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ORIGINAL ARTICLE

Correlates of Loneliness in Children with Attention-Deficit/Hyperactivity Disorder: Comorbidities and Peer Problems

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Abstract

Children with attention-deficit/hyperactivity disorder (ADHD) are well-documented to experience social-emotional difficulties; however, little is known about their loneliness—an aspect of social-emotional functioning. Using a cross-sectional design, we examined how loneliness relates to comorbid internalizing disorders, externalizing disorders, and peer problems in a sample of 213 children with ADHD. Children (66 girls, $M_{age} = 8.58$, $SD_{age} = 1.55$) reported their loneliness. Comorbid internalizing and externalizing disorders were assessed via a multi-informant procedure. Proportion of classmates who accepted, rejected, and ignored the child, friendship quantity, and friendship quality were peer problem indicators. Results suggested that children with comorbid internalizing disorders, fewer friendships, or potentially more negative friendship quality, reported more loneliness. Gender appeared to moderate the association between peer rejection and loneliness, such that boys with peer rejection reported more loneliness than girls. Clinical implications include targeting loneliness as a social-emotional problem to assess and treat in children with ADHD.

Keywords ADHD · Loneliness · Peer relationships · School-age children

Children with Attention-Deficit/Hyperactivity Disorder (ADHD) are at risk for many social-emotional problems, including difficulties with friendship, peer regard, interpersonal skills, and peer victimization [1–5]. Such social-emotional difficulties are suggested to maintain or exacerbate subsequent maladjustment [5, 6]. However, loneliness is one aspect of social-emotional functioning about which relatively little is known in children with ADHD. Loneliness is an unpleasant or distressing feeling that stems from the perception that social experiences are not meeting one's own expectations [7]. In ADHD populations, the limited research on loneliness thus far has been typically conducted with small and predominantly male samples.

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Loneliness in Children with ADHD

A total of *ten* published studies, to our knowledge, have investigated loneliness in children or adolescents with ADHD (age range 6–18). Of these, six compared group mean levels of self-reported loneliness among youth with ADHD relative to typically developing (TD) youth. One study ($n = 39$ children with ADHD, 8 girls) found that although teachers and parents reported children with ADHD to be lonelier compared to those without ADHD ($d = 1.33$ and 1.20 respectively, both large effect sizes), child report indicated no difference between groups (no statistics reported to calculate effect size [8]). Two other studies found that youth with ADHD ($n = 84$, 10 girls [9]; $n = 25$, no girls [10]) reported similar levels of loneliness as TD youth, with effect sizes of $d = 0.19$ (almost a small effect) and $d = 0.01$ (no effect), respectively. Another study found that youth with ADHD ($n = 21$, 8 girls) and youth with weak social skills but no ADHD, had similar levels of loneliness ($d = 0.13$, no effect [11]). In contrast, one study ($n = 31$ youth with ADHD, 6 girls) found more loneliness in youth with ADHD than in TD youth with a medium effect size ($d = 0.53$ [12]); another study ($n = 59$ children with ADHD, 17 girls) found more loneliness in children with ADHD plus a learning

disability compared to TD youth with a large effect size ($d = 0.87$ [13]).

The remaining four studies examined the association between ADHD and loneliness. One study found that the presence of ADHD (ADHD status was coded dichotomously) was associated with more loneliness ($n = 199$ children with ADHD, $n = 74$ control children, no girls, $d = 0.28$, small effect [14]). The final three studies examined the association between self-reported loneliness and dimensional symptoms of ADHD in community samples. Diamantopoulou et al. [15] reported that ADHD symptoms and loneliness were not associated ($d = 0.04$, no effect). By contrast, other research found loneliness to be related to hyperactivity ($d = 0.14$–0.32, small effect [16]) and ADHD symptoms ($d = 0.80$, medium effect [17]).

Our review of the available literature first underscores the limited studies about loneliness in ADHD. Second, taking into consideration the effect size estimates, it reveals that many children with ADHD experience similar levels of loneliness relative to typically developing peers. This may be somewhat surprising, given that the presence of other social-emotional difficulties has been consistently documented in ADHD populations [1]. Taken together, this literature suggests the utility of examining the factors associated with loneliness in an ADHD sample. To our knowledge, no research has done this to date. Herein, we investigate children's comorbid disorders (which are associated with social-emotional difficulties), and peer problems (another aspect of social-emotional functioning), as potential correlates of elevated loneliness in children with ADHD.

Comorbidities and Loneliness

Many children with ADHD have comorbidities, meaning that children have been diagnosed with another mental health condition in addition to their ADHD. Comorbidities can be categorized as externalizing disorders, such as Oppositional Defiant Disorder (ODD) and Conduct Disorder (CD), or internalizing disorders, such as depression and anxiety. Both externalizing and internalizing comorbidities are associated with children's social-emotional difficulties in general (e.g., [15]), making them potentially relevant to loneliness. However, past research on loneliness and ADHD has rarely considered the effects of comorbidities on loneliness.

Nonetheless, externalizing disorders, estimated to affect about 50–60% of children with ADHD [18], have been linked to loneliness in inconsistent ways. Lempinen et al. [16] found externalizing symptoms to be positively associated with loneliness ($d = 0.10$–0.19, small effect). In another study, however, after accounting for callous-unemotional traits and ADHD symptoms, CD symptoms were associated with less loneliness ($d = 0.35$, small effect [17]). Because externalizing comorbidities are known to confer exacerbated peer problems (e.g., more rejection, less friendship) in children with ADHD, these social difficulties could increase children's loneliness. However, there is also a literature suggesting that children with ADHD and externalizing comorbidities do not always recognize that they have peer problems [19]; perhaps, then, their overestimation of social competence masks the presence of loneliness or they do not feel the dissatisfaction with social relationships that defines loneliness [7, 14].

By contrast, internalizing disorders, estimated to affect up to 36% of children with ADHD [18], are more consistently associated with elevated loneliness (no effect size provided [20, 21]). The heightened sensitivity to external evaluation and self-criticism found in internalizing comorbidities may be closely linked to the self-awareness and negative self-judgments required to experience loneliness. Thus, comorbidities, especially internalizing ones, may be risk factors for loneliness in ADHD populations.

Peer Problems and Loneliness

Approximately 50–70% of children with ADHD have peer problems [5], this encompasses social-emotional difficulties in peer regard, friendship quantity, and friendship quality. Peer regard reflects the extent to which children are accepted by the larger peer group, relative to rejected. Children who are neither accepted nor rejected are referred to as being neglected or ignored. By contrast, friendship is a reciprocal relationship between two children. Friendship quantity is the number of reciprocated friendships a child has, whereas friendship quality refers to the positive and negative features within friendships [6].

Similar to each of these peer problems, loneliness is a type of social-emotional difficulty and is related to unsatisfying social relationships. Given the research which suggests that children with ADHD have poorer peer regard, fewer reciprocated friendships, and less positive and more negative quality in any friendships they do have compared to children without ADHD [1, 2], these substantial impairments in peer relationships may lead to more loneliness in ADHD populations. Indeed, among TD children with few or no reciprocated friendships, poor friendship quality, and poor peer regard, each report more loneliness than children without these peer problems [22, 23]. This supports the idea that loneliness and peer problems are both types of social-emotional difficulties that should be related to one another. Thus, we might expect peer problems to be associated with loneliness in children with ADHD.

Nonetheless, loneliness is distinct from other social-emotional problems as it reflects a subjective, distressing

perception that one's social experiences are not as one would like [7]. By contrast, peer problems may objectively exist yet not be noticed or internalized. Therefore, loneliness captures children's internal emotional experiences, and is not simply redundant with other constructs reflecting children's peer problems.

Gender Considerations

Loneliness is theoretically affected by peer relationships as well as by children's interpretations of their peer relationships, all of which can be influenced by gender. Research in TD samples has yielded inconsistent results regarding whether boys or girls experience more loneliness on average (e.g., [22, 24, 25]). Lempinem et al. [16] found that the association between emotional problems and loneliness was only present in boys. Further, in another study, the correlation between friendship quality and emotional adjustment appeared stronger for boys [6]. These findings suggest that perhaps boys are more likely to experience consequences of social problems in the form of loneliness than are girls. On the other hand, Coplan et al. [26] found that aggression was associated with loneliness for girls, but reticent behavior was associated with loneliness for boys. This may indicate that boys and girls tend to experience loneliness when faced with different types of social problems. In addition, a recent meta-analysis found that in samples of children, there is a small but significant effect of gender on loneliness, such that boys are lonelier than girls [27].

Girls with ADHD are underdiagnosed and understudied, in part because of the large male:female ratio in the disorder [28]. The under-representation of females in ADHD research may be of the greatest concern when the outcomes examined pertain to social factors (such as loneliness), given that children's evaluations of one another may be affected by gender. For example, research indicates that the negative association between externalizing symptoms and peer problems may be stronger for girls with ADHD compared to boys with ADHD [3]. Boys' externalizing behaviors may be more socially accepted (to a certain extent); therefore, boys may be less likely to receive detrimental peer evaluations for these behaviors, compared to girls. In the existing published research literature about loneliness in children with ADHD, *no* studies contain a sufficient number of girls to examine the role of gender in loneliness.

Clinical Significance of Loneliness

Understanding loneliness among children with ADHD is a question with high clinical significance. The experience of loneliness may affect long-term adjustment. TD youth with elevated loneliness throughout childhood (relative to non-lonely children) demonstrate more aggression and suicidal ideation [29], and more depression and physical health problems [30]. The associations between loneliness and subsequent depression hold after accounting for early vulnerability and depressive symptoms [31]. Additionally, loneliness is suggested to exacerbate the association between peer problems and maladjustment among TD youth [32]. This may happen because loneliness engenders cognitive biases where children expect social interactions to be negative [33], leading to situations that confirm those biases in a self-reinforcing loop.

Although no research to date has documented whether loneliness similarly exacerbates subsequent maladjustment in ADHD populations, children with ADHD are already at elevated risk for negative outcomes in adolescence and adulthood as a function of their disorder and their well-documented peer problems [5, 34]. Therefore, determining the factors associated with loneliness in ADHD may be useful for promoting healthy social-emotional development in this at-risk population. Further, the experience of loneliness is aversive, so reducing loneliness could improve the quality of life for children with ADHD. For example, understanding correlates of loneliness could lead to novel intervention approaches that prevent loneliness from occurring, or treat loneliness once it has developed.

Objectives

We examined factors associated with loneliness in a sample of children with ADHD. After accounting for the contribution of demographic variables, we hypothesized that comorbid internalizing disorders and dimensions of peer problems, each common in children with ADHD and related to other social-emotional difficulties in this population, would be associated with elevated loneliness. Because of the mixed research about the association between externalizing disorders and loneliness, we did not make a directional hypothesis for this variable. Previous research identified impairments in friendship quantity, friendship quality, and peer acceptance, rejection, and ignoring as potential factors associated with loneliness, and so each was separately tested in this sample after accounting for demographics and comorbidities. Further, we explored whether the associations between peer problems and loneliness differed based on gender.

Method

Participants

Participants were 213 children (66 girls, ages 6–11), all of whom met criteria for ADHD based on the 5th edition of the *Diagnostic and Statistical Manual* (DSM-5; [34]). All

were enrolled in a larger clinical trial testing interventions for social impairment among children with ADHD [35]. The current study measures were collected before participants were randomized to intervention conditions. Participants were recruited through schools, hospital clinics, and practitioners at two sites in Canada: Vancouver and Ottawa/Gatineau (see Table 1).

In a screening, parents and teachers first rated the child on the nine symptoms of inattention and the nine symptoms of hyperactivity/impulsivity on the Child Symptom Inventory (CSI; [36]). If the child had at least four inattention symptoms and/or four hyperactivity/ impulsivity symptoms endorsed by both parent and teacher (as "often" or "very often" on the CSI items) at this stage, we proceeded to administer a clinical interview to the parent, the Kiddie-Schedule for Affective Disorders and Schizophrenia, to validate diagnosis (K-SADS; [37]). For 9.9% of participants, all of whom had existing ADHD diagnoses from a professional when they contacted the study, we relied on only parent report of child ADHD symptoms during the screening and did not consider teacher report either because (a) the child was medicated during all school hours ($n=16$), or (b) in a follow up phone call with the parent, the parent endorsed symptoms at school and explained why the teacher was not well-suited to report on the child's symptoms ($n=5$). In order to confirm diagnosis and meet the final inclusion criteria, in all cases children had at least six items of either inattention and/or hyperactivity/impulsivity endorsed by the parent on the K-SADS or the teacher on the CSI using the "or" algorithm, where a symptom is considered to be present if endorsed by either the parent or teacher [38].

Because the larger study tested interventions for social impairment, eligible children also needed to demonstrate problems on the Strengths and Difficulties Questionnaire peer problems subscale (SDQ; [39]). Most children had a score of at least 3 (corresponding to 1 *SD* above the mean) reported by both parent and teacher on this subscale. For 14.3% of participants, one or both informants did not endorse a 3 (although in all cases, both parent and teacher endorsed at least a 1 or 2, indicating some peer problems). For all these participants, we spoke with the parent and the parent either suggested that we "should trust the teacher" (in situations where the teacher reported more peer problems than the parent), or the parent explained reasons why peer problems were not noticed by the teacher (e.g., peer problems mainly occur on playdates and the child is anxious at school; the teacher is a substitute and is not attuned to students' peer relationships). In all cases, however, children achieved a 3 on the peer problems subscale when using the "or" algorithm, such that items were counted if endorsed by either parent or teacher.

Exclusion criteria included a Full-Scale IQ below 75 based on the Wechsler Abbreviated Scale of Intelligence (WASI; [40]) or a short form of the Wechsler Intelligence Scale for Children (WISC-IV; [41]), Autism Spectrum Disorder, or severe condition (e.g., suicidality) requiring immediate intervention. However, few children ($n=8$, of 227 assessed) were excluded for these reasons. Medication for ADHD was not exclusionary, as long as children were on a stable dose as many children with ADHD who are medicated continue to be impaired in peer relationships [42].

Procedure

The study was conducted with full ethics approval from both sites. Parents and teachers provided informed consent and children assented to all procedures. Parents and teachers independently completed the CSI and peer problems subscale of the SDQ over the phone (or by email) in a screener. If children appeared eligible for the study after these ratings, the family was invited to the lab. At the lab visit, parents were administered the K-SADS by graduate students and a postdoctoral fellow, supplemented occasionally by selected post-baccalaureate research assistants, under the supervision of the principal investigators who are clinical psychologists. At this time, parents also filled out other questionnaires about their child's behavior and reported on their child's age, gender, and ADHD medication status. The child was administered the WASI or a short form of the WISC-IV by an undergraduate or post-baccalaureate research assistant. Children completed questionnaires to assess loneliness and other behaviors in individual interviews where the research assistant read the questions aloud and recorded the child's answers. Teachers were asked to complete additional questionnaires (by mail) about the child including the Teacher Report Form (TRF; [43]) and measures of peer regard, and were asked to conduct a sociometric procedure with their class to assess friendship quantity. Parents and children were then invited to the lab for a second visit where they were asked to bring along the closest friend of the child. The child and the friend completed questionnaires about their friendship and were filmed engaging in two dyadic games (described below) to assess the quality of their friendship.

Measures

Loneliness

Children reported their experience of loneliness on the Children's Loneliness Scale [44]. This widely-used measure includes 16 items focusing on children's feelings of loneliness in school (e.g., I feel left out of things at school) each rated on a 5-point scale from 0 (*not true about me at all*) to 4 (*always true about me*). Psychometric properties are well established [44]. Trained research assistants read each question aloud to children in private interviews and checked

Table 1 Sample demographics and descriptive statistics of study variables

Demographics	Total ($N=213$)	Boys ($n=147$)	Girls ($n=66$)
	M (*SD*) or *n* (%)	*M* (*SD*) or *n* (%)	*M* (*SD*) or *n* (%)
Age	8.58 (1.55)	8.50 (1.59)	8.76 (1.44)
Ethnicity			
Caucasian/White	150 (70%)	98 (67%)	52 (79%)
Asian/Pacific Islander	11 (5%)	6 (4%)	5 (8%)
Hispanic/Latino	2 (1%)	2 (1%)	0
Afro-Canadian/Black	2 (1%)	0	2 (3%)
Multi-racial	35 (16%)	30 (20%)	5 (8%)
Not reported	13 (6%)	11 (8%)	2 (3%)
Medicated	123 (58%)	86 (59%)	37 (56%)
ADHD presentation			
Inattentive	59 (28%)	39 (27%)	20 (30%)
Hyperactive-impulsive	11 (5%)	7 (5%)	4 (6%)
Combined	143 (67%)	101 (69%)	42 (64%)
Has comorbid internalizing disorder	56 (26%)	41 (28%)	15 (23%)
Has comorbid externalizing disorder	64 (30%)	45 (31%)	19 (29%)

Study variables	*n*	*M* (*SD*)	Range	*n*	*M* (*SD*)	Range	*n*	*M* (*SD*)	Range
Friendship quantity (% of classroom peers)	150	15 (14)	0–100	99	16 (14)	0–100	51	13 (12)	0–56
Accept (% of class)	198	31 (23)	0–100	136	31 (23)	0–95	62	31 (23)	0–100
Reject (% of class)	198	19 (20)	0–90	136	17 (18)	0–90	62	24 (23)	0–80
Ignore (% of class)	198	50 (26)	0–100	136	52 (26)	0–100	62	46 (24)	0–95
Observed positive friendship quality	165	.41 (.15)	.15–.90	111	.39 (.13)	.15–.74	54	.46 (.17)	.15–.90
Observed negative friendship quality	165	.18 (.13)	0–.53	111	.19 (.12)	0–.53	54	.15 (.14)	0–.50
Loneliness	213	23.58 (13.52)	0–64	147	23.71 (13.51)	0–64	66	23.30 (13.66)	0–57

Percentages may not total to 100% due to rounding

ADHD = Attention-Deficit/Hyperactivity Disorder

children's comprehension of each item. A visual aid (pictures of water glasses ranging from empty to completely full) was used to help children understand the response scale. The total score was used to indicate loneliness, which was the criterion variable. Internal consistency in the sample was 0.89.

Child Comorbidities

In order to be categorized as having an externalizing disorder or internalizing disorder, the parent first had to endorse that the child met DSM-IV-TR criteria for a relevant disorder on the K-SADS. In addition to meeting full criteria on the parent K-SADS, we also required that an indication of this disorder be present as reported by a secondary informant (either teacher or child on a questionnaire). Therefore, all children classified as having a comorbid disorder were required to have parent endorsement of diagnosis on the K-SADS, plus elevated symptomatology according to an additional informant who was not the parent.

Specifically, children were determined to have a *comorbid externalizing disorder* if the parent endorsed ODD or CD on the K-SADS, and the teacher also rated the child as having a *T*-score of 60 or above on the Oppositional Defiant Problems and/or Conduct Problems DSM scales on the TRF. Children had a *comorbid internalizing disorder* if the parent endorsed any depressive or anxiety disorder on the K-SADS, and either (a) the teacher also rated the child as having a *T*-score of 60 or above on the Depressive Problems and/or Anxiety Problems DSM scales on the TRF, or (b) children endorsed a *T*-score of at least 60 on the Children's Depression Inventory 2 (CDI-2; [45]) if age 7 or above, or a *T*-score of at least 60 on the Multidimensional Anxiety Scale for Children (MASC; [46]) if age 8 or above. We elected to use only teacher report (and not child self-report) of child externalizing behaviors to confirm parental report from the K-SADS as children are generally poor informants of their externalizing symptoms [47].

Child Peer Problems

Peer acceptance, rejection, and ignoring was reported by teachers on the Dishion Social Acceptance Scale (DSAS; [48]). Teachers estimated the percentage of classmates who "like and accept", "dislike or reject", or "ignore or are neutral" (about) the study child. Research has found moderate correlations between teacher ratings on this measure and peer sociometrics [48, 49]. These three indicators are collectively referred to as "peer regard". We used teacher report of peer regard because of the inability to receive ethics board approval for peer sociometric questions about acceptance and rejection.

Friendship quantity was assessed through a modified sociometric procedure [23] administered in classrooms of study children. Students were given a list of all classmates and asked to circle the names of everyone who they considered their friend. They were permitted to circle as many names as they wanted. The number of reciprocated friendships (where the study child and classmate nominated each other as friends) was counted by teachers and reported to the study team. A proportion score was created for each child by dividing the number of reciprocated friendships obtained by the number of classmates who completed the sociometric procedure.

Friendship quality was assessed for the children who brought a friend to the lab. First, both children in the dyad independently reported whether the other child was a best friend, a close friend, just a friend, occasional companions (acquaintances), or a stranger (e.g., [50]). Of the full sample of 213 participants, we have data about friendship quality for the 165 dyads in which the child brought a friend to the lab and both children reported that the other was a friend (i.e., a best friend, a close friend, or just a friend). This inclusive definition of a friend is recommended in the friendship literature to minimize selection effects [51]. Forty-five participants did not bring a friend to the lab, two dyads were unilateral friends, and one dyad did not complete the task. An additional dyad completed the task but a videotape malfunction prevented it from being recorded. For this last dyad, we substituted their scores from a timepoint 10 weeks later (after the parent received a psychoeducation and social support group). Importantly, loneliness was not significantly different between the children who were able to bring a reciprocated friend to the lab compared to children who did not, $t(211) = -1.13$, $p = 0.26$.

The dyad completed two observational tasks designed to mirror real-world interactions of friends. These tasks were successfully used in previous research to assess friendship quality in children with ADHD (e.g., [2]). The first was a toy-sharing task, where the two children were given a selection of 15 toys and were told to pick five toys they liked and to share them between each other. In the second task, they played a car-race game where the goal was to transport five blocks across a table via a toy car. However, only one car could fit through the track on the table at a time. Task order was counterbalanced (see Normand et al. [2], for more details). The interactions were coded for positive and negative behaviors characterizing friendship quality by trained coders, kept unaware of other data about participants. We double-coded 20% of intervals and calculated intraclass correlation coefficients (ICC) for continuous variables and kappa for dichotomous variables to indicate inter-rater reliability [52].

Our data reduction procedure is described in greater detail in Mikami et al. [35]. Indicators of positivity included

closeness [car-race task, ICC(2,k) = 0.92; toy-sharing task, ICC(2,k) = 0.89] and positive affect (car-race task, κ = 0.81; toy-sharing task, κ = 0.81). Closeness, scored on a Likert scale of 0–5, represented the extent to which the two children were affectionate towards one another, and comfortable and warm with each other. Positive affect was calculated as the percentage of 5-second intervals in which the children displayed affection, laughter, smiles, or jokes. To put the two variables on the same scale, we divided closeness by 5 and then took the mean of the closeness and positive affect scores to create a composite score indicating positive friendship quality.

Indicators of negativity included negative affect (car-race task, κ = 0.81; toy-sharing task, κ = 0.81) and reverse-coded cooperation [toy-sharing task only, ICC(2,k) = 0.91]. Cooperation, scored on a Likert scale of 0–5, represented the extent to which the two children worked together on the task relative to demonstrated antagonism and conflict; where 5 indicated strong cooperation, 0 indicated strong conflict. Negative affect was calculated as the percentage of 5-s intervals in which the children displayed tension, frustration, irritation, anger, and sadness. To put the two variables on the same scale, we divided reverse-coded cooperation by 5 and then took the mean of the cooperation and negative affect scores to create a composite score indicating negative friendship quality.

Power Analysis

Prior to recruitment and data collection in the larger randomized trial [35], we conducted a power analysis. The results suggested that a sample of 196 would provide power of 0.88 to detect a medium effect size for the main effect of intervention (after accounting for 20% estimated attrition over the treatment period). This sample size of 196 corresponded to power of 0.99 to find a medium effect size in regressions with approximately 6 predictors that used the baseline data only, as is the case in the current study. Therefore, we aimed to enroll 196 participants, and were able to enroll 213.

Data Analytic Plan

Whereas all participants had data on demographics, comorbidities, and loneliness ($N = 213$), a subset had data assessing friendship quantity ($n = 150$) and peer regard ($n = 198$), as some school boards or teachers elected to not do these latter measures. In addition, a subset of $n = 165$ participants had data on friendship quality, because this required children to come to the lab with a reciprocated friend. Little's missing completely at random test was conducted and failed to reject the null hypothesis, indicating that the data are missing completely at random. We used Full Information Maximum Likelihood (FIML) estimation to handle missing data and all reported findings reflect analyses using FIML. As a sensitivity check, we also conducted analyses using listwise deletion and found the same results.

Six hierarchical multiple regression analyses were conducted to examine the associations between comorbidities and peer problems with loneliness. On Step 1 of all regressions we entered child gender along with the covariate of age (given the age range in our sample). On Step 2 we entered child internalizing comorbidity and externalizing comorbidity on the same step. This allowed us to determine whether either type of comorbidity was associated with loneliness after accounting for the other comorbidity and demographic variables.

The regressions differed in Step 3, where we placed each indicator of peer problems in separate regressions. This was to determine whether each peer problem had any significant association with loneliness beyond the contribution of demographics and comorbidities. In Regression A, Step 3 contained the proportion score of reciprocated friendships from the sociometric procedure as the measure of friendship quantity. Step 3 in Regressions B to D contained the proportion of peers the teacher estimated to accept (B), reject (C), or ignore (D) the study child. In Regression E, Step 3 contained positive observed friendship quality, and in Regression F Step 3 contained negative observed friendship quality. Step 4 in Regressions A to F contained the interaction term between gender and the variable in Step 3 to determine whether the association between peer problems and loneliness differed based on gender. Significant interaction effects obtained in Step 4 were probed in the manner recommended by Holmbeck [53] in order to determine the direction of the association for boys and for girls separately.

Results

Descriptive Statistics

Descriptive statistics of demographic characteristics and study variables are in Table 1 for the full sample and separately for boys and girls. Bivariate correlations separated by gender appear in Table 2. Loneliness was associated with more internalizing comorbidities and fewer reciprocated friendships on the bivariate level for boys and girls. However, in boys, externalizing comorbidities and less peer acceptance were correlated with more loneliness at the bivariate level, whereas this was not the case for girls.

Factors Associated with Loneliness

The analyses testing the primary study hypotheses are presented in Table 3. Neither gender nor age at Step 1 was

related to loneliness in this sample. At Step 2, the presence of an internalizing comorbidity was associated with more loneliness but externalizing comorbidity was not associated with loneliness. The incremental explained variance in loneliness associated with Step 2 was 10%.

Regarding the peer problems entered in Step 3 of individual regressions, after controlling for demographics and comorbidities, having fewer reciprocated friendships was associated with greater loneliness and incrementally explained 5% of the variance. Results in the current study did not suggest an association between peer regard and loneliness, or positive friendship quality and loneliness, although negative friendship quality may potentially be associated with more loneliness (at $p = 0.053$, incrementally explained 2% of the variance). Controlling for medication status in Step 1 did not change the pattern of results.

Of the six interaction terms testing gender as a moderator, there was one significant interaction between peer rejection and gender, although the incremental variance explained by the interaction was small (2%). The significant interaction indicates that, in this sample, the relationship between peer rejection and loneliness differs depending on gender. Probing to determine the direction of this interaction effect indicated that for boys, higher rejection tended to be associated with more loneliness ($B = 2.00$, $p = 0.11$), whereas the opposite trend was suggested for girls ($B = -2.05$, $p = 0.15$). Thus, boys and girls differed from one another in their associations between rejection and loneliness, but neither differed significantly from zero.

Table 3 Regression analyses examining associations between comorbidities and peer problems with loneliness

	ΔR^2	β
All Regressions		
Step 1	.00	
Child gender		− .02
Child age		.04
Step 2	.10**	
Externalizing		.03
Internalizing		.31**
Regression A		
Step 3: Quantity	.05**	− .22**
Step 4: Quantity × gender	.00	− .17
Regression B		
Step 3: Accept	.01	− .11
Step 4: Accept × gender	.01	.27
Regression C		
Step 3: Reject	.00	.02
Step 4: Reject × gender	.02*	− .46*
Regression D		
Step 3: Ignore	.01	.07
Step 4: Ignore × gender	.00	.11
Regression E		
Step 3: Positive quality	.01	− .09
Step 4: Positive quality × gender	.01	.53
Regression F		
Step 3: Negative quality	.02[a]	.16[a]
Step 4: Negative quality × gender	.01	− .22

[a]$p = .053$, *$p < .05$, **$p < .01$

Discussion

This study highlights certain child characteristics and peer problems that may be associated with loneliness in ADHD populations. Our findings indicate that children with ADHD and a comorbid internalizing disorder, fewer reciprocated friendships, or, potentially, more negative friendship quality ($p = 0.053$) may report more loneliness. Further, rejection by classroom peers may be associated with greater loneliness

Table 2 Correlations between study variables by gender

	1	2	3	4	5	6	7	8	9	10
1. Loneliness	–	.20	− .21	.40**	− .35**	.01	− .23	.18	.09	.05
2. Age	− .03	–	− .41**	.14	− .23	− .14	− .05	.17	.30*	− .48**
3. Child externalizing	.17*	− .10	–	− .19	.32**	− .09	.24	− .12	− .12	.08
4. Child internalizing	.28**	.11	.18*	–	− .21	− .04	− .17	.19	.08	.00
5. Friendship quantity	− .23*	− .13	− .02	− .09	–	.27	− .20	− .08	− .18	.31*
6. Accept	− .19*	.01	− .16	− .07	.41**	–	− .43**	− .51**	− .24	.06
7. Reject	.09	− .05	.22*	− .12	− .05	− .18*	–	− .54**	.27	− .10
8. Ignore	.10	.03	− .01	.14	− .30**	− .74**	− .53**	–	− .04	.06
9. Observed positive friendship quality	− .13	.24*	.07	.10	.06	.11	− .07	− .04	–	− .19
10. Observed negative friendship quality	.08	− .33**	.00	− .24*	− .13	.03	.01	− .03	− .08	–

Correlations for girls are above the diagonal, correlations for boys are below the diagonal

*$p < .05$, **$p < .01$

for boys compared to girls. Although, effect sizes for these findings were small overall.

Past research in non-ADHD samples has found that children with internalizing disorders experience elevated loneliness [20]; a finding replicated in the current study among children with ADHD. The low mood, low self-esteem, and worry associated with depression and anxiety may make it difficult for children to connect with peers, resulting in feelings of dissatisfaction with social relationships. A core feature of internalizing disorders is also negative self-evaluation. Children with internalizing comorbidities may perceive their social relationships to be more negative than they actually are, leading to feelings of loneliness regardless of the true nature of their relationships. Alternatively, it is possible that social difficulties experienced by children with ADHD contribute to loneliness, which leads to internalizing disorders. A bi-directional relationship may also exist, where internalizing disorders and loneliness have reciprocal influences [54]. In summary, the presence of internalizing disorders may relate to elevated loneliness in a similar way in children with ADHD as it does in children without ADHD.

By contrast, comorbid externalizing disorders were not associated with loneliness in the current sample. Children with ADHD and externalizing disorders are known to overestimate their own social competence on explicit self-report measures [19]. That is, in contrast to what parents and teachers report about them, these children may report that they have no social problems. We wonder if, therefore, children with these externalizing comorbidities may be less likely to experience loneliness because they are unaware of their own peer difficulties. Interestingly, a recent study found some support for the idea that children's overestimation of their own social competence might mask the association between ADHD diagnosis and child report of internalizing symptom severity, including loneliness [14]. This may further explain patterns found in previous research, where parents and teachers reported children with ADHD to be lonelier compared to TD children and this was not found in child self-reports [8]. Another possibility is that children with externalizing comorbidities may in fact experience loneliness but do not explicitly self-report it [55]. Examining implicit self-perceptions of loneliness and its potential implications for adjustment is an important area for future research.

After controlling for demographic factors and comorbidities, having more reciprocated friendships with classroom peers was associated with children reporting less loneliness, and more negative friendship quality was potentially associated with children reporting more loneliness (at $p = 0.053$). Notably these associations were found using peer report and observational measures. On the other hand, peer regard appeared to be unrelated to loneliness in this sample. Perhaps in preadolescence, having a good friend to play with or talk to is more important than the general acceptance or rejection from classroom peers as a whole. This would be consistent with findings that friendship may uniquely confer more protection from emotional problems relative to peer regard, due to the closeness and intimacy that friendships provide [56]. Alternatively, the lack of associations between peer regard and loneliness in our sample may be explained by measurement issues. Peer regard was based on teacher report, and teachers may not be fully aware of the extent to which their students actually like or dislike each other.

Lastly, teacher-reported peer rejection tended to be associated with more loneliness among boys compared to girls, although the interaction effect was small overall and should be interpreted cautiously. Perhaps being negatively regarded by the peer group overall is more important for boys with ADHD. Indeed, elementary school-age boys tend to play more organized games than girls [57]. It may be more obvious when a boy has nobody who wants to play with him, leading boys to experience more loneliness as a result of peer rejection. In contrast, girls' satisfaction with their peer relationships (and potential loneliness) may be more closely related to their intimate relationships [58] rather than general peer regard across a classroom. We note, however, that we did not find gender to moderate the association between friendship and loneliness in the current study.

Study Strengths and Limitations

One study limitation is the cross-sectional, correlational design which obscures conclusions about the directionality of relationships. We also had limited power to detect small effect sizes, thus, results should be interpreted with this in mind and future studies should adequately power their analyses for small effects. Further, the sample was comprised of treatment-seeking parents and their children; therefore, families may have been functioning better than those who are not ready to undertake treatment. All children also had at least some peer problems, so these findings may not generalize to children with ADHD who are not experiencing social impairment. Children with Autism Spectrum Disorder or intellectual disability were also excluded; these children may experience elevated peer problems and the relationship between these problems with loneliness may be unique. In addition, the variables examined in this paper are not an exhaustive list of what may be associated with loneliness in children with ADHD. Future research may add to the existing literature by examining other potential contributors to loneliness, such as self-esteem or social support.

Other limitations pertain to measurement. Our measure of friendship quality was based on an interaction with only one friend, which may not generalize to the quality of other friendships. We were unable to obtain peer nominations of liking and disliking, so instead relied on teacher report

of peer regard. In addition, in line with the recommended procedure for assessing internalizing disorders in school-aged children [59], parents were required to report the presence of an internalizing disorder in order for the child to be categorized as such. Due to the nature of internalizing disorders, parents may not be aware of them, which may have led to an underestimation of the number of children with these disorders. Children's self-report of their depression and anxiety was also part of the diagnostic criteria for internalizing comorbidities (and children also reported their loneliness), raising the possibility that some of the association between loneliness and internalizing comorbidities is attributable to shared rater variance. Another limitation concerns the missing data across the various peer problem measures, although we used FIML to handle this. Finally, findings from this study should be considered in light of the multiple tests conducted.

Despite these limitations, there are several strengths to this study. Child ADHD diagnosis, as well as internalizing and externalizing comorbidities, was confirmed with a parent clinical interview and reports from at least one other informant who was not the parent. Peer problems were collected from multiple informants and methods (teacher report, peer report, and observations). Overall, this procedure reduces concerns that children who perceive themselves to have peer problems (which could reflect a bias in their self-perception) are also those who report feeling lonely as a consequence of having poor social experiences. That we assessed various indicators of peer problems, instead of one dimension of peer problems, is also a strength.

Implications for Practice

Loneliness may be an important part of the constellation of social-emotional difficulties experienced by many children with ADHD. This underscores the potential importance of assessing loneliness in a clinical context, as it indicates distress. Practitioners might especially be aware that children who have internalizing comorbidities or poor friendships may be at an elevated risk for loneliness.

Loneliness may also carry implications for children's engagement in psychosocial treatment for ADHD. For example, it is possible that children who are lonely may be more motivated for psychosocial treatment to reduce ADHD symptoms or improve social competence, because the feeling of loneliness is aversive. Being able to identify which children with ADHD may experience more loneliness may lead to additional efforts to engage children in treatment and to tailor treatments appropriately.

Regardless of the potential directionality of the relationship between loneliness and internalizing disorders or peer problems, the experience of loneliness may be a barrier to subsequent social development, as loneliness may discourage children from engaging with peers. Therefore, children who avoid peer interactions as a consequence of feeling lonely may lose important opportunities to learn and practice social skills in the long run. This may be particularly problematic for children with ADHD who already tend to have fewer playdates with peers (owing to their social impairments) relative to TD children [60]. Future research might examine the consequences of loneliness for children's longer-term well-being, above and beyond the effects of ADHD, comorbid conditions, and objective levels of peer problems. If negative consequences of loneliness exist in ADHD populations (as is suggested to occur among TD children), interventions to address loneliness may be warranted.

Summary

In a sample of clinically-diagnosed children with ADHD, various factors were related to children reporting more loneliness. The presence of an internalizing disorder, fewer reciprocated friendships, and, potentially, more negative friendship quality were each associated with greater loneliness in this population. For boys, rejection from classroom peers may also be associated with more loneliness compared to girls; however, future research should continue to examine gender differences. The findings from this study may help clinicians identify children with ADHD who are more likely to be lonely and prompt consideration of loneliness in intervention efforts.

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Compliance with Ethical Standards

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study and assent was obtained from child participants.

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