Obtaining a sufficient amount of high quality sleep is crucial for healthy adolescent development (Dahl & Lewin, 2002), but sleep problems are woefully common in adolescence. Daytime sleepiness seems to increase during puberty, even when nighttime sleep duration remains the same (Carskadon, 1990). Changes associated with adolescence (e.g., changes to sleep/wake schedules) may also play a role in sleep problems (Dahl & Lewin, 2002). Sleep problems are even more pronounced among children and adolescents with autism spectrum disorder (ASD) compared with those who are typically developing (TD). ASD is characterized by social deficits and restricted and repetitive patterns of behavior (American Psychiatric Association, 2013), as well as comorbid conditions that may include sleep problems. Epidemiological reviews estimate 50% to 80% of children and adolescents with ASD have one or more chronic sleep problems, compared with 9% to 50% in TD samples (Katz, Malow, & Reynolds, 2016). Older children with ASD experience problems with delayed sleep onset, inconsistently obtain sufficient nighttime sleep, and experience more daytime sleepiness than younger children (Goldman, Richdale, Clemons, & Malow, 2012). In sleep studies, actigraphs (i.e., small electronic wristwatch devices that measure movement) supplement questionnaire-based reports of sleep problems by yielding information about periods of sleep and wake (Katz et al., 2016). Actigraphy has revealed that adolescents with ASD experience longer sleep onset latencies and less sleep efficiency than TD peers (Baker, Richdale, Short, & Gradisar, 2013).

Correlates of Sleep Quality Among TD Adolescents

Among TD children and adolescents, sleep problems (e.g., difficulty falling asleep and daytime sleepiness) have been associated with more symptoms of depression and anxiety and more family stress and conflict (Smaldone, Honig, & Byrne, 2007). The well-being of adolescents who are tired due to poor nocturnal sleep and daytime sleepiness may suffer. In a large survey study of TD adolescents, well-being
was broadly conceptualized as internalizing problems (e.g., depressive symptoms), behavior problems (e.g., difficulties at school), and family stress (Smaldone et al., 2007). Well-being has been associated with inadequate sleep, depressive symptoms, and experiencing family disagreements (Smaldone et al., 2007). The current study examines adolescents’ sleep quality in association with their individual and interpersonal health and daily functioning: their well-being, adaptive behaviors, and quality of family relationships.

Correlates of Sleep Quality Among Adolescents With ASD

Among adolescents with ASD, sleep problems have been associated with greater internalizing and externalizing behaviors (Adams, Matson, & Jang, 2014) and more psychopathologies (e.g., depression and anxiety; Richdale, Baker, Short, & Gradisar, 2014). For example, parent reports about sleep problems, anxiety, and behavior problems in children and adolescents with ASD revealed significant correlations between sleep and anxiety, and sleep and behavior problems; sleep problems and anxiety were strong predictors of behavior problems (Rzepacka, McKenzie, McClure, & Murphy, 2011).

Sleep issues for children and adolescents with ASD are not only troublesome just at night, but also are associated with problems in daytime functioning. No studies to our knowledge have examined links between sleep quality in adolescents with ASD and adaptive functioning during the day. However, such studies with younger children have found that better sleep was associated with the better handling of common daily demands (i.e., adaptive functioning; Sikora, Johnson, Clemons, & Katz, 2012). Adolescents with ASD have more sleep problems than TD peers (Baker et al., 2013), which may compromise adaptive functioning and exacerbate maladaptive behaviors for adolescents with ASD.

Sleep, the Family System, and ASD

As adolescents develop autonomy from their parents, parent–child relationships undergo change. Relative to children, adolescents are more self-reliant and thus at night, they may not signal parents when sleep difficulties arise. Nocturnal sleep problems and sleepiness during the day may fall below parental awareness but still be associated with family relationship quality. Biological changes that occur because of puberty (e.g., changes in sleep; Carskadon, 1990), influence subsystems within the family system, including parent–child and sibling relationships. These normative changes present challenges to the equilibrium of the family system and may be further exacerbated when the adolescent has ASD. Because poor sleep is linked to greater irritability and more negativity in family relationships among TD youth (National Sleep Foundation, 2006), adolescents with ASD may be at risk of difficult social relationships; poor sleep and its correlates may add to social difficulties that are characteristic of ASD. A recent study showed that adolescents with ASD who had more sleep problems and daytime sleepiness reported more discordant peer relationships (Phung & Goldberg, 2017). Because ASD is characterized by challenges in social communication, sleep problems in combination with compromised social functioning may contribute to conflicts and poor communication with family members, although this association has not yet been explored. That it is likely is suggested by the finding that maladaptive behaviors and social impairments in adolescents with ASD are among the strongest predictors of problems in mother–adolescent relationships (Orsmond, Seltzer, Greenberg, & Krauss, 2006). Although individual factors have been linked to poorer family relationship quality, sleep has not yet been examined in this context.

In the current study, we positioned sleep as the independent variable based on past work concerning sleep and individual functioning in children and adolescents with ASD (Adams et al., 2014). In addition, because circadian rhythms (i.e., the organization of sleep and wake periods) typically shift during puberty among TD adolescents (Carskadon, 1990), and children with ASD often have disrupted sleep that continues into adolescence (Goldman et al., 2012), sleep quality was the predictor variable with well-being and family relationships serving as the outcomes.

Assessing Sleep Quality

Sleep research among TD children has used a variety of assessment tools, including sleep questionnaires that are parent- or self-reported (Katz et al., 2016). Adolescents’ own reports about sleep are important to obtain because parents tend to overestimate how much sleep adolescents get on school nights (National Sleep Foundation, 2006). Actigraphy also has become a valuable tool to objectively evaluate activity in healthy and clinical samples (Sadeh & Acebo, 2002). Actigraphy can be conducted in the convenience of the participants’ homes, which allows for more naturalistic settings relative to overnight in a sleep laboratory (Katz et al., 2016). Multimethod and multisource designs are needed for studying sleep in ASD populations (Baker et al., 2013). In this article, parent-, adolescent-reports, and actigraphy were used.

The Current Study

Past research has established the importance of examining sleep quality in relation to well-being, adaptive functioning, and to a lesser extent, family relationships, but gaps include relying solely on maternal reports of sleep and relationship quality, omitting measures of daytime sleepiness, and not
examining links between sleep and well-being, broadly defined. Few studies have examined links between sleep and family relationship quality.

**Study 1 Aims and Hypotheses**

The aims for Study 1 were to examine questionnaire-based reports of: (a) differences between ASD and TD groups in sleep quality, psychological well-being, adaptive and problem behaviors, and mother–adolescent relationship quality; and (b) sleep quality in relation to (1) adolescents’ psychological well-being, adaptive and problem behaviors and (2) mother–adolescent relationship quality, within ASD and TD groups. Based on self- and maternal reports, poorer nocturnal sleep quality and greater daytime sleepiness were expected to be linked to: (a) poorer psychological well-being, lower adaptive behaviors, and greater maladaptive behaviors, and (b) poorer quality family relationships.

**Study 2 Aims and Hypotheses**

Within the Study 2 sample of adolescents with ASD, the aims were to examine actigraph-based reports of sleep quality in relation to: (a) psychological well-being, adaptive and problem behaviors, and (b) quality of relationships with mothers and siblings. Actigraph measures of poorer sleep quality were expected to be linked to: (a) higher levels of depressive symptoms and more internalizing and externalizing behaviors, and (b) poorer relationship quality with mothers and siblings.

**Study 1**

**Method**

**Participants.** Participants recruited for Study 1 were 28 mother–adolescent dyads with adolescents with ASD (12–18 years; $M = 14.64; SD = 1.97; 89.3\%$ male), and 27 mother–adolescent dyads with TD adolescents (12–17 years; $M = 14.59; SD = 1.64; 40.7\%$ male) without a family history of ASD or other major childhood disorder. Because this study required adolescents to complete self-report measures, inclusionary criteria for participants with ASD were the ability to participate in the assess process and an IQ score $\geq 85$ on the *Wechsler Abbreviated Scale of Intelligence—Second Edition* (WASI-II). Participating adolescents were able to read and complete the self-report questionnaire items without parental assistance.

Adolescents with ASD were recruited from ASD-oriented community events and centers. Ethnicity for the ASD group was 45.2% White, 35.5% Multiracial/other, and 19.3% Hispanic/Latino. Adolescents in the TD group were recruited from community organizations and a departmental database. Ethnicity for the TD group was 70.4% White, 18.5% Asian/Asian American, 7.4% Multiracial/other, and 3.7% Hispanic/Latino. Average maternal age for the ASD group was 46.96 years ($SD = 7.47$) and for the TD group was 46.44 years ($SD = 5.32$). Adolescents in the ASD group had parent-reported clinical diagnoses of ASD that were confirmed by the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003). SCQ scores of 12 or higher combined with parent-report clinical diagnoses of ASD are consistent with the gold standard diagnostic assessment as recommended by studies implemented within the Interactive Autism Network (IAN; Daniels et al., 2012). The diagnostic group difference in SCQ score was statistically significant, $t(32.48) = -13.53, p < .01$. None of the TD participants scored above 10 (TD SCQ Total: $M = 2.78, SD = 2.08$) and all but two participants with ASD scored at least 12 (ASD SCQ Total: $M = 20.54, SD = 6.61$). The two participants with ASD who scored less than 12 on the SCQ had scores of 7 and 11. Further diagnostic confirmation was obtained for a subsample of adolescents ($n = 11$) who were available to come to the university for another visit to complete the Autism Diagnostic Observation Schedule (ADOS-2; Lord et al., 2012). The two participants with ASD who scored less than 12 on the SCQ were included in the study after their ASD status was confirmed using the ADOS-2. All 11 adolescents tested with the ADOS-2 met ASD criteria on Module 3 or 4 of the ADOS-2.

**Measures.** Mothers and adolescents completed questionnaires and mothers reported demographic information. Adolescent IQ and observation-based ASD symptomatology were direct assessments.

**WASI-II.** The WASI-II (Wechsler, 2011) is a brief measure of intelligence used to assess verbal comprehension and perceptual reasoning abilities. Full-scale IQ scores were significantly lower in the ASD group ($M = 95.50, SD = 19.05$) compared with TD ($M = 114.15, SD = 10.62$), $t(42.60) = 4.50, p < .01$.

**Lifetime SCQ.** The SCQ (Rutter et al., 2003) is a 40-item parent report tool. Mothers responded “Yes” or “No” to questions that described impairments in social functioning and stereotyped/restrictive behaviors. Responses were summed to yield a total score ranging from 0 to 39; scores of at least 15 indicate possible ASD. A cutoff score of 12 has been used by IAN studies to maximize measure sensitivity (Daniels et al., 2012).

**ADOS-2.** The ADOS-2 (Lord et al., 2012), a semistructured diagnostic tool and the gold standard in the field, was used to confirm ASD in a subsample of participants. The ADOS-2 has demonstrated reliability and validity (Lord et al., 2012).

**The Children’s Sleep Habits Questionnaire (CSHQ).** The CSHQ (Owens, Spirito, & McGuinn, 2000) is a 45-item
parent-report measure designed to assess nocturnal sleep functioning in children and has been used extensively in prior ASD research (Goldman et al., 2012; Rzepecka et al., 2011). It contains items about bedtime behavior, sleep duration, sleep-disordered breathing, and night-wakings. Mothers used a 3-point scale to indicate the frequency of sleep behaviors during a “typical” week. Scores were summed; higher scores indicated poorer nocturnal sleep quality (Cronbach’s α = .77).

The Sleep Habits Survey (SHS). The SHS (Wolfson & Carskadon, 1998) is an adolescent self-report measure that has been successfully used in a prior study of adolescents with ASD (Baker et al., 2013). For the current study, two sections were used: sleep–wake problems and daytime sleepiness. Sleep–wake problems refer to difficulties that participants experienced with nighttime sleep (e.g., had a hard time falling asleep, needed reminders to get up in morning). Ten sleep–wake problem items, each with a 5-point scale, were summed. Higher scores represented greater frequency of sleep–wake problem behaviors (Cronbach’s α = .80). The 10-item daytime sleepiness subscale had a 4-point response scale on which adolescents indicated whether they struggled to stay awake or fell asleep in various situations (e.g., in class) in the past 2 weeks. Scores were summed; higher scores represented greater daytime sleepiness (Cronbach’s α = .70).

The Center for Epidemiological Studies Depression Scale (CES-D). The CES-D (Radloff, 1977) was used to subjectively assess depressive symptomatology among adolescents. The 20-item CES-D used a 4-point response scale on which adolescents rated the frequency of symptoms over the past week. To avoid inflated correlations with the sleep measures, the single sleep item was omitted from the total score. The remaining 19 items were summed; higher scores indicated more depressive symptoms (present sample: Cronbach’s α = .89).

The Child Behavior Checklist (CBCL). Using a 3-point response scale, mothers responded to 113 items concerning the presence of problem behaviors (Achenbach & Rescorla, 2001). Raw scores on the affective problems, anxiety problems, and externalizing problems subscales were converted to T-scores per the scoring instructions. The CBCL demonstrates good reliability.

The Vineland Adaptive Behavior Scales—Second Edition (VABS-II). The VABS-II (Sparrow, Cicchetti, & Balla, 2005) was used to assess adaptive (e.g., daily living skills, socialization, communication skills) and maladaptive (e.g., internalizing, externalizing behaviors) functioning. It has previously been used in ASD samples (Klin et al., 2007). Mothers rated on a 3-point response scale the likelihood of their adolescent performing behaviors in each domain. Raw scores on each of the scales were converted to standardized scores to yield the Vineland’s Adaptive Behavior Composite and the Maladaptive Behavior indices.

The Network of Relationships Inventory-Relationship Qualities Version (NRI-RQV). The NRI-RQV (Furman & Buhrmester, 2010) was used to assess closeness and discord in family and social relationships. Mothers and adolescents reported on the quality of relationships with one another. Five positive (“closeness”) relationship features and five negative (“discord”) relationship features were assessed on a 5-point response scale. Scores were averaged; higher scores corresponded to greater closeness and greater discord (Cronbach’s α ranged from .86 to .94).

Procedure. The study was approved by the university’s institutional review board. Following consent procedures, adolescents and mothers independently completed questionnaires during a home visit. One year later, families who had agreed to be recontacted (82.1%, n = 23) were called to arrange a visit to the university for an ADOS-2 assessment; of the 23, 47.8% (n = 11) were successfully tested, 30.4% (n = 7) declined to participate, and 21.7% (n = 5) could not be reached.

Plan of analysis. ANCOVAs controlling for income and adolescent IQ were conducted to examine mean differences between the ASD and TD groups. Pearson correlation analyses were conducted within groups to examine associations among the major study variables. Ordinary least squares (OLS) regression models, controlling for income and adolescent IQ, were conducted within diagnostic groups.

Results

Before conducting the main analyses, Pearson correlational analyses were used to examine associations between adolescent-reported sleep and mother-reported sleep. None of the associations was significant (rs < .04, ps ≥ .78).

Diagnostic group (ASD, TD) differences in sleep, psychological well-being, behavior, and mother–adolescent relationship quality. As shown in Table 1, significant differences between the diagnostic groups were in the expected direction for mothers’ reports of poor sleep quality, affective and anxiety issues, externalizing problems, and adaptive and maladaptive behaviors in the direction of poorer sleep, more affective, anxiety and externalizing problems, poorer adaptive functioning, and greater maladaptive behavior in the ASD group compared with the TD group, adjusting for adolescent gender. For relationship quality, both mother- and adolescent-reported relationship discords were significantly higher in the ASD group than the TD group (see Table 1).
Within-group correlations between sleep quality and adolescents’ psychological well-being and behavior: ASD sample. As shown in Table 2, Pearson correlations indicated that adolescents’ poorer sleep quality, as reported by mothers on the CSHQ, was associated significantly with greater affective problems on the CBCL (maternal report). Although no significant associations emerged between adolescents’ sleep–wake problems on the SHS and well-being, adolescents’ reports of greater daytime sleepiness on the SHS was associated significantly with more adolescent-reported depressive symptoms on the CES-D and more mother-reported externalizing problems on the CBCL. More daytime sleepiness was also significantly correlated with greater mother–adolescent discord (maternal report).

Within-group regression analyses for sleep quality in relation to adolescents’ psychological well-being and behavior: ASD sample. The overall regression model for sleep quality in relation to adolescent-reported depressive symptoms on the CES-D, adjusted for income and adolescent IQ, was significant and explained 23% of the variance (see Table 3A, Panel 1). Adolescents’ daytime sleepiness was significantly associated with higher levels of depressive symptoms: for every one standard unit increase in daytime sleepiness, there was a .44 unit increase in the level of depressive symptoms. Although the regression models that tested sleep quality in relation to mother-reported affective and anxiety problems on the CBCL were not significant, affective problems $F(5, 22) = 1.54, p = .22$; anxiety problems $F(5, 22) = 1.94, p = .13$, the model for mother-reported adolescent sleep quality and externalizing problems on the CBCL was significant and accounted for 27% of the variance (see Table 3A, Panel 2). Poorer sleep quality was marginally associated with more externalizing problems: For every one standard unit increase in daytime sleepiness, there was a .31 standard unit increase in externalizing problems.

The model testing sleep quality and adolescents’ adaptive functioning was marginally significant, accounting for 21% of the variance; however, none of the sleep variables was significantly associated with adaptive functioning (see Table 3A, Panel 3). The model for sleep quality and the outcome of maladaptive behavior on the VABS-II was not significant, $F(5, 22) = 2.00, p = .12$.

Within-group correlations between sleep quality and adolescents’ psychological well-being and behavior: TD sample. As shown in Table 2, there were no significant correlations between maternal reports of TD adolescents’ sleep quality on the CSHQ and measures of TD adolescents’ well-being. However, more adolescent-reported sleep–wake problems and more daytime sleepiness on the SHS were positively associated with more depressive symptoms in the TD group.
### Table 2. Pearson Correlations Among Major Study 1 Variables: ASD (Top Row; n = 28), TD (Bottom Row; n = 27).

<table>
<thead>
<tr>
<th>Study 1</th>
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<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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</thead>
<tbody>
<tr>
<td>1. Poor sleep quality&lt;sup&gt;a&lt;/sup&gt;</td>
<td>−.08</td>
<td>−.12</td>
<td>.20</td>
<td>.42&lt;sup&gt;*&lt;/sup&gt;</td>
<td>.32&lt;sup&gt;†&lt;/sup&gt;</td>
<td>.25</td>
<td>−.07</td>
<td>.37&lt;sup&gt;†&lt;/sup&gt;</td>
<td>−.14</td>
<td>−.35&lt;sup&gt;†&lt;/sup&gt;</td>
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<td>.21</td>
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<td>2. Sleep–wake problems&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>.42&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>.26</td>
<td>−.09</td>
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<td>−.03</td>
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<td>−.13</td>
<td>−.16</td>
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<td>.14</td>
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<td>3. Daytime sleepiness&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>.57&lt;sup&gt;**&lt;/sup&gt;</td>
<td>−.26</td>
<td>−.22</td>
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<td>−.24</td>
<td>.07</td>
<td>−.23</td>
<td>−.22</td>
<td>.12</td>
<td>.47&lt;sup&gt;**&lt;/sup&gt;</td>
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<td>4. Depressive symptoms&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>.46&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>−.05</td>
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<td>−.11</td>
<td>−.34&lt;sup&gt;†&lt;/sup&gt;</td>
<td>−.11</td>
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<td>6. Anxiety problems&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>−.18</td>
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<td>.35&lt;sup&gt;†&lt;/sup&gt;</td>
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<td>8. Adaptive behavior&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>.30</td>
<td>.66&lt;sup&gt;**&lt;/sup&gt;</td>
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<td>.37&lt;sup&gt;*&lt;/sup&gt;</td>
<td>.36&lt;sup&gt;†&lt;/sup&gt;</td>
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<td>9. Maladaptive behavior&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>.30</td>
<td>.62&lt;sup&gt;**&lt;/sup&gt;</td>
<td>−.21</td>
<td>−.30</td>
<td>.31</td>
<td>.43&lt;sup&gt;*&lt;/sup&gt;</td>
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<td>10. Mother–teen closeness&lt;sup&gt;a&lt;/sup&gt;</td>
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<td></td>
<td>−.38&lt;sup&gt;†&lt;/sup&gt;</td>
<td>.02</td>
<td>.26</td>
<td>.35&lt;sup&gt;†&lt;/sup&gt;</td>
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<td>11. Teen–mother closeness&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>.18</td>
<td>−.39&lt;sup&gt;†&lt;/sup&gt;</td>
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<td>12. Mother–teen discord&lt;sup&gt;b&lt;/sup&gt;</td>
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<td>−.20</td>
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<td>13. Teen–mother discord&lt;sup&gt;b&lt;/sup&gt;</td>
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<td></td>
<td>.38&lt;sup&gt;†&lt;/sup&gt;</td>
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</table>

Notes. For the value of 0.37, the difference in the significance of p values is due to rounding. The marginal 0.37 is 0.366 before rounding and the significant 0.37 is 0.374 before rounding. For the value of 0.38, the difference is due to the two different samples. The significant -0.38 is derived from the ASD sample (n=28), whereas the marginal 0.38 is derived from the TD sample (n=27). ASD = autism spectrum disorder; TD = typically developing.

<sup>a</sup>Mother reported. <sup>b</sup>Adolescent reported.

<sup>†</sup>p < .10. <sup>*</sup>p < .05. <sup>**</sup>p < .01.

**Within-group regression analyses for sleep quality in relation to adolescents’ psychological well-being and behavior: TD sample.** The overall regression model for sleep quality in relation to adolescent-reported depressive symptoms on the CES-D was significant and explained 39% of the variance [F(5, 21) = 4.29, p = .01]. More sleep–wake problems were significantly associated with higher levels of depressive symptoms: For every one standard unit increase in sleep–wake problems, there was a .73 unit increase in the level of depressive symptoms. The models testing associations between sleep quality and mother–adolescent relationship closeness in the ASD sample [mother-reported F(5, 22) = .59, p = .71, ns; adolescent-reported F(5, 22) = 1.12, p = .38, ns]. However, mother-reported discord in the mother–adolescent relationship was significant in an equation that explained 31% of the variance (see Table 3A, Panel 4). Daytime sleepiness made a significant independent contribution: For every one standard unit increase in daytime sleepiness, there was a .73 unit increase in the level of discord. The model for sleep measures and adolescent-reported discord was not significant in the ASD group [F(5, 22) = .61, p = .70, ns].

**Within-group regression analyses for sleep quality in relation to mother–adolescent relationship quality: TD sample.** None of the regression models testing associations between sleep and relationship quality emerged as significant within the TD sample (all F’s ≤ 1.73, ns).
Table 3. OLS Regressions of Sleep Parameters on Well-Being and Family Relationship Discord in Adolescents With ASD.

<table>
<thead>
<tr>
<th>A. Study 1 (n = 28)</th>
<th>Depressive symptoms*</th>
<th>Externalizing problemsb</th>
<th>Adaptive behaviorb</th>
<th>Mother–teen discordb</th>
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<tr>
<td></td>
<td>b</td>
<td>SE (b)</td>
<td>β</td>
<td>b</td>
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<tr>
<td>Income</td>
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<td>.40</td>
<td>.06</td>
<td>.43</td>
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<td>Adolescent IQ</td>
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<td>.10</td>
<td>−.16</td>
<td>−.06</td>
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<tr>
<td>Poor sleep qualityb</td>
<td>0.50</td>
<td>.30</td>
<td>.28</td>
<td>.45</td>
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<tr>
<td>Sleep–wake problemsa</td>
<td>0.23</td>
<td>.28</td>
<td>.15</td>
<td>.35</td>
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<tr>
<td>Daytime sleepinessa</td>
<td>1.17</td>
<td>.56</td>
<td>.44</td>
<td>.67</td>
</tr>
<tr>
<td>F, adjusted R²</td>
<td>2.65*</td>
<td>.23</td>
<td></td>
<td>3.01*</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>B. Study 2 (n = 20)</th>
<th>Depressive symptoms*</th>
<th>Teen–sibling discorda</th>
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<tbody>
<tr>
<td></td>
<td>b</td>
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<tr>
<td>Total sleep time (min)</td>
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<tr>
<td>Sleep efficiency (%)</td>
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<td>.30</td>
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<tr>
<td>Wake episodes (#)</td>
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<td>.40</td>
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<tr>
<td>F, adjusted R²</td>
<td>3.37*</td>
<td>.30</td>
</tr>
</tbody>
</table>

Notes. ASD = autism spectrum disorder; OLS = ordinary least squares.
*Adolescent reported. bMother reported.

Study 2

Method

Participants. Inclusionary requirements for adolescents with ASD were the same as in Study 1. The Study 2 sample was recruited by contacting the Study 1 families; those who agreed to participate in Study 2 (n = 11, 47.8%) did so approximately one year later. Participants who declined to participate or who could not be reached did not differ from the recontacted group on demographic variables. The remainder of the Study 2 sample was recruited via snowball sampling (n = 9). All adolescents in Study 2 met criteria for ASD on the ADOS-2. The total sample for Study 2 consisted of 20 adolescents with ASD (age range = 11–20 years, M = 16.74, SD = 2.52; 80% male) and their mothers. Ethnicity was 45% White, 30% Multiracial/other, and 25% Hispanic/Latino. Maternal age averaged 50.59 years (SD = 6.92). All adolescents had at least one sibling (sibling age: M = 17.80 years; SD = 4.71).

Measures. Most Study 2 measures overlapped with Study 1 measures; demographic information, SCQ, ADOS-2, CES-D (M = 12.78, SD = 6.92), and VABS-II (adaptive behavior: M = 69.58, SD = 6.92; maladaptive behavior: M = 20.16, SD = 1.61); see Study 1 measures for descriptions.

The NRI-RQV. The NRI-RQV (Furman & Buhrmester, 2010) was used again in Study 2 to measure mother–adolescent relationship quality as reported by adolescents (closeness with mother: M = 3.14, SD = .87; discord with mother: M = 2.71, SD = .59). Unique to Study 2, adolescents also were asked to report on relationship quality with one sibling (closeness with sibling: M = 2.68, SD = .79; discord with sibling: M = 2.78, SD = .64). Adolescents chose a sibling whom they considered to be closest to them. Cronbach’s α ranged from .85 to .94 in the Study 2 sample.

Actigraph. New in Study 2 was the assessment of objective sleep quality using an actigraph sleep watch (Micro Motionlogger Sleep Watch; Ambulatory Monitoring Inc., Ardsley, NY). Actigraph data were reduced using the validated software, Act Millennium Version 3.68, and the Sadeh algorithm was used to estimate sleep parameters based on movement during periods of downtime. Each of the sleep parameters was averaged across the seven nights that participants wore the actigraph. Three commonly-used sleep parameter scores were extracted for use in the present study: total sleep time (total duration of minutes from bedtime to rise time; M = 410.31 min, SD = 85.29), sleep efficiency ([(100 × sleep min) / [true sleep period]]; M = 90.47%, SD = 8.76, and number of wake episodes (number of blocks of continuous wake epochs; M = 3.81, SD = 2.13). Two of these parameters (total sleep time [TST] and sleep efficiency [SE%]) were selected based on a previous study that used actigraphy with adolescents with and without ASD (Baker et al., 2013). Adolescents also completed a sleep log that reported the date, bedtime, and wake–time for the seven nights that they wore the actigraph.

Procedure. Following consent procedures, adolescents completed the ADOS-2 with a trained administrator. Next, parent and adolescent questionnaires were completed.
Adolescents were then instructed on how to wear the actigraph on the non-dominant wrist beginning at bedtime and ending at rising from bed for seven consecutive nights.

Plan of analysis. OLS regression models were conducted to examine sleep in relation to adolescents’ depressive symptoms, adaptive and maladaptive behaviors, and family relationship quality.

Results

Within-ASD associations for sleep parameters in relation to adolescents’ depressive symptoms and behavior. In the ASD sample, the regression model for sleep and adolescent-reported depressive symptoms on the CES-D was significant and accounted for 30% of the variance (see Table 3B, Panel 1). TST (in minutes), and sleep efficiency (percent) were significant. For every one standard unit increase in TST, there was a .73 standard unit increase in level of depressive symptoms. For every one standard unit increase in sleep efficiency, there was a .94 standard unit decrease in depressive symptoms. Models that tested sleep in relation to adaptive and maladaptive behaviors were not significant (Fs ≤ .77, ns).

Within-ASD associations between sleep measures and quality of adolescents’ relationships with mothers and siblings. In the ASD sample, sleep quality was not significantly associated with adolescent-reported closeness with mothers and siblings (Fs ≤ .36, ns) nor with adolescent-reported discord with mothers (F = .76, ns). However, the model that tested actigraph sleep variables in relation to adolescent-reported discord with siblings was significant and accounted for 47% of the variance (see Table 3B, Panel 2). TST (in minutes) was significant, and sleep efficiency (percent) was marginal. For every one standard unit increase in TST, there was a .60 standard unit increase in level of discord in sibling relationships. For every one standard unit increase in sleep efficiency, there was a .62 standard unit decrease in level of discord in sibling relationships.

Discussion

Adolescence is a period of change, both within the individual in the form of biological changes, and interpersonally in terms of the family system. The aims of Study 1 and 2 were to examine whether sleep quality and daytime sleepiness among adolescents with and without ASD were associated with psychological well-being, adaptive functioning, problem behaviors, and quality of family relationships. In past research, sleep problems have been associated with higher levels of psychopathologies (Richdale et al., 2014), but few studies have examined sleep quality with quality of family relationships. Some past research has linked sleep disturbances and daytime sleepiness to poorer well-being; the current study extended these findings to a broader array of indicators of psychological well-being and family relationship quality.

The pattern of significant findings varied by diagnostic group, aspect of sleep, and type of sleep and outcome measure. Partially supporting Study 1 Hypothesis 1 about well-being, several markers of poor sleep quality had significant associations with depressive symptoms. Adolescents’ reports of greater daytime sleepiness were significantly associated with their own reports of more depressive symptoms in the ASD sample. In the TD sample, nocturnal sleep–wake problems were associated with higher levels of self-reported depressive symptoms. Although the aspect of sleep varied (daytime sleepiness in the ASD sample and nighttime sleep in the TD sample), in both samples, sleep problems were associated with higher levels of depressive symptoms. These results confirm prior research with children and adolescents with ASD that linked sleep problems to more internalizing symptoms (Rzepecka et al., 2011; Sikora et al., 2012) and extend them to include adolescent-reported sleep quality.

Adolescents with ASD are not only at risk for comorbidity of sleep problems but also for psychopathologies (e.g., anxiety and depression; Richdale et al., 2014). Nearly 40% of the adolescents with ASD in Study 1 and 35% in Study 2 reported depressive symptoms that were beyond the clinical cutoff of 16 (Radloff, 1977). Understanding the association between poor sleep quality and internalizing conditions could have important implications for the treatment of psychological symptoms that impede daily functioning and diminish quality of life for adolescents with ASD. Explained variance underscored the important role of nocturnal sleep for adolescents’ functioning in the ASD group: nighttime sleep quality explained 21% to 27% of the variance in well-being in Study 1 and 30% in the Study 2. Although meaningful, the explained variance was somewhat lower than that reported in past studies (e.g., Richdale et al., 2014; Rzepecka et al., 2011), which could reflect differences in samples and outcomes. Nonetheless, in the current study, the variance explained by sleep quality is enough to justify further research with sleep as the independent variable. Importantly, bidirectional associations have been found between sleep quality and well-being, and between sleep quality and family stress (Smaldone et al., 2007). Mood disorders such as depression could compromise sleep quality, or the stress associated with family conflict could trigger sleep problems. Such bidirectional associations merit further examination.

Partially supporting Hypothesis 2 about family relationships, results from Study 1 showed that daytime sleepiness was important in the ASD sample; this aspect of sleep
quality explained 31% of variance in family relationships in Study 1 and 47% in Study 2. When adolescents with ASD reported more daytime sleepiness, their mothers reported more relational discord; when adolescents with ASD slept longer at night, they reported more discord with their siblings. Sleepiness and poor nocturnal sleep may be linked to social irritability, which then produces relational conflict without threatening closeness. Support for this explanation comes from several studies that have examined children and adolescents with ASD. Poor sleepers had more affective problems and reciprocal social interaction difficulties compared with good sleepers (Malow et al., 2006); fewer hours slept per night predicted greater difficulty in social interactions (Schreck, Mulick, & Smith, 2004), and more social problems were associated with poorer mother–adolescent relationship quality (Orsmond et al., 2006). The cascading effects of sleep disturbances on relationships may be heightened when family members are also sleep-deprived.

The positive association between more sleep time and greater discordant relationships with siblings was unexpected. More sleep efficiency of adolescents with ASD was negatively associated with lower levels of depressive symptoms, so longer sleep time did not mean better quality sleep. Because difficulties in interpersonal relationships are characteristic of ASD, the presence of sleep problems may further exacerbate these social deficits, making it more difficult to maintain satisfactory relationships with family members. Future work should examine the sleep quality of other family members to better determine whether and how the disrupted sleep of adolescents with ASD might affect the family system.

Study limitations include the correlational design, an especially high male–female ratio, the lack of generalizability to less cognitively-able adolescents with ASD, and sample size, which may have constrained power to detect small differences. There could be additional potentially confounding variables that we lacked the sample size to include (e.g., siblings’ gender, age, and birth order). Although IQ ranged fairly widely, our two studies included adolescents with ASD who were high-functioning enough to comprehend commonly used measures and to be reporters of their behaviors and feelings.

A strength of both studies is that both mother and adolescent perspectives were collected when assessing sleep and well-being. Adolescents’ perspectives gave access to their perception of their sleep quality and internal feeling states, characteristics that parents cannot readily access especially if their adolescent has communication problems. Another strength was the multimethod assessment of sleep quality using questionnaires and actigraphy. The differential associations between the aspects of sleep, and the well-being scales and family relationship measures suggest that it is worthwhile to include multiple aspects of sleep in studies of adolescents with ASD. Future research also should examine the sleep quality of adolescents with ASD in relation to other outcomes such as academic motivation and performance.

Conclusion

Findings from the current study underscore the potent role of sleep issues for individual functioning and relationship quality in adolescents with ASD. Sleep disruptions may have detrimental correlates that extend beyond individual functioning to reach the family domain. The significant associations were found in non-clinical samples; even stronger associations might be found in a sample with clinically-diagnosed sleep problems. Clinical interventions by professionals who are knowledgeable about sleep problems and sensitive to the needs of adolescents with ASD could address the well-being and interpersonal goals of the adolescent while also helping to ameliorate sleep problems.

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References


