



Daytime Sleepiness and Prosocial Behaviors in Kindergarten: The Mediating Role of Student-Teacher Relationships Quality

Claudio Longobardi, Shanyan Lin* and Matteo Angelo Fabris

Department of Psychology, University of Turin, Turin, Italy

OPEN ACCESS

Edited by:

Mohamed A. Ali,
Grand Canyon University,
United States

Reviewed by:

Marta Moraleda-Cibrián,
Hospital Quirón Teknon, Spain
Sergey Kolomeichuk,
Institute of Biology of Karelian
Research Centre (RAS), Russia
Xing-Da Ju,
Northeast Normal University, China
Maria Clelia Zurlo,
University of Naples Federico II, Italy

*Correspondence:

Shanyan Lin
shanyan.lin@unito.it

Specialty section:

This article was submitted to
Educational Psychology,
a section of the journal
Frontiers in Education

Received: 16 May 2021

Accepted: 21 February 2022

Published: 13 April 2022

Citation:

Longobardi C, Lin S and
Fabris MA (2022) Daytime Sleepiness
and Prosocial Behaviors in
Kindergarten: The Mediating Role
of Student-Teacher Relationships
Quality. *Front. Educ.* 7:710557.
doi: 10.3389/educ.2022.710557

High sleep quality is an important indicator of children's development as well as their good health. The aim of this study was to examine the relationship between excessive daytime sleepiness (EDS) and prosocial behaviors in kindergarten-aged children, as well as exploring the possible mediating role of the teacher-student relationship underlying them. Participants included 60 teachers aged from 23 to 62 ($M = 47.9$, $SD = 9.73$) in Italy who completed the student-teacher relationship scale, the daytime sleepiness questionnaire, and the strength and difficulties questionnaire. The children who were rated by teachers were 936 kindergarten children aged from 3 to 6 ($M = 4.20$, $SD = 0.91$). The results showed that children's daytime sleepiness significantly predicted all three dimensions of the student-teacher relationship. Specifically, children's EDS negatively predicted closeness and positively predicted conflict and dependence, and furthermore, these three dimensions of the relationship significantly predicted children's prosocial behaviors. For older children in our sample, their EDS was more significantly and positively associated with conflict in their relationship with teachers. Our data seem to support the importance of good teacher-student relationship quality in promoting a child's positive social adjustment, especially in children with behavioral difficulties. Our data also suggest the importance of evaluating the quality of the student-teacher relationship as well as the sleep quality in the children's daytime sleepiness.

Keywords: student-teacher relationship, prosocial behavior, sleep problems, daytime sleepiness, kindergarten

INTRODUCTION

Excessive Daytime Sleepiness and Social Functioning in Kindergarten

High sleep quality is an important indicator of children's development as well as their good health, and kindergarten-aged children are particularly vulnerable to the effects of low sleep quality (Alfano et al., 2009; Aronen et al., 2009). Several longitudinal and cross-sectional studies show that poor sleep quality tends to decrease quality of life, resulting associated with behavioral difficulties, such as externalizing and internalizing behaviors (Williamson et al., 2020), poor academic performance (Cook et al., 2020), and physical illness, such as obesity (Fatima et al., 2016). It is estimated that almost 40% of children during in kindergarten develop some sleep-related problems; however, it

is difficult to estimate the prevalence of sleep disorders in pediatrics because there are different definitions and a variety of assessment tools used to diagnose sleep disorders at this stage of development (Wang et al., 2016).

Excessive daytime sleepiness (i.e., the tendency to fall asleep during the day) is considered a possible indicator of sleep disturbance and it can affect children's positive adjustment in kindergarten; it is associated with poor academic performance and emotional and behavioral difficulties (Reynaud et al., 2018). In particular, poor sleep quality might be detrimental to children's adaptation to the school environment by affecting their social competence, such as their prosocial behaviors.

In kindergarten, children with more prosocial behaviors present themselves as cooperative and socially responsible; they are inclined to help other children in need. Prosocial behaviors help children adjust to the school context in kindergarten, considering that more developed social competences tend to be linked with greater peer acceptance, more positive interpersonal relationships, and better academic performance (Hamre and Pianta, 2001). Several authors highlighted the importance of promoting prosocial behaviors in children (Eisenberg, 2014; Laguna et al., 2020) and are researching possible risk factors that may hinder the development of prosocial behaviors in early childhood (Malti and Dys, 2018; Memmott-Elison et al., 2020).

Sleep disorders, including excessive daytime sleepiness (EDS), appear to reduce prosocial behaviors among children in kindergarten ages. Some studies on preschool children found a positive association between sleep duration and social skills (Vaughn et al., 2015). In addition, specifically for kindergarten-aged children, some research highlights a negative association between low sleep quality (including EDS) and prosocial behavior (Horiuchi et al., 2020). This research also tends to report an association between poor sleep quality and a variety of behavioral difficulties, including externalizing disorders (Astill et al., 2012; Reynaud et al., 2018) and internalizing disorders (Astill et al., 2012), aggressive behavior, oppositional behavior, impulsivity, hyperactivity, and attention disorders (Reynaud et al., 2018). These behaviors tend to be negatively related to prosocial behaviors in children and lead to poor self-regulation capacity in adolescents (Memmott-Elison et al., 2020).

Some evidence suggests that sleep disorders in children can also increase emotional and behavioral dysregulation levels, which negatively contributing to the child's social adjustment (Williams et al., 2017), while having a relatively high level of the ability to regulate themselves is necessary for the children to maintain and achieve positive and effective social interactions. Children with poor regulation skills tend to find it more difficult to engage in positive relationships with peers, family members and teachers; they also appear to be aggressive and show a few social skills (Williams et al., 2017). In the peer group, children with relatively poor self-regulation tend to be ostracized and rejected by their peers, and this increases distress and negative interactions among them, helping to inhibit the development of prosocial behaviors (Sette et al., 2013). This indicates the potential harmful influence of poor sleep quality on kindergarten-aged children's prosocial behaviors development. Coincided with this, some previous studies highlight that sleep

disorders in kindergarten can affect the social and emotional development of the children, with consequences for adolescence and adulthood (Wang et al., 2016).

Prosocial Behavior and the Quality of Student-Teachers Relationships

Prosocial behavior tends to develop more easily in children experiencing warm, responsive, supportive, and sensitive relationships with significant adults, including teachers (Longobardi et al., 2020). The teacher is a significant emotional and relational references for the child (Quaglia et al., 2013), and a positive teacher-student relationship tends to promote good psychological adjustment in children (Longobardi et al., 2016a,b, 2019a). In particular, for most Italian children, kindergarten is the first significant social experience outside of the family context. Teachers provide important emotional support for children and help them to adapt to this new social context (Sette et al., 2013; Longobardi et al., 2019b); they serve as adaptive relational models (Quaglia et al., 2013; Longobardi et al., 2020) for the children because generally they stay at school 3 years (3–6 years) with the same teacher for several hours a day on weekdays (Sette et al., 2013).

According to attachment theorists (Bowlby, 1969/1982, Bowlby, 1973), the teacher can be an *ad hoc* figure for developing attachment within the child, who can use the teacher as a safe base to explore the school environment and to seek protection in case of need (Verschueren and Koomen, 2012). Through the relationship with the teacher, the child can internalize positive relational models, which makes the teacher-student relationship so important, as it could affect the child's social competences into the future (Bowlby, 1969/1982). The research on the teacher-student relationship shows three kind of dimensions: closeness, conflict, and dependence (Birch and Ladd, 1997; Pianta, 2001; Longobardi et al., 2019b). Closeness reflects a supportive relationship, characterized by affection and open communication, while a conflict-oriented teacher-child relationship is characterized by discordant interactions and a lack of rapport between the teacher and the child (Birch and Ladd, 1997). Dependence, less studied than the other dimensions, refers to the degree of overreliance of the child on the teacher and the extent to which the child displays clinginess and possessiveness toward the teacher (Sabol and Pianta, 2012; Verschueren and Koomen, 2020). A positive teacher-student relationship tends to be characterized by low conflict and dependence and high levels of closeness, and research suggests it is associated with higher levels of prosocial behaviors in children in both kindergarten-aged children (Palermo et al., 2007; Sette et al., 2013) and school-aged children (Longobardi et al., 2020; Zendarski et al., 2020). Overall, these data seem to indicate that in a positive relationship, which characterized by affection, closeness and respect, the child could internalize a positive and prosocial relational model that could help them in their relationships with others, including adults and their peers (Wentzel, 2002; Quaglia et al., 2013). A positive teacher-student relationship helps the child to develop self-regulation, thus promoting an adequate modulation of emotions and inhibiting inappropriate behaviors;

in this way, socially adaptive behaviors of the child are improved, resulting in greater social competence (Ferreira et al., 2020).

In addition, teachers mediate relationships in the class; they encourage positive behaviors, discourage deviant behaviors, and promote the learning of prosocial behaviors, creating a positive relationship between peers and a more positive class climate (Hamre and Pianta, 2001; Gastaldi et al., 2015; Longobardi et al., 2019a, 2020). However, it is possible that teachers may establish a more positive relationship with prosocial children, precisely because of their improved willingness to have a relationship and their temperamental characteristics (Birch and Ladd, 1997). This suggests a possible bi-directionality between relationship quality and socioemotional outcomes. Some evidence, however, suggests a negative association between both conflictual student-teacher relationships (Mitchell-Copeland et al., 1997; Pasta et al., 2013; Skalická et al., 2015; Marengo et al., 2018) and dependency (Sette et al., 2013; Roorda et al., 2020) and prosocial behaviors in children. Children who have conflicts with their teacher tend to report more externalizing behaviors and are more likely to be rejected by their peers, contributing to poor social adjustment in these children. Similarly, children with a high level of dependency tend to have internalizing symptoms, engage in fewer classroom activities and social interactions, and to be more rejected by peers (Sette et al., 2013; Berchiatti et al., 2020; Ferreira et al., 2020), thus potentially inhibiting the development of social competences.

The Mediating Role of Quality of Student-Teacher Relationships

No previous study has examined the role of the teacher-student relationship on prosocial behaviors in kindergarten-aged children with ESD. Sleep disorders and their effects on the daily functioning of the child could affect the quality of the relationship with adults (Holdaway and Becker, 2018), including teachers. Behavioral problems and poor academic performance may result from a child's poor sleep quality. To the best of our knowledge, only one study conducted among school-aged children has explored the possible relationship between sleep disorder and the quality of student-teacher relationships (Holdaway and Becker, 2018). Holdaway and Becker (2018) identified an association between poor sleep quality and conflicts between students and teachers, particularly between EDS and having a poor relationship with the teacher. According to Holdaway and Becker (2018), children with EDS feel tired and demotivated; they are less motivated to engage in social interactions or to volunteer to participate in class activities. More generally, emotional and behavioral regulation difficulties and academic performance difficulties associated with poor sleep quality and daytime sleepiness could, therefore, affect the quality of the teacher-student relationship, which, in turn, could predict outcomes related to the development of prosocial behaviors in children.

Aim of the Study

The purpose of this research is to extend our knowledge on the relationship between EDS and prosocial behavior in kindergarten-aged children. In particular, we explore the

relationship between EDS and the quality of the teacher-student relationship; we also consider whether the quality of the teacher-student relationship could further mediate the relationship between daytime sleepiness and prosocial behavior. In particular, we expect EDS to be negatively related to prosocial behavior and this relationship would be mediated by the dimensions of teacher-student relationship. Specifically, we hypothesize that EDS is negatively associated with a close student-teacher relationship and that closeness positively correlates with prosocial behavior. In addition, we expect EDS to be positively related to teacher-student relationships characterized by conflict and dependence, leading to a decrease in prosocial behaviors among kindergarten-aged children (Figure 1).

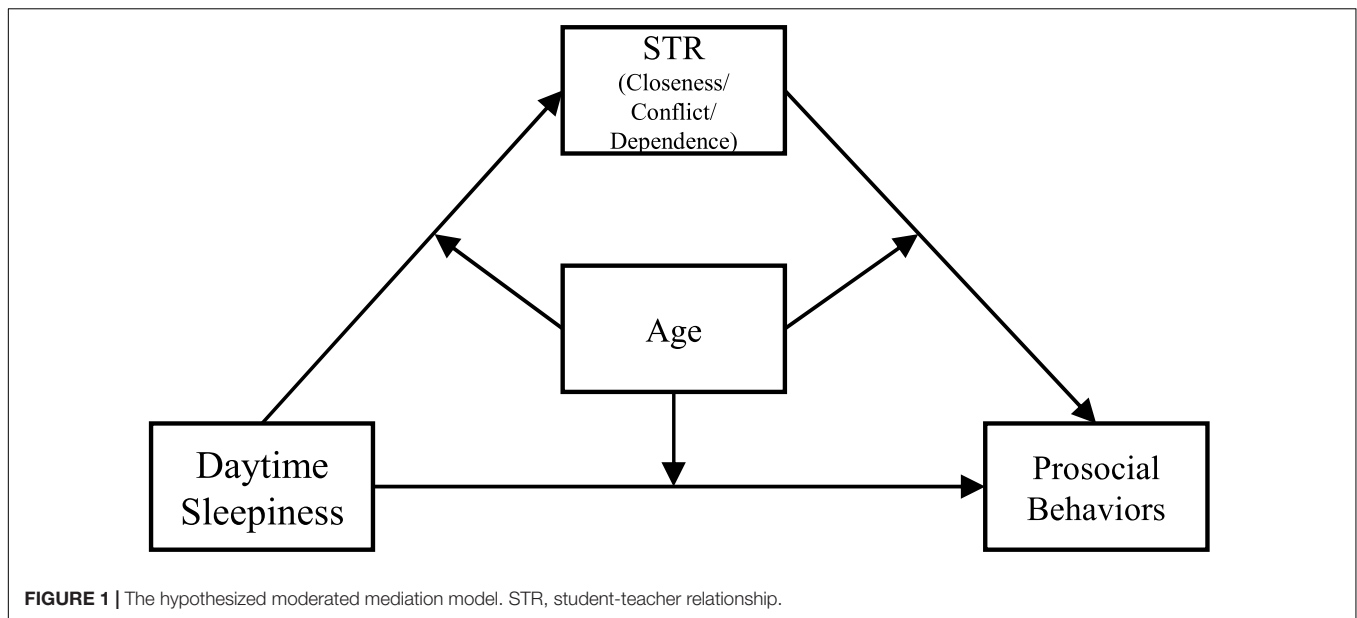
According with Holdaway and Becker (2018), we test the moderating role of age. The authors found in a sample of school-age children that sleep problems and a conflictual student-teacher relationship is significant only for young children due to the inability to regulate itself. Furthermore, the authors found that age moderates the relationship only in reference to the total score of sleep problems, and not of daytime sleepiness. Of course, this age-moderating aspect has not yet been adequately investigated in the literature, and some research suggests that daytime sleepiness tends to increase with age (Liu et al., 2019), and this may have an effect on student-teacher relationship quality in kindergarten. Finally, we believe that the study of EDS in kindergarten children is important, considering that there are few studies on EDS in preschool-aged children, probably due to methodological difficulties, such as the lower availability of psychometrically valid instruments for this developmental period (Sen and Spruyt, 2020).

MATERIALS AND METHODS

Participants

Participants were 936 kindergarten children aged from 3 to 6 ($M = 4.20$, $SD = 0.91$). These children were recruited from 14 kindergartens located in northwestern Italy. There were 456 (48.7%) female children. Most of the children were recognized as Italian ($n = 869$, 92.8%), while the rest were the first or second wave immigrants ($n = 67$, 7.2%). In addition, 60 Italian teachers participated in this research, all of whom were females and spend 8 h per day in a classroom. The average age of the teachers was 47.9 ($SD = 9.73$, $Min = 23$, $Max = 62$).

The teachers of the 936 kindergarten children were recruited online through an online survey because of the current coronavirus (COVID-19) pandemic. After reading the research presentation, the participants (teachers) gave their informed consent by clicking "I accept." and also the parents/legal guardians of kindergarten children were asked to sign written informed consent forms describing the nature and objective of the study. Once they accepted, teachers could begin filling out the anonymous questionnaire. Participation in the study was anonymous and unpaid. The research protocol complies with the 1964 Declaration of Helsinki and the rules of the Italian Association of Psychology (AIP) and was approved by the Ethics Committee of the University of Turin.



Measures

Socio-Demographic Characteristics

Teachers completed a questionnaire inquiring about their age, gender, and education level. Also, were asked to report age, gender and nationality of their kindergartner children.

Daytime Sleepiness

A short scale consisting of ten items, the Teacher's Daytime Sleepiness Questionnaire (TDSQ, Shahid et al., 2011), was used to measure the children's daytime sleepiness in schools from the perspective of their teachers. Sample items of this scale are "How often does this child have trouble staying awake in the morning?" and "How often does this child disrupt school activities because of sleepiness?" Teachers were asked to rate the frequency of such behavior among their students on a 3-point Likert-type scale (1 = *Never or rarely*, 2 = *Sometimes*, and 3 = *Usually*). The final score was the sum of all the ten items, with higher scores indicating more daytime sleepiness problems in school context for the child. For the current sample, the Cronbach's alpha coefficient was 0.76.

Student-Teacher Relationship

The 22-item student-teacher relationship scale (STRS, Fraire et al., 2013) was used, which include three subscales: closeness (eight items, e.g., "I share an affectionate, warm relationship with this child"); conflict (10 items, e.g., "This child and I always seem to be struggling with each other"); and dependence (four items, e.g., "This child is overly dependent on me"). Teachers rated much they agreed with each item on a 5-point Likert-type scale (1 = *Definitely not applies*, 5 = *Definitely applies*). The dimension score was the average of all the items belonging to each dimension, respectively, with a higher score indicating more closeness, conflict, and dependence in the student-teacher relationship. For the current sample, the Cronbach's alpha

coefficients for closeness ($\alpha = 0.88$), conflict ($\alpha = 0.89$), and dependence ($\alpha = 0.72$) were all satisfactory.

Prosocial Behaviors

The subscale of prosocial behaviors in the Strengths and Difficulties Questionnaire (SDQ, Goodman, 1997) was used to measure the children's prosocial behaviors. There are five-item subscales in the SDQ: (1) *hyperactivity* (e.g., "Easily distracted, concentration wanders"); (2) *peer relation problems* (e.g., "Gets along better with adults than with other children"); (3) *emotional symptoms* (e.g., "Nervous or clingy in new situations, easily loses confidence"); (4) *behavioral problems* (e.g., "Often lies or cheats"); and (5) *Prosocial behaviors* (e.g., "Shares readily with other children, for example toys, treats, pencils"). Teachers were required to rate each item on the 3-point Likert-type subscale (0 = *Not true*, 1 = *Somewhat true*, and 2 = *Certainly true*). The final score was the sum of the all the five items in the *prosocial behaviors* subscale, with a range of 0–10. For the current sample, the Cronbach's alpha coefficient was 0.84.

Data Analysis

The SPSS 22.0 (IBM Corp., Armonk, NY, United States) was used to conduct all the data analyses. First, the descriptive and correlative statics for all the studied and controlled variables were calculated. Second, the PROCESS macro (Model 4, Hayes, 2018) was adapted to explore the mediating role of the student-teacher relationship between children's daytime sleepiness and prosocial behaviors. Third, the potential moderating role of children's age in the mediation model of the second step was examined by adapting the PROCESS macro (Model 59, Hayes, 2018). All the continuous variables were standardized. If the 95% confidence intervals, which were estimated by using the 5,000 bias-corrected bootstrapped samples from the original data, do not include zero, the mediation effects and the moderation effects exist. Finally, the

essence of the possible moderating effects of age was explored by applying the simple slope test.

RESULTS

Descriptive Analysis Results

The descriptive and correlative analysis results are presented in **Table 1**. Most of the variables of interests were significantly correlated with one another. Specifically, children's daytime sleepiness was negatively correlated with closeness ($r = -0.35$, $p < 0.001$) and prosocial behaviors ($r = -0.46$, $p < 0.001$) and positively associated with conflict ($r = 0.48$, $p < 0.001$) and dependence ($r = 0.34$, $p < 0.001$). Prosocial behaviors were correlated with all the three dimensions of the student-teacher relationship (closeness: $r = 0.55$, $p < 0.001$; conflict: $r = -0.45$, $p < 0.001$; dependence: $r = -0.21$, $p < 0.001$). Conflict was negatively correlated with closeness ($r = -0.39$, $p < 0.001$), while it was positively correlated with dependence ($r = 0.40$, $p < 0.001$).

In addition, boys had more daytime sleepiness problems ($r = -0.17$, $p < 0.001$) and more conflicts with their teachers ($r = -0.13$, $p < 0.001$) than girls, while girls had a closer relationship with their teachers ($r = 0.17$, $p < 0.001$) and exhibited more prosocial behaviors ($r = 0.18$, $p < 0.001$). Younger children had more daytime sleepiness problems ($r = -0.31$, $p < 0.001$), and they were more dependent on their teachers ($r = -0.09$, $p < 0.01$), while older children had a closer relationship with teachers ($r = 0.12$, $p < 0.001$) and exhibited more prosocial behaviors ($r = 0.27$, $p < 0.001$).

The Mediating Effects of the Student-Teacher Relationship

The PROCESS macro (Model 4) was used to analyze the mediating role of student-teacher relationship in terms of the relationship between children's daytime sleepiness and prosocial behaviors. As illustrated in **Figure 2**, children's daytime sleepiness significantly predicted all three dimensions of the student-teacher relationship. Specifically, children's daytime sleepiness negatively predicted closeness ($B = -0.33$, $p < 0.001$) and positively predicted conflict ($B = 0.47$, $p < 0.001$) and dependence ($B = 0.35$, $p < 0.001$); furthermore, these three dimensions of the relationship significantly predicted the children's prosocial behaviors. At the same time, the residual direct relationship between children's daytime sleepiness and their prosocial behaviors remained significant ($B = -0.20$, $p < 0.001$). These results indicated that the three dimensions of the student-teacher relationship acted as partial mediators between the children's daytime sleepiness and their prosocial behaviors.

The bootstrap procedure was applied to generate the 95% confidence intervals (95% CI) for all the indirect effects of the student-teacher relationship between the children's daytime sleepiness and their prosocial behaviors. The indirect effect of daytime sleepiness on the prosocial behaviors mediated by closeness, conflict, and dependence were, respectively, estimated at -0.1331 (95% CI: $-0.1697 \sim -0.1020$), -0.0782 (95% CI: $-0.1162 \sim -0.0446$), and -0.0219 (95% CI: $-0.0433 \sim -0.0029$). All the 95% CIs did not include zero, which indicates that

children's daytime sleepiness significantly exerted indirect effects on prosocial behaviors *via* all three dimensions of the student-teacher relationship.

The Moderating Effect of Age

To further explore age differences in the mediating model, the PROCESS macro (Model 59) was used to analyze the moderating effects of children's age in both the residential direct effect and the indirect effects between daytime sleepiness and prosocial behaviors. The parameters were estimated in four regression models. In Model 1 to Model 3, the moderating roles of age in the first part of the mediation path between daytime sleepiness and prosocial behaviors were examined. In Model 4, the moderating roles of age in the second part of the mediation path, as well as in the residential direct path, were estimated.

Table 2 illustrates the analysis results. In Model 1 to Model 3 (the first part of the mediation path), daytime sleepiness significantly predicted closeness ($B = -0.32$, $p < 0.001$), conflict ($B = 0.54$, $p < 0.001$), and dependence ($B = 0.36$, $p < 0.001$), while the interaction of daytime sleepiness and age only predicted the conflict dimension of the student-teacher relationship ($B = 0.12$, $p < 0.001$). In Model 4 (the second part of the mediation path and the residential direct path), closeness ($B = 0.39$, $p < 0.001$), conflict ($B = -0.19$, $p < 0.001$), and dependence ($B = -0.06$, $p < 0.05$) still significantly predicted children's prosocial behaviors, and the residential direct path remained significant ($B = -0.15$, $p < 0.001$), while none of the interactions between age and the student-teacher relationship or between age and daytime sleepiness were significant. The second part of the mediation path and the residential direct path were not moderated by age.

To further analyze the moderating effect of age between daytime sleepiness and conflict, a simple slope test was conducted (See **Figure 3**). The results indicated that for older children (1 *SD* above the mean), their daytime sleepiness was significantly and positively associated with conflict in their relationship with their teachers ($B_{simple} = 0.64$, $SE = 0.05$, $p < 0.001$). For younger children (1 *SD* below the mean), the relationship between daytime sleepiness and conflict was also positive and significant ($B_{simple} = 0.39$, $SE = 0.04$, $p < 0.001$), but this association was weaker than in older children. This result emphasized that the adverse impact of daytime sleepiness on enhancing conflicts in the student-teacher relationship was stronger for the older children.

DISCUSSION

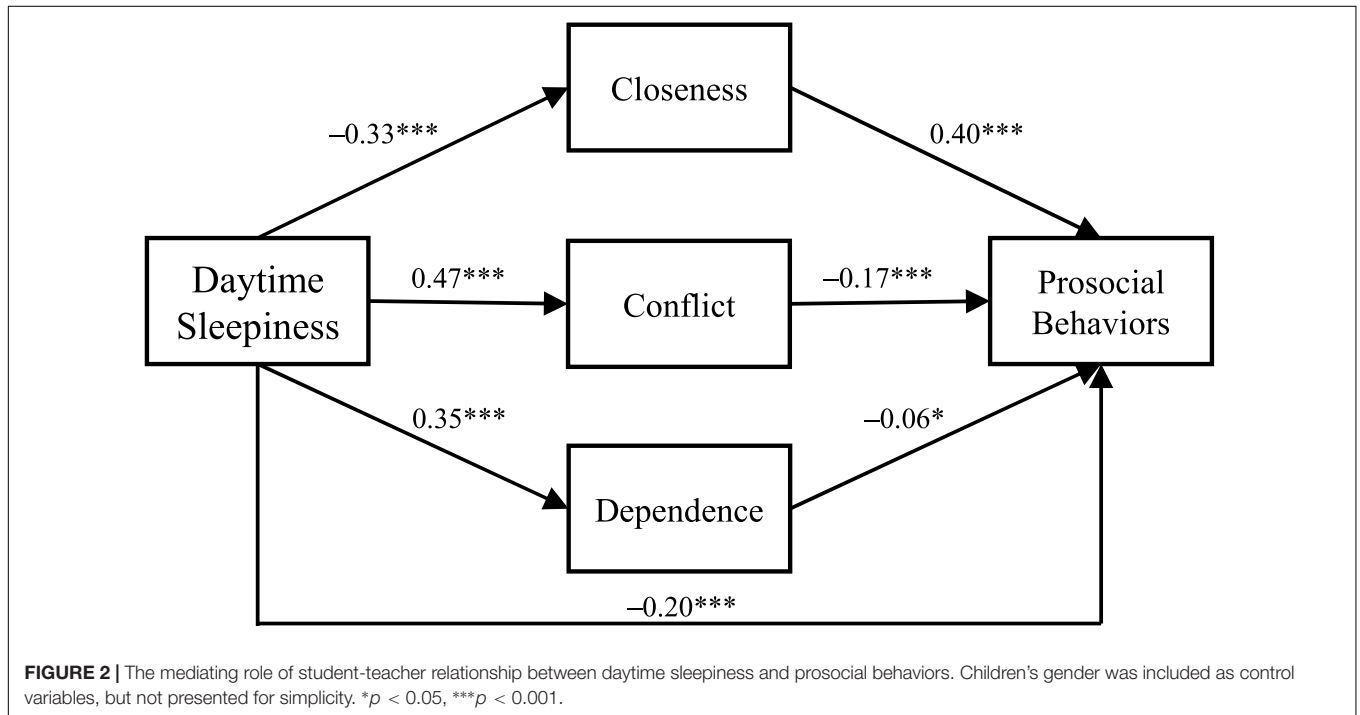
The aim of our research is to extend knowledge about the relationship between EDS and prosocial behaviors of children in kindergarten, as well as exploring the possible mediating effects of the teacher-student relationship quality. Previous research examined school-age sleep disorders within clinical populations, with parents reporting their children's sleep disorders (Astill et al., 2012). In the current research, we employed the teacher as a reference to estimate EDS in kindergarten. We selected EDS as an indicator of sleep quality, not only because it

TABLE 1 | Means, standard deviations, and correlations of the variables (N = 936).

Variables	1	2	3	4	5	6	7
1. Gender	–						
2. Age	–0.02	–					
3. Daytime sleepiness	–0.17***	–0.31***	–				
4. Closeness	0.17***	0.12***	–0.35***	–			
5. Conflict	–0.13***	–0.06	0.48***	–0.39***	–		
6. Dependence	–0.01	–0.09**	0.34***	–0.04	0.40***	–	
7. Prosocial behaviors	0.18***	0.27***	–0.46***	0.55***	–0.45***	–0.21***	–
M	1.49	4.20	11.92	4.15	1.35	1.57	7.04
SD	0.50	0.91	2.47	0.80	0.61	0.76	2.64

Gender was coded as 1 = male, 2 = female.

p < 0.01, *p < 0.001.



can be conceptualized as a consequence of sleep disorders but also because it is an easily observable behavior in the school context (Holdaway and Becker, 2018). In addition, EDS was more associated with school functioning than other sleep disorders (Dewald et al., 2010). Therefore, studying daytime sleepiness and its impact on children's other behaviors (e.g., prosocial behaviors), as well as the mediating and moderating mechanisms in this relationship, might help us better understand children's behaviors in school context and further help us develop some possible intervention programs. Our study shows that males are more at risk of EDS, but the literature on gender distinctions regarding sleep disorders, especially at this age, appears incomplete and contradictory (Yağcıntaş-Sezgin and Ulus, 2019). Females report more prosocial behavior and enjoy a better quality relationship with their teacher than boys. These results are in accordance with the literature that seems to indicate in females a greater propensity to exhibit prosocial behavior and

to have a better relationship with their teachers. These gender differences may be related to cultural aspects that lead girls to develop greater emotion and behavior regulation skills (Hamre and Pianta, 2001; Horn et al., 2020).

The data from the present study suggest that a negative correlation between EDS and prosocial behaviors in children and identify the possible mediating role of the quality of the teacher-student relationship. In this regard, our research supports a direct and indirect association between daytime sleepiness and prosocial behavior. These results are also in line with previous research showing that poor sleep quality tends to be associated with a decrease in prosocial behavior in children (da Silva et al., 2020; Horiuchi et al., 2020). This finding could be due to the fact that children with sleep disorders, and daytime sleepiness in particular, tend to present emotional and behavioral dysregulation, which could, therefore, negatively affect the child's social adjustment and result in greater rejection and exclusion

TABLE 2 | Testing the moderated mediating effect of daytime sleepiness on prosocial behaviors.

Predictors	Model 1 (Closeness)			Model 2 (Conflict)			Model 3 (Dependence)			Model 4 (Prosocial behaviors)		
	B	SE	95% CI	B	SE	95% CI	B	SE	95% CI	B	SE	95% CI
Children's gender	0.22***	0.06	[0.10, 0.35]	-0.08	0.06	[-0.20, 0.03]	0.11	0.06	[-0.01, 0.23]	0.13*	0.05	[0.03, 0.23]
Children's age	0.03	0.03	[-0.04, 0.09]	0.11***	0.03	[0.05, 0.17]	0.02	0.03	[-0.05, 0.08]	0.16***	0.03	[0.11, 0.22]
Daytime sleepiness	-0.32***	0.03	[-0.39, -0.25]	0.54***	0.03	[0.48, 0.17]	0.36***	0.04	[0.27, 0.42]	-0.15***	0.03	[-0.21, -0.08]
Daytime sleepiness × Age	0.01	0.03	[-0.06, 0.07]	0.12***	0.03	[0.05, 0.18]	0.01	0.03	[-0.06, 0.08]	-0.01	0.03	[-0.07, 0.06]
Closeness										0.39***	0.03	[0.33, 0.45]
Conflict										-0.19***	0.03	[-0.25, -0.13]
Dependence										-0.06*	0.03	[-0.11, -0.01]
Closeness × Age										-0.01	0.03	[-0.07, 0.05]
Conflict × Age										-0.02	0.03	[-0.09, 0.04]
Dependence × Age										0.03	0.03	[-0.03, 0.08]
R ²	0.14			0.25			0.11			0.43		
F	36.83***			77.76***			30.67***			71.09***		

N = 936.
 Gender was coded as 1 = male, 2 = female.
 Every column is a regression model, and the outcome variable at the top of each column was predicted by its model. All the continuous variables were standardized.
 *p < 0.05, ***p < 0.001.

from their peers, thus inhibiting social interactions and the development of prosocial behavior (Palermo et al., 2007; Sette et al., 2013). However, we must also keep in mind here that our study is a cross-sectional study and therefore it is not possible to draw conclusions about linear causal relationships between variables. For example, if it is true that poor sleep quality tends to be associated with a decline in prosocial behavior, then it is also true that there is evidence that sleep problems and aggressive behavior share similarities from a genetic perspective. In this sense, poor sleep may not be the cause of aggressive behavior, but rather appears to be a reflection of shared genes (Madrid-Valero et al., 2019). In addition, some studies find that children who exhibit less prosocial behavior tend to be less monitored by their parents in a number of activities that potentially affect sleep quality, such as media consumption (Gentile et al., 2014). Therefore, further studies are needed to clarify the relationship between prosocial behaviors and sleep quality.

Kindergarten-aged children are in a developmental stage that is important for developing prosocial behaviors, and the literature indicates that children tend to develop more prosocial behavior in relational contexts that are characterized by support, emotional closeness, and sensitivity (Longobardi et al., 2020). In this regard, literature suggests that sleep disorders tend to affect the quality of relationships that children have with adults, including teachers (Holdaway and Becker, 2018). Our data seem to support this position, indicating a negative association between EDS and closeness in teacher student-relationships and a positive association between EDS and both conflict and dependency in teacher-child relationships.

These results concur with what Holdaway and Becker (2018) found in a sample of school-aged children. Overall, it can be argued that children with poor sleep quality have a worse relationship with their teacher. It is, therefore, possible that children with EDS tend to present themselves as demotivated, tired, socially unresponsive, and less inclined to take part in class activities, resulting in a relationship with their teacher that is perceived as less close. In addition, children with EDS tend to have poorer academic results and may present aggressive and externalize symptoms in interactions with their teacher, resulting in a teacher-student relationship characterized by more conflicts.

Our study considers the dependence dimensions of the teacher-student relationship, which was not evaluated by Holdaway and Becker (2018) study in school-aged children. Our data show a positive relationship between EDS and dependence in teacher-student relationships. For this result, one possible explanation is that difficulties in academic performance and poor motivation to interact socially and participate in class activities may require the child to have more support from their teacher, who could understand the negative relationship to stem from the child's lack of autonomy.

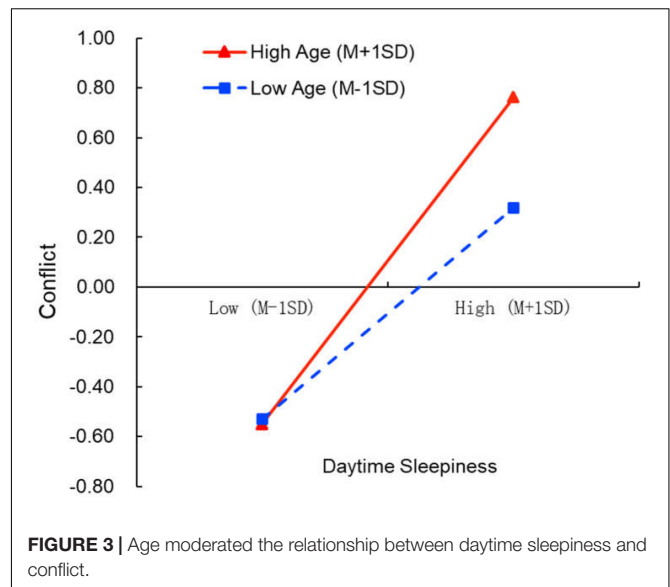
We must point out, however, that our study took a cross-sectional approach and therefore it is not possible to infer a causal relationship from our data. Along these lines, some findings from studies on the relationship between sleep quality and relationship quality with parents suggest a bidirectional relationship between the two constructs (Kelly and El-Sheikh, 2011), and this could also apply to the relationship with the teacher. For example, it

is possible that a relationship with the teacher that is perceived as less close and more conflictual is a source of stress and worry for the child, thus increasing rumination or distress, which may affect sleep quality and ultimately EDS. Further studies are needed to understand the direction of causality between EDS and the quality of the teacher-student relationship and what mechanisms are involved.

Finally, our study found that the quality of the teacher-student relationship quality may act as a mediator in the relationship between EDS and prosocial behaviors in kindergarten-aged children. In particular, EDS seems to negatively affect prosocial behavior through a relationship with the teacher that is characterized by dependence and conflict, while closeness seems to shield the negative effects of daytime sleepiness by predicting more prosocial behaviors. The teacher plays an important role in favoring the processes of social and psychological adjustment of the child in the school context (Quaglia et al., 2013; Gastaldi et al., 2015; Longobardi et al., 2019a). Within a supporting relationship, characterized by closeness and respect for the needs of the child, the teacher can stimulate the emotional and behavioral regulation of the child and transmit more positive relational models, which are characterized by prosocial behaviors and low aggression (Wentzel, 2002; Quaglia et al., 2013).

In contrast, sleep disorders and their effects on the daily functioning of the child could contribute to a poorer teacher-student relationship, thus hindering the development of social skills and prosocial behaviors among children. In this regard, EDS can be associated with behavioral difficulties, such as oppositional behaviors, aggressive conduct, and hyperactivity, which tend to be associated with a more conflictual relationship with the teacher. Thus, in turn, this increases the child's distress and does not facilitate the good social adjustment of the child in the class context, thus leading to fewer prosocial behaviors. In addition, children with EDS may present themselves as tired and socially unresponsive; they may also have internalizing disorders (Astill et al., 2012; Reynaud et al., 2018) and difficulties in a cognitive performance (Dewald et al., 2010), thus demonstrating less autonomy and making the student appear more dependent on the teacher. Children with much dependency on the teacher tend to present internalizing symptoms and avoid class activities, which results in greater rejection by their peers and prevents students from having more social interactions. In this way, a greater dependence on the teacher could hinder the child's social adjustment and affect the development of their social skills (Sette et al., 2013; Ferreira et al., 2020).

Finally, Holdaway and Becker (2018) found age had a moderating effect, indicating that in school-aged children sleep problems are significantly associated with conflictual student-teacher relationships, but only for younger children. According to the authors, this is due to the fact that older children tend to be more skilled in self-regulation and the teacher seems to be less exposed to sleepiness than older children. However, the moderating function of gender has been found only for the total score of the sleep problem and not for specific domains, such as daytime sleepiness. We wanted to test the moderating effect of age in our sample as well. Our data show that age moderates the relationship between EDS but only in terms of conflict and the



student-teacher relationship. This association is significant and positive in both young and older children. However, it is much stronger in older than young children.

This result deserves more attention in future research. The fact that younger children are less skilled in self-regulation than school-aged children could probably explain why the association between EDS and conflict was positive in both groups in our sample. However, the fact that the association is stronger in older children seems to contradict the findings of Holdaway and Becker (2018). Some methodological features may explain this difference, and, indeed, our research is based on a large sample of kindergarten children, while Holdaway and Becker (2018) investigated a narrower sample of aged-children schools, with a longer timeframe considered in the age of the sample. However, some studies suggest that EDS tends to grow with age (Liu et al., 2019), and this may explain why in older children, the association between EDS and conflictual relationships with teachers is stronger.

Our study has strengths and limitations. In terms of strengths, our study seeks to expand our knowledge of EDS and its relationship to prosocial behavior and the quality of student-teacher relationships in an under-researched sample. In addition, we recruited a relatively large sample of kindergarten students, and teachers were included as informants related to EDS. Despite the contribution our findings make to the literature, caution must be exercised in interpreting our data, and the limitations of the research must be carefully considered. Indeed, the cross-sectional approach we used precludes expressing our findings in terms of linear causality. Future studies should therefore adopt a longitudinal/experimental approach to examine longitudinal/causal relationships between these constructs. In addition, we used EDS as an indicator of poor sleep quality, which is readily observable in the preschool context. However, our study does not directly measure sleep quality or sleep disturbance. Therefore, future studies could incorporate appropriate instruments to directly measure these

variables. More generally, we should note that ESD is a difficult symptom to assess objectively in pediatric populations, particularly in preschool children. In addition, future research could include more sleep-quality informants (teachers and parents together, for example) and could make comparisons on the relationship between the constructs investigated at different ages (e.g., comparing kindergarten-aged children with school-aged children, both preadolescents and adolescents).

CONCLUSION

In conclusion, our data extend knowledge about the relationship between EDS and prosocial behaviors in kindergarten-aged children, identifying the possible mediating role of on the teacher-student relationship quality. In particular, EDS could negatively affect this relationship, resulting in fewer possibilities for the children to develop adequate social competences. Our data also seem to support the importance of a positive teacher-student relationship in promoting the social adjustment of the child, especially in children with behavioral difficulties.

In addition, our research could also have practical implications. In fact, our data suggest the importance of evaluating sleep quality in children with low prosocial behaviors in kindergarten as well as soliciting specific assessments and implementing psychological interventions. Moreover, it is important to evaluate the social functioning of children who have

EDS and to work with teachers in the school context in order to observe the relationship with their students and stimulate more adaptive social behaviors.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Turin. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

CL, SL, and MF were involved with the design and interpretation of this work as well as writing the manuscript. CL and MF were involved in the acquisition of the data. SL and MF analyzed the data and contributed to the writing of the manuscript. CL supervised all phase of research. All authors contributed to the article and approved the submitted version.

REFERENCES

- Alfano, C. A., Zakem, A. H., Costa, N. M., Taylor, L. K., and Weems, C. F. (2009). Sleep problems and their relation to cognitive factors, anxiety, and depressive symptoms in children and adolescents. *Depr. Anx.* 26, 503–512. doi: 10.1002/da.20443
- Aronen, E. T., Liukkonen, K., Simola, P., Virkkula, P., Uschakoff, A., Korkman, M., et al. (2009). Mood is associated with snoring in preschool-aged children. *J. Dev. Behav. Ped.* 30, 107–114. doi: 10.1097/DBP.0b013e31819d70a2
- Astill, R. G., Van der Heijden, K. B., Van Ijzendoorn, M. H., and Van Someren, E. J. (2012). Sleep, cognition, and behavioral problems in school-age children: a century of research meta-analyzed. *Psychol. Bull.* 138:1109. doi: 10.1037/a0028204
- Berchiatti, M., Badenes-Ribera, L., Ferrer, A., Longobardi, C., and Gastaldi, F. G. M. (2020). School Adjustment in Children Who Stutter: The Quality of the Student-Teacher Relationship, Peer Relationships, and Children's Academic and Behavioral Competence. *Child. Youth Serv. Rev.* 2020:105226. doi: 10.1016/j.childev.2020.105226
- Birch, S. H., and Ladd, G. W. (1997). The teacher-child relationship and children's early school adjustment. *J. Sch. Psychol.* 35, 61–79.
- Bowlby, J. (1969/1982). *Attachment and loss: Vol. 1. Attachment*. New York, NY: Basic Books.
- Bowlby, J. (1973). *Attachment and loss: Vol. 2. Separation: Anxiety and anger*. New York, NY: Basic Books.
- Cook, F., Conway, L. J., Giallo, R., Gartland, D., Sciberras, E., and Brown, S. (2020). Infant sleep and child mental health: a longitudinal investigation. *Archiv. Dis. Childh.* 105, 655–660. doi: 10.1136/archdischild-2019-318014
- da Silva, A. C., do Carmo, A. S., and dos Santos, L. C. (2020). Associations between sleep practices and social behavior of children and adolescents: a systematic review. *J. Public Health* 1–12. doi: 1007/s10389-020-01388-8
- Dewald, J. F., Meijer, A. M., Oort, F. J., Kerkhof, G. A., and Bögels, S. M. (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: a meta-analytic review. *Sleep Med. Rev.* 14, 179–189. doi: 10.1016/j.smrv.2009.10.004
- Eisenberg, N. (2014). *Altruistic emotion, cognition, and behavior (PLE: Emotion)*. Hove: Psychology Press.
- Fatima, Y., Doi, S. A. R., and Mamun, A. A. (2016). Sleep quality and obesity in young subjects: a meta-analysis. *Obesit. Rev.* 17, 1154–1166. doi: 10.1111/obr.12444
- Ferreira, T., Cadima, J., Matias, M., Leal, T., and Matos, P. M. (2020). Teacher-child dependency in preschool: links with teacher-child closeness, conflict and children's effortful control. *Attach. Hum. Dev.* 2020, 1–16. doi: 10.1080/14616734.2020.1752438
- Fraire, M., Longobardi, C., Prino, L. E., Sclavo, E., and Settanni, M. (2013). Examining the Student-Teacher Relationship Scale in the Italian context: a factorial validity study. *Electr. J. Res. Educ. Psychol.* 11, 851–882. doi: 10.14204/ejrep.31.13068
- Gastaldi, F. G. M., Longobardi, C., Quaglia, R., and Settanni, M. (2015). Parent-teacher meetings as a unit of analysis for parent-teacher interactions. *Culture & Psychology* 21, 95–110. doi: 10.1177/1354067X15570488
- Gentile, D. A., Reimer, R. A., Nathanson, A. I., Walsh, D. A., and Eisenmann, J. C. (2014). Protective effects of parental monitoring of children's media use: a prospective study. *JAMA pediatrics* 168, 479–484. doi: 10.1001/jamapediatrics.2014.146
- Goodman, R. (1997). The Strengths and Difficulties Questionnaire: a research note. *J. Child Psychol. Psychiat. All. Dis.* 38, 581–586. doi: 10.1111/j.1469-7610.1997.tb01545.x
- Hamre, B. K., and Pianta, R. C. (2001). Early teacher-child relationships and the trajectory of children's school outcomes through eighth grade. *Child Dev.* 72, 625–638. doi: 10.1111/1467-8624.00301
- Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*, 2nd Edn. New York, NY: Guilford Press.
- Holdaway, A. S., and Becker, S. P. (2018). Children's sleep problems are associated with poorer student-teacher relationship quality. *Sleep Med.* 47, 100–105. doi: 10.1016/j.sleep.2017.12.001
- Horiuchi, F., Kawabe, K., Oka, Y., Nakachi, K., Hosokawa, R., and Ueno, S. I. (2020). Mental Health and Sleep Habits/Problems in Children at 3–4 Years of

- Age: a General Population Study. *Res. Square* 2020:94419. doi: 10.21203/rs.3.rs-94419/v1
- Horn, E. P., McCormick, M. P., O'Connor, E. E., McClowry, S. G., and Hogan, F. C. (2020). Trajectories of teacher-child relationships across kindergarten and first grade: the influence of gender and disruptive behavior. *Early Childh. Res. Q.* 55, 107–118. doi: 10.1016/j.ecresq.2020.10.003
- Kelly, R. J., and El-Sheikh, M. (2011). Marital conflict and children's sleep: reciprocal relations and socioeconomic effects. *J. Family Psychol.* 25, 412. doi: 10.1037/a0023789
- Laguna, M., Mazur, Z., Kędra, M., and Ostrowski, K. (2020). Interventions stimulating prosocial helping behavior: a systematic review. *J. Appl. Soc. Psychol.* 50, 676–696. doi: 10.1111/jasp.12704
- Liu, Y., Zhang, J., Li, S. X., Chan, N. Y., Yu, M. W. M., Lam, S. P., et al. (2019). Excessive daytime sleepiness among children and adolescents: prevalence, correlates, and pubertal effects. *Sleep Med.* 53, 1–8. doi: 10.1016/j.sleep.2018.08.028
- Longobardi, C., Settanni, M., Lin, S., and Fabris, M. A. (2020). Student-teacher relationship quality and prosocial behaviour: the mediating role of academic achievement and a positive attitude towards school. *Br. J. Educ. Psychol.* 2020:12378. doi: 10.1111/bjep.12378
- Longobardi, C., Prino, L. E., Marengo, D., and Settanni, M. (2016a). Student-teacher relationships as a protective factor for school adjustment during the transition from middle to high school. *Front. Psychol.* 7:1988. doi: 10.3389/fpsyg.2016.01988
- Longobardi, C., Gastaldi, F. G. M., Prino, L. E., Pasta, T., and Settanni, M. (2016b). Examining student-teacher relationship from students' point of view: Italian adaptation and validation of the young children's appraisal of teacher support questionnaire. *Open Psychol. J.* 9:1. doi: 10.2174/1874350101609010176
- Longobardi, C., Badenes-Ribera, L., Gastaldi, F. G. M., and Prino, L. E. (2019b). The student-teacher relationship quality in children with selective mutism. *Psychol. Sch.* 56, 32–41. doi: 10.1002/pits.22175
- Longobardi, C., Settanni, M., Prino, L. E., Fabris, M. A., and Marengo, D. (2019a). Students' Psychological Adjustment in Normative School Transitions From Kindergarten to High School: Investigating the Role of Teacher-Student Relationship Quality. *Front. Psychol.* 10:1238. doi: 10.3389/fpsyg.2019.01238
- Malti, T., and Dys, S. P. (2018). From being nice to being kind: development of prosocial behaviors. *Curr. Opin. Psychol.* 20, 45–49. doi: 10.1016/j.copsyc.2017.07.036
- Marengo, D., Jungert, T., Iotti, N. O., Settanni, M., Thornberg, R., and Longobardi, C. (2018). Conflictual student-teacher relationship, emotional and behavioral problems, prosocial behavior, and their associations with bullies, victims, and bullies/victims. *Educ. Psychol.* 38, 1201–1217. doi: 10.1080/01443410.2018.1481199
- Madrid-Valero, J. J., Ordoñana, J. R., Klump, K. L., and Burt, S. A. (2019). Children sleep and antisocial behavior: differential association of sleep with aggression and rule-breaking. *J. Abnorm. Child Psychol.* 47, 791–799. doi: 10.1007/s10802-018-0480-0
- Memmott-Elison, M. K., Holmgren, H. G., Padilla-Walker, L. M., and Hawkins, A. J. (2020). Associations between prosocial behavior, externalizing behaviors, and internalizing symptoms during adolescence: a meta-analysis. *J. Adolesc.* 80, 98–114. doi: 10.1016/j.adolescence.2020.01.012
- Mitchell-Copeland, J., Denham, S. A., and DeMulder, E. K. (1997). Q-sort assessment of child-teacher attachment relationships and social competence in the preschool. *Early Educ. Dev.* 8, 27–39. doi: 10.1207/s15566935eed0801_3
- Palermo, F., Hanish, L. D., Martin, C. L., Fabes, R. A., and Reiser, M. (2007). Preschoolers' academic readiness: what role does the teacher-child relationship play? *Early Childh. Res. Q.* 22, 407–422. doi: 10.1016/j.ecresq.2007.04.002
- Pasta, T., Mendola, M., Longobardi, C., Pino, L. E., and Gastaldi, F. G. M. (2013). Attributional style of children with and without Specific Learning Disability. *Electr. J. Res. Educ. Psychol.* 31, 649–664. doi: 10.14204/ejrep.31.13064
- Pianta, R. C. (2001). *STRS: Student-teacher Relationship Scale: professional manual*. Lutz, FL: Psychological Assessment Resources.
- Quaglia, R., Gastaldi, F. G., Prino, L. E., Pasta, T., and Longobardi, C. (2013). The pupil-teacher relationship and gender differences in primary school. *Open Psy. J.* 6, 69–75. doi: 10.2174/1874350101306010069
- Reynaud, E., Vecchierini, M. F., Heude, B., Charles, M. A., and Plancoulaine, S. (2018). Sleep and its relation to cognition and behaviour in preschool-aged children of the general population: a systematic review. *J. Sleep Res.* 27:e12636. doi: 10.1111/jsr.12636
- Roorda, D. L., Zee, M., and Koomen, H. M. (2020). Don't forget student-teacher dependency! A Meta-analysis on associations with students' school adjustment and the moderating role of student and teacher characteristics. *Attach. Hum. Dev.* 2020, 1–14. doi: 10.1080/14616734.2020.1751987
- Sabol, T. J., and Pianta, R. C. (2012). Recent trends in research on teacher-child relationships. *Attach. Hum. Dev.* 14, 213–231. doi: 10.1080/14616734.2012.672262
- Sen, T., and Spruyt, K. (2020). Pediatric sleep tools: an updated literature review. *Front. Psychiat.* 11:317. doi: 10.3389/fpsyg.2020.00317
- Sette, S., Spinrad, T. L., and Baumgartner, E. (2013). Links among Italian preschoolers' socioemotional competence, teacher-child relationship quality, and peer acceptance. *Early Educ. Dev.* 24, 851–864. doi: 10.1080/10409289.2013.744684
- Shahid, A., Wilkinson, K., Marcu, S., and Shapiro, C. M. (2011). *Teacher's Daytime Sleepiness Questionnaire (TDSQ) in STOP, THAT and One Hundred Other Sleep Scales*. New York, NY: Springer, 387–388.
- Skalická, V., Stenseng, F., and Wichstrøm, L. (2015). Reciprocal relations between student-teacher conflict, children's social skills and externalizing behavior: a three-wave longitudinal study from preschool to third grade. *Inter. J. Behav. Dev.* 39, 413–425. doi: 10.1177/0165025415584187
- Vaughn, B. E., Elmore-Staton, L., Shin, N., and El-Sheikh, M. (2015). Sleep as a support for social competence, peer relations, and cognitive functioning in preschool children. *Behav. Sleep Med.* 13, 92–106. doi: 10.1080/15402002.2013.845778
- Verschueren, K., and Koomen, H. (2020). Dependency in teacher-child relationships: deepening our understanding of the construct. *Attach. Hum. Dev.* 2020, 1–9. doi: 10.1080/14616734.2020.1751986
- Verschueren, K., and Koomen, H. M. (2012). Teacher-child relationships from an attachment perspective. *Attachment & human development* 14, 205–211. doi: 10.1080/14616734.2012.672260
- Wang, B., Isensee, C., Becker, A., Wong, J., Eastwood, P. R., Huang, R. C., et al. (2016). Developmental trajectories of sleep problems from childhood to adolescence both predict and are predicted by emotional and behavioral problems. *Front. Psychol.* 7:1874. doi: 10.3389/fpsyg.2016.01874
- Wentzel, K. R. (2002). Are effective teachers like good parents? Teaching styles and student adjustment in early adolescence. *Child Dev.* 73, 287–301. doi: 10.1111/1467-8624.00406
- Williams, K. E., Berthelsen, D., Walker, S., and Nicholson, J. M. (2017). A developmental cascade model of behavioral sleep problems and emotional and attentional self-regulation across early childhood. *Behav. Sleep Med.* 15, 1–21. doi: 10.1080/15402002.2015.1065410
- Williamson, A. A., Mindell, J. A., Hiscock, H., and Quach, J. (2020). Longitudinal sleep problem trajectories are associated with multiple impairments in child well-being. *J. Child Psychol. Psychiatry* 61, 1092–1103. doi: 10.1111/jcpp.13303
- Yalçınbaş-Sezgin, E., and Ulus, L. (2019). Parental influence on sleep habits and problems in preschool children. *Sleep Hypn.* 21, 281–292. doi: 10.37133/sleep.hypn.2019.21.0196
- Zendarski, N., Haebich, K., Bhide, S., Quek, J., Nicholson, J. M., Jacobs, K. E., et al. (2020). Student-teacher relationship quality in children with and without ADHD: a cross-sectional community based study. *Early Childhood Res. Q.* 51, 275–284. doi: 10.1016/j.ecresq.2019.12.006

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2022 Longobardi, Lin and Fabris. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.