Examining Adolescent Sleep Within a Family Context: Evidence from Three Studies Spanning Early, Middle, and Late Adolescence

by

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ABSTRACT

This dissertation combines three first-author manuscripts that focused broadly on the study of adolescent sleep within a family context (Sasser et al., 2021; Sasser & Oshri, 2023; Sasser et al., 2023). First, Chapter 1 introduces the theoretical background and empirical research that grounded the research questions and hypotheses explored across the studies. The first study (Chapter 2) examined the influence of family connection on actigraphy-measured sleep among Latinx late adolescents and explored family dynamics and cultural values as potential moderators. The second study (Chapter 3) investigated daily and average concordance between parent and youth actigraphy-measured sleep and how this varied as a function of family context (e.g., parenting, family functioning). The third study (Chapter 4) examined concordance in actigraphy sleep among parent-youth and sibling dyads and explored how relations differed across zygosity type and sleeping arrangements. The dissertation concludes with an immersive discussion (Chapter 5) that summarizes the key differences, similarities, and takeaways across studies and highlights future directions and implications for developmental science, public policy, and clinical interventions. Collectively, this dissertation contributes to the understanding of youth and adolescent sleep within a family context by identifying proximal (e.g., daily interactions with parents/siblings) and broader family-level factors (e.g., dynamics, culture) that may help promote more healthful sleep among both adolescents and their family members.

DEDICATION

For my brother, who taught me to cherish every moment, lead whenever capable, and never stop dreaming. I hope you are still flying.

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"Are You What You Want to Be?" – Foster the People

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CHAPTER 1

INTRODUCTION

Adolescence is a time characterized by major change and development, including biological shifts (e.g., pubertal onset, brain maturation), increased responsibilities (e.g., academic demands, extracurricular commitments), the navigation of social relationships (e.g., greater peer influence, parent-child conflict), and increased susceptibility to risk-taking behaviors (Branje et al., 2018; Steinberg et al., 2008). Sleep patterns also change markedly across adolescence, with reduced sleep hours and increased sleep problems (Gradisar et al., 2011; Maslowsky & Ozer 2014), which are often attributed to the biological delaying of youths' circadian rhythms (i.e., desire to stay up and wake up later) in combination with contextual demands (e.g., early school start times; Owens et al., 2014). Studying determinants of adolescent sleep health[1] is critical, as sleep has been identified as a strong, consistent, and malleable predictor of developmental outcomes, including physical and mental health (Lovato & Gradisar, 2014; Zhang et al., 2017). Indeed, adolescents who obtain poor or insufficient sleep may be ill-equipped to navigate the emotional, social, and biological changes that occur during adolescence (Galván, 2020). However, there are individual differences in the extent to which youth experience sleep difficulties during adolescence, and several contextual factors can shape sleep patterns during this period (Becker et al., 2015). Continued research is needed focusing

[1] In Chapter 1, we refer broadly to "sleep health" as a collection of sleep indices commonly recognized as promotive for youth and adolescent development, including but not limited to: longer sleep duration, higher sleep quality and efficiency, shorter sleep latency, and earlier and regular sleep schedules (bed/wake time). Chapters 2-4 contain more in-depth reviews of the literature with specific examples of how family factors are uniquely linked with different sleep parameters.

on malleable factors that can promote or protect adolescent sleep health, particularly factors that are central to youths' day-to-day lives, such as the *family context.*

Why Study Sleep in a Family Context?

Developing youth spend the majority of their years nested in the context of their family, which can include both characteristics of the home environment, as well as family dynamics, interactions, and relationships. For example, older adolescents in America (i.e., ages 15-18) spend an average of 3.8 to 4.5 hours interacting with their family (e.g., parents, siblings) each day, an estimate that decreases drastically across the lifespan after age 18 (Ortiz-Ospina et al., 2020). Moreover, youth typically spend time with their families during the morning and evening hours (Baxter et al., 2018), which may influence youths' sleep-wake behaviors depending on the nature of these interactions (e.g., positive versus negative, stressful versus relaxing, obligation versus leisure). Indeed, the ways that youth interact and cohabitate within the family environment have been shown to influence several aspects of their health and well-being, including sleep (El-Sheikh & Kelly, 2017). In recognition of this, developmental and family science researchers have advocated for research focused on better understanding the sleep of children, adolescents, and parents in a family context. In the *Journal of Family Psychology's* 2007 special issue, "Considering Sleep in a Family Context," the guest editors noted:

> *"The articles in this special issue begin to raise a set of compelling questions. They provide examples of studies that use a broad range of methods, including not only subjective measures of sleep but also experience sampling, time diaries, and objective measures such as wrist-worn actigraphs, which provide a template for future studies that will (hopefully) explore these issues with greater breadth and depth. It seems likely that the next decade will be an even more exciting time for advancing our understanding of sleep and health within a family context."* (Dahl & El-Sheikh, 2007, p. 2).

This special issue set the groundwork for a large collection of research, including how characteristics of the family environment (e.g., socioeconomic status, family climate) directly influence adolescent sleep (Bartel et al., 2015; Doane et al., 2019), the interplay between relational and demographic aspects of the family in the prediction of adolescent sleep (Tsai et al., 2018; Maratia et al., 2023), sleep as an intervening process underlying links between family stress and youth adjustment (Kelly et al., 2014; Sasser et al., 2021a), and the synchrony or alignment of sleep patterns among multiple family members (Fuligni et al., 2015; Kouros & El-Sheikh, 2017). This special issue, and similar theoretical pieces (Becker et al., 2015 and El-Sheikh & Kelly, 2017), heavily informed the collection of papers in this dissertation, which sought to expand the growing literature in this area and advance our understanding of sleep in a family context, with a particular focus on family members (e.g., parents, siblings) as *promotive* of adolescent sleep health.

How Parents Influence Adolescent Sleep

Theories of attachment have long highlighted the importance of parents as a security base for youth to explore new social contexts from early development (i.e., infancy) into later stages of life, including adolescence (Bowlby, 1969; Cummings & Davies, 1996). Parents continue to play a significant role in their child's life during adolescence, as youth remain highly sensitive to parent-child interactions and benefit from the availability and responsiveness of parents during a time of major biological, social, and cognitive change (Booth-LaForce & Roisman, 2021). Adolescents who are reared in contexts that promote the development of autonomy and individualization, while still providing parental support, warmth, and involvement, often exhibit positive outcomes (e.g., emotional, cognitive, and social functioning; Moretti & Peled, 2004). In the context of sleep in particular, a similar theme emerges for the influence of parental support and security (Keller & El-Sheikh, 2010). In general, research suggests that positive parenting (e.g., warmth, support, quality relationships) may help promote adolescent sleep, whereas negative or harsh parenting (e.g., abuse or neglect, parent-child conflict) is linked with poorer sleep outcomes among youth (El-Sheikh & Kelly, 2017; Sasser et al., 2021a; Schønning et al., 2022). These findings are further supported by theories of sleep regulation and arousal (Dahl, 1996, 2002), such that youth who feel unsafe or threatened (e.g., due to harsh parenting, unsafe home environments) may experience hyper-vigilance that disrupts their ability to initiate and maintain sleep. On the other hand, parents who form strong social bonds and promote a sense of safety within the home can help youth achieve healthy sleep by facilitating restfulness and reducing nightly disturbances (Dahl, 1996, 2002). Each of the papers comprising this dissertation investigate how aspects of parenting (e.g., adverse parenting), as well as the broader family context (e.g., dynamics) can help promote or hinder youths' sleep behaviors across adolescence. However, in many families, parents are only part of the picture, and more research is needed considering *siblings* as proximal and significant influencers of adolescent sleep patterns.

How Siblings Influence Adolescent Sleep

Family systems theory posits that the actions and behaviors of family members are largely interconnected, in that they directly and indirectly shape the behaviors of one another (Cox & Paley, 1997). While many studies focus on the parent-child dyad as a subsystem, growing research has highlighted the importance of the sibling subsystem, given the developmental significance of this relationship (i.e., longevity and centrality across the lifespan; Feinberg et al., 2012; McHale et al., 2012; Whitemen et al., 2011). For example, approximately 80% of U.S. youth under the age of 18 live with at least one or more siblings (McHale et al., 2012; U.S. Census Bureau, 2022). Thus, a large majority of adolescents are likely to engage with their siblings, at least to some extent, on a daily basis. Despite this, the influence of siblings on youth development and health is often underestimated (Feinberg et al., 2012), and very few studies have directly examined how sibling interactions influence sleep patterns in adolescence. There is considerable reason to believe that siblings would exert a strong influence on adolescent sleep, due to shared living environments, daily routines/activities, and mere time spent together (Breitenstein et al., 2018; Hagenauer et al., 2009; Ortiz-Ospina et al., 2020). Furthermore, positive sibling relationships have been correlated with a range of positive outcomes, including greater health-promoting behaviors (e.g., diet and exercise; Senguttuvan et al., 2014), lower risk taking (e.g., substance use; East and Khoo 2005), and fewer symptoms of anxiety and depression (Buist et al., 2013). The current dissertation sought to complement this existing research by examining how the quantity, and quality, of time spent with siblings influenced adolescent sleep, as well how sibling sleep patterns related to one another, on a day-to-day basis.

Within-Family Relations in Sleep During Adolescence

As conveyed above, both broader aspects of the family, as well as direct interactions and experiences with family members, may influence sleep patterns during adolescence. While most of these studies focus on the *waking behaviors* of parents and siblings on youth sleep, a growing body of work has begun examining how the *sleep behaviors* of family members may co-occur within a given household. In the sleep literature, “concordance” is defined as the extent to which the sleep behaviors of one family member coincide or depend on the sleep of another family member (Fuligni et al., 2015). This is congruent with the family systems perspective (Cox & Paley, 1997), in which behaviors are conceptualized as interdependent across family subsystems (e.g., parent-child, siblings), which can be due to both genetic and environmental reasons (Breitenstein et al., 2021). A collection of existing work has documented associations between family members’ overall sleep, including parents, children, and siblings (e.g., Brand et al., 2009; Sletten et al., 2013). However, fewer studies focus on how *daily* sleep patterns may co-occur across family members (Fuligni et al., 2015; Kouros & El-Sheikh, 2017). Investigating *daily* concordance in sleep can help disentangle whether, beyond mean-level similarities in family members’ sleep, there is coordination in day-to-day fluctuations (i.e., more/less sleep than usual) among certain family members. Enhancing our understanding of *when* and *how* families exhibit coordination in their sleep behaviors can inform the development of preventive intervention programs focused on improving sleep for adolescents and their family members. The papers in this dissertation examined both (1) parent-child and (2) sibling concordance in daily and average sleep patterns, with key similarities, differences, and take-aways across studies discussed in Chapter 5.

Considering the Broader Family Context

Consistent with transactional and ecological models of youth development (Becker et al., 2015; Bronfenbrenner, 1979, 1992), it is imperative that relationships between more proximal family factors (e.g., interactions with parents/siblings) and adolescent sleep outcomes are contextualized within the broader family context. Much research suggests that characteristics of the family environment, including socioeconomic status, household size, sleeping arrangements, and perceived safety can serve as key determinants of adolescent sleep (Hawkins et al., 2016; Maratia et al., 2023). In line with family systems theory, there is also evidence that families differ in their unique roles, rules, and dynamics, such as how family members communicate with one another, their levels of cohesion or closeness, the ability to adapt to change, and the responsibility that they feel towards one another (Cox & Paley, 1997; Olson, 2000). These broader aspects of the family context can influence the ways that youth are sleeping in general (i.e., direct effects), but also the extent to which daily family processes affect sleep (i.e., moderation effects). For example, daily interactions with family members may enhance sleep quality in *positive* family environments, but have harmful effects on sleep in *negative* family contexts. In recognition of this, each paper in this dissertation considers the broader context in which adolescent sleep is nested, to better understand *under what conditions* family and sleep processes are intertwined. This information has the potential to aid sleep health programs by identifying specific aspects of family functioning (e.g., parenting strategies, communication styles) that can be targeted to enhance overall sleep quality and quantity of adolescents in their daily lives.

The Current Study

The current dissertation combines three first-author manuscripts that focus, broadly, on adolescent sleep in a family context (Sasser et al., 2021b; Sasser & Oshri, 2023; Sasser et al., 2023a). Together, these three samples are diverse with regards to developmental period (e.g., early, middle, late adolescence), ethnic/racial background (e.g., predominantly Latinx and diverse samples), geographic location (e.g., southwest and southeast United States; rural, urban, and suburban), and socioeconomic background.

These studies also harness advanced statistical techniques (e.g., multi-level modeling) and objective assessments of sleep (e.g., wrist-based accelerometer) to elucidate the natural sleep patterns of adolescents in their day-to-day lives (as opposed to lab-based, single-night studies). It is important to note that, rather than merely being related in substantive topic, the three studies in this dissertation directly build off one another, such that the order of the chapters represent the chronology in which research questions were developed, each informed by the previous.

The first paper (Chapter 2) examined how family connection (i.e., spending time with parents and siblings) influenced daily and average actigraphy-measured sleep in a sample of Latinx late adolescents ($M_{\text{age}} = 18.11$) in their senior year of high school, and also explored the moderating role of family dynamics and cultural values (Sasser et al., 2021b). The second study (Chapter 3) examined within-family (e.g., daily) and between-family (e.g., average) concordance between parent and youth ($M_{age} = 12.90$) actigraphy sleep, as well as the degree to which these relations varied as a function of the family context (e.g., parenting tactics, family dynamics; Sasser & Oshri, 2023). The third study (Chapter 4) leveraged the strengths of a large sample of twins ($M_{age} = 10.74$) and their primary caregivers to explore dyadic concordance between the sleep of parents and their children, as well as siblings, and explored differences in concordance as a function of zygosity type and sleeping arrangements (Sasser et al., 2023a). This collection of studies sought to accomplish the goals set forth by Dahl and El-Sheikh (2007), by contributing to the study of sleep within a family context, addressing notable gaps in the existing body of literature, and identifying adaptable family-level factors that can enhance the sleep health of both adolescents and their parents. Specifically, these studies not only shed light on the intricate dynamics of sleep within families, but also underscore the potential for targeted family-focused interventions to enhance both sleep hygiene and quality of family interactions, which can ultimately promote better well-being and quality of life for the entire family unit.

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CHAPTER 2

STUDY 1: Daily Family Connection and Objective Sleep in Latinx Adolescents: The Moderating Role of Familism Values and Family Communication

ABSTRACT

Spending time with family (“family connection”) is a salient aspect of adolescents’ daily lives linked with healthy sleep. Less is known regarding the unique effects of parent and sibling connection on sleep. This study examined daily and average associations between parent/sibling connection and objective sleep (duration, efficiency) in a sample of Latinx adolescents (N=195; M_{age}=18.11, SD=0.41; 65.6% female) and explored familism values and family communication as moderators. Adolescents slept longer on days that they spent more time with siblings, and youth who typically spent more time with parents had longer sleep durations. Family communication and familism-obligation moderated associations between family connection and sleep. These results provide support for the role of family interactions in promoting healthy sleep among Latinx adolescents.

INTRODUCTION

Sleep is essential for day-to-day functioning and has been linked to a wide range of competencies in adolescence, including improved psychological well-being, better academic performance, and enhanced emotion regulation (Baum et al., 2014; Shochat et al., 2014). Sleep patterns shift markedly during adolescence, starting with biological changes in early adolescence (i.e., phasic shift in the circadian pattern; Owens et al., 2014) and continue to vary in late adolescence as youth become more autonomous and balance social and academic responsibilities (Becker et al., 2015). Sleep problems may be particularly pronounced during *late adolescence*, with previous studies observing declines in both sleep duration (i.e., total time spent asleep) and sleep efficiency (i.e., percentage of time in bed actually spent sleeping) as youth near the end of high school (Maslowsky & Ozer, 2014; Park et al., 2019). Recent literature emphasizes the need for more research examining various aspects of *daily family life* that can promote youth well-being, including sleep (Buehler, 2020). Whereas negative aspects of family functioning (e.g., adverse parenting) have been associated with sleep problems in adolescence (Turner et al., 2020), positive aspects of family functioning (e.g., parental support) have shown more beneficial effects on sleep (Fuligni et al., 2015). However, most existing evidence is limited to between-person associations of family processes and sleep (e.g., Bartel et al., 2015), and less is known regarding whether day-to-day fluctuations in family interactions may influence sleep. Spending time with family members, referred to as “family connection,” is a normative daily interaction that may be implicated in adolescents’ sleep at both the daily (i.e., within-person) and average (i.e., between-person) level (Tavernier et al., 2017). Further, these interactions may be particularly salient in cultures that place high importance on family connectedness, such as Latinx communities (Hardway & Fuligni, 2006). Building upon prior work examining the impact of family connection on adolescents' sleep behaviors (Kuo et al., 2015; McHale et al., 2011), the present study investigated individual differences in family connection (i.e., average time spent with parents/siblings across the week) and day-to-day changes in family connection (i.e., within-person differences) as predictors of Latinx adolescents' objectively-measured sleep duration and sleep efficiency. In addition, adolescents' self-reported familism values and perceived family communication were examined as potential moderators of these associations.

Family Connection and Sleep

Some evidence supports the hypothesis that mere *time* spent with family can influence adolescents' subsequent sleep patterns (Adam et al., 2007; McHale et al., 2011), with one study showing that individual and day-to-day differences in family connection are associated with sleep (Tavernier et al., 2017). Indeed, in a recent study of ethnically diverse youth, adolescents exhibited longer sleep latencies on days that they had spent more time than usual with their family, whereas adolescents who generally spent more time with their family experienced more efficient sleep overall (Tavernier et al., 2017). Interestingly, the latter association was only found for older adolescents (i.e., 16-17 years old), highlighting family connection as a potential promotive factor for sleep behaviors during late adolescence in particular. With the exception of the aforementioned study, previous work examining family time and sleep have been limited by their reliance on subjective sleep measures (e.g., phone interviews, questionnaires), which points to a need for future research examining family connection as it relates to objective assessments of sleep (e.g., actigraphy).

Spending time with family may be particularly important for Latinx adolescents' sleep patterns, as traditional Latinx cultures often emphasize family connectedness and daily activities with family (Hardway & Fuligni, 2006). For example, national trends report that Hispanic/Latinx adolescents are more likely to eat meals with their family on a regular basis, compared to Non-Hispanic White or Black youth (Sacks et al., 2014), and a separate study linked longer time spent eating meals with greater hours of sleep in adolescence (Adam et al., 2007). Despite this, relatively few studies have investigated the link between family connection and sleep outcomes among Latinx adolescents (Kuo et al., 2015; McHale et al., 2011; Roblyer & Grzywacz, 2015). In one diary-based study, daily time spent with fathers, but not mothers, was linked to greater nighttime sleep duration in Mexican-American adolescents aged 12-16 years (McHale et al., 2011). However, when following these same participants into late adolescence (i.e., age 18), no significant associations were observed between family time and sleep duration or variability (Kuo et al., 2015). Although these findings may point to developmental differences in family connection and sleep, it should be noted that the latter study measured family time as an aggregate of time spent with parents *and/or* siblings, whereas the former study only assessed time with parents. In addition, a study of predominantly Latinx adolescents found that parental involvement (i.e., how often youth spent time with their parent during the past year) was not predictive of sleep (Roblyer & Grzywacz, 2015); however, time spent with siblings was not considered in this study. Given that siblings often undergo developmental changes in their relationships during late adolescence (e.g., increased intimacy; Updegraff et al., 2002), are a prominent component of Latinx households (i.e., compared to non-Hispanic whites; Landale et al., 2006), and spend considerably more time together than they do with their parents (e.g., Updegraff et al., 2005), it is likely that parent and sibling-connections may exert unique effects on adolescents' sleep behaviors during this time. Although no known studies have linked spending time with siblings to adolescent sleep, we predict that sibling connection may be associated with sleep based on prior work connecting close sibling relationships with healthier behaviors during adolescence (i.e., diet and exercise behaviors, lower substance use; East & Khoo, 2005; Senguttuvan et al., 2014).

Familism Values

In addition to differences in time spent with family, a large body of research suggests that cultural values, such as familism, promote Latinx adolescents' well-being (Gonzales et al., 2012), including a lower likelihood of developing internalizing (Zeiders et al., 2013) and externalizing problems (Kapke et al., 2017). Attitudinal familism values (*familismo*) are typically defined as the cultural value of loyalty, reciprocity, and solidarity among family members (Sabogal et al., 1987) and are comprised of values related to family support (e.g., social/emotional support), obligation (e.g., family assistance), and referent (e.g., meeting family expectations; Knight et al., 2010). Considering sleep within a family context, Latinx adolescents' who report higher levels of familism should be expected to exhibit better sleep patterns, as supportive home environments are generally associated with fewer sleep disturbances (El-Sheikh and Kelly 2017). Yet, prior work has revealed mixed findings regarding the main effects of familism on adolescent sleep, with some studies suggesting that parents' familism values are related to more healthful sleep in Mexican-American adolescents (i.e., greater sleep duration; McHale et al., 2011), and others revealing nonsignificant associations (Kuo et al., 2015). Thus, it is possible that instead of directly promoting more high quality sleep, familism may play a moderating role in the link between family connection and sleep, such that the impact of family time on sleep may differ depending on Latinx adolescents' degree of family orientation. In addition, cultural psychologists have called for the examination of the subcomponents of familism values (i.e., familism-support, -obligation, -referent; Campos et al., 2014), given evidence that suggests that different components of familism may be differentially linked to youth outcomes. For example, whereas familism support has often been recognized as a promotive subcomponent for Latinx youth (Edwards and Lopez 2006; Zeiders et al., 2013), the role of familism obligation in Latinx adolescents' development is more complex. Studies have found that the cultural obligation to adhere to the needs and wishes of the family may be associated with negative mental health outcomes (Davila et al., 2011; Parsai et al., 2009), whereas other studies suggest that family obligation can provide a meaningful daily routine for Latinx adolescents (Telzer & Fuligni, 2009). The present study primarily focuses on whether associations between family connection and sleep differ by attitudinal familism values broadly (i.e., familism-total), but also explores the differential role of familism subcomponents in these links.

Family Communication

Importantly, the impact of time spent with family members on sleep may also differ as a function of family dynamics, such as family communication. A large body of work suggests that positive family relationships, including open communication and support, promote adolescent well-being, including greater social competencies, fewer high-risk behaviors, and identity development (Fulkerson et al.. 2006; Sacks et al., 2014). Much evidence suggests that parents (i.e., warmth, support) promote better quality of sleep for their children in diverse as well as Latinx youth samples (for a review, see El-Sheikh & Kelly, 2017). Indeed, parent-adolescent communication has been found to reduce risk for externalizing problems (Davidson & Cardemil, 2009) and substance use (Guilamo-Ramos et al., 2006) among predominantly Latinx samples. In addition, many previous studies are limited by the examination of parent-child communication in particular, which excludes communication offered by other family members (e.g., siblings). This is a gap in existing research, given the central role that siblings play in the lives of Latinx adolescents in particular (i.e., spending approximately 17 hours per week together; Updegraff et al., 2005). Regarding sleep, it is expected that adolescents' perceptions of how well their family communicates, in general, may influence the degree to which family time influences subsequent sleep patterns. That is, Latinx adolescents who are spending more time with their family *and* who perceive positive family dynamics (e.g., high, enjoyable communication) may obtain the most restful sleep. Indeed, there is substantial work suggesting that Latinx cultures emphasize positivity and minimize negativity in relational settings (e.g., Campos & Kim, 2017), making characteristics of familial relationships (e.g., communication) an important determinant of whether daily and average family time promotes or hinders healthy sleep. Although no known studies have directly examined this hypothesis, a previous study found that the interaction between family time and perceived parental acceptance in late adolescence predicted fewer depressive symptoms in Latinx young adults (Zeiders et al., 2015).

Further, another study found that parental support was linked to greater sleep duration and efficiency, but only in the context of family stress (i.e., parental support was not directly promotive of sleep; Tsai et al., 2018). Taken together, these findings suggest that family processes may work in an interactive manner to predict subsequent adaptive health outcomes, including sleep.

The Current Study

The first aim of the study was to examine individual differences in family connection (i.e., average time spent with parents across the week) and day-to-day fluctuations in time with family (i.e., within-person differences) as predictors of adolescents' objectively-measured sleep duration and sleep efficiency over seven days. It was hypothesized that adolescents who spent more time with their parents would have longer sleep duration and more efficient sleep on average (Hypothesis 1) and would exhibit greater sleep duration and sleep efficiency on days that they spent more time than usual with their parents (Hypothesis 2). Hypotheses examining within- and between-person processes based on sibling connection were exploratory, as no previous studies have examined relations between time spent with siblings and adolescent sleep outcomes. The second aim was to investigate whether differing levels of familism values moderated the within- and between-person associations between Latinx adolescents' family connection and sleep outcomes. It was hypothesized that the predicted within- and between-person associations between time spent with family (e.g., parents, siblings) and sleep outcomes would be more pronounced for adolescents' higher in familism values, as compared to those low in familism (Hypothesis 3). Lastly, the third aim examined whether relations between time spent with family and objective sleep differed depending on family dynamics (e.g., family communication). It was hypothesized that within- and between-person associations between family connection and sleep duration/efficiency would be strongest among adolescents perceiving more positive family communication (Hypothesis 4).

Methods

Participants

Participants were 195 Hispanic/Latinx adolescents (M_{age} = 18.11, SD = 0.41; 65.6% female) that were part of a larger ongoing study examining Latinx adolescents transitioning to college (N = 209; see Doane et al., 2018, for more details). Participants were recruited during the spring of their senior year in high school from over 90 different schools in a large metropolitan area in the southwestern United States. Inclusion criteria required that participants had gained acceptance to the focal university, were seniors in high school, identified as Hispanic/Latinx, and lived within 60 miles of the university campus. For the current study, adolescents who did not report having at least one sibling were excluded, resulting in a sample size of 195 (93.3% of sample). All participants broadly identified as Hispanic or Latinx. A majority of the participants specifically identified as being of Mexican descent (85.6%), followed by South or Central American (8.2%), Cuban (5.1%), Puerto Rican (2.6%), or other Hispanic/Latinx (2.6%). The sample's generational status was also diverse: 10.8% of participants were first-generation immigrants (born outside the U.S.), 65.1% were second generation (born in U.S. with at least one parent born outside the U.S.), and 24.1% were third generation or greater (both parents born in the U.S.). Adolescents also reported varying socioeconomic status as measured via their parents' level of education: 34.4% of the sample reported that their parents had attained less than a high school degree, 22.5% of parents earned a high school degree or GED, 24.6% of parents completed some college, 14.9% of parents had obtained a Bachelor's degree, and 3.6% reported that their parents had a graduate education.

Procedure

The university Institutional Review Board approved all procedures. During the spring or summer prior to matriculating to college, study personnel visited participants' homes or hosted participants in an on-campus lab to deliver study materials, collect survey responses, and provide instructions regarding actigraphy and daily diary reporting procedures. Participants' height and weight were also measured during this appointment. Prior to beginning study procedures, informed consent and assent (for participants under the age of 18) were obtained from all individuals participating in the study. Participants and their guardians completed these forms in their preferred language. Participants were instructed to wear a wrist-based accelerometer (e.g., actigraphy watch) for a full week from Sunday evening to the following Sunday morning. Participants were instructed to push an event marker on the watches when they were in bed attempting to go to sleep (e.g., bedtime) and in the morning upon waking (e.g., wake time). Participants also completed daily diary reports using their smartphones (97.5%) or using paper-and-pencil diaries (2.5%) before they went to bed ($M_{\text{bedtime reports}}$ = 6.39, SD = 1.16). Project staff contacted participants daily at their preferred method of contact to provide reminders to complete diary reports and answer any questions. Participants also completed an online battery of survey measures immediately prior to the study week or during the study week, including questions about demographic information, cultural values, and emotional health. Participants were compensated upon completion of the project.

Measures

Objective Sleep

Sleep was assessed via actigraphy using the Micro Motion Logger Watch, a wrist-based accelerometer (Ambulatory Monitoring, Inc. Ardsley, NY USA) worn on participants' non-dominant wrists for seven consecutive days and nights. Actigraphy has been validated against polysomnography (Sadeh 2011) and demonstrates adequate reliability when assessed for at least 4-5 nights (Acebo et al., 1999). Activity was measured in 1-min epochs using a zero-crossing mode, and periods of sleep and waking were detected using the Sadeh algorithm in Action W-2 (Version 2.7.1; Ambulatory Monitoring), which were cross-checked with diary reports and actigraph-event markers of bed and wake times (Sadeh et al., 1994). Significant drops in actigraph-measured ambient light and high-intensity movement, in correspondence with diary reports and event markers of bedtime, were used to indicate when participants first fell asleep (sleep onset). Significant increases in ambient light and high-intensity movement, along with diary-reported wake times and event markers, were used to indicate when participants were first waking from sleep (sleep offset). In the instance of missing event markers or diary-reported bed and wake time, actigraphy indicators (e.g., ambient light, movement) were used to determine sleep/wake times. Actigraphy and diary-based bed and wake times were significantly correlated ($r = .56$, $p < .001$; $r = .63$, $p < .001$, respectively). The current study focused on two objective sleep outcomes: (1) sleep duration and (2) sleep efficiency. Sleep duration is defined as the total time (in hours) spent asleep between the first period of sleep onset to sleep offset, excluding episodes of waking and latency prior to the first onset. Sleep efficiency is the ratio of time spent asleep (duration) to total time in bed, with total time in bed including both true sleep and waking episodes. There were approximately 94.5% nights of valid sleep (5.51% missing), with an average of 6.61 nights of sleep across participants (*SD* = 1.68). In total, 73.3% (*n* = 143) participants wore the actigraph for 7 nights or more, 13.8% (*n* = 27) had data for 6 nights, 6.2% (*n* = 12) had data for 5 nights, 1.5% (*n* = 3) had data for 4 nights, 1.5% (*n* = 3) had data for 3 nights, and 3.6% (*n* = 7) had no valid nights of sleep. Post-hoc sensitivity analyses were conducted excluding cases with less than 5 valid nights of actigraphy sleep (6.7% of sample) and results stayed consistent. Thus, all cases were included in the analyses.

Daily Family Connection

In each bedtime daily diary report, participants responded to questions asking how much time they spent connecting 1) with parents and 2) with siblings. Specifically, they were asked in two separate questions: “How much time did you spend today with your parent(s)/sibling(s), talking or listening to them, either in person, on the phone, through text messaging, or other forms of communication?” Participants responded on a Likert-type scale ranging from 0 (*Little or none of the day*) to 5 (*Most or all of the day*). For within-person analyses, participants’ answers for each day were used to measure the daily amount of time spent with parents and siblings, separately. Across seven days, parent connection items had 0.6% missing data and sibling connection items had 2.2% missing data. For between-person analyses, average parent and sibling connections were measured as the mean of each individual’s daily scores on time spent with parents and siblings, respectively. Prior studies have utilized similar measures to assess the amount of time Latinx adolescents spend participating in daily activities with their family (e.g., Hardway and Fuligni 2006).

Familism Values

Participants responded to 16 items assessing familism values from the Mexican American Cultural Values Scale (MACVS; Knight et al., 2010). The three subscales include: Familism-Support (6 items), Familism-Obligation (5 items), and Familism-Referent (5 items). Items were worded on a Likert-type scale that ranged from 1 (*not at all*) to 5 (*completely*). Example items included “Family provides a sense of security because they will always be there for you” (Familism-Support), “Older kids should take care of and be role models for their younger brothers and sisters” (Familism-Obligation), and “A person should always think about their family when making important decisions” (Familism-Referent). A total familism subscale was created by taking the average of all items across each subscale ($\alpha = .92$). Higher scores reflect greater levels of familism values. The MACVS has demonstrated adequate construct validity among Mexican-origin adolescents (Knight et al., 2010), as well as broader Latinx samples (i.e., Mexican American, South American, Puerto Rican; Corona et al., 2017).

Family Communication

Participants responded to a 10-item Family Communication Scale (FCS; Olson et al., 2004) adapted from the Parent Adolescent Communication Scale (PAC; Barnes and Olson 1985), which was shortened and adjusted to reflect family communication broadly. The FCS measures the degree to which family members share information, thoughts, ideas, and feelings with one another. Participants responded to items on a Likert-scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Example items include “Family members are happy with how they communicate with each other" and "Family members enjoy talking to each other." Items were averaged to create a measure of family communication, with greater scores reflecting more positive family communication. Cronbach's alpha revealed good internal consistency for this scale (α = .86). The PAC scale has been used in previous research examining Latinx adolescents (e.g., Córdova et al., 2016; Schwartz et al., 2012).

Covariates

Daily covariates included whether it was a weekend vs. weekday night (1 = Friday or Saturday). Person-level covariates included participants' age, gender (1 = Male), body mass index (BMI), whether participants completed the study during the summer, parents' education level (1 = less than high school to 10 = graduate degree), and immigrant generation status. BMI was calculated based on CDC's (2015) recommendations. Immigrant generation status ranged from 0 to 7, with zero representing that the participant, both parents, and both sets of grandparents were born outside of the U.S. and 7 indicating that the participant, both parents, and both sets of grandparents were born in the U.S. (Umaña-Taylor et al., 2009). Depressive and anxiety symptoms were also examined as covariates, given prior research documenting the co-occurrence of sleep problems with anxiety and depressive symptomology in late adolescence (e.g., Doane, Gress-Smith, & Breitenstein, 2015). Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff 1977; α = .89) and anxiety symptoms were measured using the Depression, Anxiety, and Stress Scale (DASS; Lovibond & Lovibond, 1995; α = .89).

Analytic Plan

Independent t-tests were conducted to investigate group differences between participants who reported having a sibling (N = 195, 93.3% of full sample) and those who did not. Results revealed no significant group differences by age (t (205) = 1.45, p = .15), gender (t (205) = -1.10, p = .27), or Mexican origin (t (205) = 1.00, p = .32). There was a marginally significant difference by parents' level of education (t (205) = -1.94, p = .05), with adolescents from less educated households more likely to have a sibling. Lastly, consistent with prior research (e.g., Harker 2001), there were significant differences by immigrant generation scores (t (205) = -2.42, $p < .05$), such that adolescents who reported more recent immigration generation statuses (i.e., recently immigrated to the U.S.) were significantly more likely to have at least one sibling.

Level 2 predictors were grand mean-centered and daily (Level 1) parent and sibling connection were within-person centered. Preliminary analyses were conducted to examine outliers. Cases in which the independent variable or interaction product were above or below 3 SD from the mean were treated as missing in final analyses (n = 4). To assess daily and between-person variation in sleep, multilevel models were fit in Mplus 8.0 (Muthén and Muthén 1998–2017) using maximum likelihood estimation with robust standard errors to account for nested data (days within persons) and handle data missingness. Two-level models were fit separately for each sleep outcome: sleep duration and sleep efficiency. In the first set of models testing main effects, average time spent with parents and average time spent with siblings were entered as between-person (Level 2) predictors of model intercepts (average sleep; Hypothesis 1; N = 1,213 daily observations). Daily time spent with parents and siblings were also entered as within-person (Level 1) predictors of day-to-day variation in sleep (Hypothesis 2). Covariates were included at Level 2 (e.g., gender, BMI) and Level 1 (e.g., weekend vs. weekday night) if they were significantly associated with the sleep outcome. In the second set of models, familism was included as a predictor of individual differences in the day-to-day associations between time spent with parents/siblings and sleep outcomes (i.e., cross-level interactions) and average parent/sibling connection, familism, and their interactions were entered as Level 2 predictors (i.e., between-person interactions; Hypothesis 3). Lastly, in the third set of models, family communication was examined as a moderator in the link between daily and average parent/sibling connection and sleep outcomes (Hypothesis 4). Note that parent and sibling connection were each tested separately in the second and third model sets (i.e., two models per sleep outcome; eight total models). Significant interactions were probed using simple slopes technique for multilevel modeling (Preacher et al., 2006).

Results

Descriptive statistics and bivariate correlations are presented in Table 1. On average, adolescents reported 94.9% sleep efficiency ($SD = 4.41$) and averaged 6.55 hours of sleep (true sleep which excluded wake bouts; $SD = 1.03$). Youth reported spending more time connecting with their parents on average ($M = 2.22$; $SD = .82$) than they did with their siblings ($M = 2.04$, $SD = 1.22$). Average parent connection was positively associated with sleep duration ($r = .19$, $p < .01$), but not sleep efficiency ($r = -.04$, $p = .55$).

Parent/Sibling Connection and Sleep Outcomes

Intraclass correlation coefficients of sleep efficiency and sleep duration were 0.41 and 0.24, respectively. Results for within- and between-person associations between time spent with family (e.g., parents, siblings) and sleep outcomes are in Table 2. Adjusting for covariates, greater average time spent with parents was significantly associated with longer sleep duration (γ_{01} = 0.21, p = .02), but not sleep efficiency (γ_{01} = -0.29, p = .47). Average time spent with siblings was not significantly associated with sleep duration (γ_{02} = -0.08, p = .17) or sleep efficiency (γ_{02} = -0.52, p = .07). At the day level, spending more time with siblings than usual (i.e., greater daily sibling connection) was significantly associated with longer sleep duration (γ_{20} = 0.12, p = .02), but not sleep efficiency (γ_{20} = 0.26, p = .07). There were no within-person associations between daily time spent with parents and objective sleep outcomes (ps > .11).

Moderation Analyses

Familism Values

Adjusting for covariates, familism values did not significantly moderate any of the between-person (ps > .10) or day-to-day associations (ps > .11) between parent/sibling connection and sleep outcomes (see Table 3). Notably, the interaction between average sibling connection and familism values predicting sleep efficiency did not reach traditional statistical significance levels but had a p-value below .10 (γ_{03} = -0.73, p = .098). Additionally, there were no main effects of familism on either sleep outcome (ps > .34).

Family Communication

Family communication significantly moderated the association between average time spent with parents and sleep duration (γ_{03} = 0.25, p = .02), adjusting for covariates (see Table 4). Probing simple slopes revealed that 1 *SD* greater time spent with parents was associated with approximately 22 more minutes of average sleep for adolescents who reported higher family communication (+1 *SD* from mean; $b = 0.37$, $p < .01$) and 11 more minutes of sleep for youth with average family communication ($b = 0.18$, $p = .04$), as compared to adolescents with lower family communication (-1 *SD* from mean; $b = -0.00$, $p = .99$; see Figure 1a). Regions of significance suggested that associations between greater time spent with parents and greater sleep minutes was significant at values of family communication greater than 3.42, 56.5% of the sample. The interaction between average sibling connection and family communication was not statistically significant but the *p*-value was less than .10 ($\gamma_{03} = .17$, $p = .07$). Thus, this marginal effect was further explored by probing simple slopes. Simple slopes revealed that 1 *SD* greater time spent with siblings was associated with approximately 14 less minutes of sleep on average for adolescents who reported lower family communication ($b = -0.23$, $p = .03$); this association was not significant for those who reported average ($b = -0.10$, $p = .11$) or higher levels of family communication ($b = 0.03$, $p = .71$; see Figure 1b). Regions of significance showed that associations between greater sibling connection and less sleep duration were significant at values of family communication lower than 3.21, 29.9% of the sample. No significant between-person interactions were found predicting sleep efficiency (*p*s > .49). Further, there were no significant cross-level interactions predicting sleep outcomes (*p*s > .21).

Sensitivity Analyses

Given research suggesting that the different subscales of familism may be differentially related to adolescent outcomes (i.e., Toyokawa and Toyokawa 2019), sensitivity analyses were conducted testing each separate subscale of familism values (e.g., support, referent, obligation) to identify whether a specific subscale was driving the interaction between average sibling connection and familism values predicting sleep efficiency. Adjusting for covariates, there were no significant within- or between-person interactions between sibling connection and familism-support (*p*s > .27) or familism-referent (*p*s > .09) predicting sleep efficiency. Familism-obligation moderated the link between average time spent with siblings and sleep efficiency ($\gamma_{03} = -0.79$, $p = .050$). Probing simple slopes revealed that 1 *SD* greater average sibling connection was associated with *less efficient* sleep, but only for adolescents who reported higher family obligation ($b = -1.02$, $p = .01$; see Figure 2); this association was not significant for those reporting average ($b = -0.47$, $p = .09$), or lower levels of family obligation ($b = .08$, $p = .85$). Regions of significance showed that associations between more time spent with siblings and less sleep efficiency were significant at values of familism-obligation greater than 3.93, 55.4% of the sample.

Discussion

Spending time with family, or "family connection," is a salient aspect of adolescents' daily family lives that has been linked with more healthful sleep in adolescence (Tavernier et al., 2017). However, to date, no previous studies have examined the unique effects of parent and sibling connection on sleep behaviors, despite the central role that siblings play in adolescents' daily lives, and in Latinx households in particular (Updegraff et al., 2005). Thus, the present study investigated within- and between-person differences in time spent with parents and siblings on adolescents' objectively-measured sleep duration and sleep efficiency. Further, expanding on previous work studying family and cultural influences on youth sleep (e.g., McHale et al., 2011), self-reported familism values and family communication were examined as potential moderators of these associations. Day-level results showed that adolescents slept longer on days that they had spent more time than usual with their siblings. At the person-level, adolescents who typically spent more time with their parents had longer sleep durations on average. Family communication moderated the link between average parent connection and sleep duration. In general, spending more time with parents was associated with longer sleep duration for adolescents who perceived positive family communication. Sensitivity analyses exploring interactions that did not attain conventional statistical significance found that greater average sibling connection was associated with shorter sleep duration for youth who reported negative family communication, and with lower sleep efficiency for youth who reported higher levels of family obligation.

Family Connection and Sleep

Results are consistent with prior research suggesting that positive aspects of family functioning are related to more healthful sleep (El-Sheikh and Kelly 2017) and are partially consistent with previous work examining family time and sleep in Latinx adolescents (McHale et al., 2011). Specifically, the finding that average parent connection was positively associated with sleep duration is consistent with prior work linking time spent with fathers to greater sleep duration in middle adolescence (McHale et al., 2011), but differs from another study that found no significant associations between family time and sleep in late adolescence (Kuo et al., 2015). The within-person, but not between-person, association between daily sibling connection and sleep duration is an interesting finding that should be further explored. Contrary to previous work (Updegraff et al., 2005), this study found that Latinx adolescents reported spending more time with their parents than they did with their siblings, on average. Thus, a potential explanation could be that sibling connection is especially promotive of healthy sleep on days when adolescents are spending more time than usual with their sibling(s), given that their weekly time spent together is less. The finding that neither parent nor sibling connection were associated with sleep efficiency was unexpected and requires further analysis in future studies, given prior evidence that greater average family connection was associated with better quality sleep on average (Tavernier et al., 2017).

Familism Values and Sleep

Contrary to the study hypotheses, familism values as a whole did not moderate any of the within- or between-associations between family connection and sleep. Further, there were no main effects of familism on sleep duration or efficiency. Although surprising, these findings are similar to a previous study that found no association between parents' familism values and sleep in late adolescence (Kuo et al., 2015). In addition, whereas previous studies have found positive effects of familism on well-being (e.g. lower depressive symptoms, externalizing problems; Kapke et al., 2017; Zeiders et al., 2013), these associations may differ as sleep is not an internalizing or externalizing disorder, but is a biological necessity. Interestingly, sensitivity analyses revealed an interaction between average sibling connection and familism-obligation, such that greater average sibling connection was associated with less efficient sleep for adolescents who reported higher family obligation. Although prior studies have demonstrated a protective effect of family obligation against negative outcomes in adolescence, including substance abuse (Telzer et al., 2014), risky behaviors (Milan and Wortel 2015), and internalizing problems (Telzer et al., 2015), there have also been studies suggesting that family obligation may serve as a source of stress among Latinx individuals (Corona et al., 2017). Indeed, prior evidence suggests that family obligation can serve as both a protective and a vulnerability factor (Milan and Wortel 2015) for adolescent girls. Thus, future work is needed to further examine the role of family obligation in alternate aspects of adolescents' daily lives as they relate to sleep and well-being.

Family Communication as a Moderator

Average Parent Connection

The findings that family communication amplified the association between average parent connection and sleep duration yields support for daily family interactions as promotive processes for adolescent well-being (Buehler 2020), especially in the context of positive family environments. In addition, these results may also capture the importance of *simpatía*, or the emphasis on expressing emotional positivity, which is a salient cultural value within the Latinx community (Campos and Kim 2017). However, future research is needed to directly explore this hypothesis. Interestingly, family communication was not directly promotive of sleep duration in this study, which underscores the importance of examining the *interactive effects* of promotive family processes on adolescents' sleep. Indeed, a previous study found that greater time spent with family predicted less depressive symptoms in the context of high parental acceptance; however, neither family time nor parental acceptance were directly predictive of depressive symptoms (Zeiders et al., 2015). Further, other research found that positive family relationships (e.g., parental support) were only linked with more healthful sleep under conditions of high familial stress (Tsai et al., 2018). Therefore, future research should aim to extend these findings by examining the interaction between family communication and other salient daily interactions in the lives of Latinx adolescents (e.g., family assistance behaviors) as they relate to sleep.

Average Sibling Connection

Sensitivity analyses suggested that adolescents who spend more time with their siblings on average, but who perceive negative family dynamics (i.e., family members do not enjoy communication), may be at-risk for negative sleep outcomes. Although unexpected, this finding may be due in part to the added complexity of Latinx sibling relationships. Siblings in families across various racial/ethnic groups (Asian, White, Hispanic, and African American) tend to serve as companions and a source of support, but also are a focus of rivalry and conflict (McHale et al., 2012). In addition, Latinx siblings often take on the role of acting as a resource for contexts outside of the family (e.g. college), in which parents of these families may not have as much knowledge or firsthand experience of attending college in the United States due to recent immigration status (Updegraff et al., 2011). Due to the nature of the Latinx sibling relationship, it may be that siblings are communicating out of obligation as opposed to for their own enjoyment or benefit, and these close relationships with siblings do not necessarily fulfill the desire of adolescents to have peer relationships outside of the home (Fuligni et al., 1999). In this way, Latinx adolescents may be satisfying the expectations regarding assisting and supporting their families, but may not view this time with siblings as positive communication (Fuligni et al., 1999).

Of particular interest are the differential effects of sibling connection on sleep at the day-to-day and between-person levels, such that greater average sibling connection in the context of poor family communication was linked to shorter sleep duration, while day-to-day increases in sibling time were linked to longer sleep. A potential explanation for these findings may relate to the cumulative effect of spending increased time with siblings under negative circumstances. Specifically, whereas spending more quality time than usual with siblings may confer short-term benefits on adolescents' sleep (i.e., at the daily level), youth who are spending more time with their siblings overall, and who generally perceive these interactions as less enjoyable, may experience an average decline in sleep hours. It is also important to note that the present study included *all forms* of communication (e.g., face-to-face, over the phone) as sibling connection, but did not account for differences due to type of communication. Future research would be strengthened by examining the method of communication adolescents used when connecting with their siblings, and how this relates to their sleep.

Familism vs. Family Communication as Moderators

The present study sought to examine whether family communication and familism values modified day-to-day and person-level interactions within the family. As previously mentioned, familism values were not significant moderators in this study (with the exception of a sensitivity analysis), but family communication significantly moderated the association between parent connection and sleep duration. Although unexpected, there are several important distinctions between the two constructs that may explain these findings. First, family communication may be more salient and/or present within adolescents' daily lives. In this study, family communication measured adolescents' perception of their family members' degree of enjoyment in sharing information, ideas, thoughts, and feelings with one another. It is expected that adolescents' overall perceptions of their family members' happiness when communicating can provide general feelings of belonging within the household, which may contribute to more positive engagement with family members (Ackerman et al., 2011). Indeed, the availability of a comfortable space to discuss challenging topics (e.g., worries of the future, relationship conflicts) may explain the negative correlation between family communication and internalizing symptoms in the present study and in prior work (i.e., Telzer and Fuligni 2013). Therefore, it may be that households that are characterized by frequent and regular positive communication represent ideal family environments for healthful sleep in Latinx adolescents.

Another important distinction between the two constructs is the emphasis that familism places on loyalty, reciprocity, and solidarity among family members (Sabogal et al., 1987), which may be more representative of family culture, rather than family dynamics (i.e., family communication). Although familism values and family communication are likely intertwined within overall family functioning (as is demonstrated by their significant correlation in the present study), familism is capturing the degree to which adolescents' beliefs align with the traditional values that are typically fostered within the Latinx community. As such, the nonsignificant findings in the present study may be due to familism representing the values and beliefs of the family, rather than an observable interaction. Constructs that capture behavioral manifestations of familism values (e.g., family assistance behaviors) may be more evident in proximal day-to-day analyses (Doane et al., 2018). In addition, future research may consider examining other cultural values such as *simpatía*, which often promotes quality and enjoyable interactions in Latinx cultural contexts (Holloway et al., 2009). These findings provide evidence regarding how family communication and familism values are independent constructs and should be differently conceptualized in future studies.

Differential Effects of Family Factors on Sleep Duration and Efficiency

Whereas the present study provides evidence for the impact of family connection on both sleep duration and efficiency, the main effects of time spent with parents and siblings were only found for sleep duration. It is likely that these varying findings are a result of family connection and sleep duration both being based on time. For example, a prior study found that adolescents who reported higher parental support and larger household sizes (which may be indicative of siblings) exhibited greater parent-adolescent concordance in sleep habits (e.g., hours, bedtime; Fuligni et al., 2015). These findings suggest that youth with greater parent connection go to bed around the same time as their parents, which may explain the results of the current study (i.e., average parent connection linked to longer sleep duration). In contrast, sleep efficiency captures the quality of adolescents' sleep by examining the percentage of time that youth spent asleep during their intended sleep period. Thus, it is possible that sleep duration may be impacted more by external factors, such as time spent with family members or school-start times (Owens et al., 2014), whereas sleep efficiency is likely more influenced by individual-level factors (e.g., rumination; Slavish and Graham-Engeland 2015). Indeed, although there were no direct effects of family time on sleep efficiency, greater time spent with siblings was associated with less sleep quality for youth with greater internalized values of familial obligation. Future research examining family time and sleep efficiency may aim to incorporate additional individual-level factors to further elucidate conditions in which spending time with family predicts sleep quality.

Limitations and Future Directions

Findings of the current study should be interpreted in light of its limitations. First, participants were recruited from one metropolitan area in the southwestern United States and were preparing to attend one focal higher education institution, which may not generalize well to populations residing in other areas of the United States. Results may differ for adolescents planning to attend colleges further from home, community colleges, and/or who forego higher education immediately following high school graduation. Despite this, participants attended over 90 different high schools from varying neighborhood and SES circumstances, which likely represents the county in which they were recruited. Second, the study sample had more female participants than males, which could have impacted the results. Regarding methodological limitations, this study relied predominantly on adolescent self-reports for time spent with family, familism values, and family communication. Future studies should follow the lead of previous studies that utilized both parent and adolescent reports of time spent together (e.g., McHale et al., 2011). Furthermore, in this study, family connection referred to both in-person *and/or* virtual (e.g., phone, text messaging) time spent with family, which prevents the ability to disentangle the effects of face-to-face and virtual communication on sleep behaviors. Future research should specify whether communication was in-person or over the phone (e.g., Tavernier et al., 2017). Last, the current study did not have information on whether youth slept in the same bedroom as their sibling(s), which could have impacted associations between sibling connection and sleep.

Directions for future research include specifying various characteristics of adolescents' parent and sibling relationships. For example, future studies should examine daily connection with parental figures separately, as prior studies have found differences in the impact of time spent with mothers and fathers on adolescents' sleep (e.g., McHale et al., 2011). Regarding sibling relationships, future studies would be strengthened by examining the gender constellation of the sibling dyad, as previous studies reveal evidence for differences in communication depending on gender (i.e., sister-sister dyads communicating most frequently; Killoren et al., 2014). Similarly, it would also be beneficial for future studies to incorporate information on number of siblings, as well as the age of these siblings, to determine whether these characteristics may lead to more frequent or higher enjoyment of communication (McHale et al., 2012). Lastly, future research should examine these associations at other stages of development (e.g., early childhood, young adulthood), to examine the potentially promotive effects of family connection across the lives of Latinx individuals.

Conclusion

There is strong empirical support for the link between family functioning, including time spent with family, and adolescent sleep. However, this was the first study to examine the unique effects of time spent with parents and siblings on sleep behaviors. Using a sample of Latinx adolescents, the current study addressed multiple gaps in the literature by examining the day-to-day and between-person effects of parent and sibling connection on adolescents' objective sleep. Further, given the importance of family connectedness and tradition within the Latinx culture, cultural values (e.g., familism) and family dynamics (e.g., communication) were examined as potential moderators of these associations. The results of the current study provide general evidence for the promotive effects of family connection on adolescent sleep, while also identifying the unique effects of spending time with parents and siblings. Additionally, this study highlights positive family communication as a potential resource for adolescents who frequently spend time with their families. Future research should aim to expand these findings by disentangling the impact of face-to-face and virtual interactions on adolescents' sleep behaviors. Moreover, it would be meaningful to examine when these associations first become evident and whether they remain stable later in development. Spending time with both parents and siblings may promote healthful sleep for Latinx adolescents, and these effects may be strongest for families who have strengthened communications.

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Table 1. *Bivariate correlations and descriptive statistics*

	1	2	3	4	5	6	7
1. Sleep efficiency (%)	--						
2. Sleep duration (hours)	.37***	--					
3. Average parent connection	-.04	.19**	--				
4. Average sibling connection	-.13†	.03	.46***	--			
5. Familism values	-.08	.07	.13†	.16*	--		
6. Family communication	.01	-.03	.09	.03	.25***	--	
7. Age	-.03	-.01	-.10	.05	.03	-.03	--
8. Gender	-.33***	-.34***	-.19**	-.09	.04	.08	.05
9. Body mass index	-.22**	-.23**	-.02	.01	-.04	.02	-.04
10. Summer participation	-.09	.28***	.03	.03	.01	-.07	.27***
11. Immigrant generation	-.10	-.04	-.10	-.03	.01	.02	-.02
12. Parent education	-.07	-.02	-.16*	-.12†	-.14†	.02	-.05
13. Depressive symptoms	-.01	.06	-.01	-.04	-.09	-.39***	-.05
14. Anxiety symptoms	.02	.01	-.04	.03	.00	-.25***	-.07
M	94.90	6.55	2.22	2.04	3.78	3.46	18.11
SD	4.41	1.03	0.82	1.22	0.69	0.74	0.41
Skewness	-1.52	-0.12	0.11	0.24	-0.79	-0.72	-0.13
Kurtosis	2.34	-0.03	0.17	-0.76	0.73	0.72	0.42

Note. N = 195. Average parent/sibling connection = person-level average of daily diaries; Gender: 1 = male, 0 = female; Summer participation: 1 = study completed in summer, 0 = study completed during school year; Immigrant generation: 0 = participant, parents, and both sets of grandparents born outside U.S., 7 = all were born in U.S. Parent education (average of maternal and paternal education): 1 = completed less than high school, 10 = graduate degree. Depressive symptoms: CES-D scale (Radloff, 1977). Anxiety symptoms: DASS (Lovibond & Lovibond, 1995).

†p < .10, *p < .05, **p < .01, ***p < .001

Table 1 (contintuted). *Bivariate correlations and descriptive statistics*

	8	9	10	11	12	13	14
1. Sleep efficiency (%)							
2. Sleep duration (hours)							
3. Average parent connection							
4. Average sibling connection							
5. Familism values							
6. Family communication							
7. Age							
8. Gender	--						
9. Body mass index	-.01	--					
10. Summer participation	.05	-.11	--				
11. Immigrant generation	.01	.12†	-.08	--			
12. Parent education	.07	-.02	-.07	.42***	--		
13. Depressive symptoms	-.18*	.01	.03	.01	-.06	--	
14. Anxiety symptoms	-.11	-.01	-.13†	-.02	.02	.58***	--
M	0.34	25.06	0.35	2.54	3.65	16.46	8.00
SD	0.48	5.64	0.48	2.30	2.33	10.11	7.07
Skewness	0.66	1.04	0.62	0.82	0.81	0.91	1.24
Kurtosis	-1.58	1.17	-1.64	-0.79	-0.33	0.57	1.29

Note. N = 195. Average parent/sibling connection = person-level average of daily diaries; Gender: 1 = male, 0 = female; Summer participation: 1 = study completed in summer, 0 = study completed during school year; Immigrant generation: 0 = participant, parents, and both sets of grandparents born outside U.S., 7 = all were born in U.S. Parent education (average of maternal and paternal education): 1 = completed less than high school, 10 = graduate degree. Depressive symptoms: CES-D scale (Radloff, 1977). Anxiety symptoms: DASS (Lovibond & Lovibond, 1995).

$^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 2. *Fixed Effects Estimates from Multilevel Models Predicting Objective Sleep from Sibling/Parent Connection (Main Effects)*

Fixed effects	Sleep Efficiency (%) Est.	Sleep Efficiency (%) *SE*	Sleep Duration (hrs) Est.	Sleep Duration (hrs) *SE*
Models 1 & 2				
Intercept (γ_{00})	96.29**	0.32	6.47**	0.09
Level 2 (person-specific)				
Average Parent Connection (γ_{01})	-0.29	0.39	0.21*	0.09
Average Sibling Connection (γ_{02})	-0.52†	0.29	-0.08	0.06
Gender (γ_{03})	-3.40**	0.70	-0.69**	0.13
Body Mass Index (γ_{04})	-0.18**	0.05	-0.04**	0.01
Summer Participation (γ_{05})			0.60**	0.15
Level 1 (day-specific)				
Daily Parent Connection (γ_{10})	0.36	0.14	-0.07	0.04
Daily Sibling Connection (γ_{20})	0.26†	0.15	0.12*	0.05
Weekend (γ_{30})	-0.76*	0.35	0.46**	0.12

Note. 1,213 days nested within 195 individuals. Est. = partial regression coefficient estimate (unstandardized); *SE* = robust standard error. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Gender: 1 = Male, 0 = Female; Summer: 1 = summer, 0 = school year; Weekend: 1 = Friday or Saturday, 0 = all other nights.
$^{\dagger}p < .10$, $*p < .05$, $**p < .01$

Table 3. *Fixed Effects Estimates from Multilevel Models Predicting Objective Sleep from Family Connection, Familism, and Their Interaction*

	Sleep Efficiency (%)		Sleep Duration (hrs)	
Fixed effects	Est.	*SE*	Est.	*SE*
Models 3 & 4				
Intercept (γ_{00})	96.29**	0.33	6.49**	0.09
Level 2 (person-specific)				
Average Parent Connection (γ_{01})	-0.40	0.38	0.20*	0.09
Familism Values (γ_{02})	-0.39	0.52	0.09	0.10
Average Parent Connection X Familism Values (γ_{03})	-0.79	0.65	-0.09	0.13
Average Sibling Connection (γ_{04})	-0.45	0.29	-0.09	0.06
Gender (γ_{05})	-3.23**	0.66	-0.68**	0.13
Body Mass Index (γ_{06})	-0.16**	0.05	-0.04**	0.01
Summer Participation (γ_{07})			0.57**	0.14
Level 1 (day-specific)				
Daily Parent Connection (γ_{10})	0.01	0.14	-0.07†	0.04
Daily Parent Connection X Familism Values (γ_{11})	-0.24	0.23	-0.07	0.05
Daily Sibling Connection (γ_{20})	0.29*	0.14	0.13*	0.05
Weekend (γ_{30})	-0.76*	0.34	0.46**	0.12
Models 5 & 6				
Intercept (γ_{00})	96.29**	0.33	6.48**	0.09
Level 2 (person-specific)				
Average Sibling Connection (γ_{01})	-0.49†	0.29	-0.10	0.06
Familism Values (γ_{02})	-0.47	0.52	0.10	0.10
Average Sibling Connection X Familism Values (γ_{03})	-0.73†	0.44	-0.03	0.09
Average Parent Connection (γ_{04})	-0.31	0.37	0.20*	0.09
Gender (γ_{05})	-3.09**	0.65	-0.70**	0.13
Body Mass Index (γ_{06})	-0.17**	0.05	-0.04**	0.01
Summer Participation (γ_{07})			0.60**	0.14
Level 1 (day-specific)				
Daily Sibling Connection (γ_{10})	0.27†	0.15	0.13*	0.05
Daily Sibling Connection X Familism Values (γ_{11})	0.07	0.30	0.01	0.06
Daily Parent Connection (γ_{20})	0.02	0.14	-0.07†	0.04
Weekend (γ_{30})	-0.73*	0.35	0.47**	0.19

Note. 1,213 days nested within 195 individuals. Est. = partial regression coefficient estimate (unstandardized); *SE* = robust standard error. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Gender: 1 = Male, 0 = Female; Summer: 1 = summer, 0 = school year; Weekend: 1 = Friday or Saturday, 0 = all other nights. †p < .10, *p < .05, **p < .01

Table 4. *Fixed Effects Estimates from Multilevel Models Predicting Objective Sleep from Family Connection, Family Communication, and Their Interaction*

Fixed effects	Sleep Efficiency (%) Est.	Sleep Efficiency (%) *SE*	Sleep Duration (hrs) Est.	Sleep Duration (hrs) *SE*
Models 7 & 8				
Intercept (γ_{00})	96.28**	0.33	6.44**	0.09
Level 2 (person-specific)				
Average Parent Connection (γ_{01})	-0.45	0.41	0.18*	0.09
Family Communication (γ_{02})	0.42	0.37	0.04	0.08
Average Parent Connection X Fam Communication (γ_{03})	0.34	0.49	0.25*	0.10
Average Sibling Connection (γ_{04})	-0.51†	0.28	-0.09	0.06
Gender (γ_{05})	-3.42**	0.69	-0.66**	0.13
Body Mass Index (γ_{06})	-0.17**	0.05	-0.04**	0.01
Summer Participation (γ_{07})			0.63**	0.15
Level 1 (day-specific)				
Daily Parent Connection (γ_{10})	0.01	0.14	-0.07†	0.04
Daily Parent Connection X Fam Communication (γ_{11})	-0.24	0.19	-0.00	0.04
Daily Sibling Connection (γ_{20})	0.27†	0.14	0.12*	0.05
Weekend (γ_{30})	-0.77*	0.35	0.47**	0.12
Models 9 & 10				
Intercept (γ_{00})	96.24**	0.33	6.46**	0.09
Level 2 (person-specific)				
Average Sibling Connection (γ_{01})	-0.47	0.29	-0.10	0.06
Family Communication (γ_{02})	0.38	0.33	-0.02	0.08
Average Sibling Connection X Fam Communication (γ_{03})	0.09	0.25	0.17†	0.10
Average Parent Connection (γ_{04})	-0.42	0.40	0.20*	0.09
Gender (γ_{05})	-3.30**	0.69	-0.70**	0.13
Body Mass Index (γ_{06})	-0.17**	0.05	-0.04**	0.01
Summer Participation (γ_{07})			0.63**	0.15
Level 1 (day-specific)				
Daily Sibling Connection (γ_{10})	0.27†	0.15	0.13**	0.05
Daily Sibling Connection X Fam Communication (γ_{11})	-0.11	0.21	0.04	0.05
Daily Parent Connection (γ_{20})	0.02	0.14	-0.08†	0.04
Weekend (γ_{30})	-0.73*	0.35	0.46**	0.12

Note. 1,213 days nested within 195 individuals. Est. = partial regression coefficient estimate (unstandardized); *SE* = robust standard error. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Gender: 1 = Male, 0 = Female; Summer: 1 = summer, 0 = school year; Weekend: 1 = Friday or Saturday, 0 = all other nights. †$p < .10$, *$p < .05$, **$p < .01$

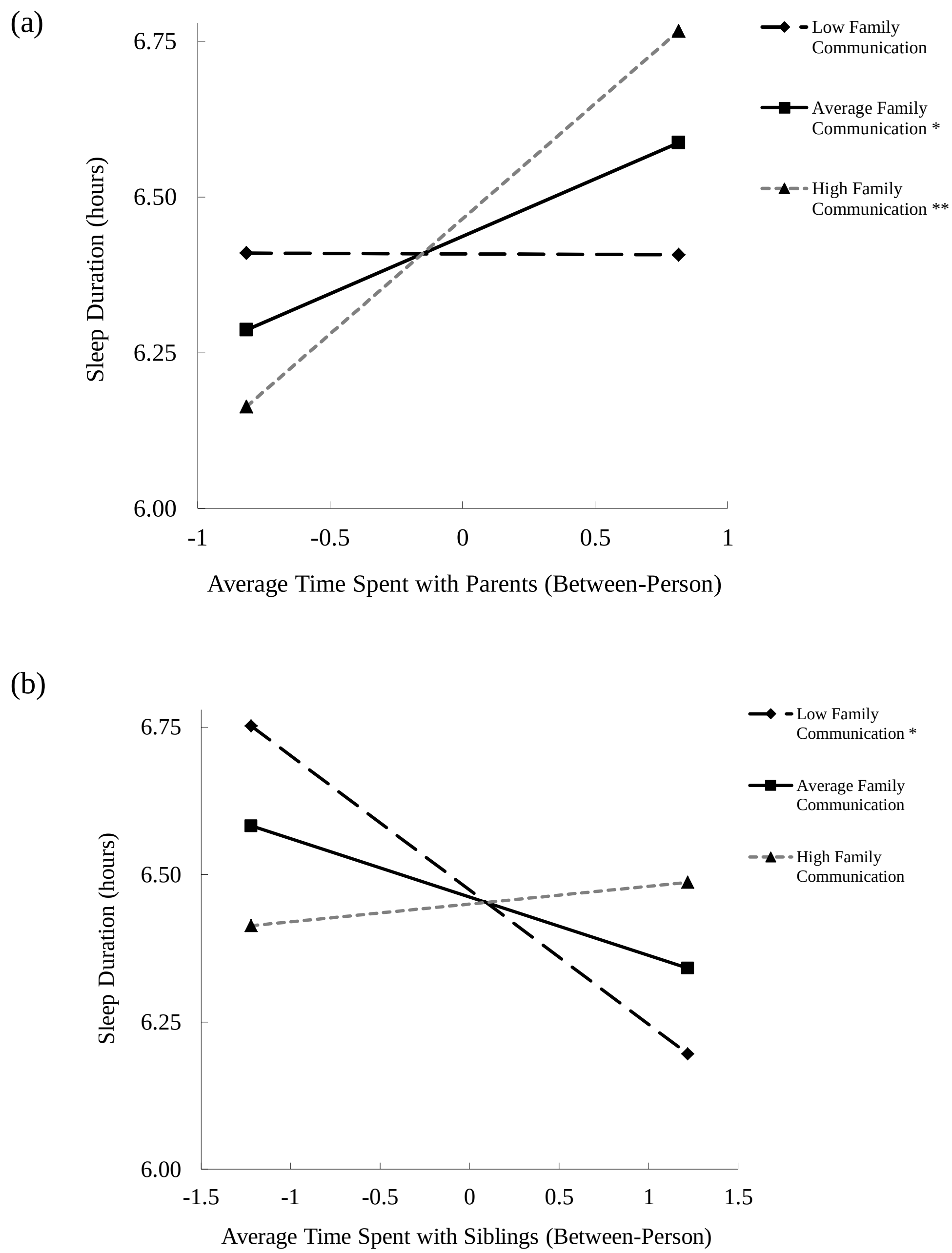

Figure 1. Simple slopes for between-person associations of time spent with (a) parents and (b) siblings (±1 SD from grand mean) with sleep duration by family communication (±1 SD from grand mean).
*$p < .05$, **$p < .01$

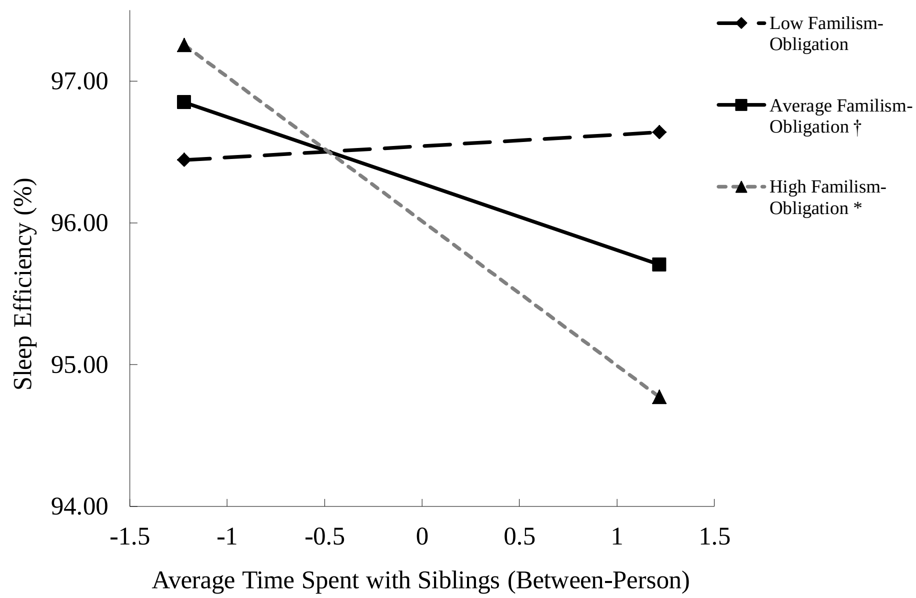

Figure 2 Simple slopes for between-person associations of time spent with siblings (±1 SD from grand mean) with sleep efficiency by familism-obligation (±1 SD from grand mean).
†$p < .10$, *$p < .05$

CHAPTER 3

STUDY 2: In or Out of Sync? Concordance Between Parent and Adolescent Sleep Varies by Family Context

ABSTRACT

Evidence suggests significant interrelations among parent and adolescent sleep (i.e., concordance). However, less is known regarding how parent-adolescent sleep concordance varies as a function of the family context. This study examined daily and average concordance between parent and adolescent sleep and explored adverse parenting and family functioning (e.g., cohesion, flexibility) as potential moderators. 124 adolescents (M_{age}=12.90) and their parents (93% mothers) wore actigraphy watches assessing sleep duration, efficiency, and midpoint across one week. Multilevel models indicated daily (within-family) concordance between parent and adolescent sleep duration and midpoint. Average (between-family) concordance was found for sleep midpoint only. Family flexibility was linked with greater daily concordance in sleep duration and midpoint, whereas adverse parenting predicted discordance in average sleep duration and efficiency.

INTRODUCTION

Sleep is critical for optimal health and development across the lifespan, particularly during adolescence, a time of rapid biological and emotional change (Galván, 2020). Adolescents who do not obtain sufficient sleep and/or who experience low-quality sleep often report increased rates of depression, substance use, as well as impaired emotion regulation and mood reactivity (Tarokh et al., 2016; Short & Weber, 2018). As such, it is vital to examine determinants of sleep health during this time. The family context, including parenting and family dynamics, plays a vital role in shaping adolescent sleep patterns (El-Sheikh & Kelly, 2017). However, adolescent sleep does not operate "in a vacuum," in that it is highly connected to parental sleep behaviors. Indeed, within-family relations, or *concordance* between caregiver and youth sleep behaviors, is gaining growing attention in the field of developmental psychology (Fuligni et al., 2015; Kouros & El-Sheikh, 2017). These studies have begun to find that adolescent and parental sleep behaviors are dependent on one another, and that dyadic sleep patterns are embedded within the larger family context (Fuligni et al., 2015). However, the literature on parent-youth sleep concordance is still emergent, and few studies have examined how family-level factors influence concordance between parent and adolescent sleep. The current study employs a multilevel modeling framework to examine (1) daily (e.g., within-family) and average (e.g., between-family) relations between parent and youth actigraphy-measured sleep (e.g., duration, efficiency, midpoint) across multiple nights, and (2) the degree to which aspects of the family environment (e.g., parenting tactics, family cohesion/flexibility) moderate concordance between parent and adolescent sleep at the daily and average level.

Adolescent Sleep in a Family Context

For many adolescents, the family context plays a major role in shaping sleep health, including sleep duration (i.e., total time spent asleep), sleep efficiency (i.e., percentage of time in bed actually asleep), and sleep timing (e.g., bedtime, waketime). During this period in which youth are developing autonomy, but still reliant on their parents in several areas (e.g., finances, transportation), adolescents often spend a large proportion of their time nested within family contexts that may promote or hinder optimal sleep. For example, previous work suggests that various aspects of family functioning, such as emotional connection (e.g., parental warmth), rule-setting (e.g., household rules), and time spent together (e.g., eating meals, connecting) can each independently influence youths' sleep behaviors (Adam et al., 2007; Sasser et al., 2021b). From a family systems perspective (Cox & Paley, 1997), the functioning of one family member is interdependent, or influenced to a great degree, by the functioning or behavior of other members of the family, supporting the notion that parents' sleep may directly affect and be affected by their own child's sleep health. Accordingly, a limited but growing body of literature suggests that sleep behaviors experienced by one family member can translate across other family members (Fuligni et al., 2015; Kouros & El-Sheikh, 2017). This concordance between parent and adolescent sleep represents a promising construct for developmental research as it allows for dynamic examination of parent and youth sleep health, as well as factors that may hinder or promote synchronous sleep behaviors across family members.

Concordance Between Parent and Adolescent Sleep

Concordance is a term used across disciplines to define simultaneous relationships between events, emotions, or behaviors across multiple levels of analysis. In family and developmental sciences, concordance is used to delineate parent and youths' coordination in bio-behavioral states (i.e., physiological, behavioral; Davis et al., 2018; Feldman, 2012). In the context of the parent-child relationship, bio-behavioral concordance has been shown to serve as a proxy for the relational bond, or relationship quality, between the dyad. Similarly, the degree of parent-child concordance is sensitive to parenting behaviors, with high-risk or harmful parenting related to *reduced* opportunities for bio-behavioral concordance (Feldman, 2012; Lunkenheimer et al., 2018). However, concordance between parents' and youths' bio-behavioral states may not always be positive, and previous work has shown that *higher* dyadic synchrony may be harmful in negative family contexts (Oshri et al., 2021). Because sleep regulation and maintenance is rooted in biological mechanisms (i.e., Eban-Rothschild et al., 2018; Zielinski et al., 2016) and has implications for neurobiological changes in adolescence (e.g., brain development; Galván, 2020), the present study positions sleep as an additional form of biological concordance, wherein sleep behaviors of adolescents and their parents are dependent on one another.

Existing research provides compelling evidence for concordance between parent and adolescent sleep (Fuligni et al., 2015; Kalak et al., 2012; Kouros & El-Sheikh, 2017). For example, a study by Fuligni and colleagues (2015) examined parent-adolescent concordance in diary-reported sleep habits over a 2-week period and observed significant daily concordance in sleep hours, bedtime, and waketime. In addition, Kouros and El-Sheikh (2017) examined within-family relations in sleep based on actigraphy data collected across seven nights, finding that youths’ sleep duration, efficiency, wake minutes, and waketime were predicted by mothers', but not fathers' sleep in these domains on the same night (i.e., mother-child sleep concordance), and that within-person fluctuations in youths’ sleep duration, quality, and schedule similarly predicted mothers', but not father's, sleep that same night. Another study utilized home-based sleep-EEG recordings for one night and found that adolescents’ sleep duration was significantly associated with mother and father sleep duration, whereas sleep onset latency and efficiency were correlated between adolescents and mothers (Kalak et al., 2012). Notably, other studies using questionnaire data support average, or between-family, associations between parent and adolescent sleep behaviors (Bajoghli et al., 2013; Brand et al., 2009).

Taken together, these findings provide evidence that parent and youth sleep may vary similarly from night-to-night and across families, suggesting that parents' own sleep may better promote their adolescents' sleep health, and vice versa. However, it is important to acknowledge that this phenomenon operates as a “double-edged sword,” as greater dyadic concordance can also reflect *problematic* family sleep in scenarios in which one family member experiences significant deficits in sleep. In other words, just as concordance suggests that when family members sleep well, they sleep well together, it equally implies that when family members sleep poorly, they sleep poorly together. Despite compelling evidence for bidirectional, recriprocal associations between parent and youth sleep (Varma et al., 2021), there is a need for research that further disentangles how aspects of the family environment may relate to concordance between parent and adolescent objective sleep.

Family-Level Predictors of Parent-Adolescent Sleep Concordance

Family systems theory (Cox & Paley, 1997) posits that the functioning of one family member cannot be fully understood without consideration of the broader family context, which can include interactions and relationships with other family members (e.g., parent-adolescent relationships), as well as broader indicators of family functioning (e.g., closeness, structure). Recognizing the importance of studying adolescent sleep in a family context (El-Sheikh & Kelly, 2017), the present study examined multiple aspects of family functioning as potential predictors of concordance between parent and youth objective sleep.

Adverse Parenting

A large body of evidence suggests that parenting significantly influences youths' sleep patterns, with positive parenting behaviors (e.g., warmth, support) promotive of better sleep outcomes, and adverse parenting (e.g., harsh, abusive) linked with a range of sleep problems (El-Sheikh & Kelly, 2017; Schønning et al., 2022). Accordingly, it is expected that parenting behaviors may also influence the degree of *concordance* between parent and youth sleep, such that positive parenting may promote greater synchrony in sleep patterns across dyads. To date, only one known study has has examined how aspects of the parent-child relationship relate to parent-adolescent sleep concordance. Specifically, Fuligni et al. (2015) found that daily concordance between parent and youth diary-reported sleep hours was *stronger* for families with more supportive parent-adolescent relationships, as compared to families who reported less-supportive relationships. Whereas *positive* parent-child relations may promote synchronous sleeping patterns, a growing body of work has shown that harmful parenting behaviors (i.e., negative parenting styles, abuse/neglect) are linked with increased adolescent sleep disturbance (Bajoghli et al., 2013; Brand et al., 2009; Sasser et al., 2021a), which may influence the degree to which parent and youth sleep differs within and between families.

Drawing on theories of sleep regulation and arousal (Dahl, 1996), higher levels of adverse parenting may underlie patterns of *reduced* bio-behavioral synchrony, or discordance, in parent-adolescent sleep. Bio-behavioral asynchrony may stem from harsh or abusive parenting behaviors that promote feelings of unsafety or hyper-vigilance among youth (Alen et al., 2022), which can cause arousal leading to problems with sleep initiation, quality, and duration, which may not be experienced by the parent as well (i.e., discordance). Furthermore, it is possible that discordance between parent and adolescent sleep may be *adaptive* for youth experiencing harsh parenting, such that youth who obtain better quality sleep than their parent(s) in these contexts may be protected against the harms of family stress via improved sleep (e.g., Sadeh, 1996). Though no known study has tested this question, a study examining parent-child coregulation of respiratory sinus arrhythmia (RSA), a common proxy for parasympathetic processes, found that increased maltreatment severity (e.g., physical abuse, neglect) led to more discordant RSA among parents and young children (Lunkenheimer et al., 2018). Thus, it remains to be examined whether adverse parenting is similarly predictive of parent-youth concordance in sleep behaviors.

Family Functioning

When investigating within-family relations in sleep, it is also critical to consider aspects of the broader family context in which adolescent and parent sleep is nested. The circumplex model of marital and family systems (Olson, 2000) highlights two major dimensions that capture the dimensionality of the family environment: *cohesion* (i.e., family closeness, emotional bonding) and *flexibility* (i.e., adaptability, how the family system balances change). Whereas levels of family cohesion and flexibility that are *too low* (i.e., disengaged, rigid) or *too high* (i.e., enmeshed, chaotic) have been linked with negative developmental outcomes, non-extreme or "balanced" levels of these dimensions are indicative of healthy family functioning, and have been closely linked with positive socio-emotional outcomes (Liu et al., 2021; Mastrotheodoros et al., 2020; Renzaho et al., 2013).

In the context of parent and youth sleep in particular, cohesive, tight-knit families may exhibit *greater* dyadic sleep concordance due to their closeness and time spent together (i.e., similar sleeping patterns overall). This hypothesis is supported by findings of increased parent-youth sleep concordance in supportive family contexts (Fuligni et al., 2015) and empirical work suggesting that shared family time and positive family dynamics promote healthy sleep patterns in adolescence (Adam et al., 2007; Sasser et al., 2021b). Further, the quality and expression of change in family leadership, rules, and relationships (i.e., flexibility) may relate to greater coordination between parent and adolescent sleep. For example, in the context of day-to-day changes, families with greater flexibility may be better able to adapt to the demands or stressors of the day together (i.e., sleeping more or less than usual, waking up earlier/later than usual). Indeed, family connectedness and flexibility are both considered key processes that promote family resilience (e.g., ability to adapt to stress or change in a cooperative manner; Walsh, 2021). Despite this, no known study has examined the role of family cohesion or flexibility in relation to parent-youth sleep concordance, which may help us better understand aspects of the family context that promote interrelations among parent and youth sleep.

The Present Study

Acknowledging the various benefits of healthful sleep for developing adolescents (Galván, 2020), as well as the major role of the family context in youths' sleep behaviors (El-Sheikh & Kelly, 2017), the present study seeks to expand previous research by examining concordance between adolescent and parent sleep, as well as the degree to which family-level factors may influence dyadic sleep concordance. The first aim of the study was to investigate daily and average concordance between parents' and adolescents' actigraphy-measured sleep duration, sleep efficiency, and sleep midpoint. Specifically, we sought to examine whether daily fluctuations in one member of the dyad's sleep, compared to their average sleep in this domain, predicted similar fluctuations in the other family member's sleep that night (e.g., within-family relations), as well as whether there were average associations between sleep parameters across dyads (e.g., between-family relations). Based on previous research among youth and adolescent samples (Fuligni et al., 2015; Kouros & El-Sheikh, 2017), we hypothesized that there would be significant concordance between parent and youth sleep duration, efficiency, and midpoint at both the day-level (e.g., within-families) and average level (e.g., between-families; *Hypothesis 1*). The second aim of the study was to examine whether daily and average concordance between parent and adolescent sleep varied by parenting and family dynamics. We predicted that higher levels of adverse parenting would be associated with discordance in parent-youth sleep (i.e., one family member's sleep would be increasing/improving while the other family member's sleep would be decreasing/worsening; *Hypothesis 2a*). In contrast, we predicted that higher levels of family cohesion and flexibility would be associated with greater concordance in parent-youth sleep outcomes (i.e., coordination in sleep patterns among family members; *Hypothesis 2b*).

Method

Participants

124 youth (M_{age} = 12.90, *SD* = 0.80; 52% female) and their primary caregivers (93% mothers) participated in a longitudinal study based in a catchment area of rural communities in the Southeastern United States. Data collection for the first wave of the study (used in the current study) took place from January 2018 to early March 2020. The racial-ethnic composition of the sample was: 76.4% European American, 12.2% African American, 4.9% Hispanic/Latino(a), 0.8% Asian/Pacific Islander, and 5.7% Other. Inclusion criteria required that youth were between the ages of 12-14, fluent in English, and able to read/answer questions as part of the survey (i.e., youth with significant developmental delays were not eligible to participate).

Procedures

The university's Institutional Review Board approved all study procedures prior to data collection. Primary caregivers provided informed consent and youth provided informed assent. Study staff travelled to participants' homes to deliver study materials (e.g., actigraphy watches) and administer a questionnaire. During the home visit, youth and their primary caregivers were instructed to wear wrist-based accelerometers to assess objective sleep between the home visit and the lab visit approximately one week later. Adolescents and their primary caregivers also completed a questionnaire, which included measures of demographics, parenting behaviors and family functioning. All team members of the study were mandatory reporters of suspected child abuse and neglect.

Sleep

Parent and youth sleep was assessed via actigraphy using the Micro Motion Logger Watch, a wrist-based accelerometer worn on participants' non-dominant wrists (Ambulatory Monitoring, Inc. Ardsley, NY USA). Actigraphy has been validated against polysomnography (Sadeh, 2011) and demonstrates good reliability when assessed 4-5 nights or more (Acebo et al., 1999). Activity was measured in 1-minute epochs using a zero-crossing mode; periods of sleep and waking were detected using the Sadeh algorithm in Action W-2 (Version 2.7.1; Ambulatory Monitoring). The current study focused on three sleep indicators: (1) sleep duration (i.e., total time spent asleep (in hours), excluding waking episodes), (2) sleep efficiency (i.e., ratio of time spent asleep (duration) to total time in bed, with total time in bed consisting of true sleep and waking episodes), (3) sleep midpoint time (i.e., midpoint between sleep onset and wake time). From the larger base sample, 92 families received actigraphy watches to wear during the week. Twenty-nine participants (n=29) did not have valid actigraphy data due to watch malfunctions (n=14 youth, n=15 parents) and one participant (n=1 youth) had no data because they did not wear the watch across the week. The remaining valid actigraphy data came from 90 different families; 47 families had data for parent and youth sleep (n=94) and the remaining had data for parents (n=15) or adolescents only (n=28). There was an average of 6.85 nights of sleep across parents and adolescents (SD = 2.86), with the majority of participants (85.4%) wearing the watch for at least 5 nights or more. Post-hoc sensitivity analyses were conducted excluding cases with less than 5 valid nights of actigraphy (14.6% of sample) and the results remained consistent (ps < .05). Thus, all cases were included in the analyses.

Adverse Parenting

Adverse parenting was measured using 15 items from the Parent-Child Conflict Tactic Scale (CTSPC; Straus et al., 1998). Primary caregivers were asked to indicate the frequency of certain behaviors towards their child that had occurred in the past year, including psychological aggression (e.g., “called him/her/them dumb or lazy or some other name like that”), corporal punishment (e.g., “hit him/her/them on the bottom with something like a belt, a hairbrush, a stick or some other hard object”), and neglect (e.g., “had to leave your child home alone, even when you thought some other adult should be with him/her/them”). Answer choices ranged from “0” (*this has not happened in the past year*) to “6” (*more than 20 times in the past year*). For the current study, an adverse parenting composite was created by summing across all items (α = .70), with higher scores indicating higher levels of adverse parenting. Previous studies have utilized the CTSPC similarly as a measure of family stress and adverse parenting (Oshri et al., 2020; Sasser et al., 2021a).

Family Functioning

The Family Adaptability and Cohesion Evaluation Scale (FACES IV; Olson et al., 2006) was used to assess dimensions of family cohesion and flexibility. Primary caregivers were asked to respond to questions about current family functioning on a scale from “1” (*strongly disagree*) to “5” (*strongly agree*). The balanced *cohesion* scale consisted of seven items (e.g., “Family members feel very close to each other.”; “Family members like to spend some of their free time with each other.”), with higher scores reflecting balanced connection and independence among family members. The balanced *flexibility* scale consisted of seven items (e.g., "My family is able to adjust to change when necessary."; "When family problems arise, we compromise"), with higher scores reflecting greater ability of the family to adapt if needed. Mean scores were computed for each scale (family cohesion α = .74; family flexibility α = .67).

Covariates

Several covariates were tested to minimize potential confounds and better isolate the relation between parent and adolescent sleep. Level 1 (e.g., daily) covariates included whether it was a weekend night (1=weekend, 0=weekday) and Level 2 (e.g., between-person) covariates included youth and parent biological sex, youth and parent race/ethnicity, whether the family was on vacation during the study week (1=study week occurred during a vacation period such as summer/winter break, 0=study week was not during vacation), and youth pubertal status. Youth pubertal status was measured via self-report using five items from the Pubertal Development Scale (Petersen et al., 1988) and one item assessing peer-relative pubertal development (see Earls et al., 2006).

Analytic Plan

To examine daily (e.g., within-family) and average (e.g., between-family) variation in youth and parent sleep, two-level multilevel models were fit in *Mplus* version 8.0 (Muthén and Muthén 1998–2017) using maximum likelihood estimation with robust standard errors to account for nested data (days within persons) and handle missing data. Level 1 predictors (e.g., daily sleep) were within-person centered and Level 2 predictors (e.g., average sleep) were grand-mean centered. First, daily (e.g., within-family) and average (e.g., between-family) concordance between parent and youth sleep were tested by entering parent/youth sleep as a daily (Level 1) and between-person (Level 2) predictor of day-to-day variation in parent/youth sleep and average parent/youth sleep, respectively. Covariates were included at Level 1 (e.g., weekend) and Level 2 (e.g., sex, race/ethnicity, vacation, pubertal status). Two sets of models were tested: one with parent sleep as a predictor of youth sleep (Model 1a) and one with youth sleep as a predictor of parent sleep (Model 1b). Multilevel models were fit separately for each sleep outcome (e.g., duration, efficiency, midpoint). Previous work examining daily within-family relations in sleep utilized similar analytic strategies (Kouros & El-Sheikh, 2017). Next, to test whether aspects of the family environment moderated within- and between-family relations in sleep (*Aim 2*), each of the family-level factors (e.g., adverse parenting, family cohesion, family flexibility) were included as predictors of individual differences in daily associations between parent and youth sleep (e.g., cross-level interaction) and average parent/youth sleep, the family-level factors, and their interaction terms (e.g., average sleep*adverse parenting) were included as Level 2 predictors (e.g., between-family interaction). Two sets of moderation models were tested per moderator: parent sleep predicting youth sleep (Models 2-4a) and youth sleep predicting parent sleep (Models 2-4b). Significant interactions were probed using the simple slopes technique for multilevel modeling (Preacher et al., 2006).

The analytic sample was limited to adolescents (n = 75; N = 506 daily observations) and parents (n = 62; N = 432 daily observations) with valid actigraphy data (90 total families). Independent t-tests were conducted to investigate whether there were group differences in demographic variables between participants who had valid actigraphy data and those who did not. Results revealed no significant group differences by youth sex (*t* (121) = .-68, *p* = .50), parent sex (*t* (121) = .024, *p* = .98), youth race/ethnicity (*t* (122) = -.92, *p* = .36), parent race/ethnicity (*t* (122) = -.47, *p* = .64), or youth pubertal status (*t* (117) = .61, *p* = .55). There were significant group differences by youth age (*t* (121) = -2.42, *p* = .01), such that adolescents with actigraphy data (M_{age} = 13.04, *SD* = .80) were older than adolescents who did not have actigraphy data (M_{age} = 12.69, *SD* = .78). Similarly, parents with actigraphy data had children who were older (M_{age} = 13.06, *SD* = .77) than children of parents without actigraphy data (M_{age} = 12.74, *SD* = .81); *t* (121) = -2.29, *p* = .024).

Results

Descriptive statistics and bivariate correlations are presented in Table 5. On average, adolescents slept 7 hours and 20 minutes (*M* = 7.33, *SD* = 1.19) and parents slept 6 hours and 47 minutes (*M* = 6.79, *SD* = 1.39) across the study week. Youth averaged 91.74% sleep efficiency (*SD* = 6.90) and parents averaged 91.38% efficiency (*SD* = 6.99). The average sleep midpoint time was 4:04AM (*M* = 4.07, *SD* = 1.51) for adolescents and 3:34AM (*M* = 3.57, *SD* = 1.27) for parents. There were no significant correlations between average youth and average parent sleep other than sleep midpoint time, which was positively correlated across dyads ($r = .68$, $p < .001$). Intraclass correlation coefficients from unconditional multilevel models were as follows: 0.22 (youth duration), 0.60 (youth efficiency), 0.54 (youth midpoint), 0.43 (parent duration), 0.54 (parent efficiency), and 0.62 (parent midpoint).

Aim 1: Concordance Between Parent and Youth Sleep

Parent Sleep Predicting Youth Sleep

Results from multilevel models examining parent sleep as a predictor of daily and average youth sleep outcomes are presented in Table 6, Model 1a. At the day level, fluctuations in parents' sleep duration (i.e., greater nightly sleep duration) were associated with longer sleep duration for youth that same night ($\gamma_{10} = 0.21$, $p = .005$, 95% CI [.06, .36]). For example, a 1-hour increase in parents' sleep, relative to their average sleep duration, predicted an increase in youths' sleep duration by approximately 13 minutes that same night. Further, within-person fluctuations in parents' sleep midpoint times also predicted youths' sleep midpoints that same night ($\gamma_{10} = 0.53$, $p < .001$, 95% CI [.28, .78]), such that for every 1-hour increase (i.e., delay) in parents' sleep midpoint time, compared to their average levels, youths' sleep midpoint time was delayed by approximately 32 minutes on that same night. There were no significant daily associations between parent and youth sleep efficiency ($\gamma_{10} = 0.03$, $p = .37$, 95% CI [-.04, .10]). At the between-family level, parents' average sleep midpoint time was significantly associated with youths' average midpoint time ($\gamma_{01} = 0.51$, $p < .001$, 95% CI [.32, .70]). Specifically, on average, a 1-hour later midpoint time in parents was expected to predict an approximate 30-minute later sleep midpoint for youth. Parent and youth sleep efficiency ($\gamma_{01} = 0.04$, $p = .87$, 95% CI [-.47, .56]) and sleep duration ($\gamma_{01} = -0.15$, $p = .42$, 95% CI [-.50, .21]) were not significantly associated at the between-family/average level.

Youth Sleep Predicting Parent Sleep

Multilevel models examining youth sleep as a predictor of daily and average parent sleep are presented in Table 6, Model 1b. Findings were similar to the model predicting youth sleep, such that daily fluctuations in youth sleep duration ($\gamma_{10} = 0.19$, $p = .011$, 95% CI [.04, .33]) and midpoint time ($\gamma_{10} = 0.25$, $p = .002$, 95% CI [.09, .40]), but not efficiency (γ_{10} = 0.05, p = .33, 95% CI [-.05, .16]), were associated with fluctuations in parents' sleep that same night. Specifically, a 1-hour increase in youths' sleep duration, relative to their typical levels, predicted an approximate 11-minute increase in parents' sleep duration that night. In addition, a 1-hour change in youths' sleep midpoint times, compared to their typical levels, predicted an approximate 15-minute change in sleep midpoint time for parents on that same day. At the between-family level, youths' average sleep midpoint time was significantly associated with parents' average sleep midpoint (γ_{01} = 0.58, p < .001, 95% CI [.34, .83]), such that a 1-hour later youth midpoint time, on average, was linked with an approximate 35-minute later midpoint time for parents. There were no significant between-family links for sleep efficiency (γ_{01} = 0.00, p = .99, 95% CI [-.36, .36]) or duration (γ_{01} = -0.03, p = .90, 95% CI [-.46, .40]).

Aim 2: Sleep Concordance Moderation by Family Context

Adverse Parenting

Parent Sleep Predicting Youth Sleep. Results from multilevel moderation models predicting youth sleep are presented in Table 7, Model 2a. There were no significant cross-level interactions predicting sleep outcomes (ps > .21). At the between-family level, adverse parenting significantly moderated the association between parent and youth sleep efficiency (γ_{03} = -0.03, p < .001, 95% CI [-.04, -.01]). Simple slopes revealed that higher parent sleep efficiency was associated with *less* youth sleep efficiency at high levels of adverse parenting (+1 *SD* from mean; b = -0.39, p = .011) and was marginally associated with *better* youth sleep efficiency at low levels of adverse parenting (-1 *SD* from mean; b = 0.48, p = .056); this association was not significant at average levels of adverse parenting (b = 0.04, p = .81; Figure 3a). Specifically, on average, a 5-unit increase in parental sleep efficiency (5% more efficient sleep) was associated with nearly 2% *less* sleep efficiency for youth in conditions of high adverse parenting, but approximately 2.4% *more* sleep efficiency for youth in low adverse parenting contexts. Further, adverse parenting also moderated associations between average parent and youth sleep duration (γ_{03} = -0.01, *p* = .046, 95% CI [-.02, -.001]). Simple slopes indicated that, on average, a 1-hour increase in parents' sleep duration was associated with approximately 19 *less* minutes of sleep for youth at high levels of adverse parenting (+1 *SD* from mean; *b* = -0.31, *p* = .029), but not at average (*b* = -0.15, *p* = .41) or low levels of adverse parenting (-1 *SD* from mean; *b* = 0.02, *p* = .94; Figure 3b). The interaction between average parent sleep midpoint and adverse parenting was not statistically significant (γ_{03} = 0.01, *p* = .24, 95% CI [-.01, .02]).

Youth Sleep Predicting Parent Sleep. Results from multilevel moderation models predicting parent sleep are presented in Table 7, Model 2b. The findings were similar to those predicting youth sleep. Specifically, there were no significant cross-level interactions (*p*s > .47). However, adverse parenting moderated between-family associations between average youth and parent sleep efficiency (γ_{03} = -0.02, *p* = .035, 95% CI [-.05, -.002]) and sleep duration (γ_{03} = -0.03, *p* = .047, 95% CI [-.05, -.001]), but not sleep midpoint (γ_{03} = 0.004, *p* = .39, 95% CI [-.005, .01]). Simple slopes revealed that higher youth sleep efficiency was associated with less parental sleep efficiency at high levels of adverse parenting (+1 *SD* from mean; *b* = -0.42, *p* = .039), but not average (*b* = -0.03, *p* = .81) or low levels (-1 *SD* from mean; *b* = 0.36, *p* = .14; Figure 3c). Accordingly, on average, a 5% higher sleep efficiency score for youth would be associated with an approximate 2.1% lower sleep efficiency score for parents who reported higher levels of adverse parenting. Lastly, simple slopes for sleep duration showed that, on average, a 1-hour increase in youth sleep duration was associated with approximately 34 fewer minutes of sleep for parents reporting high levels of adverse parenting (+1 *SD* from mean; b = -0.57, p = .005), but not average (b = -0.15, p = .42) or low levels of adverse parenting (-1 *SD* from mean; b = 0.26, p = .43; Figure 3d).

Family Cohesion

There were no statistically significant moderation findings for family cohesion predicting youth (*p*s > .15) or parent sleep (*p*s > .06). Complete results from these multilevel moderation models are presented in Table 8.

Family Flexibility

Parent Sleep Predicting Youth Sleep. Results from multilevel moderation models predicting youth sleep are presented in Table 9, Model 4a. The cross-level interaction predicting sleep duration was statistically significant (γ_{11} = 0.03, p = .016, 95% CI [.01, .06]), such that family flexibility moderated daily (within-family) associations between parent and youth sleep duration. Probing simple slopes revealed that on nights that parents slept more hours than usual, adolescents also slept more that same night, for families with average (b = 0.24, p = < .001) and high levels of family flexibility (+1 *SD* from mean; b = 0.35, p < .001), but not among families with low levels of flexibility (-1 *SD* from mean; b = 0.12, p = .051; Figure 4a). Specifically, a 1-hour increase in parents' sleep duration, relative to their average levels, predicted an increase in adolescents' sleep duration that same night by approximately 14 minutes at average levels of family flexibility, and 21 minutes at high levels of flexibility. Further, the cross-level interaction predicting sleep midpoint time was also significant (γ_{11} = 0.09, p = .023, 95% CI [.01, .17]). Simple slopes revealed that nightly fluctuations in parents' sleep midpoint were associated with nightly fluctuations in youths' sleep midpoint, but only at average ($b = 0.43$, $p < .001$) and high levels of family flexibility (+1 *SD* from mean; $b = 0.74$, $p < .001$); this link was not significant at low levels of flexibility (-1 *SD* from mean; $b = 0.11$, $p = .50$; Figure 4b). For example, a 1-hour delay in parents' sleep timing, relative to their average levels, was linked with a delay in youths' sleep timing that same night by approximately 26 minutes at average levels of flexibility and 44 minutes at higher levels of flexibility. There were no statistically significant moderation findings for family flexibility at the between-family level (*p*s > .19).

Youth Sleep Predicting Parent Sleep. Results from multilevel moderation models predicting youth sleep are presented in Table 9, Model 4b. The cross-level interaction predicting sleep duration was significant ($\gamma_{11} = 0.03$, $p = .017$, 95% CI [.01, .06]). Simple slopes showed that nightly fluctuations in youth sleep duration were associated with same-night fluctuations in parent sleep duration at average ($b = 0.22$, $p < .001$) and high levels of family flexibility (+1 *SD* from mean; $b = 0.34$, $p < .001$); this association was not significant at lower levels of flexibility (-1 *SD* from mean; $b = 0.11$, $p = .13$; Figure 4c). For example, a 1-hour longer night of sleep for adolescents, relative to their average levels, predicted an increase in their parent's sleep duration that same night by approximately 13 minutes at average levels of flexibility, and 20 minutes at high levels of flexibility. The cross-level interaction predicting sleep midpoint time was not statistically significant ($\gamma_{11} = 0.02$, $p = .051$, 95% CI [.000, .05]). However, we proceeded to test simple slopes given that $p = .051$, and in light of the significant interaction in the previous model predicting youth sleep. Simple slopes revealed that daily associations between youth and parent sleep midpoint time were significant across all levels of family flexibility, but this association was particularly pronounced at higher levels of flexibility (+1 *SD* from mean; $b = 0.40$, $p < .001$), as compared to average ($b = 0.31$, $p < .001$) and lower levels of flexibility (-1 *SD* from mean; $b = 0.23$, $p < .001$; Figure 4d). Specifically, on nights that adolescents had 1-hour later sleep timings than usual, their parents also had predicted later sleep timings that night by approximately 14 minutes (lower flexibility), 19 minutes (average flexibility), and 24 minutes (higher flexibility). There were no statistically significant moderation findings at the between-family level (*p*s > .60).

Discussion

Obtaining sufficient, quality sleep is essential for adolescent health and development (Galván, 2020), and the family context plays a major role in promoting or modifying sleep behaviors during this time (El-Sheikh & Kelly, 2017). A growing body of literature suggests that sleep is interrelated among parents and adolescents (Fuligni et al., 2015; Kouros & El-Sheikh, 2017; Varma et al., 2021). However, less was known regarding family-level influences on concordance between parent and youth objective sleep. The present study expands the literature on parent-child sleep concordance by investigating daily and average associations between parents' and adolescents' actigraphy-measured sleep across one week, as well as the moderating role of the family context. Findings provide partial evidence for parent-youth sleep concordance. At the day-level, within-person variation in parents' sleep duration and midpoint time predicted youths' sleep duration and midpoint that same night. Daily fluctuations in youths' sleep were similarly predictive of parents' sleep. In addition, average concordance was observed between parent and youth sleep midpoint times (i.e., between-family relations), but not sleep duration or efficiency. Our findings also revealed variation in concordance by family context. Between families, higher levels of adverse parenting were related to *discordance* in parent-youth sleep duration and sleep efficiency (i.e., on average, higher duration/efficiency for one family member was linked with lower duration/efficiency for the other family member). Within families, daily concordance in sleep duration and midpoint time was strongest among families characterized by high flexibility. These findings highlight concordance between parent and adolescent sleep patterns, particularly sleep *timing* and *duration*, and identify family-level correlates of congruence between parent and youth sleep.

Evidence for Parent-Adolescent Sleep Concordance

Daily (Within-Family) Findings

Findings of the current study garner additional evidence for the existence of bio-behavioral concordance between parents' and adolescents' objective sleep. Specifically, at the day-level, there was coordination between parents' and youths' sleep duration and sleep timing (i.e., midpoint time). These results suggest that on nights when parents exhibited later sleep timing than what was typical for them, their child also exhibited a shift, or delay, in their sleep schedule that same night. Further, on nights when parents obtained more hours of sleep than usual, adolescents also achieved more hours of sleep that night. Examining youth sleep as a predictor of parent sleep revealed the same pattern, such that parents' sleep was predicted by daily fluctuations in youths' sleep duration and midpoint time. Our findings closely mirror work by Kouros and El-Sheikh (2017), who found daily concordance between youths' and mothers' actigraphy-measured sleep minutes and wake times. In addition, our findings are similar to Fuligni et al. (2015), who found significant daily concordance between parent and adolescent diary-reported sleep hours and sleep schedule (e.g., bed and wake times). Despite our predictions, and in contrast to previous studies (Kalak et al., 2012; Kouros & El-Sheikh, 2017), we did not find evidence for daily concordance between parent and adolescent sleep efficiency. Although unexpected, these findings may highlight the malleability of sleep parameters that are rooted in time (e.g., midpoint, duration) by external factors such as parent sleep habits, which may be indicative of rule-setting or routines that promote daily coordination in these areas of sleep (Adam et al., 2007; Fuligni et al., 2015). In contrast, daily fluctuations in aspects of sleep *continuity* may be better explained by individual-level experiences, such as daily affective processes (e.g., Kouros et al., 2022; Tavernier et al., 2016).

Similar to conceptualizations of bio-behavioral concordance in physiological-based work (Davis et al., 2018; Feldman, 2012), these "in-sync" fluctuations in daily sleep timing and duration among dyads may be viewed as a positive aspect of the parent-youth relationship**,** particularly on days when fluctuations are in the desired direction for sleep gain/benefit (e.g., more hours of sleep than usual). Indeed, these findings suggest that parents may be able to help improve their child's sleep merely by improving their own, and vice versa. However, these bidirectional relations among dyads exist as a double-edged sword, such that days marked by *worse* sleep than usual for parents can equate to negative changes in adolescents' daily sleep, which have consequences for next-day behavioral functioning (e.g., Doane & Thurston, 2014; Fuligni & Hardway, 2006). From a prevention standpoint, these results have meaningful implications for the promotion of adolescent sleep health. Many adolescents do not obtain the amount of sleep that they need per recommended hourly guidelines, which is thought to be driven, in part, by biologically-driven delays in youths' circadian patterns (Owens et al., 2014). The identified daily concordance in sleep duration and timing suggests that sleep-focused intervention programs may benefit from concurrently involving parents and children, with a particular focus on sleep hygiene, sleep schedules, and meeting nightly sleep requirements.

Average (Between-Family) Findings

At the between-family level (e.g., comparing across families), we found that average sleep midpoint times were positively associated across parent-adolescent dyads – such that children of parents with later average sleep midpoint times tended to have later average midpoint times themselves, and vice versa. The between-family results are similar to Kouros and El-Sheikh (2017), who found that mothers' and fathers' averaged bedtimes and wake times were associated with youths' averaged bedtimes and wake times. Coupled with the day-level findings, our results suggest that sleep *timing* is highly concordant across parents and adolesents, with daily fluctuations, as well as overall/average sleep timing, highly correlated across parent-youth dyads. These findings are expected due to the extent of time youth are likely to spend with their parents, at home or in shared activities or routines (e.g., Adam et al., 2007; Sasser et al., 2021b), which may foster an alignment of bed and wake times (Fuligni et al., 2015). Importantly, our results suggest that family members may exert daily influences on each other's sleep "for better or for worse," and highlight a need for the examination of behavioral outcomes associated with concordance. Contrary to our predictions, the present study did not find evidence for concordance between parent and youth average sleep efficiency or sleep duration, despite previous work that observed such associations (Bajoghli et al., 2013; Brand et al., 2009; Kouros & El-Sheikh, 2017). Although unexpected, these null findings point to the importance of studying moderating variables that may help uncover whether there are subgroups of families that demonstrate sleep concordance (or discordance).

Variation in Parent-Adolescent Sleep Concordance by Family Context

Adverse Parenting

Findings from moderation analyses revealed that average concordance between parent and youth sleep duration and efficiency both varied as a function of adverse parenting severity. Specifically, results suggested that adverse parenting served as a risk factor for *discordance* between parent and adolescent sleep, such that higher parent/youth sleep duration and efficiency were linked with *lower* youth/parent duration and efficiency, but only in contexts marked by higher levels of adverse parenting within our sample. These findings indicate that a greater severity of harmful and/or abusive parenting behaviors may correspond with a “mismatch” between parent and youth sleep patterns, wherein gains for one family member coincide with declines for the other. This is comparable to findings that supportive parent-adolescent relationships promoted greater daily concordance in diary-reported sleep hours (Fuligni et al., 2015). However, in our study, this moderation was observed at the between-family level, indicating that these negative associations were only evident for overall sleep (i.e., averaged across all nights) and differed between families as a function of *harmful*, rather than supportive parenting. Notably, these results indirectly support prior work suggesting that concordance in parasympathetic processes among parents and youth varied as a function of parenting behaviors, wherein more severe maltreatment (e.g., physical abuse, neglect) and risk factors for undesirable parenting (e.g., maternal depression) were associated with RSA discordance among parent-child dyads (Lunkenheimer et al., 2018; Suveg et al., 2019). This similarity across studies, coupled with evidence that physiological regulation may underlie disruptions in youths' objective sleep (e.g., El-Sheikh & Buckhalt, 2005), may garner increased support for the examination of sleep as an additional form of biological concordance.

There are a few explanations for why adverse parenting may relate to discordance in parent and youth sleep behaviors. In general, these findings support the notion that adolescent sleep is embedded in the family context (El-Sheikh & Kelly, 2017), in which sleep serves as a dyadic bioregulatory process that is shaped by parenting practices. Theoretical perspectives posit that facets of the home environment that evoke feelings of threat or insecurity (e.g., harsh or abusive parenting) can lead to disruptions in sleep resulting from hyper-vigilance or arousal (Alen et al., 2022; Dahl, 1996). As an extension of this, our results suggest that adverse parenting may underlie *incongruent* dyadic sleep patterns among parents and youth, wherein one family member's gain in sleep is linked with the other's loss. Discordant sleep patterns may stem from a lack of positive interactive synchrony between adolescents and their parents, which is common among youth experiencing harsh parenting (e.g., Giuliano et al., 2015) and may emerge due to feelings of mistrust or fear regarding parents' punishment tactics and neglectful behaviors. In addition, harsh parenting tends to be less effective across development, and has been linked with fewer efforts to promote close relationships with parents in adolescence (Bender et al., 2007). Thus, reduced parent-child closeness, coupled with greater youth autonomy and unsuccessful parental limit-setting, may help explain discordance in the context of adverse parenting. Future longitudinal studies will help elucidate whether early intervention against harsh parenting may improve congruence between parent and youth sleep later in adolescence.

In line with the notion that discordance in parent-youth bio-behavioral states are not inherently maladaptive (e.g., Lunkenheimer et al., 2018; Oshri et al., 2021), our findings of discordance may reflect youths' *adaptive* response to stressful family environments. For example, in the context of high adverse parenting, discordance in parent-youth sleep may be protective for youth in scenarios where their parents are exhibiting worse sleep, but they themselves are experiencing better sleep. This pattern of improved sleep in high-stress contexts may reflect the "shut-off" reaction, wherein youth sleep is deepened and/or extended in response to increased stress or adverse rearing environments (Sadeh, 1996). Indeed, the current study observed that sleep duration was *highest* among youth in high adverse parenting contexts when their parents had lower average sleep durations (predicted 7.73 hours of sleep for these youth). Similarly, sleep efficiency was considerably high for adolescents whose parents reported high adverse parenting and had lower average sleep efficiency (predicted 97% youth sleep efficiency). Taken together, these findings highlight the complexities of parent-adolescent sleep concordance and point to the importance of the interplay among parenting and sleep behaviors in relation to youths' sleep health outcomes.

Family Cohesion and Flexibility

Despite our predictions, the current study did not find evidence for variation in parent-adolescent sleep concordance as a function of family cohesion. This was surprising, given that previous work observed greater daily concordance in contexts of highly supportive parent-adolescent relationships (Fuligni et al., 2015). Further, our measure of family cohesion tapped into both emotional closeness, as well as time spent together as a family, which would be expected to predict concordance in daily routines such as sleep timing. However, we did find evidence that family *flexibility* moderated daily associations between parent and youth sleep duration and midpoint time, with concordance particularly pronounced among highly flexible families. This finding is in line with our hypotheses, as well as the circumplex model of family systems (Olson, 2000), which suggests that balanced flexibility is indicative of healthy family functioning, which in this case may be evinced by greater concordance in sleep. Interestingly, family flexibility was only promotive of concordance at the daily level (e.g., within-families), not the average level. This finding may be reflective of the *adaptability* of these highly-flexible families on days where the demands and/or stressors of the day resulted in more or less sleep than usual, such that these dyads were adapting to change together, as compared to parent/youth in low-flexibility families, whose daily associations were relatively flat.

Recognizing the "double-edged sword" of dyadic sleep concordance, it is worth noting that the largest differences in adolescent sleep duration and midpoint time (across levels of family flexibility) were observed on days that parents (a) obtained more sleep than usual and (b) had earlier sleep timings than usual. Specifically, adolescents in highly flexible families exhibited larger within-person increases (e.g., gains) in sleep duration and larger within-person decreases (e.g., advances) in sleep midpoint time on these days, relative to youth in families with average or low flexibility. In other words, on days that parents' sleep was changing "for the better," youth in highly flexible families received the most significant sleep benefits. This pattern of results suggests that daily concordance is especially pronounced in healthy/balanced family contexts, which may be beneficial for these adolescents (i.e., daily improvements in parents' sleep linked with daily improvements in their own). In contrast, on days that parents exhibited later sleep timing or slept fewer hours than usual, there was less variation by family context, such that youth also experienced these "negative" daily fluctuations, regardless of their family's adaptability. Thus, an important next step for the literature is an examination of family-level factors that serve as both promotive *and* protective factors in relation to youth sleep behaviors, and how these may interact with parent sleep to predict later adolescent well-being.

Strengths, Limitations, and Future Directions

The present study harnessed the strengths of a multi-method, multi-level modeling approach to investigate daily (e.g., within-family) and average (e.g., between-family) relations among parent and adolescent actigraphy-measured sleep, as well as the moderating role of the family context. The implications of the current findings for intervention programs are two-fold. First, the observed dyadic sleep concordance at the daily and average level suggests that efforts to promote optimal sleep health in adolescence may benefit from including parents in intervention/prevention programs, with a particular focus on ways to improve sleep habits as a broader, interconnected family unit. Moreover, in light of the findings that concordance varied as a function of adverse parenting and family flexibility, sleep programs should also target aspects of the family environment, more explicitly parenting practices/tactics and family structure (e.g., leadership/organization). Reducing harmful parenting practices and promoting positive, adaptive family dynamics may promote dyadic sleep concordance, as has been observed in previous work (Fuligni et al., 2015).

The findings of the current study should be interpreted alongside limitations. First, the sample size and demographic background of the sample (i.e., predominantly European American youth living in rural communities) may limit the generalizability of our findings across different groups of adolescents. Indeed, previous work studying parent-youth concordance in actigraphy-measured sleep was also conducted in a predominantly European American sample in the rural Southeastern U.S. (Kouros & El-Sheikh, 2017). Thus, future work should aim to replicate these findings in an ethnically/racially and geographically diverse sample of adolescents utilizing actigraphic measures of sleep. Second, adverse parenting was assessed using a parent-reported measure, which could have led to an underreporting of negative parenting practices (i.e., social desirability; Straus et al., 1998). However, significant results were still found for variation by adverse parenting, suggesting that parents' full reports of negative parenting practices may have resulted in stronger results. Third, in this study, mostly mothers participated in actigraphy procedures. This is a limitation, as previous research found differences in within-family relations in sleep between youth and mothers and fathers (Kouros & El-Sheikh, 2017). Further, despite the analytical strengths of this study (e.g., multilevel modeling), the data were correlational in nature, and thus we were unable to examine the direction of causality between parent and adolescent sleep behaviors. Similarly, although we controlled for several relevant covariates, other potential confounding factors (e.g., room-sharing, day-level experiences; Fuligni et al., 2015) were not measured as part of the study and were unable to be accounted for in the models. Additionally, while the assessment of sleep via actigraphy was a strength of this study, future studies would be strengthened by examining subjective sleep alongside objective sleep, in an effort to examine whether concordance differs across methods. Lastly, although not examined in the current study, a promising next-step for this literature is the examination of socioemotional outcomes associated with parent-youth sleep concordance, which will significantly improve our understanding of how dyadic sleep patterns may harbor risk and/or promote competencies for adolescents.

Conclusion

In summary, the current study provides additional evidence for concordance between parents' and adolescents' objectively-measured sleep, at both the daily (e.g., within-family) and average (e.g., between-family) level. Further, our findings suggest that this dyadic concordance varies as a function of the family context, with greater adverse parenting behaviors linked with *discordance* between average parent and adolescent sleep duration and efficiency, and higher family flexibility linked with greater daily concordance between parent and youth sleep duration and midpoint time. Future research should aim to replicate these findings in larger samples of adolescents from diverse backgrounds, and examine developmental outcomes associated with parent-youth sleep concordance/discordance. Implications for future preventive efforts include the implementation of family-focused programs that target both adolescents' *and* parents' sleep habits, and that aim to reduce harmful parenting tactics and promote positive environments in which adolescent sleep is nested.

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Table 5. *Bivariate Correlations and Descriptive Statistics*

	1	2	3	4	5	6	7
1. Youth Sleep Duration	—						
2. Youth Sleep Efficiency	.51***	—					
3. Youth Sleep Midpoint	.08	-.02	—				
4. Parent Sleep Duration	-.05	-.12	.004	—			
5. Parent Sleep Efficiency	.10	.10	-.12	.63***	—		
6. Parent Sleep Midpoint	-.08	-.14	.68***	-.29*	-.30*	—	
7. Adverse Parenting	-.10	-.14	-.10	-.07	-.05	.10	—
8. Family Cohesion	.002	.04	-.02	.27*	.09	-.11	-.12
9. Family Flexibility	-.03	.09	-.19	.21	.03	-.03	-.09
10. Youth Sex	-.21	-.32**	-.15	.05	-.14	-.16	.18*
11. Parent Sex	.03	.06	-.02	-.20	-.17	.07	.08
12. Youth Race/Ethnicity	.03	-.04	.15	.07	.13	-.06	-.13
13. Parent Race/Ethnicity	.05	.01	.19	.20	.26*	-.12	-.04
14. Vacation	-.06	-.09	.50***	-.09	-.17	.48***	.14
15. Youth Pubertal Status	.17	.13	.18	.02	.25†	.17	-.10
M	7.33	91.74	4.07	6.79	91.38	3.57	16.67
SD	1.19	6.90	1.51	1.39	6.99	1.27	15.26
Minimum	3.25	70.98	1.33	3.43	71.60	1.57	0.00
Maximum	11.10	99.76	8.42	10.33	99.65	7.28	70.00

Notes. Sleep duration = time asleep (in hours); Sleep efficiency = percentage of time asleep out of total time in bed; Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Youth pubertal status: higher scores indicate more advanced pubertal development. $^{\dagger}p < .10$, $*p < .05$, $** p < .01$, $*** p < .001$

Table 5 (continued). *Bivariate Correlations and Descriptive Statistics*

	8	9	10	11	12	13	14	15
1. Youth Sleep Duration								
2. Youth Sleep Efficiency								
3. Youth Sleep Midpoint								
4. Parent Sleep Duration								
5. Parent Sleep Efficiency								
6. Parent Sleep Midpoint								
7. Adverse Parenting								
8. Family Cohesion	—							
9. Family Flexibility	.69***	—						
10. Youth Sex	.04	-.01	—					
11. Parent Sex	.03	.08	.02	—				
12. Youth Race/Ethnicity	.05	-.07	.05	.07	—			
13. Parent Race/Ethnicity	.02	-.07	.02	.03	.72***	—		
14. Vacation	-.01	-.05	.07	.06	.20†	.11	—	
15. Youth Pubertal Status	-.12	-.11	-.55***	-.13	-.01	-.05	.09	—
M	31.09	28.14	0.46	0.07	0.76	0.82	0.29	15.40
SD	2.95	3.39	--	--	--	--	--	3.70
Minimum	20.00	20.00	--	--	--	--	--	7.00
Maximum	35.00	35.00	--	--	--	--	--	24.00

Notes. Sleep duration = time asleep (in hours); Sleep efficiency = percentage of time asleep out of total time in bed; Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Youth pubertal status: higher scores indicate more advanced pubertal development. †$p < .10$, *$p < .05$, ** $p < .01$, *** $p < .001$

Table 6. *Estimates from Multilevel Models Predicting Youth Sleep from Parent Sleep and Parent Sleep from Youth Sleep (Main Effects)*

	Youth Sleep Efficiency			Youth Sleep Duration		
Model 1a	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	94.05**	2.38	[89.37, 98.72]	7.34**	0.29	[6.77, 7.90]
Level 2 (between-family)						
Average Parent Sleep (γ_{01})	0.04	0.26	[-.47, .56]	-0.15	0.18	[-.50, .21]
Youth Sex (γ_{02})	-4.49†	2.33	[-9.06, .09]	-0.57	0.39	[-1.33, .20]
Youth Race/Ethnicity (γ_{03})	0.21	2.34	[-4.38, 4.81]	0.24	0.30	[-.34, .83]
Vacation (γ_{04})	-3.38	3.49	[-10.22, 3.47]	-0.10	0.60	[-1.28, 1.01]
Pubertal Status (γ_{05})	-0.39	0.26	[-.91, .12]	0.01	0.05	[-.08, .11]
Level 1 (within-family)						
Daily Parent Sleep (γ_{10})	0.03	0.04	[-.04, .10]	0.21**	0.08	[.06, .36]
Weekend (γ_{20})	0.44	0.55	[-.63, 1.52]	0.39*	0.19	[.02, .76]
	Parent Sleep Efficiency			Parent Sleep Duration		
Model 1b	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	89.55**	2.61	[84.45, 94.66]	6.88**	0.43	[6.04, 7.72]
Level 2 (between-family)						
Average Youth Sleep (γ_{01})	0.00	0.18	[-.36, .36]	-0.03	0.22	[-.46, .40]
Parent Sex (γ_{02})	-2.69	5.00	[-12.49, 7.12]	-0.10	0.38	[-.85, .65]
Parent Race/Ethnicity (γ_{03})	4.06	2.71	[-1.25, 9.38]	0.29	0.48	[-.64, 1.23]
Vacation (γ_{04})	-4.14	3.01	[-10.04, 1.76]	-0.55	0.51	[-1.55, .46]
Level 1 (within-family)						
Daily Youth Sleep (γ_{10})	0.05	0.06	[-.05, .16]	0.19*	0.07	[.04, .33]
Weekend (γ_{20})	0.46	0.53	[-.98, 1.91]	0.14	0.22	[-.29, .56]

Note. Model 1a: 432 days nested within 62 parents; Model 1b: 506 days nested within 75 adolescents. Est. = partial regression coefficient estimate (unstandardized); *SE* = robust standard error. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. †p < .10. *p < .05, **p < .01

Table 6 (continued). *Estimates from Multilevel Models Predicting Youth Sleep from Parent Sleep and Parent Sleep from Youth Sleep (Main Effects)*

	Youth Sleep Midpoint		
Model 1a	Est.	*SE*	95% CI
Intercept (γ_{00})	3.33**	0.36	[2.63, 4.04]
Level 2 (between-family)			
Average Parent Sleep (γ_{01})	0.51**	0.10	[.32, .70]
Youth Sex (γ_{02})	-0.23	0.27	[-.76, .30]
Youth Race/Ethnicity (γ_{03})	0.37	0.32	[-.25, .99]
Vacation (γ_{04})	0.54†	0.32	[-.08, 1.16]
Pubertal Status (γ_{05})	0.01	0.04	[-.07, .08]
Level 1 (within-family)			
Daily Parent Sleep (γ_{10})	0.53**	0.13	[.28, .78]
Weekend (γ_{20})	0.77**	0.20	[.37, 1.17]

	Parent Sleep Midpoint		
Model 1b	Est.	*SE*	95% CI
Intercept (γ_{00})	3.95**	0.26	[3.43, 4.46]
Level 2 (between-family)			
Average Youth Sleep (γ_{01})	0.58**	0.13	[.34, .83]
Parent Sex (γ_{02})	-0.30	0.24	[-.78, .18]
Parent Race/Ethnicity (γ_{03})	-0.51†	0.29	[-.1.08, .06]
Vacation (γ_{04})	0.39	0.34	[-.29, 1.06]
Level 1 (within-family)			
Daily Youth Sleep (γ_{10})	0.25**	0.08	[.09, .40]
Weekend (γ_{20})	0.43*	0.18	[.08, .79]

Note. Model 1a: 432 days nested within 62 parents; Model 1b: 506 days nested within 75 adolescents. Est. = partial regression coefficient estimate (unstandardized); *SE* = robust standard error. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. $^{\dagger}p < .10$. $*p < .05$, $**p < .01$

Table 7. *Estimates from Multilevel Models Examining Variation in Parent-Youth Sleep Concordance by Adverse Parenting*

	Youth Sleep Efficiency			Youth Sleep Duration		
Model 2a	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	95.03**	1.80	[91.50, 98.55]	7.36**	0.30	[6.77, 7.94]
Level 2 (between-family)						
Average Parent Sleep (γ_{01})	0.04	0.17	[-.30, .38]	-0.15	0.18	[-.49, .20]
Adverse Parenting (AP) (γ_{02})	-0.05	0.06	[-.16, .06]	-0.003	0.01	[-.02, .01]
Average Parent Sleep*AP (γ_{03})	-0.03**	0.01	[-.04, -.01]	-0.01*	0.01	[-.02, -.001]
Youth Sex (γ_{04})	-4.57*	2.24	[-8.96, -.18]	-0.43	0.35	[-1.12, .26]
Youth Race/Ethnicity (γ_{05})	-0.65	1.86	[-4.29, 2.99]	0.19	0.29	[-.39, .76]
Vacation (γ_{06})	-4.60	3.38	[-11.22, 2.03]	-0.21	0.65	[-1.49, 1.08]
Pubertal Status (γ_{07})	-0.24	0.20	[-.63, .15]	0.02	0.05	[-.07, .11]
Level 1 (within-family)						
Daily Parent Sleep (γ_{10})	0.03	0.66	[-1.27, 1.32]	0.25**	0.08	[.10, .41]
Daily Parent Sleep*AP (γ_{11})	-0.001	0.02	[-.03, .03]	-0.004	0.00	[-.01, .003]
Weekend (γ_{20})	0.50	0.58	[-.64, 1.63]	0.38*	0.19	[.002, .75]

	Parent Sleep Efficiency			Parent Sleep Duration		
Model 2b	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	90.68**	1.42	[87.91, 93.46]	6.58**	0.48	[5.63, 7.53]
Level 2 (between-family)						
Average Youth Sleep (γ_{01})	-0.03	0.12	[-.27, .21]	-0.15	0.19	[-.53, .22]
Adverse Parenting (AP) (γ_{02})	-0.04	0.05	[-.13, .05]	-0.01	0.01	[-.03, .01]
Average Youth Sleep*AP (γ_{03})	-0.02*	0.01	[-.05, -.002]	-0.03*	0.01	[-.05, -.001]
Parent Sex (γ_{04})	-4.85	4.34	[-13.36, 3.66]	-0.83	0.84	[-2.48, .82]
Parent Race/Ethnicity (γ_{05})	2.00	1.68	[-1.29, 5.28]	0.50	0.53	[-.54, 1.54]
Vacation (γ_{06})	-2.47	2.74	[-7.83, 2.90]	-0.35	0.46	[-1.25, .55]
Level 1 (within-family)						
Daily Youth Sleep (γ_{10})	0.08	0.08	[-.07, .24]	0.21**	0.08	[.06, .37]
Daily Youth Sleep*AP (γ_{11})	-0.001	0.01	[-.01, .01]	-0.003	0.00	[-.01, .005]
Weekend (γ_{20})	0.49	0.75	[-.98, 1.96]	0.10	0.22	[-.33, .53]

Note. Model 2a: 432 days nested within 62 parents; Model 2b: 506 days nested within 75 adolescents. Est. = unstandardized regression coefficient estimate; *SE* = robust standard error; AP = adverse parenting. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. $^{\dagger}p < .10$. $*p < .05$, $**p < .01$

Table 7 (continued). *Estimates from Multilevel Models Examining Variation in Parent-Youth Sleep Concordance by Adverse Parenting*

	Youth Sleep Midpoint		
Model 2a	Est.	*SE*	95% CI
Intercept (γ_{00})	3.31**	0.35	[2.63, 3.98]
Level 2 (between-family)			
Average Parent Sleep (γ_{01})	0.47**	0.11	[.25, .68]
Adverse Parenting (AP) (γ_{02})	-0.01	0.01	[-.02, .01]
Average Parent Sleep*AP (γ_{03})	0.01	0.01	[-.01, .02]
Youth Sex (γ_{04})	-0.20	0.27	[-.74, .33]
Youth Race/Ethnicity (γ_{05})	0.31	0.32	[-.32, .94]
Vacation (γ_{06})	0.66*	0.28	[.11, 1.20]
Pubertal Status (γ_{07})	0.002	0.04	[-.07, .07]
Level 1 (within-family)			
Daily Parent Sleep (γ_{10})	0.50**	0.15	[.21, .80]
Daily Parent Sleep*AP (γ_{11})	-0.01	0.01	[-.02, .005]
Weekend (γ_{20})	0.84**	0.20	[.44, 1.24]

	Parent Sleep Midpoint		
Model 2b	Est.	*SE*	95% CI
Intercept (γ_{00})	4.11**	0.33	[3.46, 4.75]
Level 2 (between-family)			
Average Youth Sleep (γ_{01})	0.66**	0.13	[.40, .92]
Adverse Parenting (AP) (γ_{02})	0.01†	0.01	[-.002, .02]
Average Youth Sleep*AP (γ_{03})	0.004	0.01	[-.005, .01]
Parent Sex (γ_{04})	-0.32	0.48	[-1.26, .61]
Parent Race/Ethnicity (γ_{05})	-0.75*	0.35	[-1.42, -.07]
Vacation (γ_{06})	0.27	0.40	[-.51, 1.04]
Level 1 (within-family)			
Daily Youth Sleep (γ_{10})	0.31**	0.08	[.15, .46]
Daily Youth Sleep*AP (γ_{11})	0.00	0.003	[-.01, .005]
Weekend (γ_{20})	0.39*	0.17	[.06, .73]

Note. Model 2a: 432 days nested within 62 parents; Model 2b: 506 days nested within 75 adolescents. Est. = unstandardized regression coefficient estimate; *SE* = robust standard error; AP = adverse parenting. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. †$p < .10$. *$p < .05$, **$p < .01$

Table 8. *Estimates from Multilevel Models Examining Variation in Parent-Youth Sleep Concordance by Family Cohesion.*

	Youth Sleep Efficiency			Youth Sleep Duration		
Model 3a	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	94.32**	2.44	[89.55, 99.10]	7.47**	0.27	[6.95, 7.99]
Level 2 (between-family)						
Average Parent Sleep (γ_{01})	-0.01	0.25	[-.50, .47]	-0.15	0.18	[-.50, .20]
Family Cohesion (FC) (γ_{02})	0.45	0.45	[-.44, 1.34]	0.04	0.06	[-.07, .14]
Average Parent Sleep*FC (γ_{03})	0.02	0.08	[-.13, .18]	-0.08	0.07	[-.21, .05]
Youth Sex (γ_{04})	-4.38*	1.94	[-8.19, -.58]	-0.64†	0.34	[-1.31, .03]
Youth Race/Ethnicity (γ_{05})	-0.35	2.51	[-5.28, 4.57]	0.19	0.29	[-.37, .75]
Vacation (γ_{06})	-2.69	3.48	[-9.50, 4.13]	-0.04	0.58	[-1.18, 1.10]
Pubertal Status (γ_{07})	-0.27	0.29	[-.84, .31]	-0.03	0.06	[-.15, .10]
Level 1 (within-family)						
Daily Parent Sleep (γ_{10})	0.03	0.03	[-.03, .09]	0.24**	0.08	[.09, .39]
Daily Parent Sleep*FC (γ_{11})	0.01	0.01	[-.01, .03]	0.02	0.02	[-.02, .06]
Weekend (γ_{20})	0.43	0.56	[-.66, 1.52]	0.38†	0.20	[-.02, .77]

	Parent Sleep Efficiency			Parent Sleep Duration		
Model 3b	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	89.64**	2.41	[84.91, 94.36]	6.58**	0.48	[5.70, 7.47]
Level 2 (between-family)						
Average Youth Sleep (γ_{01})	-0.01	0.17	[-.33, .31]	-0.01	0.21	[-.42, .40]
Family Cohesion (FC) (γ_{02})	0.18	0.34	[-.49, .84]	0.09	0.06	[-.04, .21]
Average Youth Sleep*FC (γ_{03})	0.03†	0.02	[-.002, .07]	-0.01	0.05	[-.11, .09]
Parent Sex (γ_{04})	-2.23	3.59	[-9.26, 4.80]	-0.61	0.61	[-1.81, .59]
Parent Race/Ethnicity (γ_{05})	3.56	2.39	[-1.12, 8.23]	0.57	0.49	[-.40, 1.53]
Vacation (γ_{06})	-3.59	2.88	[-9.24, 2.06]	-0.50	0.50	[-1.48, .47]
Level 1 (within-family)						
Daily Youth Sleep (γ_{10})	0.08	0.06	[-.04, .20]	0.20**	0.07	[.06, .34]
Daily Youth Sleep*FC (γ_{11})	0.01	0.01	[-.02, .04]	0.02	0.02	[-.02, .06]
Weekend (γ_{20})	0.42	0.73	[-1.02, 1.85]	0.11	0.22	[-.32, .54]

Note. Model 3a: 432 days nested within 62 parents; Model 3b: 506 days nested within 75 adolescents. Est. = unstandardized regression coefficient estimate; *SE* = robust standard error; FC = family cohesion. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. $^{\dagger}p < .10$. $^{*}p < .05$, $^{**}p < .01$

Table 8 (continued). *Estimates from Multilevel Models Examining Variation in Parent-Youth Sleep Concordance by Family Cohesion.*

	Youth Sleep Midpoint		
Model 3a	Est.	*SE*	95% CI
Intercept (γ_{00})	3.28**	0.32	[2.65, 3.91]
Level 2 (between-family)			
Average Parent Sleep (γ_{01})	0.56**	0.11	[.35, .77]
Family Cohesion (FC) (γ_{02})	-0.11**	0.03	[-.18, -.05]
Average Parent Sleep*FC (γ_{03})	-0.05	0.04	[-.13, .02]
Youth Sex (γ_{04})	-0.25	0.27	[-.77, .27]
Youth Race/Ethnicity (γ_{05})	0.49	0.30	[-.09, 1.07]
Vacation (γ_{06})	0.35	0.28	[-.20, .90]
Pubertal Status (γ_{07})	-0.03	0.04	[-.09, .04]
Level 1 (within-family)			
Daily Parent Sleep (γ_{10})	0.47**	0.13	[.22, .73]
Daily Parent Sleep*FC (γ_{11})	0.06	0.05	[-.04, .15]
Weekend (γ_{20})	0.84**	0.20	[.44, 1.23]
	Parent Sleep Midpoint		
Model 3b	Est.	*SE*	95% CI
Intercept (γ_{00})	4.09**	0.28	[3.54, 4.64]
Level 2 (between-family)			
Average Youth Sleep (γ_{01})	0.70**	0.12	[.46, .94]
Family Cohesion (FC) (γ_{02})	0.09†	0.05	[-.003, .19]
Average Youth Sleep*FC (γ_{03})	0.06	0.06	[-.06, .17]
Parent Sex (γ_{04})	-0.51	0.44	[-1.38, .35]
Parent Race/Ethnicity (γ_{05})	-0.69*	0.30	[-1.29, -.10]
Vacation (γ_{06})	0.37	0.34	[-.29, 1.03]
Level 1 (within-family)			
Daily Youth Sleep (γ_{10})	0.32**	0.08	[.16, .47]
Daily Youth Sleep*FC (γ_{11})	0.02	0.02	[-.01, .05]
Weekend (γ_{20})	0.37*	0.17	[.04, .70]

Note. Model 3a: 432 days nested within 62 parents; Model 3b: 506 days nested within 75 adolescents. Est. = unstandardized regression coefficient estimate; *SE* = robust standard error; FC = family cohesion. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. $^{\dagger}p < .10$. $*p < .05$, $**p < .01$

Table 9. *Estimates from Multilevel Models Examining Variation in Parent-Youth Sleep Concordance by Family Flexibility.*

	Youth Sleep Efficiency			Youth Sleep Duration		
Model 4a	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	93.34**	2.52	[88.40, 98.28]	7.36**	0.30	[6.78, 7.94]
Level 2 (between-family)						
Average Parent Sleep (γ_{01})	-0.08	0.22	[-.51, .36]	-0.15	0.17	[-.48, .19]
Family Flexibility (FF) (γ_{02})	0.61†	0.33	[-.03, 1.26]	0.03	0.04	[-.04, .10]
Average Parent Sleep*FF (γ_{03})	-0.08	0.06	[-.20, -.04]	-0.03	0.05	[-.12, .06]
Youth Sex (γ_{04})	-4.54*	2.21	[-8.86, -.22]	-0.57	0.38	[-1.31, .18]
Youth Race/Ethnicity (γ_{05})	1.54	2.40	[-3.17, 6.25]	0.23	0.29	[-.34, .81]
Vacation (γ_{06})	-4.60	3.45	[-11.37, 2.17]	-0.05	0.60	[-1.22, 1.11]
Pubertal Status (γ_{07})	-0.35	0.25	[-.84, .14]	0.002	0.05	[-.10, .11]
Level 1 (within-family)						
Daily Parent Sleep (γ_{10})	0.03	0.03	[-.03, .09]	0.24**	0.07	[.10, .37]
Daily Parent Sleep*FF (γ_{11})	0.01	0.01	[-.02, .03]	0.03*	0.01	[.01, .06]
Weekend (γ_{20})	0.44	0.57	[-.68, 1.56]	0.35†	0.21	[-.06, .75]
	Parent Sleep Efficiency			Parent Sleep Duration		
Model 4b	Est.	*SE*	95% CI	Est.	*SE*	95% CI
Intercept (γ_{00})	89.75**	2.58	[84.70, 94.80]	6.52**	0.47	[5.60, 7.43]
Level 2 (between-family)						
Average Youth Sleep (γ_{01})	-0.04	0.15	[-.32, .25]	-0.01	0.21	[-.41, .40]
Family Flexibility (FF) (γ_{02})	0.02	0.28	[-.53, .58]	0.07	0.05	[-.02, .15]
Average Youth Sleep*FF (γ_{03})	-0.01	0.04	[-.08, .06]	-0.03	0.05	[-.12, .07]
Parent Sex (γ_{04})	-1.69	4.21	[-9.93, 6.55]	-0.48	0.66	[-1.77, .81]
Parent Race/Ethnicity (γ_{05})	3.64	2.48	[-1.23, 8.50]	0.67	0.51	[-.33, 1.67]
Vacation (γ_{06})	-3.47	2.82	[-9.00, 2.06]	-0.54	0.52	[-1.55, .47]
Level 1 (within-family)						
Daily Youth Sleep (γ_{10})	0.08	0.06	[-.04, .20]	0.22**	0.06	[.10, .34]
Daily Youth Sleep*FF (γ_{11})	0.01	0.02	[-.03, .04]	0.03*	0.01	[.01, .06]
Weekend (γ_{20})	0.41	0.73	[-1.02, 1.83]	0.09	0.24	[-.39, .57]

Note. Model 4a: 432 days nested within 62 parents; Model 4b: 506 days nested within 75 adolescents. Est. = unstandardized regression coefficient estimate; *SE* = robust standard error; FF = family flexibility. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. $^{\dagger}p < .10$. $*p < .05$, $**p < .01$

Table 9 (continued). *Estimates from Multilevel Models Examining Variation in Parent-Youth Sleep Concordance by Family Flexibility.*

	Youth Sleep Midpoint		
Model 4a	Est.	*SE*	95% CI
Intercept (γ_{00})	3.44**	0.34	[2.77, 4.10]
Level 2 (between-family)			
Average Parent Sleep (γ_{01})	0.52**	0.09	[.34, .70]
Family Flexibility (FF) (γ_{02})	-0.07**	0.03	[-.12, -.02]
Average Parent Sleep*FF (γ_{03})	0.01	0.02	[-.03, .05]
Youth Sex (γ_{04})	-0.35	0.28	[-.90, .20]
Youth Race/Ethnicity (γ_{05})	0.33	0.30	[-.26, .92]
Vacation (γ_{06})	0.55†	0.32	[-.06, 1.17]
Pubertal Status (γ_{07})	-0.02	0.03	[-.08, .05]
Level 1 (within-family)			
Daily Parent Sleep (γ_{10})	0.43**	0.12	[.19, .66]
Daily Parent Sleep*FF (γ_{11})	0.09*	0.04	[.01, .17]
Weekend (γ_{20})	0.82**	0.19	[.44, 1.20]

	Parent Sleep Midpoint		
Model 4b	Est.	*SE*	95% CI
Intercept (γ_{00})	3.99**	0.27	[3.47, 4.52]
Level 2 (between-family)			
Average Youth Sleep (γ_{01})	0.69**	0.12	[.45, .93]
Family Flexibility (FF) (γ_{02})	0.04	0.04	[-.03, .11]
Average Youth Sleep*FF (γ_{03})	-0.01	0.04	[-.08, .07]
Parent Sex (γ_{04})	-0.50	0.42	[-1.31, .32]
Parent Race/Ethnicity (γ_{05})	-0.61*	0.30	[-1.19, -.03]
Vacation (γ_{06})	0.26	0.36	[-.44, .96]
Level 1 (within-family)			
Daily Youth Sleep (γ_{10})	0.31**	0.07	[.17, .45]
Daily Youth Sleep*FF (γ_{11})	0.02†	0.01	[.000, .05]
Weekend (γ_{20})	0.36*	0.17	[.03, .70]

Note. Model 4a: 432 days nested within 62 parents; Model 4b: 506 days nested within 75 adolescents. Est. = unstandardized regression coefficient estimate; *SE* = robust standard error; FF = family flexibility. Sleep efficiency = percentage of time asleep out of total time in bed; Sleep duration = time asleep (in hours); Sleep midpoint = midpoint time between sleep onset and offset; Sex: 1 = Male, 0 = Female; Race/Ethnicity: 1 = European American, 0 = racial-ethnic minority. Vacation: 1 = study week was during school vacation; 0 = sleep was assessed during a regular school week. Weekend: 1 = Friday or Saturday night, 0 = all other nights. Average Parent/Youth Sleep and Daily Parent/Youth Sleep = the corresponding youth sleep parameter being predicted to. †$p < .10$. *$p < .05$, **$p < .01$

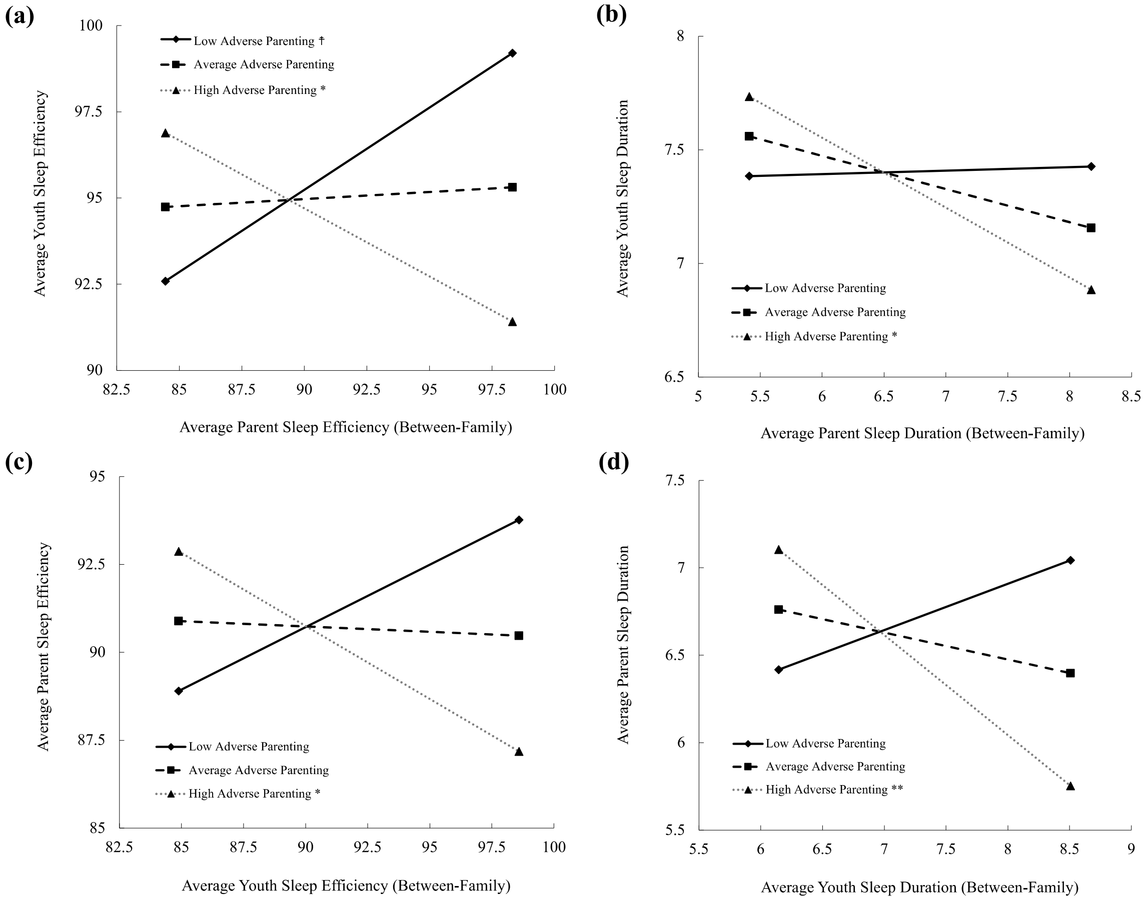

Figure 3. Simple slopes demonstrating between-family associations between average parent and youth sleep efficiency and sleep duration (±1 SD from grand mean) by levels of adverse parenting (±1 SD from grand mean). *Note.* Figures on the top (a-b) represent models in which youth sleep was predicted by parent sleep; figures on the bottom (c-d) represent models in which parent sleep was predicted by youth sleep. On the x-axis, youth/parent sleep duration and efficiency are centered at the grand mean, for visualization purposes.$^{\dagger}p < .10$. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

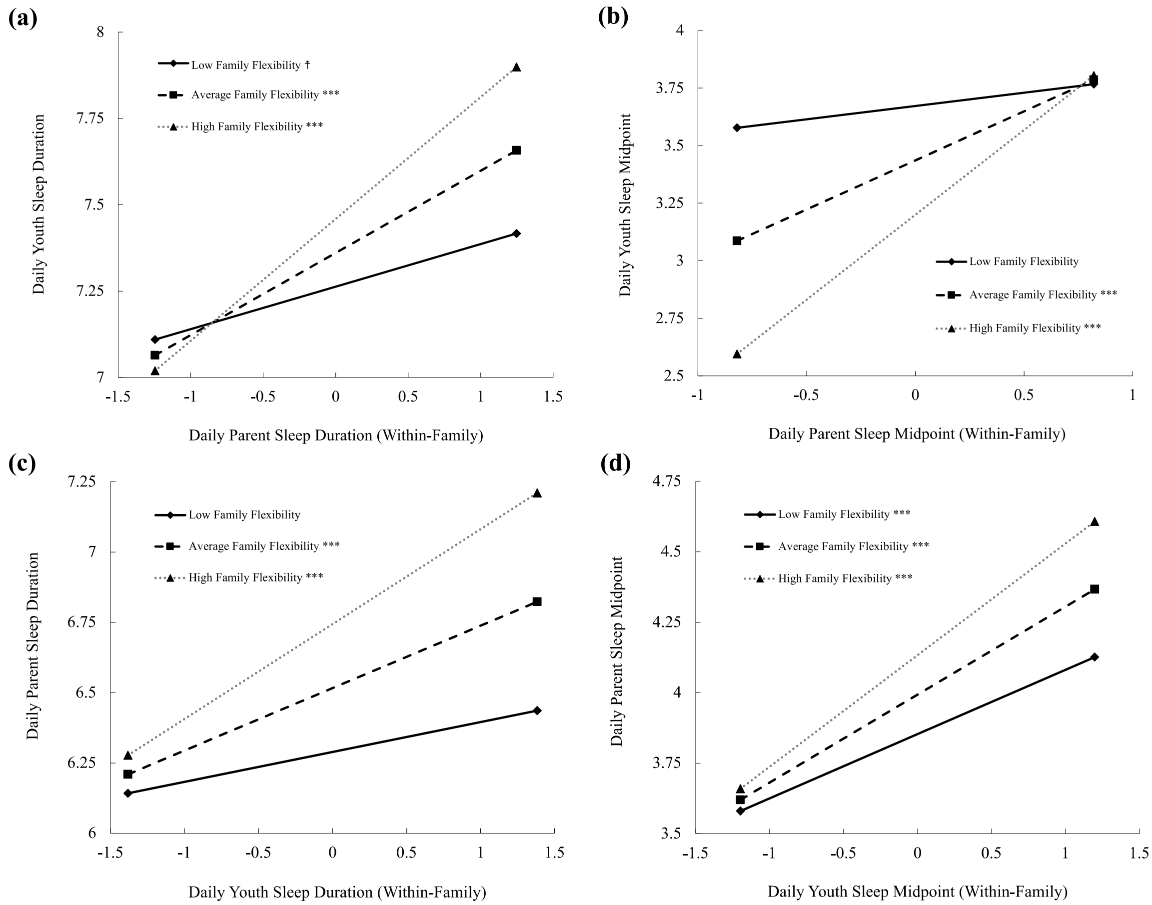

Figure 4. Simple slopes demonstrating within-family associations between daily parent and youth sleep duration and sleep midpoint time (±1 SD from within-person mean) by levels of family flexibility (±1 SD from grand mean). *Note*. Figures on the top (a-b) represent models in which youth sleep was predicted by parent sleep; figures on the bottom (c-d) represent models in which parent sleep was predicted by youth sleep. On the x-axis, youth/parent sleep duration and midpoint are centered, with zero representing the within-person mean. †p < .10. *p < .05, **p < .01, ***p < .001.

CHAPTER 4

STUDY 3: Concordance in Parent-Child and Sibling Actigraphy-Measured Sleep: Evidence Among Early Adolescent Twins and Primary Caregivers

ABSTRACT

Growing evidence suggests concordance between parent and youth sleep. However, no known study has simultaneously examined concordance among siblings' sleep patterns. This study investigated daily and average concordance in (1) parent-youth and (2) sibling actigraphy-measured sleep, as well as the degree to which sibling concordance varied by sleeping arrangements. 516 twin siblings (M_{age} = 10.74, 51% female; 30% monozygotic (MZ) twin pairs, 37% same-sex dizygotic pairs (DZ-ss), 33% opposite-sex DZ pairs (DZ-os)) and their primary caregivers (M_{age} = 40.59, 95% female) wore wrist-based accelerometers for 7 consecutive nights to measure sleep duration, efficiency, midpoint time, and latency. Primary caregivers also reported on demographics, youth pubertal status, and room-sharing. Two-level multilevel models were estimated to examine daily and average concordance in parent-youth and sibling sleep. Daily concordance was observed between parent and youth sleep duration and midpoint; average concordance was found for sleep duration, midpoint, and latency. Within sibling dyads, daily and average concordance was evident across all sleep parameters (duration, efficiency, midpoint, latency), with generally stronger concordance patterns for MZ than DZ twin pairs, and for twins who shared a room with their co-twin. This is the first known study to document concordance among parent-youth and siblings' actigraphy-measured sleep within the same study (i.e., triad). Our findings can help inform the development of family-level interventions targeting daily and overall sleep hygiene.

INTRODUCTION

Sleep health is critical for youth and adolescent well-being with extensive, documented benefits for mental, physical, and emotional health (Short et al., 2019; Zhang et al., 2017). Despite this, many children struggle with sleep problems (e.g., quality, latency, maintenance) and do not obtain recommended nightly sleep hours (Wheaton et al., 2018). Additionally, there are several biological, psychological, social, and contextual factors that influence youths' sleep behaviors (Becker et al., 2015). Recent research has paid particular attention to the role of the family context on children's sleep health, including how sleep patterns look similar within families (Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023). "Concordance" is defined as the degree to which the sleep behaviors of one member of a unit or dyad (e.g., family, couple) are similar to the sleep behaviors of the other member(s) of that system (Fuligni et al., 2015; Sasser & Oshri, 2023). This work has demonstrated promising evidence that parents' sleep behaviors may serve as potential determinants of adolescent sleep health (i.e., parent-child sleep concordance). However, much less work has examined concordance between *siblings'* sleep patterns, and most existing work is limited to subjective (i.e., self- or parent-reported indicators) measures of sleep. Additional research is needed examining how day-to-day and average variation in sleep co-occurs across multiple family members (e.g., parents, children, siblings) and whether detected daily or average concordance varies depending on the dyad (i.e., parent-child vs. sibling). To address these gaps, the present study harnessed a large ethnically/racially and socioeconomically diverse sample of early adolescent twins and their primary caregivers to examine daily and average concordance in (a) parent-child and (b) sibling actigraphy-measured sleep duration, efficiency, midpoint, and latency across 7 nights.

Evidence for Parent-Child Sleep Concordance

Growing research provides evidence for concordance, or similarities, in the sleep behaviors of parents and their children. For example, several studies have found overall (i.e., average) associations between parents' and youths' self-reported sleep patterns, including sleep duration and quality (Bajoghli et al., 2013; Brand et al., 2009; Meltzer & Mindell, 2007). Further, in a two-week daily diary study, Fuligni et al. (2015) found evidence for *daily* concordance between parent and adolescent self-reported sleep time (i.e., duration), wake time, and bedtime. Studies have also found evidence for concordance when using objective measures of sleep. For example, one study utilized a single night home-based sleep EEG and found significant associations between parent and adolescent sleep duration, continuity, and architecture (Kalak et al., 2012). Recent studies have also garnered evidence for *daily* and *average* parent-youth concordance using wrist-based accelerometers. Kouros and El-Sheikh (2017) examined within-family relations in actigraphy-measured sleep across 7 nights and found that daily fluctuations in mothers' sleep duration, efficiency, wake minutes, and wake time predicted similar changes in their 9-11 year old child's sleep on that same day. This study also found significant associations between mothers' and youths' average sleep efficiency, wake minutes/episodes, bedtime, and wake time, and links between fathers' and youths' average sleep duration, wake minutes, and wake time (Kouros & El-Sheikh, 2017). In another study, Sasser and Oshri (2023) measured youth (12-14 years old) and parent sleep across one week via actigraphy and observed daily concordance in parent-youth sleep midpoint time and duration, average-level concordance in sleep midpoint time only, and no evidence for concordance in sleep efficiency at the daily or average level. Lastly, using a concordance analysis that calculated the percentage of epochs that both parents and children (2-12 years old) were asleep, Varma et al. (2022) observed relatively high (e.g., average of 70.6%) concordance in actigraphy-based parent-child sleep across 14 nights, with parents awake approximately 35% of the times that their child was awake at night (and youth awake 11.8% of the times their parent was awake). This study also tested concordance for pseudo-parent-child dyads (e.g., randomly matched adults/children) and found that concordance estimates were much lower for pseudo-parent-child dyads than true parent-child dyads (Varma et al., 2022), suggesting that within-family concordance is distinct from shared sleeping periods across populations.

While it is difficult to directly compare effect sizes across studies (due to differences in analytic plan, sample size, and data structure), it is worth noting that, overall, most existing studies found evidence for concordance at both the daily *and* average level, suggesting within-family daily variation in sleep, as well as similarities among average sleep behaviors of parents and their children. In general, this body of work found consistent evidence for concordance in aspects of sleep timing (e.g., bedtime, wake time, midpoint) and quantity (e.g., duration), while evidence for sleep quality was more variable. Notably, there is limited research examining concordance in sleep *latency*, making this a promising future direction to elucidate concordance among multiple indicators of sleep quality.

Evidence for Sibling Sleep Concordance

Relative to parent-offspring concordance, sibling concordance in sleep patterns is likely to be as strong or stronger for a host of reasons. For example, siblings are closer in age (e.g., similarities in the homeostatic and circadian regulation of sleep), share similar routines (e.g., school, activities) and home environments, and spend a greater proportion of time together (Breitenstein et al., 2018; Hagenauer et al., 2009). Despite this, dyadic concordance in sibling sleep has been less extensively studied in comparison to parent-youth dyads, with most existing work limited to average (not daily) relations in sleep. For example, in two studies examining heritability of actigraphy sleep, cross-twin correlations exhibited strong, significant correlations between monozygotic (MZ) and dizygotic (DZ) twins' sleep across the study period, especially for indicators of sleep timing (Inderkum & Tarokh, 2018; Sletten et al., 2013). Studies using parent or self-reported sleep provide additional evidence for average concordance in sibling sleep. In a longitudinal sample, Gregory and colleagues (2009) found significant correlations between twins' parent-reported sleep problems at ages 8 and 10, with notably higher correlations among MZ as compared to DZ twins. Another study examined concordance in MZ adolescent twins' self-reported sleep by categorizing sibling pairs as concordant or discordant, which revealed a high proportion of concordant dyads during early adolescence (e.g., > 70% of pairs concordant in sleep duration/problems; Vermeulen et al., 2021). Lastly, in a sample of young adults (aged 18-27 years), several indicators of sleep problems measured via the Pittsburgh Sleep Quality Index (PSQI) were correlated across sibling dyads (Barclay et al., 2010). In this same study, the strongest correlations among sleep components were found for twins (MZ and DZ), as compared to non-twin siblings, with the exception of sleep duration (i.e., the magnitude of correlations for sleep duration were similar across all sibling types).

To the authors' knowledge, no studies examining relations between sibling sleep behaviors have considered characteristics of the sleeping environment, such as room-sharing. This is an important gap, as previous research among parent and infant dyads (Volkovich et al., 2015) and young adult couples (Countermine & Teti, 2010; Drews et al., 2020) suggest that individuals can influence one another's sleep markedly, especially when sleeping in the same room. Moreover, in their study examining parent and adolescent sleep habits, Fuligni et al. (2015) found that household size was associated with greater concordance in sleep duration and wake time. The authors speculated that this may be due to shared sleeping quarters among family members (i.e., room-sharing), but were unable to test this hypothesis in their study. Thus, the current study aims to extend this line of work by examining whether sleeping arrangements moderate associations between siblings' sleep patterns (i.e., if concordance in sibling sleep varies according to room-sharing).

Heritability of Sleep in Childhood and Adolescence

Concordance in sleep patterns among family members can occur for genetic as well as environmental reasons. Twin studies of subjective and objective (e.g., actigraphy) sleep in childhood and adolescence offer consistent evidence for moderate to high *heritability*, defined as the proportion of phenotypic variance in a trait attributable to genetic influences within a given sample at a given time (Kocevska et al., 2021; Lewis & Gregory, 2021; Madrid-Valero et al., 2020; Madrid-Valero & Gregory, 2023). However, considerable heterogeneity in the magnitude of estimates exists across studies, and heritability differs according to measurement, sleep indicator, sample characteristics such as age, and environmental context. For instance, in a previous study of 608 twins from this sample at age 8 (Breitenstein et al., 2021), we found moderate to high heritability of actigraph-assessed sleep duration (.69) and efficiency (.58), whereas sleep latency was influenced by both additive genetic (.30) and shared environmental (.47) factors, and sleep midpoint nearly fully driven by the shared environment (.91). Other studies of actigraph-assessed sleep in childhood and adolescence demonstrate moderate-to-high heritability of sleep duration (.46-.65), efficiency (.42-.52), and latency (.83), and environmental influences on timing (.67-.76; Runze et al., 2021; Sletten et al., 2013). The current study builds on our previous work that demonstrates the heritability of sleep by considering broader, within-family relations in daily and average sleep patterns as well as contextual influences (i.e., room-sharing) on concordance.

The Current Study

There is growing evidence for daily and average concordance in parent-youth sleep patterns (Fuligni et al., 2015; Kalak et al., 2012; Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023). However, evidence among siblings remains less extensive, with most studies examining subjective indicators of sleep and not capturing how daily fluctuations in sleep co-occur across siblings. Further, no known study has examined concordance between both parent-youth and sibling sleep (i.e., triad) within the *same* study. The examination of concordance across multiple dyads within the same family can help shed light on the extent to which family members exert influence on each other's sleep depending on their role (i.e., parent, child, sibling) and whether they share sleeping contexts. Such information can help identify potential targets for family-based sleep health programs. Thus, the current study aimed to fill existing gaps in the literature by investigating daily and average concordance in actigraphy-based sleep (e.g., duration, efficiency, midpoint, latency) between (1) parent-child dyads, and (2) sibling dyads. Further, we tested the degree to which sibling concordance varied as a function of room-sharing. Based on previous work (Fuligni et al., 2015; Kalak et al., 2012; Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023), we expected that there would be significant daily and average concordance in sleep duration, efficiency, midpoint time, and latency between parents and their children (*Hypothesis 1*). We predicted that concordance would be strongest for sleep midpoint, considering previous evidence that sleep timing indicators are more environmentally influenced than sleep quality/quantity (Breitenstein et al., 2021), as well as studies documenting robust daily and average relations in parent-youth sleep timing (Fuligni et al., 2015; Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023). We predicted similar concordance patterns between siblings, such that there would be significant daily and average relations across all sleep indicators, especially sleep midpoint (*Hypothesis 2*; Barclay et al., 2010; Gregory et al., 2009). Lastly, we expected that sleep concordance would be greater among sibling dyads that shared rooms (*Hypothesis 3*).

Methods

Participants

Participants were twin siblings and their primary caregivers (393 families) who took part in the 10-year study wave (data collection took place May 2018 to July 2021) of the ongoing longitudinal Arizona Twin Project (Lemery-Chalfant et al., 2013, 2019). Families were initially recruited through Arizona state birth records to participate in a first assessment wave at 12 months old. Additional families were recruited at later study waves to allow for a sample size with power to conduct twin modeling with a total of 551 families contacted and eligible to participate in the 10-year study wave.

Families included in the 10-year study wave were 392 primary caregivers (94.5% mothers; M_{age} = 40.88, *SD* = 5.72) and 784 twin children (M_{age} = 10.88, *SD* = 1.15; 51% female; 30% MZ twin pairs, 37% same-sex DZ pairs (DZ-ss), 33% opposite-sex DZ pairs (DZ-os)). Primary caregivers were 21.8% (twins: 25.7%) Hispanic/Latino, 1.3% (2.6%) Asian/Asian American, 2.7% (3.3%) Black/African American, 2.4% (3.0%) Native American, 0.5% (0.5%) Native Hawaiian/Pacific Islander, 67.7% (56.5%) non-Hispanic White, 2.3% (6.8%) biracial or multiracial (of which 1.5% (4.6%) report Hispanic/Latino as one of their racial/ethnic origins), and 1.1% (1.6%) other race/ethnicity). Our sample consisted of families living below the poverty line (6.6%), living near the poverty line (21.6%), lower middle class (22.7%), and middle to upper class (49.1%). Primary caregiver education completion included a college degree (37.8%), two or more years of graduate school (4.3%), completed graduate or professional degree (21.4%), completed some college (28.1%), a high school degree or equivalent (7.3%), or less than a high school degree (1.1%).

Out of the 551 contacted to participate in the 10-year study wave, 393 families participated in some form (71%). Reasons for nonparticipation included declining participation at that study wave, families unable to be located, or twins aging into the next assessment age group before they could participate or be scheduled. Of the 393 families who participated, 348 families were eligible to participate in the study week portion of the study as they resided in Arizona, and 293 provided actigraphy data from at least one family member (84%). Reasons for nonparticipation in actigraphy procedures included participation during the COVID-19 pandemic, or requests to only participate in surveys.

Procedures

Institutional Review Board approval was obtained, and primary caregiver informed consent and children's assent were obtained, prior to the start of data collection. Families were contacted to participate in an intensive assessment involving online questionnaires, one home (or virtual) visit, and a week of actigraphy-based sleep measurement. During the home visit, two trained research assistants collected primary caregiver and twin biological measurements, including height, weight, waist circumference, and percent body fat. Primary caregivers completed questionnaires reporting on their twins' pubertal development and sleep. To measure their sleep for approximately 7 consecutive nights, primary caregivers (M = 6.70, SD = .82) and twins (M = 6.66, SD = 1.00) wore wrist-based accelerometers. Primary caregivers reported on self and twin wake times and bedtimes via assessment tables to cross-reference actigraphy measures as a check of compliance. Before and during the study week, study staff contacted families to ensure study procedures were being followed and to answer any questions. Families were compensated for their participation.

Measures

Actigraphy

Parent and twin actigraphy sleep were measured using the Micro Motion Logger Watch, a wrist-based accelerometer worn on participants' non-dominant wrists (Ambulatory Monitoring, Inc. Ardsley, NY USA). Activity was measured in 1-minute epochs using a zero-crossing mode; periods of sleep and waking were detected using the Sadeh algorithm in Action W-2 (Version 2.7.1; Ambulatory Monitoring). Actigraphy has been validated against polysomnography[23] and demonstrates good reliability when assessed 4-5 nights or more.[24] Four sleep parameters were examined in the present study: (1) sleep duration (i.e., total time asleep (in hours), excluding waking episodes), (2) sleep efficiency (i.e., ratio of time spent asleep (duration) to total time in bed, with total time in bed consisting of true sleep and waking episodes), (3) sleep midpoint (i.e., midpoint between sleep onset and offset), (4) sleep latency (i.e., number of minutes to sleep onset from first attempting to fall asleep).

Compliance was high. Of twins who participated in actigraphy (*n* = 612), 42 (6.9%) children had watches that malfunctioned upon data download, 5 (0.8%) watches were lost, 44 (7.2%) had insufficient data to analyze (0-2 nights of sleep) or decided to opt out of the actigraphy portion of the study, and 1 (0.2%) participant wore the watch but was removed from analyses due to developmental disability that may affect sleep. Of the 516 children with valid actigraphy data, 76.0% (*n* = 392) of children had 7 or more nights of data, 13.8% (*n*=71) had 6 nights of data, 5.0% (*n* = 26) had 5 nights of data, 2.7% (*n* = 14) had 4 nights of data, and 2.5% (*n* = 13) had 3 nights of data. Of the primary caregivers who participated in actigraphy (*n* = 290), 24 (8.2%) had watches that malfunctioned upon download, 20 (6.9%) had less than 3 nights of sleep or did not wear the watch, and 1 had a watch that was lost (0.3%). Of the 245 primary caregivers with 3 or more nights of actigraphy data, 76.7% (*n* = 188) had 7 or more nights of data, 14.3% (*n* = 35) had 6 nights, 5.7% (*n* = 14) had 5 nights, 2.9% (*n* = 7) had 4 nights, and 0.4% (*n* = 1) had 3 nights of data. The valid actigraphy data used in the current study came from

287 different families. Of these, 71.8% (N = 206) had data from all three family members (i.e., both twins and primary caregiver), 21.6% (N = 62) had sleep data from two family members (n = 28 had data for both twins but not the primary caregiver, n = 34 had data for the primary caregiver and one twin), and 6.6% (N = 19) had sleep data from one family member (n = 14 had data for one twin, n = 5 had data for primary caregiver).

Zygosity

The 32-item Zygosity Questionnaire for Young Twins (Goldsmith, 1991) was completed by primary caregivers to assess the birth and observed physical differences between their twins. This questionnaire is over 95% consistent with zygosity determined by genotyping (Price et al., 2000). Hospital birth records and physical similarity assessments at the home visits were used as supplemental zygosity indicators.

Room-Sharing

Whether siblings slept in a room together was assessed using a yes/no item that asked parents: "Do your twins share a room now?" (1 = twins do share a room, 0 = twins do not share a room). Approximately 52% of the twins shared a room at the 10-year study wave (76.8% of MZ twins shared a room, 61.5% of DZ-ss twins shared a room, and 18.0% of DZ-os twins shared a room).

Covariates

Covariates at Level-1 included whether it was a weekend or weekday night (1 = Friday or Saturday night, 0 = all other nights). Covariates at Level-2 included sex (1 = female, 0 = male), age, race (two dummy variables representing White and Hispanic, with all other racial groups as the reference group), family socioeconomic status (standardized composite of family income-to-needs ratio, primary caregiver highest education level, and other caregiver highest education level), BMI, vacation (1 = twins were on summer or holiday break during the sleep study week, 0 = twins were in school during the study week). Models predicting youth sleep also included pubertal status as a covariate, which was parent-report using the Pubertal Development Scale (Petersen et al., 1988) and standardized separately for boys and girls.

Analytic Plan

A series of multilevel models were conducted in *Mplus* version 8.0 (Muthén & Muthén, 1998) using maximum likelihood estimation with robust standard errors to account for nested data and handle missing data. We implemented a two-strategy approach to examine daily (e.g., Level-1) and average (e.g., Level-2) concordance between parent and sibling sleep. Level-1 predictors (e.g., daily sleep) were within-person centered and Level-2 predictors (e.g., average sleep) were grand mean-centered across all models. Analytic strategies differed depending on the question: (1) parent-child concordance and (2) sibling (i.e., twin) concordance. First, to assess parent-child concordance (Aim 1), two-level multilevel models were specified in *Mplus* with days nested within families (N = 3,779 days of sleep nested within 287 families; n = 516 children). The cluster error command (TYPE = COMPLEX) was used to account for nonindependence of twins' data (i.e., twins clustered within families). Specifically, within families, each twin had separate cases (rows) for each night of sleep, with corresponding data for parents on those same nights. Next, to examine sibling concordance (Aim 2), multilevel models were estimated with days nested within twins (N = 2,064 days nested within 287 dyads). Following extant literature in this area (Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023), two-level models, which focused on daily and average concordance (i.e., relations) between multiple dyads within the family were used, as the focus was not to compare families or interpret concordance as the degree of within-family variance. Rather than being clustered within families, each twin had separate sleep variables (columns) within the same family, to allow the prediction of one twin's sleep from the other. This analytic strategy has been used in previous studies investigating daily and average within-family relations in actigraphy sleep (Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023). Prior to this analysis, twins within dyads were randomized into a categorization of "Twin 1" "or Twin 2", to ensure that models testing the prediction of one twin's sleep from the other would not be biased by selection based on other indicators (e.g., birth order, alphabetical order). We utilized multi-group multilevel modeling to allow daily (Level-1) and average (Level-2) associations between twin sleep to differ across zygosity type (n = 621 days nested within 86 monozygotic (MZ) dyads; n = 776 days nested within 108 dizygotic same-sex (DZ-ss) dyads; n = 667 days nested within 93 dizygotic opposite-sex (DZ-os) dyads). Wald Z-tests were used to examine whether the magnitude of parameters (i.e., slope, representing twin concordance) differed across groups. Lastly, to test whether siblings' sleep concordance varied by sleeping arrangements (Aim 3), average twin sleep, a room-sharing indicator, and the interaction term (e.g., average twin sleep*room-sharing) were entered into the multi-group model as Level-2 predictors, with Wald Z-tests examining whether the magnitude of the interaction term differed across groups. Interactions were probed using the simple slopes technique for multilevel modeling (Preacher et al., 2006).

Results

Descriptive Statistics and Preliminary Analyses

Table 10 contains descriptive statistics for average estimates of the primary sleep variables across parents and twins. Independent samples t-tests were conducted to examine whether average sleep estimates differed across Twins 1 and 2. In cases where Levene's test for equality of variances was violated ($p < .05$), we utilized the adjusted *t*-test statistic, degrees of freedom, and *p*-value (i.e., equal variances not assumed). There were no significant differences in twins' average sleep duration ($t(514) = -1.89$, $p = .06$), sleep efficiency ($t(514) = -.58$, $p = .56$), sleep midpoint time ($t(514) = .29$, $p = .77$), and sleep latency ($t(514) = -.05$, $p = .96$), supporting the randomization of twins for main analyses. We also compared whether average sleep differed across parents and youth. Parents had significantly shorter sleep duration ($t(348.22) = -14.47$, $p < .001$), later sleep midpoint times ($t(402.66) = 3.44$, $p < .001$), and shorter sleep latency ($t(759) = -2.52$, $p = .01$) than their children. Sleep efficiency did not significantly differ between parents and youth ($t(387.07) = 1.54$, $p = .13$).

Correlations between family members' average sleep estimates are presented in Table 10. Biological parents and offspring share exactly 50% of their genetics, so positive correlations were expected for heritable traits. Parent-offspring sleep duration, midpoint, and latency were all significantly positively correlated, whereas efficiency was not ($p = .20$). If twin correlations are stronger for MZ twins (who share 100% of their segregating genetics) than DZ twins (who share on average 50% of their genetics), additive genetic influences (A) are implicated. If DZ correlations are greater than half MZ correlations, shared, or common environmental influences (C) are implicated. MZ twin correlations less than 1.00 suggest the presence of nonshared environmental influences and/or measurement error (E). Twin correlations suggested AE influences on sleep duration and latency, ACE influences on sleep efficiency, and no genetic influences on sleep midpoint (i.e., CE influences). For information about the heritability of sleep in this sample at a previous wave (i.e., age 8), please refer to Breitenstein et al. (2021).

Aim 1 Results: Parent-Child Sleep Concordance

Results examining daily (e.g., Level-1) and average (e.g., Level-2) concordance in parent and youth sleep can be found in Table 11. Models predicting both offspring sleep from parent sleep and parent sleep from offspring sleep are presented. For ease of interpretation, statistically significant results from these models are summarized in text according to the specific sleep parameter being examined (e.g., duration, efficiency, midpoint time, latency). All statistics are presented in Table 11.

Sleep Duration

Results revealed significant daily and average concordance between parent and youth sleep duration (Table 11). At the daily level, on nights that parents slept one hour longer than usual, their children experienced an increase in their sleep duration by approximately 6.6 minutes on that same night. Similarly, a 1-hour longer sleep duration than youths' average was associated with 8.4 more minutes of sleep for parents on that same night. At the average level, a 1-hour increase in parents' average sleep duration corresponded to an approximately 5-minute longer duration among their children.

Sleep Efficiency

Parent and child sleep efficiency were not significantly related to one another at the daily or average level (see Table 11 for full statistics).

Sleep Midpoint

Results indicated significant daily and average concordance between parent and youth sleep midpoint time (Table 11). At the day-level, fluctuations in parents' sleep midpoint time by 1-hour corresponded to an approximate 14-minute later sleep midpoint for their offspring on that same night. Similarly, 1-hour daily deviation from youths' typical midpoint time was associated with an approximate 23-minute later sleep midpoint in parents on that same night. At the average level, a 1-hour later sleep midpoint time among parents was associated with a 17-minute later average sleep midpoint time among their offspring, while a 1-hour later average midpoint time among youth was associated with a 30-minute later average midpoint time among parents.

Sleep Latency

Daily fluctuations in sleep latency were not significantly associated across parents and offspring (see Table 11). However, there was significant average concordance between youth and parent sleep latency. Specifically, a 1-minute longer average sleep latency among parents was associated with a 0.32-minute longer sleep latency among their children (i.e., a 15-minute increase in parents' average sleep latency predicted a 5-minute longer average sleep latency among their children). Similarly, a 1-minute longer average sleep latency among youth was associated with a 0.23-minute longer sleep latency among parents (i.e., a 15-minute longer average youth sleep latency corresponded to a 3.5-minute longer average latency among parents).

Aim 2 Results: Sibling Sleep Concordance

Results from multiple-group multilevel models examining daily (e.g., Level-1) and average (e.g., Level-2) concordance in twins' sleep, separated by zygosity (MZ, DZ-ss, DZ-os) are provided in Table 12. It is important to note that, because DZ twins share roughly 50% of their genetic composition, the results from the DZ-ss and DZ-os models are more generalizable to non-twin sibling pairs (who also share 50% of their DNA), as compared to MZ twins (who share 100% of their genetics). Models predicting both Twin 1 sleep from Twin 2 sleep and Twin 2 sleep from Twin 1 sleep are presented. For ease of interpretation, we summarize results from models predicting Twin 1 sleep from Twin 2 sleep below, with estimates for models predicting Twin 2 from Twin 1 sleep given in parentheses.

Sleep Duration

At the daily level, there was significant concordance in twins' sleep duration across all zygosity types. For example, sleeping 1-hour longer than usual for Twin 2 was associated with an increase in Twin 1's sleep duration that same night by 30.6 minutes (28.2 minutes) for MZ twins, 27 minutes (28.2 minutes) for DZ-ss twins, and 24 minutes (24 minutes) for DZ-os twins. At the average level, results indicated significant concordance in twins' duration across MZ and DZ-ss, but not DZ-os, twins. For example, a 1-hour longer sleep duration for Twin 2 was associated with an average sleep duration increase in Twin 1 by 38.4 minutes (36.6 minutes) for MZ twins and 18 minutes (15.6 minutes) for DZ-ss twins.

Sleep Efficiency

At the daily level, there was significant concordance in twins' sleep efficiency across all zygosity types. Specifically, a 10% increase in Twin 2's sleep efficiency, relative to their average, was associated with an increase in sleep efficiency for Twin 1 on that same night by 3.2% (2.6%) for MZ twins, 2.6% (2.9%) for DZ-ss twins, and 2.0% (1.7%) for DZ-os twins. At the average level, sleep efficiency was concordant across all zygosity types. Overall, a 10% higher average sleep efficiency among Twin 2 was associated with a higher average sleep efficiency among Twin 1, by 7% (6.1%) for MZ twins, 4% (3.9%) for DZ-ss twins, and 3.4% (2.9%) for DZ-os twins.

Sleep Midpoint

At the daily level, there was significant concordance in twins' sleep midpoint time across all zygosity types. For example, a 1-hour later sleep midpoint time than usual for Twin 2 was associated with a delay in Twin 1's sleep midpoint time on that same night by 48.6 minutes (43.8 minutes) for MZ twins, 43.8 minutes for DZ-ss twins (45.6 minutes), and 31.2 minutes (38.4 minutes) for DZ-os twins. At the average level, sleep midpoint time was highly concordant across all zygosity types. Specifically, a 1-hour later average sleep midpoint time for Twin 2 was associated with a later average sleep midpoint among Twin 1 by 49.2 minutes (52.2 minutes) for MZ twins, 40.2 minutes (48.6 minutes) for DZ-ss twins, and 50.4 minutes (51.6 minutes) for DZ-os twins.

Sleep Latency

At the daily level, there was significant concordance in twins' sleep latency time across zygosity types (i.e., on nights when twins took longer to fall asleep than usual, their co-twin also took longer to fall asleep that night). For example, a 15-minute nightly increase in Twin 2's sleep latency corresponded to an increase in Twin 1's latency that same night by 5.9 minutes (5.9 minutes) for MZ twins, 3 minutes (3.3 minutes) for DZ-ss twins, and 2.6 minutes (2.9 minutes) for DZ-os twins. At the average level, sleep latency was also concordant across twins. Specifically, a 15-minute longer average sleep latency among Twin 2 was associated with an increase in Twin 1's average sleep latency by approximately 10.7 minutes (9.6 minutes) for MZ twins, 6.9 minutes (5.9 minutes) for DZ-ss twins, and 7.8 minutes (4.4 minutes) for DZ-os twins.

Aim 3: Room-Sharing as a Moderator

To examine whether characteristics of the sleeping environment may have influenced siblings' sleep concordance, room-sharing was tested as a moderator of average (i.e., Level-2) associations between co-twins' sleep. Full results are provided in the online Supplementary Materials. Results revealed that room-sharing significantly moderated associations between twins' sleep duration among MZ and DZ-os dyads, sleep efficiency among DZ-ss dyads, and sleep midpoint time among DZ-ss dyads. To better understand how average sleep concordance varied as a function of room-sharing, simple slopes were probed and plotted for all interactions (Figure 5). In general, concordance was stronger for co-twins who shared bedrooms (i.e., associations between twins' sleep were positive and steeper in room-sharing conditions). For example, among MZ dyads who *did not* share a room, a 1-hour longer average sleep duration was associated with a 15-minute longer average sleep duration for their co-twin, but for MZ dyads that *did* share a room, a 1-hour longer average duration corresponded to a 48.6 longer duration for their co-twin (Figure 5A). For DZ-os dyads, a 1-hour longer sleep duration predicted only 1.8 minutes of longer sleep for their co-twin if they *did not* share a room but predicted 33.6 minutes of longer sleep for their co-twin if they *did* share a room (Figure 5C). Further, among DZ-ss twins, a 10% higher average sleep efficiency corresponded to 0.89% higher average sleep efficiency for their co-twin if they *did not* share a room, and a 6% higher efficiency if they *did* share a room (Figure 5E). Lastly, among DZ-ss twins, a 1-hour later average sleep midpoint time for one twin was associated with a 31-minute later midpoint time for the co-twin if they *did not* share a room, and a 48-minute later average sleep midpoint time if they *did* share a room (Figure 5H).

Discussion

This study examined daily and average patterns of sleep concordance among two central dyads within the family: (1) parents and offspring, and (2) siblings. As one of the few studies to use objective measurement of sleep indicators and the first to consider daily coordination in sibling sleep, we contribute to and extend a growing body of literature supporting significant concordance in family members' sleep, particularly that of parents and youth (Fuligni et al., 2015; Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023) with some evidence for sibling concordance (Barclay et al., 2010; Gregory et al., 2009; Vermeulen et al., 2021). Results from our study replicate previous evidence of concordance between parent and youth sleep at both the daily and average level (Fuligni et al., 2015; Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023), particularly for sleep duration and midpoint time. Further, we provide new findings for concordance in parent-youth actigraphy-measured sleep latency at the average level. Our results also revealed significant concordance between siblings' sleep patterns across all measured sleep indicators (e.g., duration, efficiency, midpoint, latency), with strong, consistent associations at both the daily and average level. Lastly, we found that concordance between siblings' sleep varied as a function of sleeping arrangements, with twin pairs who slept in the same room exhibiting stronger concordance, in general.

Parent-Child Sleep Concordance

The findings from the first aim of the study provide partial support for our hypotheses. Specifically, at the daily level, we found significant concordance between parent and youth sleep duration and midpoint time, indicating that on nights that parents had later sleep midpoint times and/or slept more hours than usual, their children also had later sleep timings and obtained longer sleep that same night. Our findings of day-level concordance for sleep duration and midpoint, but not efficiency or latency, may be explained by shared environmental constraints that influence sleep timing (e.g., bed/wake time) and sleep duration, such as school start times, parents' work schedules, shared mealtimes, and other family activities/routines (Adam et al., 2007; Craft et al., 2021; Owens, 2014; Sasser et al., 2021b). Further, the timing of an individuals' sleep can promote or constrain the amount of sleep that they are able to obtain on a given night. Thus, it is likely that on some of the nights that youth and parents were going to bed and waking up earlier than usual, they were also obtaining more hours of sleep, and vice versa (i.e., they were obtaining less sleep on nights when their sleep timing was delayed). In contrast, sleep efficiency and latency may better capture sleep *quality*, which can differ drastically across family members due to both non-shared (e.g., aspects of sleeping context) and individual-level factors (e.g., stress, emotions/affect; Bai et al., 2022; Tavernier et al., 2016).

At the average level, reflective of relations between average or typical parent and youth sleep across one week, we found significant concordance in sleep duration, sleep midpoint, and sleep latency, but not sleep efficiency. This suggests that, in general, parents who had longer sleep durations, later sleep timings, and who typically took longer to fall asleep, had children with longer durations, later sleep timings, and longer sleep latencies. When interpreted alongside the day-level findings for concordance in sleep duration and midpoint time, these results suggest that while daily fluctuations in sleep hours and timing tend to co-occur across parent-youth dyads, they also look similar within families, on average. This is important to note as both findings are demonstrating fluctuations around individual means (i.e., child-specific, parent-specific), as opposed to family-means, suggesting that these individual-level fluctuations are also concordant with one another. These results also support the idea that sleep duration and timing may be particularly interdependent among parent-youth dyads, due to both genetic and contextual contributions (e.g., shared time, routines; Adam et al., 2007; Breitenstein et al., 2021; Fuligni et al., 2015; Sasser & Oshri, 2023). Indeed, previous work in the current sample found that sleep midpoint was more environmentally-influenced compared to other indices of objective sleep (Breitenstein et al., 2021). In the context of the parent-child relationship in early adolescence, parents are still expected to exert some degree of control or supervision over their child's bed and wake times, which may explain why findings for sleep midpoint were the most consistent across sleep indicators.

Concordance in sleep latency was found at the average level only, which may suggest less co-occurrence between parents 'and youths 'daily fluctuations in sleep latency, but rather, trait-like similarities across parent-youth dyads. For example, it is possible that similarities in person-level factors, such as stress reactivity, affect/arousal, or pre-sleep worries, may explain why parents and youth exhibited similar levels of average sleep latency (Bagley et al., 2015). However, the instances *when* parents and youth had shorter or longer sleep latencies than usual may not have occurred on the same night, given the role of person-specific past-day events that can differentially impact how long it takes a person to fall asleep (e.g., worries, stress; Fuligni & Hardway, 2006; Tavernier et al., 2016). It is worth noting that this is the first known study to investigate concordance in parent-youth sleep latency measured via actigraphy (for evidence using sleep-EEG, see Kalak et al., 2012). Thus, this finding should be replicated in future work. Lastly, the observation that sleep efficiency was *not* concordant across parent-youth dyads was unexpected, given that previous work using objective measures of sleep found significant relations between parent and child sleep continuity (e.g., efficiency, wake minutes, number of awakenings after sleep onset; Kalak et al., 2012; Kouros & El-Sheikh, 2017). However, our results are consistent with a recent study that did not find daily or average associations between parent and youth actigraphy-based sleep efficiency (Sasser & Oshri, 2023).

Sibling Sleep Concordance

The results from the second aim of the study supported our hypotheses, such that we observed significant daily and average concordance in siblings' sleep across all four of the sleep parameters examined. This was the first known study to investigate concordance in siblings' actigraphy-measured sleep, captured and modeled across several days. Moreover, our findings are similar to previous studies of siblings, which found that, in general, twins tended to report similar levels of subjective sleep behaviors as their co-twins (Barclay et al., 2010; Gregory et al., 2009; Vermeulen et al., 2021). Informed by prior work in the current sample that observed strong heritability in objectively-measured sleep in middle childhood (Breitenstein et al., 2021), we tested within-sibling relations in sleep separately by zygosity, and uncovered consistent evidence of stronger daily and average concordance among MZ twins, as compared to DZ-ss and DZ-os twins. Further, this trend of stronger MZ concordance was generally greatest for average (versus daily) sleep, suggesting a stronger genetic influence on twins' overall sleep, whereas shared environmental factors are exerting a greater influence at the day level. This is a novel finding that should be further explored in future studies, given that this is the first known study to examine concordance at the daily level using a twin design. Notably, we also found that, in several cases, DZ twins who were the same sex exhibited stronger concordance than DZ opposite-sex twins. It appears that this may be especially the case for sleep duration and efficiency (i.e., there were stronger daily and average relations among DZ-ss twins as compared to DZ-os twins, but note that not all twin comparisons reached conventional levels of statistical significance). Thus, while genetics may play a large role in concordance patterns (i.e., strongest among dyads that share 100% of their genetics), the match and/or mismatch of sex within a pair of siblings may also influence sleep concordance. These differences highlight the utility of characterizing DZ-ss and DZ-os twins as separate subgroups, rather than combining them as a broader DZ group, which has been a more common approach in previous twin concordance studies. To examine whether these results were due to other environmental factors that may look different among twins of the same/different sex, we investigated room-sharing as a meaningful variable that may further explain variation in concordance.

Variation by Room-Sharing

Our final aim examined whether concordance between siblings' average sleep patterns varied as a function of their sleeping arrangements (i.e., room-sharing). As expected, our results demonstrated that, in many cases, there was stronger concordance among twin pairs that shared a room than those who did not share a room. This effect was particularly pronounced for sleep duration, such that relations between twins 'sleep duration were *only* significant in room-sharing contexts across different twin types (i.e., MZ and DZ). Importantly, this suggests that the high heritability of sleep duration that has been identified in previous studies (including our own) may be due to environmental confounding, as MZ twins are more likely to share a room than DZ twins. Such findings indicate that future twin studies must account for this key contextual variable to disentangle accurate genetic and environmental contributors to children's sleep.

A similar pattern of findings was observed for sleep efficiency, with stronger relations between siblings' sleep efficiency among room-sharing dyads. In general, sleep midpoint and sleep latency exhibited strong concordance across both sleeping arrangements, with some evidence for greater concordance among room-sharing twins. Moderation analyses also clarified findings from initial concordance models. Specifically, relations between DZ-os twins' average sleep duration were nonsignificant in the main effect models; thus, exploring room-sharing as a moderator allowed for the discovery of a subgroup of DZ-os twins for whom sleep duration *was* concordant (i.e., those who shared rooms). Results from this aim complement existing work on room sharing during sleep among infant-parent and young adult couple dyads (Countermine & Teti, 2010; Drews et al., 2020; Volkovich et al., 2015), offering additional evidence that individuals may influence one another's sleep more drastically in shared sleep environments. These results also support the line of thinking by Fuligni et al. (2015), who hypothesized that concordance between the sleep of family members may be stronger due to shared sleeping quarters. Collectively, these findings point to the importance of investigating characteristics of the sleep environment when examining within-family relations in sleep, which may help elucidate when or why patterns of concordance are particularly prominent. Furthermore, it is essential that future twin studies of sleep measure and account for room-sharing to accurately estimate genetic and environmental influences on children's sleep.

Concordance Among the Broader Family

When interpreting findings of parent-youth and sibling sleep concordance together, there are several themes worth noting. First, results from both parent-youth and sibling models found concordance in sleep duration that was particularly evident at the day-level, such that across all models, nightly fluctuations in one family member's sleep hours co-occurred with changes in the other family member's sleep hours that same night. Our findings of robust daily links between family members' sleep duration is consistent with previous work that found parent-youth concordance in sleep duration at the daily, but not average level (Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023). Because these daily links capture within-person fluctuations (i.e., below or above typical levels across the week), it would be expected that nights of shorter/longer sleep than usual may co-occur across family members, given the degree of shared time spent together or shared daily events that may influence sleep (e.g., shared celebration that influences later bedtimes). Further, even for relatively stable and heritable traits such as sleep duration, the reduction down to an average (i.e., overall) estimate of sleep can result in the loss of meaningful and nuanced information about sleep and its processes, which may also explain why daily concordances (which capture family-level processes or events) were more robust.

Second, while sleep efficiency was highly concordant among sibling pairs, it was not observed in parent-youth dyads in the current study. A lack of concordance between parent and youth sleep efficiency could be driven by several factors, including differences in genetic and environmental contributions. It is possible that there is increased environmental influence of sleep efficiency in adults, as compared to children. Indeed, results from heritability analyses suggest that genetic and environmental influences on sleep efficiency are different in studies of adults and adolescents. For example, a sample of middle-aged adult twins found evidence for moderate genetic influence on all PSQI components *except* for sleep efficiency, for which 80% of the variance was attributed to non-shared environmental influences (Madrid-Valero et al., 2018). However, studies conducted among middle childhood and adolescent twins observed high heritability of actigraphy-measured sleep efficiency (i.e., explaining 57-79% of variance; Breitenstein et al., 2021; Inderkum & Tarokh, 2018; Sletten et al., 2013). Future studies using actigraphy-measured sleep in adult twins is needed to be able to support these hypotheses and provide important information about the changing environmental and genetic influences on sleep efficiency across development. In addition, research from non-twin samples has highlighted that contexts shape parent-youth concordance. For example, Sasser and Oshri (2023) found that concordance between parent and adolescent sleep efficiency was only evident in low adverse parenting conditions, whereas parent-youth dyads reporting high adverse parenting exhibited *discordance* in sleep (i.e., higher parent sleep efficiency corresponded to lower youth sleep efficiency). Thus, future work might continue to explore whether aspects of the parent-child relationship, or individual-level factors (e.g., stress, rumination, worries) may help explain whether there are subgroups of families for whom this discordance is evident.

Lastly, we found consistent evidence, with sizable effect sizes, for concordance in sleep midpoint across both parent-youth and sibling dyads, at both the daily and the average level. These results are not surprising, given that previous work has found significant daily and average concordance in indicators of sleep *timing* (e.g., bedtime, wake time, midpoint time) among parent-youth dyads (Fuligni et al., 2015; Kouros & El-Sheikh, 2017; Sasser & Oshri, 2023). Further, previous studies indicate that sleep midpoint time is heavily influenced by environmental factors (Breitenstein et al., 2021), including but not limited to school start times, parent work schedules, and family routines (Doane et al., 2019; Owens, 2014), which may explain why family members exhibit strong concordance in this indicator. Indeed, it was expected that sleep timing would be highly concordant at the day-level, as members of the family may be similarly (jointly) adapting their sleep schedules on particular nights of later and/or earlier bed and wake times than usual (Sasser & Oshri, 2023).

Strengths, Limitations, and Conclusions

The current study has multiple strengths and limitations worth noting for future research. While most prior studies of concordance have objective sleep data for two family members, the current study collected actigraph data for three members (i.e., primary caregiver and twin children) during the same study week. The use of twin siblings may be viewed as a limitation, but our study should generalize to broader populations of non-twin siblings given our modeling approach to understanding differences in associations by zygosity type (i.e., DZ twins are similar in genetic makeup to non-twin siblings at different ages). For example, previous work observed similar magnitudes in correlations between young adult DZ twins' and non-twin siblings' subjective sleep (e.g., quality, duration, daytime dysfunction) (Barclay et al., 2010), which may be even greater during early adolescence and when using actigraphy-measured sleep. This study focused on one time point and, therefore, further research is needed to examine how sleep concordance between parent-youth and siblings might change as youth enter the stage of adolescence, a developmental stage characterized by numerous environmentally- and biologically-driven changes in sleep (Becker et al., 2015; Owens, 2014). While multiple objective indicators of sleep were examined, the current study did not examine self-reported sleep measures or sleep problems, which may aid in our understanding of whether parents and children perceive that their sleep patterns align with each other, and whether this perceived concordance is benefitting their sleep health. Further, we controlled for key demographic variables in our analyses. However, future work should examine both between and within-group differences as opposed to just controlling for such demographic indicators as it may be important to examine concordance among separate racial groups, by SES level, and type of geographic location (e.g., rural, urban; Breitenstein et al., 2019; Rea-Sandin et al., 2022; Rojo-Wissar et al., 2020). Lastly, future research may seek to investigate other contextual factors besides room-sharing as potential moderators of concordance, including school vs. vacation days, previous-day experiences, and characteristics of the home environment (Fuligni et al., 2015; Sasser & Oshri, 2023).

Overall, the current study results provide support for interventions at the family-level targeting sleep hygiene. Given identified socioeconomic disparities in sleep health and research showing that children from lower SES backgrounds are more likely to share rooms (Doane et al., 2019; Milan et al., 2007), clinicians may want to provide information for such populations about the potential influence of room sharing (i.e., children that share rooms have similar sleep patterns and likely affect each other's sleep). Such information could include resources for room-sharing families to help promote quality sleep hygiene practices. Specifically, research has found that children who share rooms are more likely to experience sleep anxiety, night wakings, and daytime sleepiness (Li et al., 2008). As such, recommendations should include regular sleep-wake routines (i.e., consistent waking and bedtime), limited access to electronics in the bedroom after bedtime, and reductions in sleep-disruptive evening behaviors like caffeine use or exercise immediately before bed (Buxton et al., 2015). Continued focus on quality sleep environments, not just for youth, but for families as a whole, may be helpful in improving sleep outcomes. Developing healthy sleep habits during early adolescence can help prevent poorer sleep following the biological shift in circadian rhythms and changing environmental demands and stressors during adolescence.

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Table 10. *Descriptives and Correlations Between Parent-Child and Sibling Sleep*

	Siblings (Twins)			Parent-Child
Correlations	MZ	DZ-ss	DZ-os	
Sleep Duration	.72***	.33**	.23*	.15**
Sleep Efficiency	.63***	.42***	.40***	.08
Sleep Midpoint	.91***	.79***	.90***	.35***
Sleep Latency	.74***	.40***	.40***	.27***
Means (SD)	Twin 1	Twin 2		Parents
Sleep Duration	7.83 (.74)	7.95 (.67)		6.80 (1.07)
Sleep Efficiency	91.06 (5.70)	91.34 (5.52)		92.00 (7.26)
Sleep Midpoint	2.56 (.91)	2.54 (.91)		2.83 (1.12)
Sleep Latency	20.11 (15.27)	20.18 (15.14)		17.25 (14.14)

Notes. In the Siblings (Twins) column, co-twin correlations are presented, separated by zygosity type. MZ: monozygotic (n = 86 dyads); DZ-ss: dizygotic same sex (n = 108 dyads); DZ-os: dizygotic opposite sex (n = 93 dyads). In the Parent-Child column, correlations between parents and offspring are presented (e.g., twins clustered within families). Grand means are also provided for Twin 1, Twin 2, and Parents. Twin 1 and 2 were randomly assigned.
*$p < .05$, **$p < .01$, ***$p < .001$

Table 11. *Two-Level Multilevel Models Examining Daily and Average Parent-Child Sleep Concordance*

	Child Sleep Duration		Child Sleep Efficiency	
Parent → Child Sleep	Est. (SE)	*p-value*	Est. (SE)	*p-value*
Intercept (γ_{00})	7.56 (.13)	<.001***	91.08 (1.1)	<.001***
Level 2 (average)				
Parent Sleep (γ_{01})	**.08 (.03)**	**.006***	.05 (.05)	.27
Vacation (γ_{02})	.04 (.06)	.54	-.27 (.58)	.64
Family SES (γ_{03})	.04 (.04)	.31	.41 (.39)	.28
Child Age (γ_{04})	-.17 (.04)	<.001***	.35 (.29)	.23
Child Sex (γ_{05})	.11 (.06)	.087†	.72 (.52)	.16
Child BMI (γ_{06})	-.04 (.008)	<.001**	-.22 (.08)	.003**
Child Hispanic (γ_{07})	.28 (.14)	.045*	.91 (1.08)	.40
Child White (γ_{08})	.34 (.13)	.010*	-.78 (1.07)	.47
Child Pubertal Status (γ_{09})	.03 (.04)	.46	.59 (.36)	.10
Level 1 (daily)				
Parent Sleep (γ_{10})	**.11 (.03)**	**<.001***	-.001 (.02)	.95
Weekend (γ_{20})	-.03 (.05)	.54	.15 (.25)	.54
	Parent Sleep Duration		Parent Sleep Efficiency	
Child → Parent Sleep	Est. (SE)	*p-value*	Est. (SE)	*p-value*
Intercept (γ_{00})	5.79 (.35)	<.001***	86.57 (2.5)	<.001***
Level 2 (average)				
Child Sleep (γ_{01})	.12 (.09)	.15	.07 (.07)	.27
Vacation (γ_{02})	-.01 (.15)	.95	-.63 (.97)	.52
Family SES (γ_{03})	.05 (.10)	.64	1.49 (.60)	.013*
Parent Age (γ_{04})	-.02 (.01)	.10	-.23 (.09)	.014*
Parent Sex (γ_{05})	.68 (.29)	.02*	6.20 (2.39)	.009*
Parent BMI (γ_{06})	-.04 (.01)	.001**	-.23 (.07)	.001**
Parent Hispanic (γ_{07})	.13 (.24)	.58	-.13 (1.42)	.93
Parent White (γ_{08})	.36 (.22)	.10	-.29 (1.32)	.83
Level 1 (daily)				
Child Sleep (γ_{10})	**.14 (.04)**	**<.001***	.00 (.02)	.99
Weekend (γ_{20})	.40 (.08)	<.001***	.29 (.38)	.45

Notes. Unstandardized estimates are reported. N = 3,779 days nested within 287 families. Cluster error command was used to account for twins within families. Vacation: 1 = study week occurred during a vacation period, 0 = study week was not during a vacation period; Sex: 1 = female, 0 = male; Hispanic: 1 = Hispanic, 0 = race other than Hispanic; White: 1 = White, 0 = race other than White. *p < .05, **p < .01, ***p < .001

Table 11 (continued). *Two-Level Multilevel Models Examining Daily and Average Parent-Child Sleep Concordance*

	Child Sleep Midpoint		Child Sleep Latency	
Parent → Child Sleep	Est. (SE)	*p-value*	Est. (SE)	*p-value*
Intercept (γ_{00})	2.06 (.15)	<.001***	19.71 (2.4)	<.001***
Level 2 (average)				
Parent Sleep (γ_{01})	**.28 (.05)**	**<.001*** **	**.32 (.06)**	**<.001*** **
Vacation (γ_{02})	.63 (.11)	<.001***	-.97 (1.68)	.57
Family SES (γ_{03})	-.20 (.06)	.002**	-1.48 (.89)	.098†
Child Age (γ_{04})	.22 (.05)	<.001***	.02 (.72)	.98
Child Sex (γ_{05})	-.06 (.07)	.41	-1.14 (1.34)	.39
Child BMI (γ_{06})	-.02 (.01)	.068†	.17 (.21)	.43
Child Hispanic (γ_{07})	.22 (.17)	.18	.15 (2.65)	.96
Child White (γ_{08})	.15 (.16)	.33	.93 (2.48)	.71
Child Pubertal Status (γ_{09})	.06 (.04)	.30	.16 (.87)	.86
Level 1 (daily)				
Parent Sleep (γ_{10})	**.23 (.04)**	**<.001*** **	.05 (.03)	.082†
Weekend (γ_{20})	.58 (.05)	<.001***	.19 (.81)	.82
	Parent Sleep Midpoint		Parent Sleep Latency	
Child → Parent Sleep	Est. (SE)	*p-value*	Est. (SE)	*p-value*
Intercept (γ_{00})	2.15 (.32)	<.001***	19.20 (5.3)	<.001***
Level 2 (average)				
Child Sleep (γ_{01})	**.50 (.09)**	**<.001*** **	**.23 (.05)**	**<.001*** **
Vacation (γ_{02})	-.36 (.15)	.013*	4.70 (1.87)	.012*
Family SES (γ_{03})	.12 (.09)	.20	1.65 (1.02)	.11
Parent Age (γ_{04})	-.02 (.01)	.11	-.14 (.16)	.38
Parent Sex (γ_{05})	.42 (.30)	.16	-2.02 (4.52)	.66
Parent BMI (γ_{06})	.02 (.01)	.02*	.05 (.12)	.66
Parent Hispanic (γ_{07})	.27 (.22)	.23	-3.73 (2.79)	.18
Parent White (γ_{08})	.21 (.19)	.27	-2.34 (2.78)	.40
Level 1 (daily)				
Child Sleep (γ_{10})	**.38 (.05)**	**<.001*** **	.05 (.03)	.063†
Weekend (γ_{20})	.56 (.07)	<.001***	1.40 (.94)	.14

Notes. Unstandardized estimates are reported. *N* = 3,779 days nested within 287 families. Cluster error command was used to account for twins within families. Vacation: 1 = study week occurred during a vacation period, 0 = study week was not during a vacation period; Sex: 1 = female, 0 = male; Hispanic: 1 = Hispanic, 0 = race other than Hispanic; White: 1 = White, 0 = race other than White. **p* < .05, ***p* < .01, ****p* < .001

Table 12. *Two-Level Multilevel Models Examining Daily and Average Sibling Sleep Concordance*

	Twin 2 Sleep → Twin 1 Sleep		
	MZ	DZ-ss	DZ-os
Sleep Duration			
Intercept (γ_{00})	7.49 (.21)***	7.54 (.34)***	7.97 (.19)***
Level 2 (average)			
Parent Sleep (γ_{01})	.05 (.06)	.02 (.06)	.13 (.08)
Twin Sleep (γ_{02})	**.64 (.09)*****$_{a,b}$	**.30 (.12)***$_{a}$	.10 (.16)$_{b}$
Vacation (γ_{03})	.06 (.13)	-.02 (.14)	-.03 (.17)
Family SES (γ_{04})	.08 (.05)	.04 (.11)	.05 (.10)
Age (γ_{05})	-.05 (.06)	-.12 (.08)	-.11 (.10)
Sex (γ_{06})	.16 (.11)	-.14 (.14)	.18 (.16)
BMI (γ_{07})	-.02 (.02)	-.01 (.02)	-.03 (.02)*
Pubertal Status (γ_{08})	-.17 (.10)†	-.06 (.10)	.05 (.10)
Hispanic (γ_{09})	.32 (.22)	.32 (.38)	-.19 (.21)
White (γ_{010})	.26 (.21)	.39 (.35)	-.14 (.21)
Level 1 (daily)			
Parent Sleep (γ_{10})	.07 (.04)†	-.01 (.05)	.05 (.05)
Twin Sleep (γ_{20})	**.51 (.06)*****	**.45 (.05)*****	**.40 (.07)*****
Weekend (γ_{30})	-.15 (.08)†	.08 (.10)	.01 (.10)
Sleep Efficiency			
Intercept (γ_{00})	91.29 (1.5)***	89.27 (2.6)***	91.65 (1.3)***
Level 2 (average)			
Parent Sleep (γ_{01})	.03 (.09)	.02 (.08)	.06 (.08)
Twin Sleep (γ_{02})	**.70 (.08)*****$_{a,b}$	**.40 (.11)*****$_{a}$	**.34 (.12)****$_{b}$
Vacation (γ_{03})	-1.74 (1.13)	-.76 (1.19)	-1.12 (1.19)
Family SES (γ_{04})	.34 (.65)	.32 (.85)	-.51 (.89)
Age (γ_{05})	.70 (.44)†	-.20 (.54)	.90 (.62)
Sex (γ_{06})	.78 (1.02)	-1.10 (1.11)	1.97 (1.19)†
BMI (γ_{07})	-.17 (.15)	-.05 (.11)	-.13 (.15)
Pubertal Status (γ_{08})	-2.01 (.98)*	.61 (.75)	.30 (.82)
Hispanic (γ_{09})	.20 (1.68)	2.96 (2.75)	.87 (1.57)
White (γ_{010})	-.35 (1.47)	1.62 (2.71)	-1.80 (1.55)
Level 1 (daily)			
Parent Sleep (γ_{10})	.02 (.06)	.03 (.05)	.01 (.04)
Twin Sleep (γ_{20})	**.32 (.06)*****	**.26 (.05)*****	**.20 (.09)***
Weekend (γ_{30})	-.59 (.51)	.62 (.51)	.31 (.58)

Notes. MZ: monozygotic (*N*=621 days nested within 86 dyads); DZ-ss: dizygotic same sex (*N*=776 days nested within 108 dyads); DZ-os: dizygotic opposite sex (*N*=667 days nested within 93 dyads). Unstandardized estimates are reported with standard errors in parentheses (Est. (SE)). Effects that share subscripts are significantly different from one another ($p < .05$). $^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 12 (continued). *Two-Level Multilevel Models Examining Daily and Average Sibling Sleep Concordance*

	Twin 1 Sleep → Twin 2 Sleep		
	MZ	DZ-ss	DZ-os
Sleep Duration			
Intercept (γ_{00})	7.93 (.21)***	7.70 (.22)***	7.42 (.28)***
Level 2 (average)			
Parent Sleep (γ_{01})	-.04 (.06)	.10 (.06)	.14 (.06)*
Twin Sleep (γ_{02})	**.61 (.10)***$_{a,b}$**	**.26 (.08)**$_{a}$**	.09 (.13)$_{b}$
Vacation (γ_{03})	-.06 (.12)	.08 (.12)	.05 (.14)
Family SES (γ_{04})	-.04 (.06)	.02 (.07)	-.05 (.09)
Age (γ_{05})	-.09 (.06)	-.15 (.07)*	-.03 (.09)
Sex (γ_{06})	-.04 (.12)	.28 (.12)*	.22 (.16)
BMI (γ_{07})	-.02 (.02)	-.05 (.01)***	-.05 (.03)†
Pubertal Status (γ_{08})	.15 (.10)	.18 (.06)**	-.08 (.14)
Hispanic (γ_{09})	.03 (.21)	.04 (.23)	.36 (.28)
White (γ_{010})	.13 (.21)	.11 (.22)	.50 (.26)†
Level 1 (daily)			
Parent Sleep (γ_{10})	.14 (.04)***	.04 (.04)	.09 (.04)*
Twin Sleep (γ_{20})	**.47 (.07)*****	**.47 (.05)*****	**.40 (.06)*****
Weekend (γ_{30})	-.12 (.09)	-.02 (.09)	.07 (.09)
Sleep Efficiency			
Intercept (γ_{00})	91.37 (2.3)***	88.90 (3.0)***	91.51 (1.7)***
Level 2 (average)			
Parent Sleep (γ_{01})	-.06 (.08)	.09 (.11)	.02 (.06)
Twin Sleep (γ_{02})	**.61 (.11)***$_{a}$**	**.39 (.08)*****	**.29 (.11)**$_{a}$**
Vacation (γ_{03})	1.17 (.93)	.01 (.98)	.46 (.99)
Family SES (γ_{04})	-.46 (.65)	.13 (.67)	.79 (.63)
Age (γ_{05})	-.68 (.43)	-.32 (.52)	1.17 (.71)
Sex (γ_{06})	-.14 .97)	1.58 (.91)†	1.73 (1.05)†
BMI (γ_{07})	.03 (.17)	-.26 (.12)*	-.35 (.18)†
Pubertal Status (γ_{08})	2.10 (.69)**	1.20 (.47)*	.02 (.85)
Hispanic (γ_{09})	.75 (1.67)	1.13 (3.18)	-1.09 (1.65)
White (γ_{010})	.14 (1.68)	1.29 (3.15)	-.64 (1.49)
Level 1 (daily)			
Parent Sleep (γ_{10})	-.04 (.04)	-.02 (.07)	.003 (.04)
Twin Sleep (γ_{20})	**.26 (.05)*****	**.29 (.06)*****	**.17 (.07)***
Weekend (γ_{30})	-.10 (.53)	-.63 (.53)	.97 (.52)†

Notes. MZ: monozygotic (*N*=621 days nested within 86 dyads); DZ-ss: dizygotic same sex (*N*=776 days nested within 108 dyads); DZ-os: dizygotic opposite sex (*N*=667 days nested within 93 dyads). Unstandardized estimates are reported with standard errors in parentheses (Est. (SE)). Effects that share subscripts are significantly different from one another ($p < .05$). $^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 12 (continued). *Two-Level Multilevel Models Examining Daily and Average Sibling Sleep Concordance*

	Twin 2 Sleep → Twin 1 Sleep		
	MZ	DZ-ss	DZ-os
Sleep Midpoint			
Intercept (γ_{00})	2.37 (.11)***	2.29 (.25)***	2.36 (.11)***
Level 2 (average)			
Parent Sleep (γ_{01})	.23 (.11)*	.08 (.05)	-.06 (.05)
Twin Sleep (γ_{02})	**.82 (.12)*****	**.67 (.08)*****	**.84 (.07)*****
Vacation (γ_{03})	.33 (.14)*	.33 (.12)**	.24 (.11)*
Family SES (γ_{04})	-.002 (.04)	-.18 (.08)*	.06 (.06)
Age (γ_{05})	-.04 (.03)	.06 (.08)	-.06 (.06)
Sex (γ_{06})	-.24 (.09)**	-.004 (.10)	.03 (.11)
BMI (γ_{07})	-.01 (.01)	-.04 (.01)**	.03 (.01)*
Pubertal Status (γ_{08})	.09 (.04)*	.12 (.09)	-.06 (.06)
Hispanic (γ_{09})	.05 (.11)	.004 (.27)	.12 (.13)
White (γ_{010})	.11 (.10)	.28 (.26)	.004 (.12)
Level 1 (daily)			
Parent Sleep (γ_{10})	.04 (.03)	.07 (.03)**	.03 (.03)
Twin Sleep (γ_{20})	**.81 (.04)***$_{a}$**	**.73 (.05)***$_{b}$**	**.52 (.06)***$_{a,b}$**
Weekend (γ_{30})	.12 (.05)*	.08 (.06)	.37 (.07)***
Sleep Latency			
Intercept (γ_{00})	21.77 (2.8)***	5.96 (4.6)	20.83 (3.5)***
Level 2 (average)			
Parent Sleep (γ_{01})	-.06 (.10)	-.06 (.10)	-.18 (.23)
Twin Sleep (γ_{02})	**.71 (.10)***$_{a}$**	**.46 (.08)***$_{a}$**	**.52 (.18)****
Vacation (γ_{03})	4.86 (2.17)*	-1.09 (2.57)	.75 (4.45)
Family SES (γ_{04})	-1.23 (.94)	-.63 (1.40)	.86 (1.68)
Age (γ_{05})	-2.10 (.88)*	-2.44 (1.14)*	-.96 (1.47)
Sex (γ_{06})	-3.19 (1.90)†	2.19 (2.38)	-1.94 (3.59)
BMI (γ_{07})	.16 (.42)	-.003 (.25)	.23 (.37)
Pubertal Status (γ_{08})	1.06 (1.44)	2.17 (1.28)†	-.11 (1.99)
Hispanic (γ_{09})	-3.79 (2.33)	9.98 (4.77)*	2.74 (4.70)
White (γ_{010})	-1.89 (2.94)	13.74 (4.77)**	-2.09 (4.02)
Level 1 (daily)			
Parent Sleep (γ_{10})	.03 (.04)	.07 (.09)	.09 (.08)
Twin Sleep (γ_{20})	**.39 (.08)***$_{a}$**	**.20 (.06)****	**.17 (.07)*$_{a}$**
Weekend (γ_{30})	.25 (1.54)	-1.37 (1.60)	-.44 (1.60)

Notes. MZ: monozygotic (N=621 days nested within 86 dyads); DZ-ss: dizygotic same sex (N=776 days nested within 108 dyads); DZ-os: dizygotic opposite sex (N=667 days nested within 93 dyads). Unstandardized estimates are reported with standard errors in parentheses (i.e., Est. (SE)). Effects that share subscripts are significantly different from one another (p < .05). $^{\dagger}p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$

Table 12 (continued). *Two-Level Multilevel Models Examining Daily and Average Sibling Sleep Concordance*

	Twin 1 Sleep → Twin 2 Sleep		
	MZ	DZ-ss	DZ-os
Sleep Midpoint			
Intercept (γ_{00})	2.38 (.09)***	2.73 (.32)***	2.31 (.11)***
Level 2 (average)			
Parent Sleep (γ_{01})	-.02 (.06)	.02 (.05)	.08 (.04)†
Twin Sleep (γ_{02})	**.87 (.08)*** **	**.81 (.09)*** **	**.86 (.06)*** **
Vacation (γ_{03})	-.10 (.10)	.04 (.12)	.15 (.11)
Family SES (γ_{04})	-.06 (.07)	-.01 (.07)	-.13 (.06)*
Age (γ_{05})	.05 (.05)	.12 (.08)	.09 (.07)
Sex (γ_{06})	.16 (.07)*	-.02 (.10)	.12 (.09)
BMI (γ_{07})	-.01 (.01)	.002 (.01)	-.02 (.01)
Pubertal Status (γ_{08})	.04 (.06)	-.24 (.08)**	.17 (.06)**
Hispanic (γ_{09})	.02 (.10)	-.08 (.32)	.11 (.13)
White (γ_{010})	-.10 (.09)	-.26 (.31)	.18 (.12)
Level 1 (daily)			
Parent Sleep (γ_{10})	.13 (.03)***	.02 (.03)	.15 (.05)**
Twin Sleep (γ_{20})	**.73 (.06)*** **	**.76 (.05)*** **	**.64 (.06)*** **
Weekend (γ_{30})	.12 (.05)**	.18 (.06)**	.24 (.08)**
Sleep Latency			
Intercept (γ_{00})	15.99 (2.8)***	29.47 (6.8)***	26.49 (4.8)***
Level 2 (average)			
Parent Sleep (γ_{01})	.24 (.09)**	.34 (.10)**	.53 (.14)***
Twin Sleep (γ_{02})	**.64 (.07)***$_a$**	**.39 (.12)*** *	**.29 (.08)***$_a$**
Vacation (γ_{03})	-5.81 (2.05)**	-.14 (2.37)	-.02 (2.59)
Family SES (γ_{04})	-.50 (1.00)	.30 (1.62)	-2.25 (1.27)†
Age (γ_{05})	2.13 (1.24)†	.50 (1.28)	-.70 (1.33)
Sex (γ_{06})	-.33 (2.18)	-1.51 (2.81)	-2.65 (2.49)
BMI (γ_{07})	.70 (.34)*	-.07 (.20)	.90 (.58)
Pubertal Status (γ_{08})	-2.31 (1.37)†	.38 (.26)	2.54 (2.22)
Hispanic (γ_{09})	6.09 (2.73)*	-8.22 (6.76)	-5.57 (4.95)
White (γ_{010})	7.06 (2.62)**	-12.43 (6.39)†	-3.57 (4.72)
Level 1 (daily)			
Parent Sleep (γ_{10})	-.03 (.05)	.07 (.07)	.04 (.09)
Twin Sleep (γ_{20})	**.39 (.09)*** **	**.22 (.08)*** *	**.19 (.08)***
Weekend (γ_{30})	1.60 (1.85)	.58 (1.71)	-.51 (1.88)

Notes. MZ: monozygotic (*N*=621 days nested within 86 dyads); DZ-ss: dizygotic same sex (*N*=776 days nested within 108 dyads); DZ-os: dizygotic opposite sex (*N*=667 days nested within 93 dyads). Unstandardized estimates are reported with standard errors in parentheses (i.e., Est. (SE)). Effects that share subscripts are significantly different from one another ($p < .05$). $^{\dagger}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

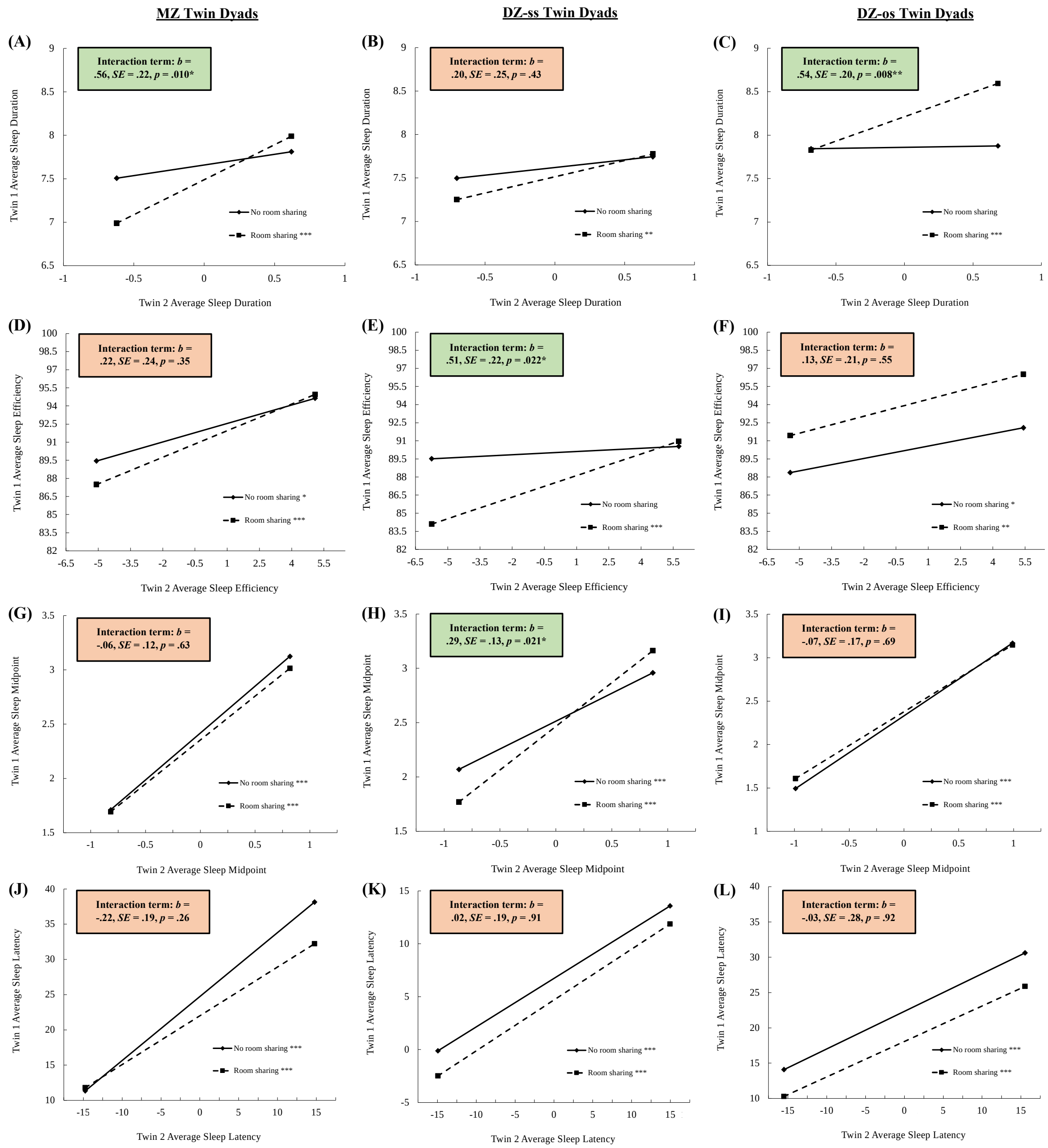

Figure 5. Room-sharing moderates concordance between co-twins’ average sleep. *Note.* Orange boxes indicate nonsignificant moderation; green boxes indicate significant moderation. Twin 2 sleep parameters are centered at the mean (i.e., zero) and plotted ± 1 SD from the grand mean.

CHAPTER 5

IMMERSIVE DISCUSSION

This dissertation combined three published papers focused on the study of adolescent sleep within a family context, including daily interactions with parents and siblings, daily sleep patterns among multiple family members, and how aspects of the broader family context (e.g., dynamics, structure) modified these relationships. These papers were written in recognition of the drastic changes in sleep that occur during adolescence (i.e., reductions in sleep duration and quality, delay in bed and wake times), which have been deemed an “epidemic” and serious public health concern (Owens et al., 2014). Further, these papers were developed in response to calls for research focused on the study of youth and adolescent sleep within a family context (Dahl & El-Sheikh, 2007; El-Sheikh & Kelly, 2017). This dissertation was informed by several developmental theories, including family systems theory (Cox & Paley, 1997), ecological and contextual models of youth development (Becker et al., 2015; Bronfenbrenner, 1979, 1992), and perspectives of attachment and security (Cummings & Davies, 1996; Dahl, 1996), each centered around the notion that adolescent development, including sleep, cannot be fully understood without considering the immediate environment in which youth are nested, as well as the interplay between family-level factors in the promotion of adolescent sleep. In this final chapter, I will briefly summarize findings from each of the studies and discuss notable similarities, takeaways, and implications for developmental science and practice.

Summary and Integration of Studies

The first study (Sasser et al., 2021b) examined the link between spending time with family (“family connection”) and actigraphy-measured sleep duration and efficiency at both the daily (i.e., within-person) and average (i.e., between-person) level in a sample of older Latinx adolescents (ages 17-19). In general, findings support the promotive role of family connection for adolescent sleep, particularly in positive family environments. At the day-level, youth who spent more time with siblings *than usual* exhibited longer sleep durations on that same night. Further, adolescents who spent greater overall time with their parents (i.e., across the study week) also had longer sleep durations, on average. The latter finding was particularly true for youth in family contexts marked by *positive communication* (e.g., satisfaction and comfort in sharing ideas, feelings, and information), such that greater parent connection was especially promotive in these contexts. In contrast, for youth who reported *negative family communication* and *higher family obligation* (i.e., responsibility to provide support to other family members), greater overall time spent with siblings was linked with *lower* sleep duration and efficiency, respectively. Overall, these results highlight the positive role of family connection on sleep in a sample of Latinx late adolescents, and highlight the importance of family dynamics and values as key moderators that may determine whether daily family interactions are helpful or harmful for youth sleep.

The second study (Sasser & Oshri, 2023) investigated daily and average concordance between parent and adolescent (ages 12-14) actigraphy-measured sleep duration, efficiency, and midpoint time, as well as the moderating role of family context (e.g., adverse parenting, family functioning). Findings revealed daily relations between parent and adolescent sleep duration and midpoint time, and average (i.e., mean-level) relations in sleep midpoint time only. Sleep efficiency was not significantly linked across parents and youth at the daily or average level. Additionally, we found that concordance patterns varied across family contexts. In conditions of high adverse parenting (e.g., emotional abuse, neglect, corporal punishment), parents and youth exhibited *discordance* in overall sleep duration and efficiency (e.g., higher duration/efficiency for parents was linked with lower duration/efficiency for youth). In contrast, family flexibility (i.e., ability to adapt cooperatively to change) was promotive of *greater* daily concordance in sleep duration and midpoint, such that daily fluctuations in sleep hours (i.e., more/less than usual) and timing (i.e., earlier/later than usual) tended to co-occur across parent and adolescent dyads in contexts of high family adaptability. These results add to the growing body of work examining concordance between parent and youth sleep (Fuligni et al., 2015; Kouros & El-Sheikh, 2017) and shed light on characteristics of the family context that may facilitate coordination in sleep behaviors. This study directly informed the research questions and hypotheses tested in Study 3, which sought to understand within-family relations in sleep across parent-youth *and* sibling dyads.

The third study (Sasser et al., 2023a) examined daily and average concordance in parent-youth and siblings actigraphy-measured sleep duration, efficiency, midpoint time, and latency in a large, ethnically/racially diverse sample of early adolescent twins and their primary caregivers. This study filled several gaps in the literature, as it was the first known study to (1) estimate daily coordination among siblings' sleep patterns, (2) examine actigraphy-measured sleep latency as an indicator of concordance across family members, (3) test sleeping arrangements as a moderator of sleep concordance among adolescent siblings, and (4) examine sleep concordance of parent-youth *and* sibling dyads within the same study (i.e., triad). Results from this study demonstrated significant concordance between parent and youth sleep at the daily (sleep duration, sleep midpoint) and average level (sleep duration, sleep midpoint, sleep latency). Siblings exhibited both daily and average concordance across *all* measured sleep indicators (i.e., sleep duration, sleep efficiency, sleep midpoint, sleep latency). Sibling sleep concordance tended to be stronger for monozygotic (compared to dizygotic) twins, especially at the average-level. Lastly, the positive relations between siblings' overall sleep estimates were particularly pronounced among co-twins who shared a room, pointing to the importance of the sleep environment in family concordance patterns.

The Influence of Family Members on Adolescent Sleep

Differential Effects of Parents and Siblings

The studies in this dissertation collectively highlight the influence that family members can have on adolescent sleep patterns. Findings from Study 1 suggest that merely spending time with parents and siblings can have a positive impact on daily and overall sleep duration among older Latinx adolescents (Sasser et al., 2021b). Study 1 also found that these effects varied across family members, such that siblings had a more proximal influence on adolescent sleep (i.e., daily fluctuations in sleep hours varied as a function of time spent with siblings), whereas relations between parent connection and sleep were evident only at the between-person level (i.e., youth who spent more time with their parents tended to sleep longer on average). The third study had similar findings, such that daily patterns in sleep duration, efficiency, midpoint, and latency tended to co-occur within sibling pairs (i.e., daily coordination in sleep), whereas only sleep duration and midpoint time were related at the day-level within parent-youth dyads (Sasser et al., 2023a). Taken together, these results suggest that siblings may play a key role in adolescents' sleep at the *day-level* (i.e., within-person). Future studies should expand this line of work by further exploring how *daily* sibling interactions, as well as the contexts in which these interactions occur, influence youth health and well-being during this period. Indeed, sibling relationships are complex during adolescence, and daily exchanges can vary widely in emotional intensity and valence (e.g., positive vs. negative interactions, moments of rivalry vs. companionship; Feinberg et al., 2012; Howe et al., 2011; McHale et al., 2012). Thus, limiting investigations of sibling relationships to mean-level (between-person) comparisons may overlook important aspects of the sibling relationship that are dynamic and fluctuate from day-to-day. Similarly, measuring the *quality* of the sibling relationship, as well as other characteristics (e.g., age, gender differences), may help elucidate the *type* of siblings for whom these daily processes are particularly evident.

Coordination in Sleep Among Family Members

Results from Studies 2 and 3 highlight the interdependence of family member's sleep patterns on one another (i.e., daily and average concordance between parent-youth and sibling sleep). Regarding parent-youth concordance, both studies found significant relations between parent and adolescent (1) daily sleep duration, (2) daily sleep midpoint time, and (3) average sleep midpoint time. The observation that duration and midpoint were consistently related between parents and youth across two samples that varied in developmental stage (e.g., early vs. middle adolescence) and geographic location (e.g., southwestern vs. southeastern U.S., primarily rural vs. suburban/urban) may shed light on aspects of sleep that are most coordinated within the family unit. Indeed, these results are consistent with previous work that found daily concordance between parent and youth sleep duration and bed and wake times (Fuligni et al., 2015; Kouros & El-Sheikh, 2017). This consistency in findings may have important implications for sleep interventions with regards to malleable and targetable sleep indices within the family (discussed later in this chapter).

One plausible explanation for the observed concordance in sleep duration and midpoint may be attributed to how both sleep parameters are rooted in *time* (i.e., sleep midpoint is the median between bed and wake time, sleep duration is the amount of true sleep time from sleep onset to offset). Indicators of sleep timing, such as sleep midpoint, have been shown to be driven largely by environmental influences in late childhood and adolescence (Breitenstein et al., 2021; Sasser et al., 2023a). Thus, parents may be playing a more active role in the day-to-day lives and sleep contexts of adolescents, which in turn promotes greater concordance. For example, youth in early-to-middle adolescence often still have their sleep schedules monitored by their parents, and parent-set bedtimes have been linked with earlier bedtimes and longer sleep duration among youth (Short et al., 2011). Further, youth of this age are still reliant on their parents in several domains (e.g., transportation, resources, finances) and spend considerable time with each other during the day (e.g., connecting, sharing meals), which may encourage greater coordination in sleep habits and schedules (Adam et al., 2007). Accordingly, concordance in sleep duration and timing may be the result of both parental supervision and rule-setting, as well as daily involvement and presence in youths' lives, thus highlighting the enduring role of parents for adolescent health and well-being beyond childhood.

Findings from Study 3 added meaningful context by examining concordance in parent-youth *and* sibling sleep behaviors. Compared to parent-adolescent dyads, sibling concordance was evident across all sleep indices, at both the daily and average level, with notably larger effect sizes. Although this is not surprising, due to the various biological and environmental factors hypothesized to promote greater synchrony between co-twins' sleep (e.g., shared genetic makeup, shared routines/environments, developmental stage), this was the first known study to examine sleep concordance among these two dyads within the same study. As noted above, one explanation for greater sleep concordance among twins may be due to genetic factors, as we found that monozygotic twins (who share 100% of their genetics) tended to demonstrate stronger relations in sleep as opposed to dizygotic twins (who share 50% of their genetics) and parent-youth dyads (who also share 50% of genetics). However, our results also lend support for the role of the shared and non-shared environment in sibling concordance, evidenced by relations between dizygotic twins' sleep that were comparable in size and stronger than parent-youth dyads, as well as the moderating role of the sleep environment (i.e., room-sharing) in sibling concordance patterns. Importantly, from a developmental perspective, similarities in siblings' sleep habits are likely driven by the distinct changes that occur in sleep during adolescence. Specifically, siblings who are the same age (twins) or near the same age (non-twin siblings) undergo similar biologically-driven shifts in sleep during adolescence (i.e., sleep phase delay) that are not experienced by their parents, and may lead to similar preferences in bed/wake time, comparable durations as a result of later sleep timing and shared contextual demands (e.g., early school start times), and problems with sleep quality that are commonly documented during this time (Gradisar et al., 2011; Owens et al., 2014).

To summarize, this dissertation provides evidence that both the waking *and* sleeping behaviors of family members are intertwined with adolescent sleep habits. Studies 1, 2, and 3 complement a growing body of literature highlighting the role of parents in youth sleep outcomes. Studies 1 and 3 were the first to investigate daily sibling connection and sleep behaviors, respectively, *alongside* parent connection and sleep, allowing a descriptive look at similarities and differences across dyads and highlighting the unique role of both parents *and* siblings in youths' daily lives.

The Role of Family Context and Dynamics

Consistent with family systems theory (Cox & Paley, 1997), each paper in this dissertation considered the extent to which daily family processes (e.g., interactions with family, coordination in sleep habits) varied as a function of the broader family context. In doing so, we highlighted the importance of parenting behaviors, family dynamics and values, and the sleeping environment as factors that can modify daily experiences within the family. A recurring theme that emerged across studies was the influence of positive family environments as contexts that supported healthy adolescent sleep patterns, whereas stressful or unresponsive family environments posed risk for youth sleep health. For example, in Study 1, the promotive effects of spending time with parents were only evident in contexts of positive family communication, but *not* for youth who perceived negative family communication. Similarly, spending more time with siblings was linked with *worse* sleep for adolescents who perceived negative family communication patterns and felt higher levels of obligation to their families. In Study 2, within *negative* family environments (e.g., high levels of adverse parenting), adolescents and parents exhibited a "mismatch" in their sleep patterns, whereas *positive* family functioning (e.g., high levels of family flexibility) corresponded to greater daily coordination in parent and youth sleep habits. Collectively, these studies highlight the importance of considering broader aspects of the family context as critical factors that influence not only the extent, but also the directionality, in which family processes and sleep are interconnected. Future studies can expand this line of work by examining other family-level factors that may moderate these relations (e.g., socioeconomic status, household chaos, family routines and values about sleep) from the perspective of multiple family members (i.e., youth, siblings, parents).

Sleep and Family Life Across Early, Middle, and Late Adolescence

The studies included as part of this dissertation ranged from early (ages 9-12) to late adolescence (ages 17-19), and thus captured distinct stages of the transition into and across adolescence. While family members continue to play a critical role in youths' lives across the entirety of adolescence, developmental changes in parent-child and sibling relationships may explain differences and similarities observed across studies. For example, youth still depend on their parents in many ways during late childhood and early adolescence (e.g., emotional support, daily routines, guidance), but begin striving for greater independence as they further develop into middle and late adolescence (e.g., autonomy seeking, individuation; Wray-Lake et al., 2010). This increased independence may result in greater conflict as parents and adolescents negotiate new roles and structure (Branje et al., 2018), which can include sleep routines. Indeed, we found more consistent evidence for parent-youth sleep concordance in Study 3 (early adolescence) as compared to Study 2 (middle adolescence), particularly for sleep duration. Youth may be seeking greater autonomy in their sleep habits during middle adolescence (Diaz-Morales et al., 2014), which may in turn disrupt concordance in sleep patterns. Increased conflict during middle adolescence may also explain Study 2's findings of *discordance* in parent-youth sleep in contexts of high adverse parenting. Specifically, adverse parenting was assessed through parents' self-reported tactics for resolving parent-child conflict (e.g., frequency of corporal punishment, verbal aggression; Straus et al., 1998) and thus may be reflective of greater conflict during middle adolescence that would further explain this observed discordance in sleep duration and efficiency.

Similarities across studies may also have implications for the study of sleep during adolescence. For example, Studies 1 (late adolescence) and 3 (early adolescence) both found evidence for daily influences of siblings on adolescent sleep, suggesting that siblings may play a more proximal role in youths' lives throughout adolescence. It is not surprising that siblings had strong influences on each other's daily sleep patterns during early adolescence, especially in shared sleeping environments, which are more common in this part of the developmental period (Li et al., 2008). It is notable that daily effects of spending *time* with siblings were evident among *older* adolescence (Study 1), among sibling pairs who may or not have been sharing environments or interacting as often with one another (e.g., on average, this sample reported spending less time with their siblings as opposed to their parents). Thus, although adolescents may be interacting with their siblings less frequently as they near emerging adulthood, these daily exchanges seem to matter, especially on days when they are getting "extra" sibling time. This is consistent with developmental work suggesting that, despite decreased contact with one another, qualities of the sibling relationship may *improve* as youth near and enter emerging adulthood (e.g., greater closeness, lower conflict; Lindell & Campione-Barr, 2017). Overall, these findings attest to the continued centrality of siblings across adolescence, from early to later years. However, additional work is needed to further understand how specific characteristics of the sibling dynamic (e.g., age gap, gender differences, rivalry versus companionship) influence or moderate these relationships across development.

Lastly, common across studies was evidence for family influences on *sleep duration* and *midpoint time*. In Study 1 (late adolescence), spending time with siblings and parents was linked with greater sleep duration (but not efficiency). In Studies 2-3 (early-to-middle adolescence), sleep duration and midpoint time were concordant across both parent-youth and sibling dyads. This similarity suggests that proximal family processes may be particularly related to the total number of hours that youth are sleeping, as well as the timing in which they initiate and discontinue sleep, across early, middle, and late adolescence. These findings are encouraging, as sleep duration and midpoint time are both malleable indicators of sleep health that have been robustly linked with a range of mental and physical health outcomes during adolescence (Lovato & Gradisar, 2014; Zhang et al., 2017). Further, well-documented developmental changes in sleep duration (i.e., linear declines across adolescence; Maslowsky & Ozer, 2014) and timing (i.e., circadian shift to eveningness preference; Owens et al., 2014) label these prime targets for interventions seeking to reduce the negative consequences of these common, predictable shifts in sleep. In practice, the results of this dissertation suggest that intervention programs focused on the family context may be helpful for sleep health *across all stages of adolescence*.

Implications and Future Directions

Implications for Prevention/Intervention

As discussed above, findings of this dissertation can have important implications for the development of family-focused interventions seeking to improve adolescent sleep health. Across studies, sleep duration and sleep midpoint time were highly dependent on the family context, including daily interactions and broader aspects of the environment.

Thus, interventions should seek to develop programs that target sleep health and family functioning by involving *multiple* family members. Indeed, while youth are especially at-risk for sleep problems during adolescence, sleep remains important for health and well-being across the lifespan, and thus can benefit the lives of younger/older siblings and parents in addition to adolescents. Importantly, studies 2-3 suggest that improving the sleep health of one family member may help improve the sleep health of other family members, providing additional support for intervention programs that employ "a rising tide lifts all boats" approach to improving sleep within the family.

Given that sleep duration and midpoint time were particularly modifiable within the family context, interventions targeting *sleep hygiene* may help improve sleep at the family level. Specifically, families with one or more adolescent in the home may benefit from (a) sleep health programs or (b) clinician-provided information and resources that focus on sleep hygiene practices within the family, such as establishing regular bed and wake times, reducing sleep-disruptive activities prior to bedtime (e.g., caffeine, exercise, electronic use), ensuring quality sleep environments (e.g., noise/light levels, cleanliness), and increasing coordination in daily routines as a family (e.g., shared activities, quality time; Adam et al., 2007; Bai et al., 2022). It is important to note that reviews of sleep interventions suggest that while sleep education programs help enhance adolescents' knowledge surrounding sleep, they may not be effective in the improvement of sleep behaviors directly (Blake et al., 2019; Blunden et al., 2012). Thus, involving other family members, especially parents, as part of these efforts may help promote accountability of change in sleep habits and behaviors across the family. This is supported by studies that found parental involvement in sleep interventions helped promote healthy sleep patterns among adolescents, including earlier bedtime, shorter sleep onset latency, longer sleep duration, and increased sleep efficiency (Bonnar et al., 2015; Flint Bretler et al., 2022).

Although sleep quality was less *directly* linked with family processes in this dissertation (apart from Study 3), indicators of sleep quality (e.g., efficiency, latency) remain robust predictors of adolescent health and well-being (Lovato & Gradisar, 2014; Short et al., 2019). For example, recent papers led by our group utilized person-centered approaches to identify unique subgroups of sleep patterns in adolescence (Sasser et al., 2023b; Sasser et al., 2023c; Zhang et al., 2023). We found that youth who struggled primarily with sleep duration (e.g., fewer than 7 hours) tended to be different people than youth who struggled with sleep quality (e.g., latency, nighttime awakenings). Despite this, *both* sleep profiles were linked with higher risk for depression, loneliness, academic difficulties, rule-breaking, and drug and alcohol use. Cognitive-behavioral therapy for insomnia (CBT-I) has shown effectiveness in enhancing sleep quality, duration, and regularity among adolescents and adults (Blake et al., 2019; Chan et al., 2023; Trauer et al., 2015). CBT-I is a structured therapeutic approach that targets various aspects of sleep, including the improvement of sleep-related behaviors such as sleep hygiene and habits, the modification of attitudes and beliefs about sleep, and management of factors in the sleep environment that may disrupt sleep (e.g., stimuli that triggers noise/arousal, limiting time in bed/bedroom for sleep only). Further, CBT-I equips individuals with tools to manage stress, anxiety, and worries that may prevent relaxation and lead to more sleep disturbances. Importantly, CBT-I for adolescents also considers the developmental challenges that contribute to sleep problems during this period (e.g., sleep phase delay;

Moore & Hartman, 2022) and thus may be an optimal method of intervention for youth who are experiencing problems with multiple aspects of sleep.

Finally, in light of findings for the moderating role of family context across all studies, prevention efforts should also seek to target the overall climate and functioning of the family system. For example, programs that work to instill healthy communication among the family unit (e.g., satisfaction and quality communication, establishing and respecting boundaries) can help ensure that daily interactions are having promotive, rather than negative, effects on family member's sleep. Similarly, efforts to enhance families' cooperative response to change (i.e., adaptability) may help promote more synchronous patterns among sleep and other health-promoting behaviors, while also helping to foster family resilience (Walsh, 2021). Beyond family-wide approaches, intervention programs should also consider the unique relationships among members of the family and tailor interventions accordingly. Specifically, programs should work to address developmental "challenges" that are common among certain dyads (e.g., improving conflict resolution between parents and adolescents, promoting support and companionship and reducing rivalry among siblings; Branje et al., 2018; Howe et al., 2011). Targeting both proximal relationships (i.e., between family members) and broader family-level characteristics (e.g., dynamics, culture) can help ensure that the interplay between family processes have health-promoting effects on the sleep of adolescents and their loved ones.

Implications for Future Research

While study-specific implications for future research are provided in Chapters 2-4, it is important to note the collective implications of this dissertation for future research, including areas that may be most promising for the field of developmental psychology, human development and family science, and sleep medicine. First, as mentioned above, there is a need for additional research focusing more closely on sibling relationships, particularly daily interactions, in relation to sleep and other behavioral and mental health outcomes. There are many scholars who have led this important work and continue to advocate for the role of siblings in youth and adolescent development (see Feinberg et al., 2012; McHale et al., 2012; Whitemen et al., 2011). Specific future directions include a greater focus on sleep outcomes, in particular, in relation to sibling relationships, as well as a thorough examination of characteristics that may add breadth and depth to these findings (e.g., number of siblings, age gap/birth order, gender differences, differential treatment from parents, degree of conflict and closeness; McHale et al., 2012; Jensen et al., 2023). For example, in Study 3, concordance was stronger among early adolescent siblings who shared a room, which was more common in siblings of the same sex (MZ: 77%, DZ-ss: 62%) as opposed to opposite sex (DZ-os: 18%). This is just one example of how both developmental stage (i.e., same age) and gender (i.e., same sex) may determine the *environments* in which sleep is occurring. Further, while this collection of studies focused on youth and their primary caregivers, the parents who took part in our studies were predominantly mothers (93-95%). Thus, future studies should seek to increase the representation of other caregivers, recognizing differences that have been observed in previous work examining the influence of both mothers and fathers on youth sleep (e.g., Kouros & El-Sheikh, 2017; McHale et al., 2011). Similarly, and consistent with family systems theory (Cox & Paley, 1997), future research should consider modeling how interactions among *other* family members influence adolescent sleep patterns, including relationships among co-parents or guardians, dynamics among multiple siblings, and the role of extended family members who may also be living within the home or nearby (e.g., grandparents, cousins).

Regarding study design and methodology, there are several exciting directions that future research may decide to go from this point. Firstly, this collection of studies focused largely on how relations between family processes and sleep varied as a function of the family context (i.e., "*for* whom" via statistical moderation). In line with theories of differential susceptibility to context (e.g., certain youth particularly reactive to negative or positive contexts; Ellis et al., 2011), it would be worthwhile for future work to explore how youths' trait characteristics (e.g., temperament, personality) modify the extent to which the family context shapes youth sleep. These findings could be informative for preventive interventions by identifying youth who are especially sensitive to the family environment and thus may benefit the most from family-focused interventions (e.g., Lemery-Chalfant et al., 2018). Further, beyond moderation, future studies may seek to investigate potential mechanisms that explain *why* family members are influencing one another's sleep (i.e., statistical mediation), as well as bidirectional or temporal relations that can specify the direction of effects. For instance, it could be that spending time with family reduces stress at the daily level, which in turn promotes better sleep for youth that night, and in general. Further, while we found that adolescents who spent more time with their siblings during the day slept more that same night, it could also be the case that obtaining longer sleep than usual helps promote more quality interactions with siblings the next day. Lastly, each of the studies utilized a multi-level modeling approach to accommodate the repeated assessment of sleep across multiple days. While this was an optimal strategy for the questions we were asking, future studies may expand on these findings by using more intensive longitudinal designs (e.g., measuring sleep across a longer period, capturing moment-level interactions among family members), measuring concordance longitudinally and testing change over time (e.g., developmental trends in concordance from early-to-late adolescence), or exploring how proximal family processes predict distal socioemotional outcomes (e.g., mental health, academic outcomes, risk-taking). Indeed, no known study has examined the longitudinal *benefits* or *consequences* of family-level sleep concordance. Clarifying the potential outcomes associated with sleep concordance can help bolster arguments for the promotion of synchronized sleep across family members and help us better understand the long-term implications of these patterns for youth and adolescent development.

Conclusion

In conclusion, this dissertation answers and echoes calls for the study of youth and adolescent sleep in a family context (Dahl & El-Sheikh, 2007; El-Sheikh & Kelly, 2017). Through three separate studies spanning early, middle, and late adolescence, we found strong, consistent evidence for connections between family life and sleep, with an emphasis on parents, siblings, and aspects of the family environment (e.g., dynamics, structure). Our findings convey that adolescent sleep is not solely an individual endeavor, but a family affair, and highlights even the most common daily occurrences (e.g., spending time together, sleeping less/more than usual) as underestimated factors that can shape the ways adolescents sleep at night. This dissertation offers valuable insights for researchers, practitioners, and policymakers aligned in the interest of promoting adolescent health and well-being. Specifically, it moves beyond traditional approaches that primarily emphasize individual-level factors as determinants of sleep and underscores the importance of a holistic, family-centered perspective to the study of sleep during adolescence. Continuing to understand how proximal and broader aspects of the family context work together to shape adolescent sleep is essential for the development of interventions and policy-level changes to address the widespread issue of insufficient and inadequate sleep during adolescence. As such, it is my sincere hope that this dissertation will be used to inform future work that carries these findings onward to further illuminate how the family context can be harnessed as a strength in the case of adolescent sleep.

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APPENDIX A

CO-AUTHOR APPROVAL FOR INCLUSION IN DISSERTATION

Co-author approval: All co-authors on the previously published papers included in this dissertation have granted permission to using these studies for this stapled dissertation.