). Using effect size—or why the P value is not enough. *Journal of Graduate Medical Education*, *4*(3), 279-282. https://doi.org/10.4300/JGME-D-12-00156.1

Tan, K. K., Treharne, G. J., Ellis, S. J., Schmidt, J. M., & Veale, J. F. (2020). Gender minority stress: A critical review. *Journal of Homosexuality*, *67*(10), 1471-1489. https://doi.org/10.1080/00918369.2019.1591789

Testa, R. J., Habarth, J., Peta, J., Balsam, K., & Bockting, W. (2015). Development of the gender minority stress and resilience measure. *Psychology of Sexual Orientation and Gender Diversity*, *2*(1), 65-77. https://doi.org/10.1037/sgd0000081

Thamrin, H., Gonzales, N. A., Toomey, R. B., Anderson, S. F., & Anhalt, K. (2021). Discrimination and depressive symptoms in sexual minority Latinx youth: Moderation by religious importance and attendance. *Journal of Family Psychology*, *36*(5), 661–670. https://doi.org/10.1037/fam0000936

Thompson, W. K., Barch, D. M., Bjork, J. M., Gonzalez, R., Nagel, B. J., Nixon, S. J., & Luciana, M. (2019). The structure of cognition in 9 and 10 year-old children and associations with problem behaviors: Findings from the ABCD study's baseline neurocognitive battery. *Developmental Cognitive Neuroscience*, *36*, 100606. https://doi.org/10.1016/j.dcn.2018.12.004

Thorne, N., Yip, A. K.-T., Bouman, W. P., Marshall, E., & Arcelus, J. (2019). The terminology of identities between, outside and beyond the gender binary: A systematic review. *International Journal of Transgenderism*, *20*(2-3), 138-154. https://doi.org/10.1080/15532739.2019.1640654

Toppin, E. (2021). Health equity and the circle of human concern. *AMA Journal of Ethics*, *23*(2), 166-174. https://doi.org/10.1001/amajethics.2021.166

Tu, K. M., Erath, S. A., & El-Sheikh, M. (2015). Peer victimization and adolescent adjustment: The moderating role of sleep. *Journal of Abnormal Child Psychology*, *43*(8), 1447-1457. https://doi.org/10.1007/s10802-015-0035-6

U.S. Department of Commerce. (2019). *How the Census Bureau measures poverty*. https://www.census.gov/topics/income-poverty/poverty/guidance/poverty-measures.html

Valkenborghs, S. R., Noetel, M., Hillman, C. H., Nilsson, M., Smith, J. J., Ortega, F. B., & Lubans, D. R. (2019). The impact of physical activity on brain structure and function in youth: A systematic review. *Pediatrics*, *144*(4), e20184032. https://doi.org/10.1542/peds.2018-4032

van Dalfsen, J. H., & Markus, C. R. (2018). The influence of sleep on human hypothalamic–pituitary–adrenal (HPA) axis reactivity: A systematic review. *Sleep Medicine Reviews*, *39*, 187-194. https://doi.org/10.1016/j.smrv.2017.10.002

Van Veen, M. M., Lancel, M., Beijer, E., Remmelzwaal, S., & Rutters, F. (2021). The association of sleep quality and aggression: A systematic review and meta-analysis of observational studies. *Sleep Medicine Reviews*, *59*, 101500. https://doi.org/10.1016/j.smrv.2021.101500

Vrijkotte, T. G., van den Born, B.-J. H., Hoekstra, C. M., Gademan, M. G., van Eijsden, M., de Rooij, S. R., & Twickler, M. T. (2015). Cardiac autonomic nervous system activation and metabolic profile in young children: The ABCD study. *PLoS One*, *10*(9), e0138302. https://doi.org/10.1371/journal.pone.0138302

Walker, M. P. (2017). *Why we sleep: Unlocking the power of sleep and dreams*. Simon and Schuster.

Walvoord, E. C. (2010). The timing of puberty: Is it changing? Does it matter? *Journal of Adolescent Health*, *47*(5), 433-439. https://doi.org/10.1016/j.jadohealth.2010.05.018

Wang, Y., & Yip, T. (2020). Sleep facilitates coping: Moderated mediation of daily sleep, ethnic/racial discrimination, stress responses, and adolescent well-being. *Child Development*, *91*(4), e833-e852. https://doi.org/10.1111/cdev.13324

Wernick, L. J., Kulick, A., & Chin, M. (2017). Gender identity disparities in bathroom safety and wellbeing among high school students. *Journal of Youth and Adolescence*, *46*(5), 917-930. https://doi.org/10.1007/s10964-017-0652-1

Williams, A. J., Jones, C., Arcelus, J., Townsend, E., Lazaridou, A., & Michail, M. (2021). A systematic review and meta-analysis of victimisation and mental health prevalence among LGBTQ+ young people with experiences of self-harm and suicide. *PLoS One*, *16*(1), e0245268. https://doi.org/10.1371/journal.pone.0245268

Williams, D. Y., Hall, W. J., Dawes, H. C., Rizo, C. F., & Goldbach, J. T. (2022). An integrated conceptual model to understand suicidality among queer youth to inform suicide prevention. *Societies*, *12*(6), 170. https://doi.org/10.3390/soc12060170

Williams, T., Connolly, J., Pepler, D., & Craig, W. (2005). Peer victimization, social support, and psychosocial adjustment of sexual minority adolescents. *Journal of Youth and Adolescence*, *34*(5), 471-482. https://doi.org/10.1007/s10964-005-7264-x

Wilson, C., & Cariola, L. A. (2020). LGBTQI+ youth and mental health: A systematic review of qualitative research. *Adolescent Research Review*, *5*(2), 187-211. https://doi.org/10.1007/s40894-019-00118-w

Wing, D., Godino, J., de Zambotti, M., Pautz, C., Inkelis, S., Higgins, M., Nichols, J., Brumback, T., Surana, J., & Nahar, P. (2017). Validation measures of physical activity and sleep in children from a consumer-level wearable. In *San Diego Epidemiology Research Exchange*.

Wittmann, M., Dinich, J., Merrow, M., & Roenneberg, T. (2006). Social jetlag: Misalignment of biological and social time. *Chronobiology International*, *23*(1-2), 497-509. https://doi.org/10.1080/07420520500545979

Wu, J., Zhu, L., Dong, X., Sun, Z., Cai, K., Shi, Y., & Chen, A. (2022). Relationship between physical activity and emotional regulation strategies in early adulthood: Mediating effects of cortical thickness. *Brain Sciences*, *12*(9), 1210. https://doi.org/10.3390/brainsci12091210

Yip, T. (2015). The effects of ethnic/racial discrimination and sleep quality on depressive symptoms and self-esteem trajectories among diverse adolescents. *Journal of Youth and Adolescence*, *44*(2), 419-430. https://doi.org/10.1007/s10964-014-0123-x

Yip, T., Cheon, Y. M., Wang, Y., Cham, H., Tryon, W., & El-Sheikh, M. (2020). Racial disparities in sleep: Associations with discrimination among ethnic/racial minority adolescents. *Child Development*, *91*(3), 914-931. https://doi.org/10.1111/cdev.13234

Zaza, S., Kann, L., & Barrios, L. C. (2016). Lesbian, gay, and bisexual adolescents: Population estimate and prevalence of health behaviors. *JAMA*, *316*(22), 2355-2356. https://doi.org/10.1001/jama.2016.11683

Zoccoli, G., & Amici, R. (2020). Sleep and autonomic nervous system. *Current Opinion in Physiology*, *15*, 128-133. https://doi.org/10.1016/j.cophys.2020.01.002

Tables

Table 1.1

Descriptive Statistics of Continuous Variables in Study I

	n	*M*	*SD*	Min.	Max.
Pubertal status	2,855	2.62	0.94	1.00	5.00
Family income	2,780	4.20	2.31	0.05	12.11
Waist circumference	2,965	28.46	4.69	18.00	55.00
Sleep minutes	2,979	450.85	37.50	262.40	598.80
Sleep efficiency	2,979	88.67	1.68	81.28	93.89
Wake after sleep onset	2,979	57.84	10.98	18.00	103.00
Sleep latency	2,979	6.72	4.89	0.00	51.00
Sleep midpoint	2,979	3:14am	62.35	11:15pm	7:21am
Variability in sleep minutes	2,979	0.14	0.07	0.01	0.44
Variability in sleep midpoint	2,979	0.04	0.02	0.01	0.23
Anxious/depressive symptoms*	211	54.87	6.84	50.00	88.00
Aggressive behavior*	211	52.62	5.23	50.00	84.00
Rule-breaking behavior*	211	52.62	4.47	50.00	71.00

Notes. *N* = 2,979. Family income was operationalized as income-to-needs ratio. Sleep minutes in hours:

M = 7.51, *SD* = 0.63, min. = 4.37, max. = 9.98.

* Reported only for subsample of sexual-minority youth.

Table 1.2

Differences in Sleep Actigraphy and Mental Health by Sex Assigned at Birth

	Assigned Female		Assigned Male		
	M	*SD*	*M*	*SD*	*t*
Sleep minutes	453.92	37.59	447.94	37.20	–4.36***
Sleep efficiency	88.91	1.61	88.45	1.73	–7.39***
Wake after sleep onset	56.88	10.51	58.76	11.33	4.68***
Sleep latency	6.84	4.64	6.61	5.11	–1.24
Sleep midpoint	3:17am	62.62	3:11am	61.97	–2.69**
Variability in sleep minutes	0.15	0.07	0.14	0.06	–3.51***
Variability in sleep midpoint	0.039	0.02	0.037	0.02	–2.53**
Anxious/depressive symptoms†	54.75	6.65	55.53	7.86	0.61
Aggressive behavior†	52.08	4.35	55.41	7.96	2.37*
Rule-breaking behavior†	52.45	4.39	53.50	4.83	1.26

Notes. For sleep variables, assigned female at birth: $n = 1{,}454$; assigned male at birth: $n = 1{,}525$. For mental health variables, assigned female at birth: $n = 177$; assigned male at birth: $n = 34$.

† Reported only for subsample of sexual-minority youth.

** $p < .05$. ** $p < .01$. *** $p < .001$.

Table 1.3

Differences in Sleep Duration and Quality by Ethnicity and Race

			95% CI	
	M	*SE*	*LB*	*UB*
Sleep minutes				
Hispanic	450.16	1.91	446.40	453.91
Asian Non-Hispanic	443.99	4.14	435.74	452.24
Black Non-Hispanic	427.46	3.04	421.47	433.45
White Non-Hispanic	455.54	0.82	453.92	457.16
Multiethnic/multiracial	445.31	1.78	441.81	448.82
Sleep efficiency				
Hispanic	88.83	0.09	88.65	89.00
Asian Non-Hispanic	88.01	0.18	87.64	88.37
Black Non-Hispanic	89.37	0.12	89.13	89.62
White Non-Hispanic	88.58	0.04	88.50	88.65
Multiethnic/multiracial	88.69	0.08	88.53	88.84
WASO				
Hispanic	56.90	0.58	55.77	58.04
Asian Non-Hispanic	60.76	1.22	58.33	63.20
Black Non-Hispanic	51.12	0.79	49.57	52.67
White Non-Hispanic	58.95	0.25	58.47	59.44
Multiethnic/multiracial	57.07	0.50	56.08	58.06
Sleep latency				
Hispanic	6.82	0.25	6.33	7.32
Asian Non-Hispanic	6.47	0.52	5.44	7.51
Black Non-Hispanic	7.26	0.34	6.58	7.93
White Non-Hispanic	6.53	0.11	6.31	6.74
Multiethnic/multiracial	7.16	0.25	6.67	7.65

Notes. Hispanic: *n* = 363; Asian Non-Hispanic: *n* = 79; Black Non-Hispanic: *n* = 210; White Non-Hispanic: *n* = 1,819; Multiethnic/multiracial: *n* = 477. Sample also included small numbers of American Indian and Alaska Native Non-Hispanic (*n* = 6) and Some Other Race Non-Hispanic (*n* = 14); means are not displayed for these groups due to small cell sizes and large standard errors. WASO = wake after sleep onset.

Table 1.4

Differences in Sleep Schedule and Regularity by Ethnicity and Race

	M	*SE*	95% CI	
			LB	*UB*
Sleep midpoint				
Hispanic	3:27am	3.37	3:20am	3:33am
Asian Non-Hispanic	3:08am	5.81	2:56am	3:19am
Black Non-Hispanic	3:40am	5.46	3:29am	3:51am
White Non-Hispanic	3:07am	1.39	3:04am	3:10am
Multiethnic/multiracial	3:21am	1.15	3:16am	3:27am
Variability in sleep minutes				
Hispanic	0.14	0.003	0.13	0.15
Asian Non-Hispanic	0.13	0.01	0.12	0.14
Black Non-Hispanic	0.19	0.01	0.18	0.20
White Non-Hispanic	0.13	0.001	0.13	0.13
Multiethnic/multiracial	0.16	0.003	0.15	0.16
Variability in sleep minutes				
Hispanic	0.04	0.001	0.04	0.04
Asian Non-Hispanic	0.03	0.002	0.03	0.04
Black Non-Hispanic	0.06	0.002	0.05	0.06
White Non-Hispanic	0.03	0.00	0.03	0.04
Multiethnic/multiracial	0.04	0.001	0.04	0.05

Notes. Hispanic: $n = 363$; Asian Non-Hispanic: $n = 79$; Black Non-Hispanic: $n = 210$; White Non-Hispanic: $n = 1,819$; Multiethnic/multiracial: $n = 477$. Sample also included small numbers of American Indian and Alaska Native Non-Hispanic ($n = 6$) and Some Other Race Non-Hispanic ($n = 14$); means are not displayed for these groups due to small cell sizes and large standard errors.

Table 1.5

Correlations Among Continuous Variables in Study I

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Pubertal status	–												
2. Family income	–0.05**	–											
3. Waist circumference	0.16***	–0.17***	–										
4. Sleep minutes	–0.11***	0.12***	–0.18***	–									
5. Sleep efficiency	0.11***	–0.05**	0.04*	–0.05**	–								
6. Wake after sleep onset	–0.14***	0.09***	–0.11***	0.48***	–0.90***	–							
7. Sleep latency	0.05*	–0.03	–0.004	0.14***	0.24***	–0.15***	–						
8. Sleep midpoint	0.15***	–0.19***	0.10***	–0.11***	0.07***	–0.10***	0.02	–					
9. Var. in sleep minutes	0.17***	–0.24***	0.16***	–0.40***	0.07***	–0.23***	–0.02	0.38***	–				
10. Var. in sleep midpoint	0.14***	–0.20***	0.17***	–0.24***	0.09***	–0.18***	0.07***	0.37***	0.64***	–			
11. Anxious/depressive†	–0.08	–0.07	0.03	0.03	0.04	–0.01	–0.02	–0.10	0.001	0.09	–		
12. Aggressive behavior†	–0.13	–0.13	0.04	0.003	–0.07	0.07	–0.04	–0.06	0.07	0.16*	0.53***	–	
13. Rule-breaking behavior†	–0.04	–0.14	0.13	–0.01	–0.04	0.03	–0.02	–0.04	0.10	0.16*	0.44***	0.62***	–

Notes. Family income was operationalized as family income-to-needs ratio.

† Reported only for subsample of sexual-minority youth.

* $p < .05$. *** $p < .001$.

Table 1.6

Differences in Sleep Actigraphy and Mental Health by Discrimination Experience Among Sexual-Minority Youth

	Did Not Experience Discrimination (n = 137)		Experienced Discrimination (n = 56)		
	M	*SD*	*M*	*SD*	*t*
Sleep minutes	444.29	39.87	444.24	41.07	0.01
Sleep efficiency	88.93	1.72	88.83	1.65	0.36
WASO	55.66	11.69	56.02	10.54	–0.20
Sleep latency	6.26	4.36	6.12	3.35	–0.23
Sleep midpoint	3:30am	69.02	3:44am	70.54	–1.23
Variability in sleep minutes	0.16	0.07	0.18	0.06	–2.58*
Variability in sleep midpoint	0.04	0.03	0.05	0.03	–2.27*
Anxious/depressive symptoms	54.53	6.56	55.54	7.30	–0.94
Aggressive behavior	52.42	4.74	53.57	6.53	–1.37
Rule-breaking behavior	52.39	4.34	53.52	4.93	–1.58

Notes. Discrimination: 0 = No, 1 = Yes to the question, "In the past 12 months, have you felt discriminated against because someone thought you were gay, lesbian, or bisexual?" WASO = wake after sleep onset.

* $p < .05$.

Table 1.7

Mean Comparisons of Sleep Actigraphy Between Sexual-Minority and Non-Sexual-Minority Youth

	Sexual-Minority		Non-Sexual-Minority		Unadjusted	Adjusted[a]	Adjusted[b]
	M	*SD*	*M*	*SD*	F (1, 2976)	F (1, 2644)	F (1, 2643)
Sleep minutes	443.12	40.85	451.45	37.00	9.79**	12.92***	13.90***
Sleep efficiency	88.97	1.73	88.65	1.68	6.93**	3.70	4.46*
Wake after sleep onset	55.34	11.56	58.03	10.89	11.83***	9.21**	10.43***
Sleep latency	6.24	4.07	6.72	4.77	2.08	3.58	3.49
Sleep midpoint	3:34am	70.12	3:12am	60.34	24.21***	15.06***	17.67***
Variability in sleep minutes	0.16	0.07	0.14	0.06	27.56***	19.86***	18.91***
Variability in sleep midpoint	0.05	0.03	0.04	0.02	15.99***	11.18***	12.00***

Notes. [a] Model adjusted for sex assigned at birth, pubertal status, race, family income, and waist circumference.

[b] Model adjusted for sex assigned at birth, pubertal status, race, family income, waist circumference, and anxious/depressive symptoms.

* $p < .05$. ** $p < .01$. *** $p \leq .001$.

Table 1.8

Sleep Minutes as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.88***	0.46	8.04	52.62***	0.34	10.09	52.62***	0.30	11.81
Sex assigned at birth	0.46	1.55	0.03	–2.96**	1.15	–0.21	–0.58	1.00	–0.05
Pubertal status	–1.07	0.79	–0.13	–0.37	0.60	–0.06	–0.38	0.51	–0.07
Race	0.02	0.18	0.01	0.15	0.13	0.08	0.05	0.12	0.03
Family income	–0.21	0.21	–0.07	–0.27	0.16	–0.13	–0.21	0.14	–0.11
Waist circumference	0.07	0.10	0.05	0.02	0.07	0.02	0.10	0.07	0.12
Discrimination	0.79	1.14	0.05	0.33	0.81	0.03	0.64	0.72	0.07
Sleep minutes	0.29	0.70	0.03	–0.15	0.51	–0.02	–0.02	0.45	–0.003
Discrimination x Sleep Minutes	2.98	1.62	0.13	3.13**	1.15	0.18	1.93	1.02	0.13
R^2	0.04	0.03		0.12**	0.04		0.06	0.03	

Notes. $N = 211$. Sleep minutes were analyzed as sleep hours (divided by 60) to aid model convergence. Models were fit separately for each outcome. R^2s are reported for full models.

** $p \leq .01$. *** $p < .001$.

Table 1.9

Sleep Efficiency as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.87***	0.47	8.04	52.61***	0.34	10.09	52.60***	0.30	11.81
Sex assigned at birth	0.22	1.59	0.01	–2.85*	1.19	–0.20	–0.46	1.01	–0.04
Pubertal status	–0.95	0.78	–0.11	–0.26	0.60	–0.04	–0.29	0.50	–0.05
Race	0.03	0.18	0.01	0.17	0.13	0.09	0.05	0.11	0.03
Family income	–0.19	0.21	–0.07	–0.27	0.16	–0.13	–0.20	0.14	–0.11
Waist circumference	0.04	0.10	0.03	–0.01	0.07	–0.01	0.07	0.06	0.08
Discrimination	0.80	1.15	0.05	0.34	0.82	0.03	0.60	0.72	0.06
Sleep efficiency	0.16	0.28	0.04	–0.08	0.21	–0.03	–0.07	0.18	–0.03
Discrimination x Sleep Efficiency	–0.61	0.66	–0.07	–0.61	0.47	–0.09	–1.03*	0.41	–0.18
R^2	0.02	0.02		0.09*	0.04		0.07*	0.04	

Notes. N = 211. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. *** $p < .001$.

Table 1.10

Wake After Sleep Onset as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.87***	0.46	8.04	52.61***	0.34	10.09	52.61***	0.29	11.81
Sex assigned at birth	0.43	1.59	0.02	–2.75*	1.18	–0.19	–0.37	1.00	–0.03
Pubertal status	–1.00	0.78	–0.12	–0.29	0.60	–0.04	–0.36	0.50	–0.06
Race	0.02	0.18	0.01	0.16	0.13	0.08	0.04	0.11	0.02
Family income	–0.20	0.21	–0.07	–0.27	0.16	–0.13	–0.20	0.13	–0.11
Waist circumference	0.03	0.10	0.03	–0.01	0.07	–0.01	0.08	0.06	0.10
Discrimination	0.78	1.142	0.05	0.32	0.82	0.03	0.60	0.71	0.06
WASO	–0.001	0.04	–0.002	0.02	0.03	0.04	0.02	0.03	0.04
Discrimination x WASO	0.17	0.10	0.13	0.17*	0.07	0.16	0.20***	0.06	0.22
R^2	0.03	0.03		0.11**	0.04		0.09*	0.04	

Notes. $N = 211$. WASO = wake after sleep onset. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. ** $p < .01$. *** $p \leq .001$.

Table 1.11

Sleep Latency as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.89***	0.47	8.04	52.63***	0.34	10.09	52.63***	0.30	11.81
Sex assigned at birth	0.27	1.57	0.02	–3.11**	1.17	–0.22	–0.70	1.01	–0.06
Pubertal status	–0.97	0.79	–0.11	–0.25	0.61	–0.04	–0.34	0.51	–0.06
Race	0.04	0.18	0.02	0.18	0.13	0.09	0.06	0.12	0.04
Family income	–0.23	0.21	–0.08	–0.32*	0.16	–0.15	–0.25	0.14	–0.14
Waist circumference	0.04	0.10	0.03	–0.001	0.07	–0.001	0.09	0.06	0.10
Discrimination	0.83	1.15	0.06	0.34	0.82	0.03	0.64	0.72	0.07
Sleep latency	0.01	0.12	0.01	–0.01	0.09	–0.004	0.02	0.08	0.02
Discrimination x Sleep Latency	0.19	0.31	0.05	0.29	0.22	0.09	0.24	0.20	0.09
R^2	0.02	0.02		0.09*	0.04		0.05	0.03	

Notes. $N = 211$. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 1.12

Sleep Midpoint as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.87***	0.47	8.04	52.65***	0.34	10.10	52.65***	0.30	11.82
Sex assigned at birth	0.26	1.57	0.01	–2.81*	1.16	–0.20	–0.41	1.00	–0.03
Pubertal status	–0.80	0.80	–0.09	–0.30	0.61	–0.05	–0.38	0.51	–0.07
Race	0.08	0.18	0.03	0.18	0.14	0.09	0.05	0.12	0.03
Family income	–0.27	0.21	–0.10	–0.31	0.16	–0.15	–0.24	0.14	–0.13
Waist circumference	0.04	0.10	0.03	0.01	0.07	0.01	0.10	0.06	0.11
Discrimination	0.88	1.15	0.06	0.52	0.83	0.05	0.79	0.73	0.08
Sleep midpoint	–0.01	0.01	–0.12	–0.01	0.01	–0.09	–0.01	0.004	–0.08
Discrimination x Sleep Midpoint	0.001	0.02	0.01	–0.01	0.01	–0.07	–0.01	0.01	–0.09
R^2	0.03	0.02		0.10*	0.04		0.06	0.03	

Notes. $N = 211$. Models fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. *** $p < .001$.

Table 1.13

Variability in Sleep Minutes as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.89***	0.48	8.04	52.75***	0.35	10.12	52.67***	0.31	11.82
Sex assigned at birth	0.32	1.59	0.02	–2.70*	1.18	–0.19	–0.40	1.02	–0.03
Pubertal status	–0.87	0.81	–0.10	–0.38	0.62	–0.06	–0.47	0.52	–0.08
Race	0.04	0.18	0.02	0.16	0.13	0.08	0.05	0.12	0.03
Family income	–0.20	0.21	–0.07	–0.23	0.16	–0.11	–0.18	0.14	–0.10
Waist circumference	0.05	0.10	0.03	–0.01	0.07	–0.01	0.09	0.06	0.10
Sleep minutes	0.33	0.74	0.03	0.04	0.54	0.01	0.14	0.47	0.02
Discrimination	0.81	1.20	0.05	0.68	0.85	0.06	0.74	0.75	0.08
Variability in sleep minutes	0.002	0.08	0.002	0.03	0.06	0.04	0.04	0.05	0.07
Discrimination x Variability in Sleep Minutes	–0.01	0.18	–0.01	–0.21	0.13	–0.12	–0.08	0.11	–0.05
R^2	0.02	0.02		0.10*	0.04		0.05	0.03	

Notes. $N = 211$. To aid model convergence, sleep minutes were analyzed as sleep hours (divided by 60) and variability in minutes was multiplied by 100. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. *** $p < .001$.

Table 1.14

Variability in Sleep Midpoint as a Moderator of Relations Between Discrimination and Mental Health Among Sexual-Minority Youth

	Anxious/Depressive Symptoms			Aggressive Behavior			Rule-Breaking Behavior		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	54.98***	0.47	8.05	52.69***	0.34	10.10	52.65***	0.30	11.82
Sex assigned at birth	0.52	1.54	0.03	–2.72*	1.14	–0.19	–0.36	0.99	–0.03
Pubertal status	–0.86	0.78	–0.10	–0.27	0.59	–0.04	–0.35	0.50	–0.06
Race	0.08	0.18	0.03	0.20	0.13	0.10	0.07	0.11	0.04
Family income	–0.21	0.21	–0.08	–0.25	0.16	–0.12	–0.20	0.14	–0.11
Waist circumference	0.02	0.10	0.02	–0.01	0.07	–0.01	0.08	0.06	0.09
Sleep midpoint	–0.02	0.01	–0.19	–0.01*	0.01	–0.18	–0.01*	0.01	–0.17
Discrimination	0.89	1.16	0.06	0.39	0.83	0.03	0.60	0.73	0.06
Variability in sleep midpoint	0.40	0.21	0.16	0.40**	0.15	0.20	0.32*	0.13	0.19
Discrimination x Variability in Sleep Midpoint	–0.47	0.41	–0.08	–0.30	0.29	–0.07	–0.12	0.26	–0.03
R^2	0.05	0.03		0.12**	0.04		0.08*	0.04	

Notes. $N = 211$. Variability in minutes was multiplied by 100 to aid model convergence. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2.1

Descriptive Statistics of Continuous Variables in Study II

	n	*M*	*SD*	Min.	Max.
Pubertal status	2,855	2.62	0.94	1.00	5.00
Family income	2,780	4.20	2.31	0.05	12.11
Waist circumference	2,965	28.46	4.69	18.00	55.00
METs/minute	2,936	2.04	0.26	1.28	2.98
MVPA	2,936	36.19	29.59	0.00	146.66
Steps	2,936	9,644.49	3,055.09	1,189.33	20,958.62
Sleep minutes	2,979	450.85	37.50	262.40	598.80
Sleep efficiency	2,979	88.67	1.68	81.28	93.89
Wake after sleep onset	2,979	57.84	10.98	18.00	103.00
Sleep latency	2,979	6.72	4.89	0.00	51.00
Sleep midpoint	2,979	3:14am	62.35	11:15pm	7:21am
Variability in sleep minutes	2,979	0.14	0.07	0.01	0.44
Variability in sleep midpoint	2,979	0.04	0.02	0.01	0.23

Notes. N = 2,979. Family income was operationalized as income-to-needs ratio. Sleep minutes in hours: M = 7.51, SD = 0.63, min. = 4.37, max. = 9.98. METs = metabolic equivalents of task. MVPA = moderate-to-vigorous physical activity.

Table 2.2

Differences in Physical Activity and Sleep Actigraphy by Sex Assigned at Birth

	Assigned Female (n = 1,454)		Assigned Male (n = 1,525)		
	M	*SD*	*M*	*SD*	*t*
METs/minute	1.95	0.22	2.13	0.27	20.18***
MVPA	23.10	18.67	48.56	32.54	26.17***
Steps	8,822.80	2,557.93	10,421.53	3,276.51	14.78***
Sleep minutes	453.92	37.59	447.94	37.20	–4.36***
Sleep efficiency	88.91	1.61	88.45	1.73	–7.39***
Wake after sleep onset	56.88	10.51	58.76	11.33	4.68***
Sleep latency	6.84	4.64	6.61	5.11	–1.24
Sleep midpoint	3:17am	62.62	3:11am	61.97	–2.69**
Variability in sleep minutes	0.15	0.07	0.14	0.06	–3.51***
Variability in sleep midpoint	0.039	0.02	0.037	0.02	–2.53**

Notes. METs = metabolic equivalents of task. MVPA = moderate-to-vigorous physical activity.

** $p < .01$. *** $p < .001$.

Table 2.3

Differences in Physical Activity by Ethnicity and Race

	M	*SE*	95% CI	
			LB	*UB*
METs/minute				
Hispanic	2.02	0.01	1.99	2.05
Asian Non-Hispanic	2.02	0.02	1.97	2.06
Black Non-Hispanic	2.05	0.02	2.02	2.09
White Non-Hispanic	2.05	0.01	2.04	2.06
Multiethnic/multiracial	2.03	0.01	2.01	2.06
MVPA				
Hispanic	32.13	1.47	29.24	35.03
Asian Non-Hispanic	34.62	2.82	29.01	40.23
Black Non-Hispanic	35.93	2.31	31.38	40.48
White Non-Hispanic	37.01	0.68	35.76	38.44
Multiethnic/multiracial	36.32	1.48	33.41	39.23
Steps				
Hispanic	8,953.67	153.24	8,652.32	9,255.02
Asian Non-Hispanic	10,101.78	312.35	9,479.93	10,723.62
Black Non-Hispanic	9,319.97	210.30	8,905.31	9,734.64
White Non-Hispanic	9,810.27	72.07	9,668.92	9,951.62
Multiethnic/multiracial	9,614.74	146.08	9,327.69	9,901.79

Notes. Hispanic: *n* = 360; Asian Non-Hispanic: *n* = 79; Black Non-Hispanic: *n* = 203; White Non-Hispanic: *n* = 1,795; Multiethnic/multiracial: *n* = 468. Sample also included small numbers of American Indian and Alaska Native Non-Hispanic (*n* = 6) and Some Other Race Non-Hispanic (*n* = 14); means are not displayed for these groups due to small cell sizes and large standard errors. METs = metabolic equivalents of task. MVPA = moderate-to-vigorous physical activity.

Table 2.4

Correlations Among Continuous Variables in Study II

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Pubertal status	–												
2. Family income	–0.05**	–											
3. Waist circumference	0.16***	–0.17***	–										
4. METs/minute	–0.26***	0.05***	0.12***	–									
5. MVPA	–0.22***	0.06**	0.18***	0.81***	–								
6. Steps	–0.25***	0.13***	–0.16***	0.82***	0.68***	–							
7. Sleep minutes	–0.11***	0.12***	–0.18***	0.01	–0.07***	–0.01	–						
8. Sleep efficiency	0.11***	–0.05**	0.04*	–0.15***	–0.13***	–0.10***	–0.05**	–					
9. Wake after sleep onset	–0.14***	0.09***	–0.11***	0.13***	0.08***	0.08***	0.48***	–0.90***	–				
10. Sleep latency	0.05*	–0.03	–0.004	–0.10***	–0.09***	–0.09***	0.14***	0.24***	–0.15***	–			
11. Sleep midpoint	0.15***	–0.19***	0.10***	–0.23***	–0.12***	–0.29***	–0.11***	0.07***	–0.10***	0.02	–		
12. Var. in sleep minutes	0.17***	–0.24***	0.16***	–0.15***	–0.07***	–0.20***	–0.40***	0.07***	–0.23***	–0.02	0.38***	–	
13. Var. in sleep midpoint	0.14***	–0.20***	0.17***	–0.13***	–0.07***	–0.19***	–0.24***	0.09***	–0.18***	0.07***	0.37***	0.64***	–

Notes. METs = metabolic equivalents of task. MVPA = moderate-to-vigorous physical activity. Var. = Variability.

Table 2.5

Differences in Physical Activity by Transgender or Gender-Diverse Status

	TGD (n = 90)		Non-TGD (n = 2,845)		
	M	*SD*	*M*	*SD*	*t*
METs/minute	1.91	0.25	2.05	0.26	4.94***
MVPA	25.38	24.37	36.53	29.68	4.24***
Steps	8,300.23	2,693.28	9,687.37	3,057.10	4.25***

Notes. METs = metabolic equivalents of task. MVPA = moderate-to-vigorous physical activity.

*** $p < .001$.

Table 2.6

Mean Comparisons of Sleep Actigraphy Between Transgender and Gender-Diverse and Non-Transgender and Gender-Diverse Youth

	TGD		Non-TGD		Unadjusted	Adjusted[a]	Adjusted[b]
	M	*SD*	*M*	*SD*	*F* (1, 2976)	*F* (1, 2644)	*F* (1, 2643)
Sleep minutes	437.59	43.40	451.26	37.23	11.01***	2.21	2.56
Sleep efficiency	88.85	1.83	88.67	1.68	0.98	0.06	0.13
Wake after sleep onset	55.41	12.11	57.91	10.93	4.30*	0.31	0.48
Sleep latency	6.46	4.43	6.73	4.90	0.22	0.54	0.52
Sleep midpoint	3:30am	73.98	3:14am	61.91	6.08*	5.08*	5.58*
Variability in sleep minutes	0.17	0.08	0.14	0.06	19.35***	7.51**	7.06**
Variability in sleep midpoint	0.05	0.03	0.04	0.02	8.17**	4.25*	4.20*

Notes. [a] Model adjusted for sex assigned at birth, pubertal status, race, family income, and waist circumference.

[b] Model adjusted for sex assigned at birth, pubertal status, race, family income, waist circumference, and anxious/depressive symptoms.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2.7

Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Duration

	Sleep Minutes		
	Estimate	*SE*	β
Intercept	451.13***	0.66	12.03
Sex assigned at birth	13.48***	1.62	0.18
Pubertal status	–6.41***	0.86	–0.16
Race	–1.17***	0.29	–0.07
Family income	1.23***	0.30	0.08
Waist circumference	–1.08***	0.15	–0.14
TGD status	–6.35	4.36	–0.03
METs/minute	4.98	2.77	0.04
TGD Status x METs/Minute	34.28***	15.33	0.05
R^2	0.08***	0.01	

Notes. $N = 2{,}979$. TGD = transgender or gender-diverse. METs = metabolic equivalents of task. R^2 is reported for full model.

*** $p < .001$.

Table 2.8

Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Quality

	Sleep Efficiency			WASO			Sleep Latency		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	88.67***	0.03	52.66	57.89***	0.20	5.27	6.73***	0.09	1.38
Sex assigned at birth	0.26***	0.07	0.08	0.14	0.48	0.01	–0.28	0.22	–0.03
Pubertal status	0.06	0.04	0.03	–1.12***	0.26	–0.10	0.20	0.12	0.04
Race	–0.003	0.01	–0.01	–0.13	0.09	–0.03	0.08	0.04	0.04
Family income	–0.03	0.01	–0.04	0.30***	0.09	0.06	–0.05	0.04	–0.02
Waist circumference	0.01*	0.01	0.04	–0.22***	0.04	–0.09	–0.004	0.02	–0.004
TGD status	–0.09	0.20	–0.01	–0.17	1.30	–0.003	–0.19	0.59	–0.01
METs/minute	–0.78***	0.13	–0.12	4.95***	0.82	0.12	–1.78***	0.37	–0.10
TGD Status x METs/Minute	–0.35	0.70	–0.01	5.50	4.55	0.03	3.18	2.05	–0.03
R^2	0.04***	0.01		0.05***	0.01		0.01***	0.004	

Notes. $N = 2{,}979$. TGD = transgender or gender-diverse. METs = metabolic equivalents of task. WASO = wake after sleep onset.

Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. *** $p \leq .001$.

Table 2.9

Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Schedule

	Sleep Midpoint		
	Estimate	*SE*	β
Intercept	163.40***	0.11	26.21
Sex assigned at birth	–1.11***	0.26	–0.09
Pubertal status	0.70***	0.14	0.11
Race	0.08	0.05	0.03
Family income	–0.42***	0.05	–0.16
Waist circumference	0.11***	0.02	0.08
TGD status	0.16	0.71	0.004
METs/minute	–5.59***	0.45	–0.24
TGD Status x METs/Minute	–1.40	2.51	–0.01
R^2	0.11***	0.01	

Notes. $N = 2{,}979$. Sleep midpoint was divided by 10 to aid model convergence; intercept is equivalent to 3:14am. TGD = transgender or gender-diverse. METs = metabolic equivalents of task. R^2 is reported for full model.

*** $p < .001$.

Table 2.10

Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Regularity

	Variability in Sleep Minutes			Variability in Sleep Midpoint		
	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	0.14***	0.001	2.16	0.04***	0.00	1.58
Sex assigned at birth	0.001	0.003	0.01	–0.001	0.001	–0.02
Pubertal status	0.01***	0.001	0.08	0.002**	0.001	0.06
Race	0.002***	0.000	0.07	0.001***	0.00	0.09
Family income	–0.01***	0.00	–0.17	–0.001***	0.00	–0.11
Waist circumference	0.001***	0.00	0.07	0.001***	0.00	0.11
Mean sleep variable	–0.001***	0.00	–0.36	0.12***	0.01	0.31
TGD status	0.01	0.01	0.03	0.01	0.003	0.03
METs/minute	–0.03***	0.004	–0.12	–0.01**	0.002	–0.05
TGD Status x METs/Minute	–0.002	0.02	–0.002	0.01	0.01	0.03
R^2	0.24***	0.01		0.18***	0.00	

Notes. N = 2,979. TGD = transgender or gender-diverse. METs = metabolic equivalents of task. For variability in sleep minutes, the mean sleep variable is sleep minutes. For variability in sleep midpoint, the mean sleep variable is sleep midpoint. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. ** p < .01. *** $p < .001$.

Table 2.11

Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Duration

	Sleep Minutes		
	Estimate	*SE*	β
Intercept	451.09***	0.66	12.03
Sex assigned at birth	12.01***	1.69	0.16
Pubertal status	–6.70***	0.86	–0.17
Race	–1.16***	0.29	–0.07
Family income	1.29***	0.31	0.08
Waist circumference	–1.00***	0.15	–0.13
TGD status	–8.09	4.22	–0.04
MVPA	–0.03	0.03	–0.02
TGD Status x MVPA	0.32*	0.16	0.04
R^2	0.08***	0.01	

Notes. N = 2,979. TGD = transgender or gender-diverse. MVPA = moderate-to-vigorous physical activity. R^2 is reported for full model.

* $p < .05$. *** $p < .001$.

Table 2.12

Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Quality

	Sleep Efficiency			WASO			Sleep Latency		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	88.67***	0.03	52.66	57.88***	0.20	5.27	6.74***	0.09	1.38
Sex assigned at birth	0.23**	0.08	0.07	0.09	0.50	0.004	–0.41	0.23	–0.04
Pubertal status	0.08*	0.04	0.05	–1.28***	0.25	–0.11	0.24*	0.12	0.05
Race	–0.002	0.01	–0.003	–0.14	0.09	–0.03	0.09*	0.04	0.04
Family income	–0.02	0.01	–0.03	0.30***	0.09	0.06	–0.04	0.04	–0.02
Waist circumference	0.02*	0.01	0.04	–0.21***	0.05	–0.09	0.00	0.02	0.00
TGD status	–0.02	0.19	–0.002	–0.76	1.26	–0.01	0.07	0.57	0.003
MVPA	–0.01***	0.001	–0.10	0.03***	0.01	0.07	–0.02*	0.003	–0.09
TGD Status x MVPA	–0.001	0.01	–0.004	0.04	0.05	0.02	0.06**	0.02	0.05
R^2	0.03***	0.01		0.04***		0.01	0.01***	0.004	

Notes. N = 2,979. TGD = transgender or gender-diverse. MVPA = moderate-to-vigorous physical activity. WASO = wake after sleep onset. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. ** $p < .01$. *** $p \leq .001$.

Table 2.13

Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Schedule

	Sleep Midpoint		
	Estimate	*SE*	β
Intercept	1,634.05***	1.11	26.21
Sex assigned at birth	–9.51***	2.81	–0.08
Pubertal status	8.92***	1.43	0.14
Race	0.86	0.48	0.03
Family income	–4.32***	0.50	–0.16
Waist circumference	0.92***	0.25	0.07
TGD status	9.08	7.04	0.03
MVPA	–0.26***	0.04	–0.12
TGD Status x MVPA	0.19	0.27	0.01
R^2	0.07***	0.01	

Notes. $N = 2{,}979$. Intercept is equivalent to 3:14am. TGD = transgender or gender-diverse. MVPA = moderate-to-vigorous physical activity. R^2 is reported for full model.

*** $p \leq .001$.

Table 2.14

Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Regularity

	Variability in Sleep Minutes			Variability in Sleep Midpoint		
	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	14.12***	0.11	2.16	3.83***	0.04	1.58
Sex assigned at birth	0.13	0.27	0.01	–0.11	0.10	–0.02
Pubertal status	0.61***	0.14	0.09	0.17***	0.05	0.07
Race	0.21***	0.05	0.07	0.09***	0.02	0.09
Family income	–0.47***	0.05	–0.17	–0.12***	0.02	–0.11
Waist circumference	0.09***	0.02	0.07	0.06***	0.01	0.11
Mean sleep variable	–0.06***	0.003	–0.36	12.29***	0.67	0.32
TGD status	1.02	0.67	0.03	0.42	0.26	0.03
MVPA	–0.02***	0.004	–0.08	–0.003	0.002	–0.04
TGD Status x MVPA	–0.02	0.03	–0.01	0.01	0.01	0.02
R^2	0.23***	0.01		0.18***	0.01	

Notes. $N = 2{,}979$. Dependent variables were multiplied by 100 to aid model convergence. TGD = transgender or gender-diverse. MVPA = moderate-to-vigorous physical activity. For variability in sleep minutes, the mean sleep variable is sleep minutes. For variability in sleep midpoint, the mean sleep variable is sleep midpoint. Models were fit separately for each outcome. R^2s are reported for full models.

*** $p \leq .001$.

Table 2.15

Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Duration

	Sleep Minutes		
	Estimate	*SE*	β
Intercept	451.11***	0.66	12.03
Sex assigned at birth	12.18***	1.60	0.16
Pubertal status	–6.85***	0.86	–0.17
Race	–1.16***	0.29	–0.07
Family income	1.34***	0.31	0.08
Waist circumference	–1.09***	0.15	–0.14
TGD status	–7.90	4.31	–0.04
Steps	–0.53*	0.23	–0.04
TGD Status x Steps	2.88*	1.44	0.04
R^2	0.08***	0.01	

Notes. $N = 2{,}979$. Steps were divided by 1,000 to aid model convergence. TGD = transgender or gender-diverse. R^2 is reported for full model.

* $p < .05$. *** $p < .001$.

Table 2.16

Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Quality

	Sleep Efficiency			WASO			Sleep Latency		
	Estimate	*SE*	β	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	88.67***	0.03	52.66	57.88***	0.20	5.27	6.73***	0.09	1.38
Sex assigned at birth	0.33***	0.07	0.10	–0.44	0.48	–0.02	–0.20	0.21	–0.02
Pubertal status	0.08	0.04	0.04	–1.27***	0.26	–0.11	0.20	0.12	0.04
Race	–0.001	0.01	–0.002	–0.14	0.09	–0.03	0.09*	0.04	0.04
Family income	–0.03	0.01	–0.04	0.32***	0.09	0.07	–0.04	0.04	–0.02
Waist circumference	0.01	0.01	0.02	–0.17***	0.04	–0.07	–0.03	0.02	–0.03
TGD status	0.02	0.20	0.002	–0.96	1.29	–0.02	–0.27	0.58	–0.01
Steps	–0.03**	0.01	–0.06	0.10	0.07	0.03	–0.15***	0.03	–0.09
TGD Status x Steps	0.02	0.07	0.01	0.23	0.43	0.01	0.22	0.19	0.02
R^2	0.03***	0.01		0.04***	0.01		0.01**	0.004	

Notes. $N = 2{,}979$. Steps were divided by 1,000 to aid model convergence. TGD = transgender or gender-diverse. WASO = wake after sleep onset. Models were fit separately for each outcome. R^2s are reported for full models.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 2.17

Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Schedule

	Sleep Midpoint		
	Estimate	*SE*	β
Intercept	1,633.92***	1.08	26.21
Sex assigned at birth	–9.53***	2.58	–0.08
Pubertal status	7.01***	1.40	0.11
Race	1.01*	0.47	0.04
Family income	–3.89***	0.49	–0.14
Waist circumference	0.18	0.24	0.01
TGD status	1.15	7.00	0.003
Steps	–5.31***	0.38	–0.26
TGD Status x Steps	–2.51	2.34	–0.02
R^2	0.12***	0.01	

Notes. $N = 2{,}979$. Steps were divided by 1,000 to aid model convergence. Intercept is equivalent to 3:14am. TGD = transgender or gender-diverse. R^2 is reported for full model.

*** $p < .001$.

Table 2.18

Steps as a Moderator of Relations Between Transgender or Gender-Diverse Status and Sleep Regularity

	Variability in Sleep Minutes			Variability in Sleep Midpoint		
	Estimate	*SE*	β	Estimate	*SE*	β
Intercept	14.12***	0.11	2.16	3.83***	0.04	1.58
Sex assigned at birth	0.17	0.25	0.01	–0.09	0.10	–0.02
Pubertal status	0.48***	0.14	0.07	0.16**	0.05	0.06
Race	0.22***	0.05	0.08	0.09***	0.02	0.09
Family income	–0.45***	0.05	–0.16	–0.12***	0.02	–0.11
Waist circumference	0.05	0.02	0.03	0.05***	0.01	0.10
Mean sleep variable	–0.06***	0.003	–0.36	11.91***	0.69	0.31
TGD status	0.78	0.68	0.02	0.40	0.26	0.03
Steps	–0.33***	0.04	–0.15	–0.05**	0.02	–0.06
TGD Status x Steps	–0.18	0.23	–0.01	0.08	0.09	0.02
R^2	0.25***	0.01		0.18***	0.01	

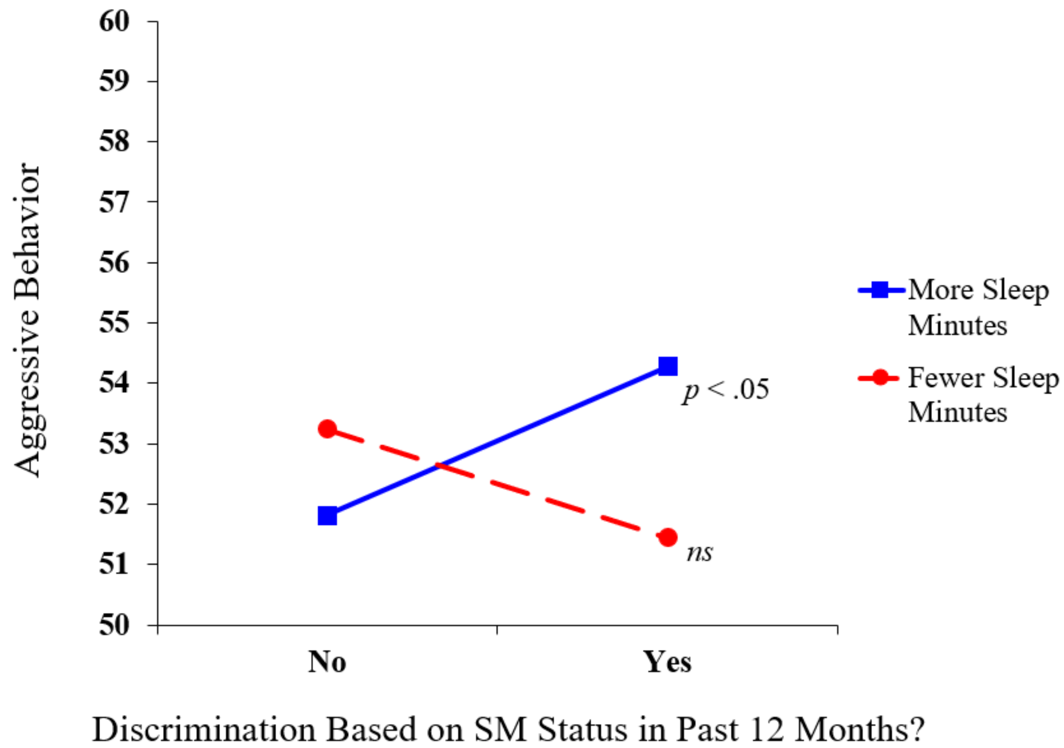
Notes. *N* = 2,979. Dependent variables were multiplied by 100 to aid model convergence. TGD = transgender or gender-diverse. For variability in sleep minutes, the mean sleep variable is sleep minutes. For variability in sleep midpoint, the mean sleep variable is sleep midpoint. Models were fit separately for each outcome. R^2s are reported for full models.

** $p < .01$. *** $p < .001$.

Figures

Figure 1.1

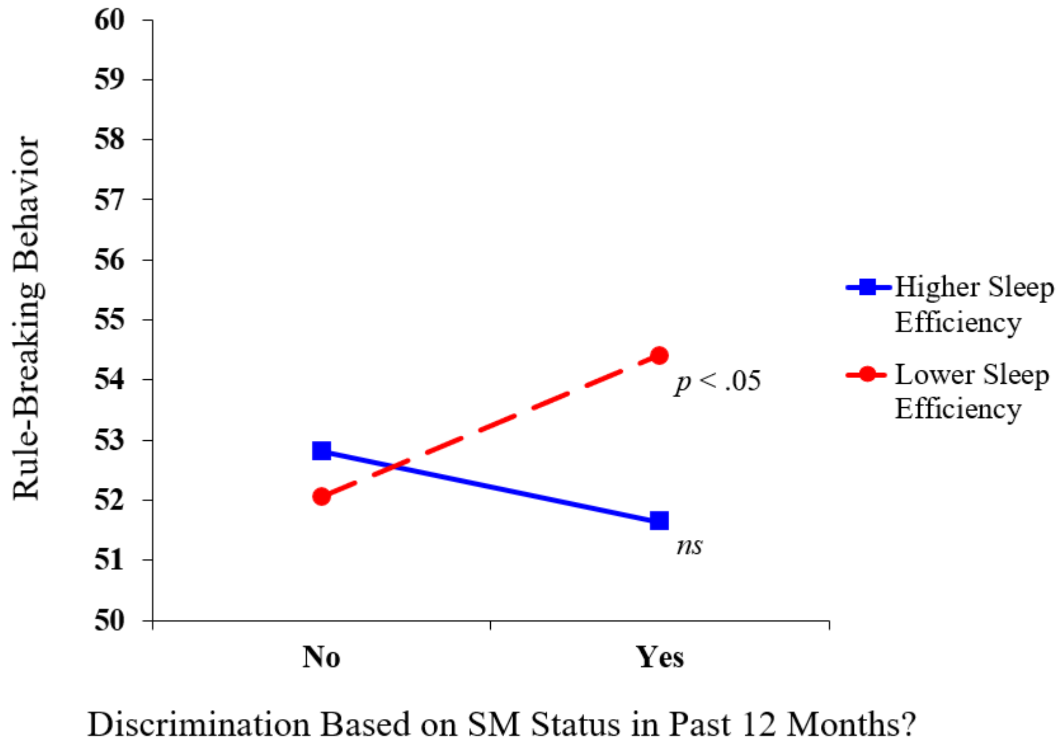
Sleep Minutes as a Moderator of Relations Between Sexual-Minority Discrimination and Aggressive Behavior



Notes. SM Status = sexual-minority status.

Figure 1.2

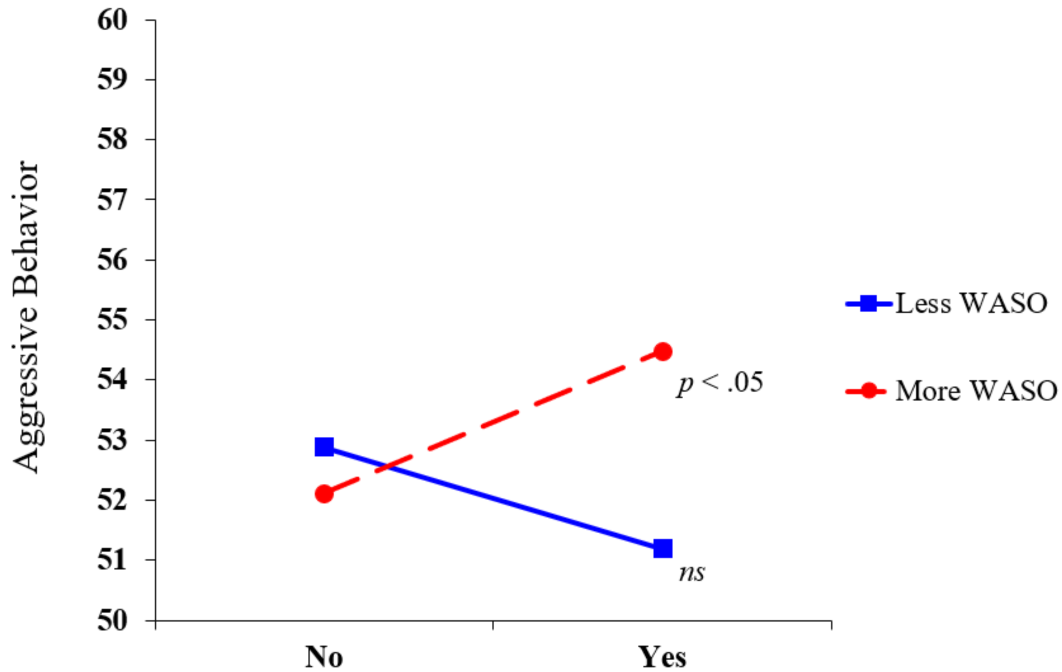
Sleep Efficiency as a Moderator of Relations Between Sexual-Minority Discrimination and Rule-Breaking Behavior



Notes. SM Status = sexual-minority status.

Figure 1.3

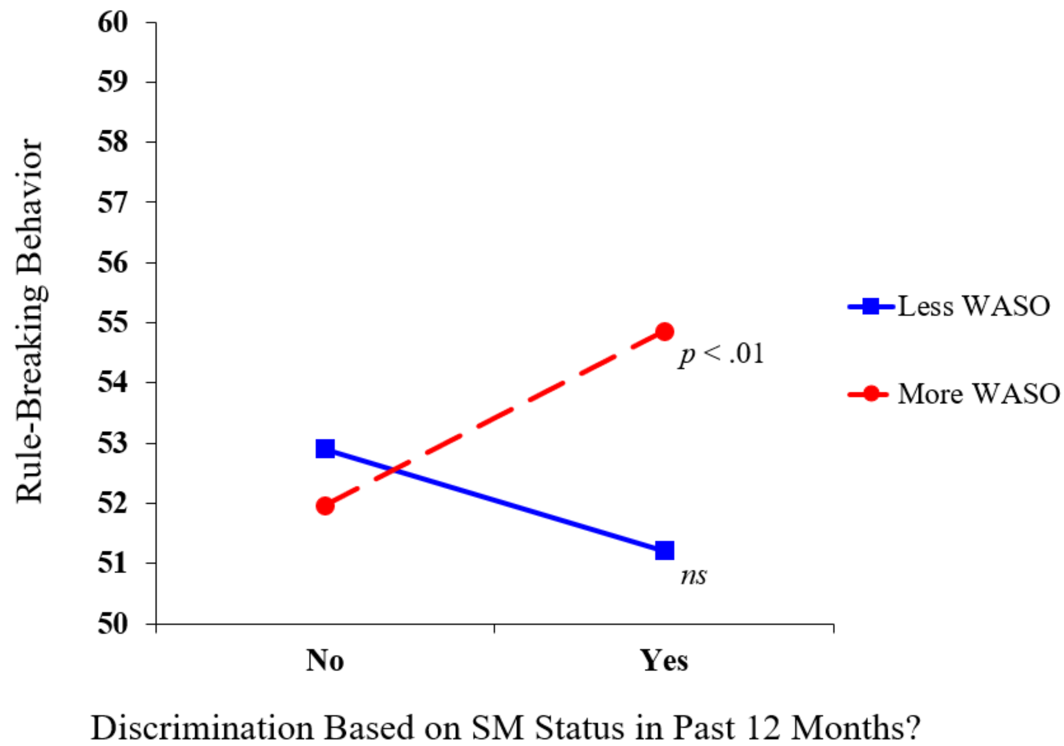
Wake After Sleep Onset as a Moderator of Relations Between Sexual-Minority Discrimination and Aggressive Behavior



Notes. WASO = wake after sleep onset. SM Status = sexual-minority status.

Figure 1.4

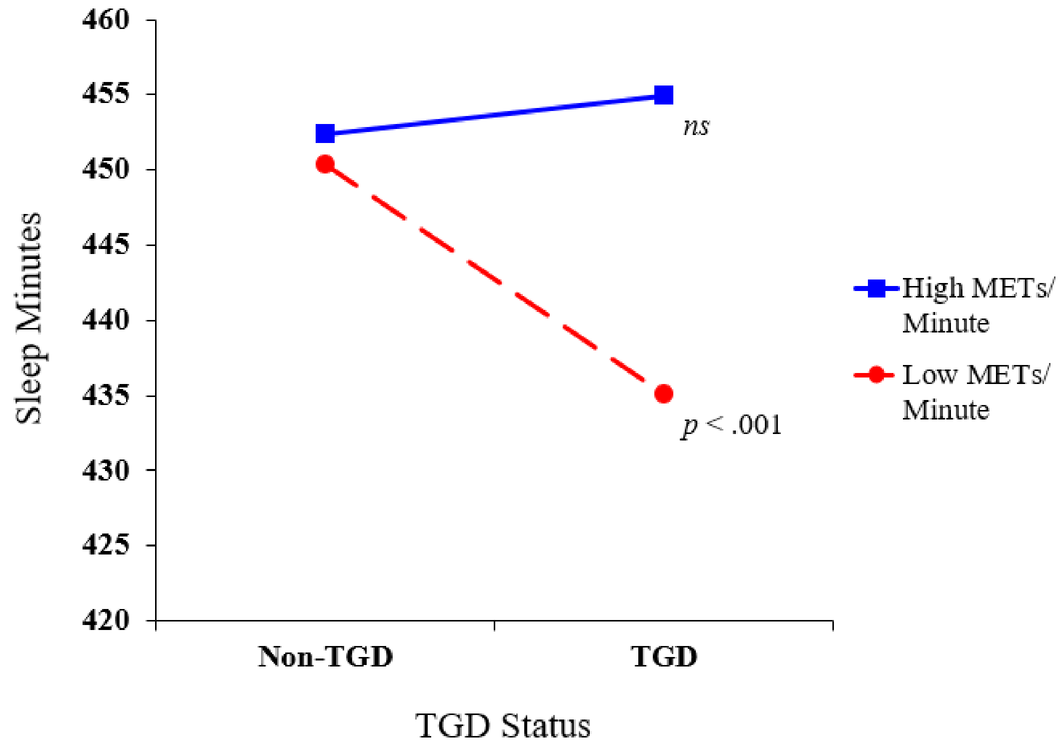
Wake After Sleep Onset as a Moderator of Relations Between Sexual-Minority Discrimination and Rule-Breaking Behavior



Notes. WASO = wake after sleep onset. SM Status = sexual-minority status.

Figure 2.1

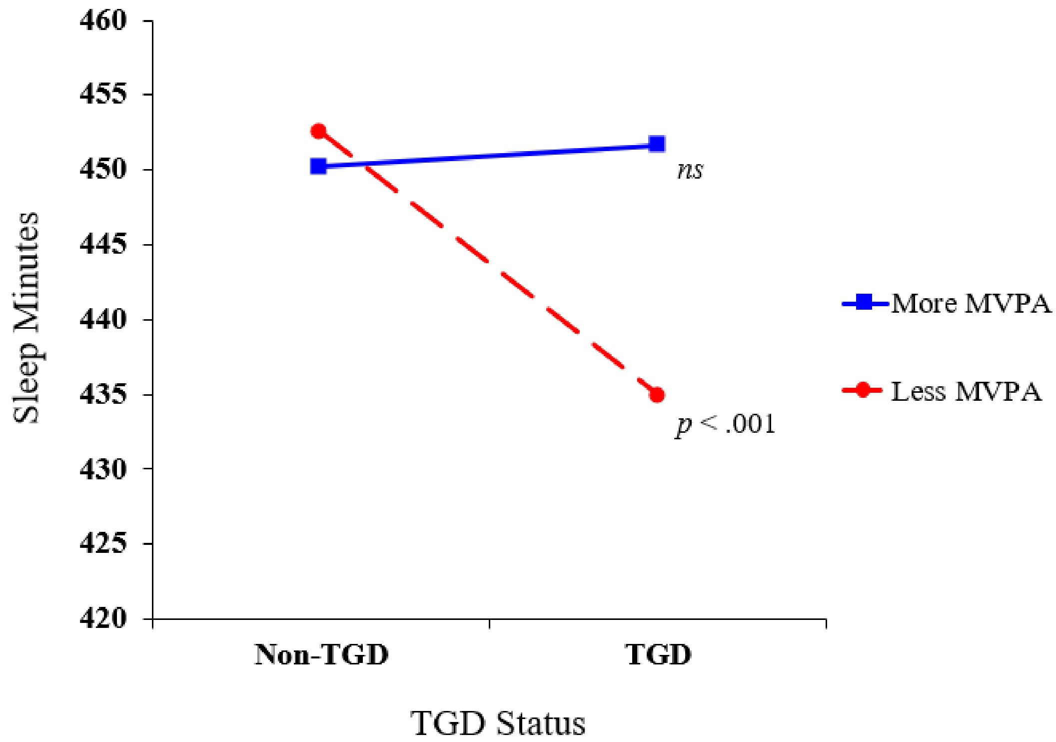
Metabolic Equivalents of Task/Minute as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Minutes



Notes. METs = metabolic equivalents of task. TGD = transgender or gender diverse.

Figure 2.2

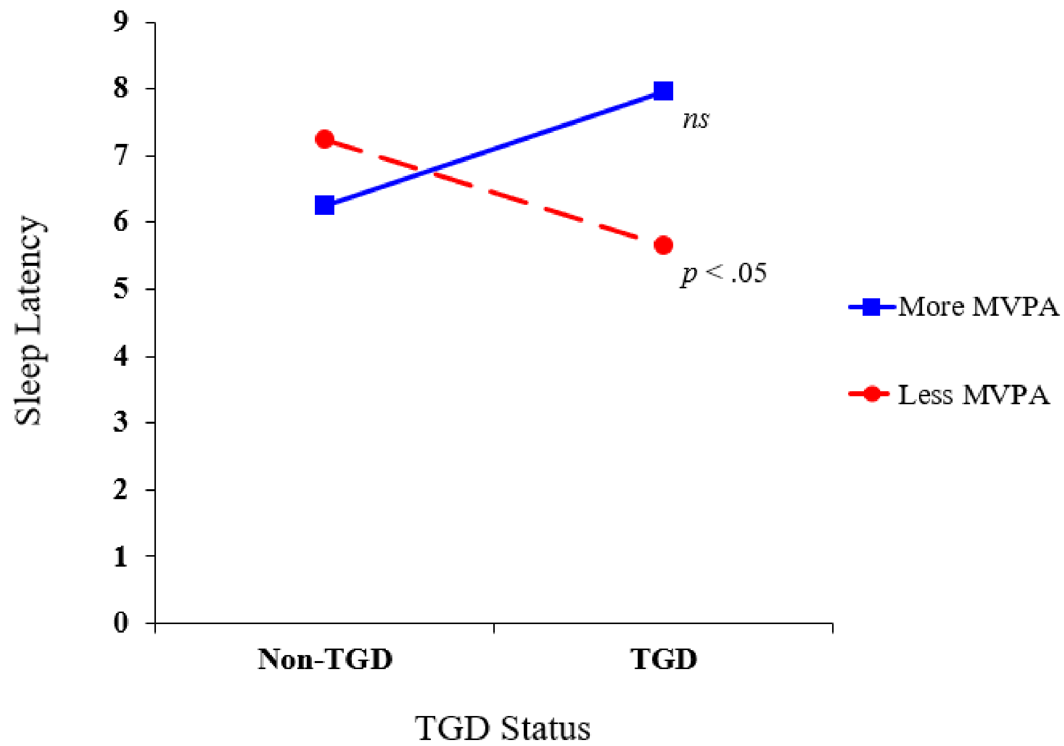
Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Minutes



Notes. MVPA = moderate-to-vigorous physical activity. TGD = transgender or gender diverse.

Figure 2.3

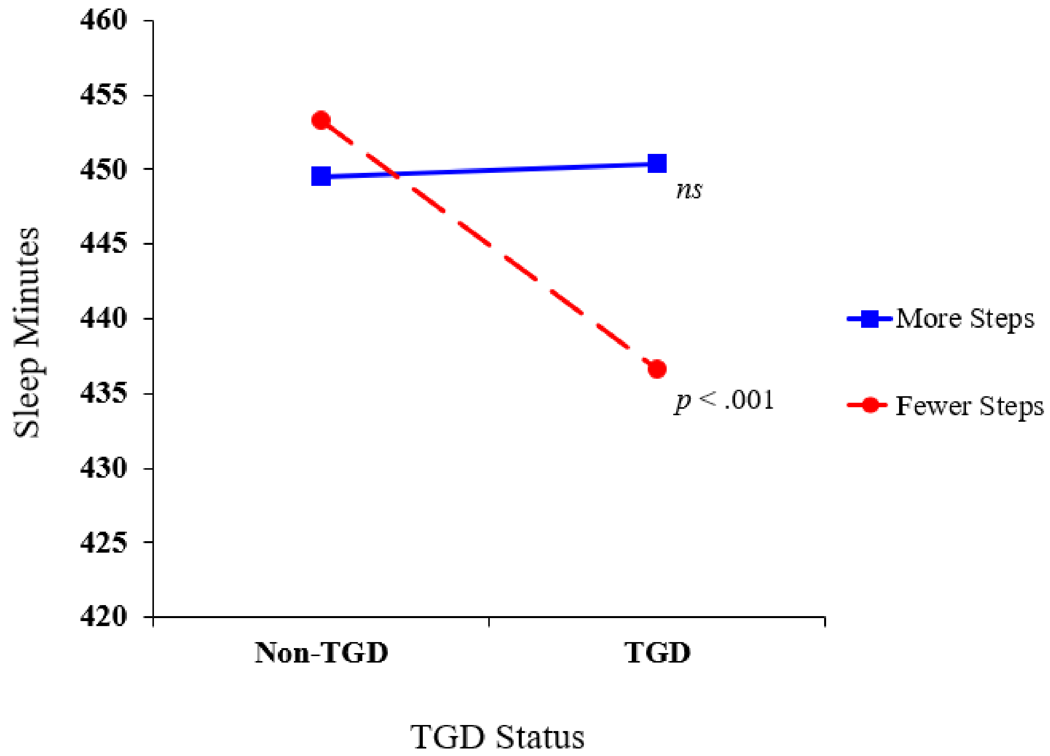
Moderate-to-Vigorous Physical Activity as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Latency



Notes. MVPA = moderate-to-vigorous physical activity. TGD = transgender or gender diverse.

Figure 2.4

Steps as a Moderator of Relations Between Transgender/Gender-Diverse Status and Sleep Minutes



Notes. TGD = transgender or gender diverse.

Appendix: Measures

Child Behavior Checklist for Ages 6-18 (Achenbach & Rescorla, 2001)

Below is a list of items that describe children and youths. For each item that describes your child ***now or within the past 6 months***, please circle the ***2*** if the item is ***very true or often true*** of your child. Circle the ***1*** if the item is ***somewhat or sometimes true*** of your child. If the item is ***not true*** of your child, circle the ***0***. Please answer all items as well as you can, even if some do not seem to apply to your child.

0 = Not True (as far as you know)

1 = Somewhat or Sometimes True

2 = Very True or Often True

A. Anxious/Depressive Syndrome Scale – 13 items

14. Cries a lot
29. Fears certain animals, situations, or places, other than school
30. Fears going to school
31. Fears he/she might think or do something bad
32. Feels he/she has to be perfect
33. Feels or complains that no one loves him/her
35. Feels worthless or inferior
45. Nervous, highstrung, or tense
50. Too fearful or anxious
52. Feels too guilty
71. Self-conscious or easily embarrassed

91. Talks about killing self

112. Worries

B. Aggressive Behavior Syndrome Scale – 17 items

3. Argues a lot

16. Cruelty, bullying, or meanness to others

19. Demands a lot of attention

20. Destroys his/her own things

21. Destroys things belonging to his/her family or others

22. Disobedient at home

23. Disobedient at school

37. Gets in many fights

57. Physically attacks people

68. Screams a lot

86. Stubborn, sullen, or irritable

87. Sudden changes in mood or feelings

89. Suspicious

94. Teases a lot

95. Temper tantrums or hot temper

97. Threatens people

104. Unusually loud

C. Rule-Breaking Behavior Syndrome Scale – 15 items

2. Drinks alcohol without parents' approval
26. Doesn't seem to feel guilty after misbehaving
28. Breaks rules at home, school, or elsewhere
39. Hangs around with others who get in trouble
43. Lying or cheating
63. Prefers being with older kids
67. Runs away from home
72. Sets fires
81. Steals at home
82. Steals outside the home
90. Swearing or obscene language
96. Thinks about sex too much
99. Smokes, chews, or sniffs tobacco
101. Truancy, skips school
105. Uses drugs for nonmedical purposes (***don't*** include alcohol or tobacco)