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Loneliness and teacher-student relationships in children and adolescents: Multilevel cross-cultural meta-analyses of cross-sectional and longitudinal studies

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ABSTRACT

This study synthesized the literature from international and Chinese databases regarding the associations between loneliness and the quality of affective teacher-student relationships (TSRs) among children and adolescents ages 5.34–17.09 years. Forty-seven studies published between 2005 and 2023 were included in a cross-sectional meta-analysis using a multi-level approach. Moderators of the relationship, including culture, study, sample, and measurement characteristics, were also examined. Findings indicated a significant medium effect size ($r = -0.226$) between loneliness and TSRs with effects moderated by students' gender and national cultural background (i.e., Hofstede's Power Distance and Long-term/Short-term Orientation Dimensions). Longitudinal meta-analyses were performed with six studies by using cross-lagged regression to investigate the prospective effects between these two variables. Results showed that loneliness predicted subsequent TSRs ($\beta = -0.1661$) and TSRs predicted subsequent loneliness ($\beta = -0.0917$), indicating a reciprocal prospective relationship over time. The findings emphasize not only the role of teachers in students' experiences of loneliness, but also the role that loneliness has on an individual's relationships with others. Recommendations for intervention include (a) increasing teacher awareness of student loneliness and (b) ensuring that any school-based work considers the specific social-cultural perspective.

1. Introduction

Loneliness among children and adolescents has received increasing attention from researchers and policymakers that includes scrutiny of school settings. Some research suggests that positive or negative interactions between students and teachers may be associated with students' perceived loneliness (Morin, 2020). Additionally, there is evidence that teacher-student relationships (TSRs) are important (Bayat et al., 2021). However, although we have a clear idea of how friendship experiences are associated with loneliness (Schwartz-Mette et al., 2020), there has been no meta-analysis exploring the associations between loneliness and TSRs. The present study fills that gap and integrates the existing literature from 2005 to provide a rigorous examination of concurrent and longitudinal relationships between loneliness and TSRs. Furthermore, we explored the role of culture in moderating the strength of

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these associations.

1.1. Loneliness in children and adolescents

Loneliness is an unpleasant emotional state resulting from a discrepancy between the interpersonal relationships people perceive and those they desire (Peplau & Perlman, 1982). Loneliness is conceptualized as a subjective aversive experience, distinct from the objective state of being alone (Jefferson, Barreto, Verity, & Qualter, 2023). Loneliness can occur even when surrounded by many people, and spending time alone does not guarantee the emergence of loneliness (Hawkley & Cacioppo, 2010). This conceptualization has also been mirrored in cross-cultural research studies (Heu, Hansen, et al., 2021). Evidence suggests a U-shaped distribution across the developmental lifespan where youth and older people face a higher risk of loneliness compared to those in middle age (Lasgaard et al., 2016; Victor & Yang, 2012), which is likely due to frequent changes in social relationships (Qualter et al., 2015). Thus, loneliness is a common experience among school children and adolescents, with nearly 20% of eight-year-old children reporting loneliness (Lempinen et al., 2018), and the pooled prevalence among adolescents aged 12–17 years ranging from 9.2% to 14.4% across 77 countries and territories (Surkalim et al., 2022).

School is an essential context for children and adolescents to build social and emotional connections (Uslu & Gizir, 2017) given the substantial amount of time they spend there (Verity et al., 2021). Loneliness can be seen as an individual's response to the absence of satisfying interactions with classmates and teachers in that social environment (Krause-Parello, 2008). Utilizing data from the Programme for International Student Assessment (PISA) survey, Twenge et al. (2021) indicated that the number of students suffering from school-related loneliness increased steadily in 36 out of 37 countries between 2012 and 2018, resulting in an average of 30.86% of adolescents reporting loneliness in the school context.

Loneliness for children and young people has been found to be a barrier to both mental and physical health (Christiansen et al., 2021; Hards et al., 2022). In the school context, loneliness has negative impacts on students' social skills, sense of school belonging, and subjective well-being (Arslan, 2021; Berguno, Leroux, McAinsh, & Shaikh, 2004). Children and adolescents who report frequently feeling lonely also perform worse academically (Jefferson, Barreto, Jones, et al., 2023) and have higher school dropout rates (Ramsdal et al., 2013). Furthermore, long-term loneliness contributes to educational attainment at the end of high school, employment prospects, and life satisfaction (Matthews et al., 2023). Thus, it is important to explore the role of loneliness throughout the child and adolescent years and make efforts to improve students' positive interpersonal relationships in school settings.

1.2. Teacher-student relationships and loneliness

Teachers are often considered to be the most critical adults in the school social environment for children and adolescents; consequently, TSRs quality influences students' social, cognitive, and emotional development (Baker et al., 2008; Birch & Ladd, 1998; Eccles & Roeser, 2011; Hamre & Pianta, 2001). Teachers often provide a safe environment for students to engage in school and classroom activities and to confront mental health challenges (Bowlby, 1997; Verschueren & Koomen, 2012). Conversely, low-quality TSRs may cause feelings of insecurity among students that negatively affect students' academic performance and socioemotional engagement (Lei et al., 2016; Roorda et al., 2011).

Regarding loneliness, teachers play a crucial role in supporting students who suffer from the negative emotions that make up the loneliness experience in school settings (Bayat et al., 2021). Prioritizing the voices of young people, Verity et al. (2024) emphasized that school is a preferential environment over home for some lonely students as attentive teachers often help students in their management of negative emotions and their experiences of loneliness. Students may, in contrast, have their loneliness experiences dismissed by teachers. Under such circumstances, school is considered an overwhelming place where teachers are inclined to pay more attention to academic outcomes compared to student wellbeing (Verity et al., 2021). Moreover, several quantitative studies have investigated the statistical associations between loneliness and TSRs (e.g., Al-Yagon et al., 2016; Baskin et al., 2010; Zhang et al., 2015) and other studies have reported these associations across different time points (e.g., Cavanaugh & Buehler, 2016; Gest et al., 2005; Lätsch, 2018).

Galanaki and Vassilopoulou (2007) reviewed the existing literature and emphasized teachers' role as socializers who are expected to convey care and promote positive relationships with others in the school environment. However, aside from their review, the significant role of teachers in students' loneliness has been explored less systematically within and over time. The present study aimed to fill this gap by conducting a meta-analysis to examine both the cross-sectional and longitudinal associations between loneliness and TSRs among children and adolescents, thereby contributing to a deeper understanding of the powerful role that TSRs play in students' perceived loneliness.

In comparison to instructional support, the present meta-analysis concentrated on the affective dimensions of TSRs, with a particular focus on the emotional connections between teachers and students (Cornelius-White, 2007). Pianta (1994) classified TSRs as having three key dimensions (i.e., closeness, conflict, and dependency) that were incorporated in the Student-Teacher Relationship Scale (STRS; Pianta, 2001) that has been used by a growing number of researchers (e.g., Arbeau et al., 2010; Engels et al., 2021; Fraire et al., 2013). The predominant view is that positive TSRs encompass lower levels of conflict and dependency and higher levels of closeness (Sabol & Pianta, 2012). However, in certain cultural contexts and age groups, empirical evidence suggests that dependency is positively associated with closeness, which is beneficially related to students' social and emotional development (Garner et al., 2014; Gregoriadis et al., 2021). Moreover, TSRs can be expressed in a variety of ways (e.g., teacher connectedness, teacher support, teacher power). However, not all emotional interactions between teachers and students can simply fit into the dimensions of closeness, conflict, and dependency (McGrath & Van Bergen, 2015).

In the present meta-analysis we distinguished high-quality TSRs (i.e., positive and supportive connections between teachers and students) from those of low-quality TSRs that are characterized by a lack of security and may act as a barrier to students' attempts to contend with demands in school (Roorda et al., 2011). In high-quality TSRs, teachers' behaviors foster students' school engagement and facilitate their adaptation to the demands of the school environment (Howes et al., 1994; Rey et al., 2007; Roorda et al., 2011). These relationships can be manifested through mutual trust, respect, care, and sense of relatedness (Mosley et al., 2021; Wentzel, 2010). Conversely, in low-quality TSRs, teachers may not be able to, or simply may not be interested in, understanding each student's current emotional state and intentions and then respond inappropriately (Pastore & Luder, 2021). Negative relationship qualities are strengthened when students and teachers experience conflict, rejection, and strain in their interactions with each other (Engels et al., 2021; Roorda et al., 2017).

Furthermore, the measurement of TSRs varies at the individual dyadic level and on a broader "global" scale, such as students' relationships with multiple teachers within the classroom or across the whole school environment (Liu et al., 2018). A recent meta-analysis showed that higher-quality TSRs, both at the dyadic and classroom levels, were linked to reduced instances of bullying and peer victimization (Ten Bokkel et al., 2023). Nevertheless, it is important to acknowledge that different perspectives are utilized to define these interactions, whether it's from the viewpoint of the teacher or that of the student (Vandenbroucke et al., 2018). The present review aimed to provide insights into how TSRs measurement features, such as measurement level (group or dyadic) and reporter type (student or teacher), moderate the relationship between TSRs and loneliness.

1.3. Culture and culture differences

Bronfenbrenner (1979) highlighted the importance of cultural context in shaping an individual's mental development. Cultural background is believed to be part of the macrosystem that influences all developmental layers, including micro-, meso-, and exo-systems (Vélez-Agosto et al., 2017). Teachers at school are viewed as integral to making up young people's microsystems (Eriksson et al., 2018). Vélez-Agosto et al. (2017) expanded this view and argued that culture is capable of organizing microsystems and that it is a central process in individual development.

An individual's sociocultural background can influence their perceived loneliness (Maes et al., 2016; Yang, 2019). From Bronfenbrenner's social-ecological perspective, loneliness can be viewed as the product of the interactions between individual and sociocultural environmental factors (Marquez et al., 2022). Differences between cultures and the way people's social relations are organized result in cross-cultural variations in how people perceive, experience, and cope with loneliness (Rokach & Bacanli, 2001). More attention is now being given to the cross-cultural exploration of loneliness. For example, Barreto et al. (2021) found that loneliness increased with the levels of individualism within the country (Hofstede, 1991). In addition, Jefferson, Barreto, Jones, et al. (2023) revealed that national culture, especially those with high power distance and low uncertainty avoidance, is significant in understanding adolescents' loneliness experience.

Researchers have argued that we should expect cultural differences to exist in TSR quality. For instance, Hofstede (1986) indicated that teachers are encouraged to be strictly impartial in individualist societies, whereas teachers are expected to offer preferential treatment to specific students in collectivist societies. This means that students' expectations of what their social relationships with their teacher will look like will be influenced by culture. For example, Chinese teachers are regarded as the authority in the classroom (Yuan, 2006), whereas teachers in America are more likely to be respectful, cooperative, and allow students to express their own opinions (Wilkins, 2014). TSRs also vary in subcultures, ethnic minority groups, and multicultural classes (Ang, 2016; den Brok & Levy, 2005) where specific cultural expectations exist.

A need exists for research to explore the role of culture in TSRs and its role in loneliness. From the cultural psychology perspective, Heu, van Zomeren, and Hansen (2021) indicated that more restrictive norms about social relationships may increase the likelihood of loneliness. In the present meta-analysis, cultures were listed with reference to the Western/non-Western dichotomy and Hofstede's Cultural Dimensions (Hofstede et al., 2010). Going beyond the traditional Western/non-Western categorization, we examined national culture along six dimensions, including (a) Power Distance (i.e., the extent to which less powerful members within a country or cultural society accept unequal distribution of power); (b) Uncertainty Avoidance (i.e., the degree to which people tolerate unknown situations); (c) Individualism versus Collectivism (i.e., whether the dominant principles in society are individual-centered [i.e., individualism] or group-centered [i.e., collectivism]), which depends on group members' self-image being defined by "I" or "We"; (d) Motivation towards Achievement and Success, which previously has been expressed as Masculinity versus Femininity (i.e., what is the core driver of a society, competition, achievement, and success [i.e., decisive] or quality of life and caring [i.e., consensus-oriented]); (e) Indulgent versus Restraint (i.e., the extent to which national residents try to control their needs and impulses; a high score [i.e., indulgence] implies that they are inclined to value the satisfaction of human desires); and (f) Long-term versus Short-term Orientation (i.e., whether a specific society looks forward to the future [i.e., long-term orientation] or resorts to the past and present [i.e., short-term orientation] with respect to solving the problems in the present or the future.

It is important to note that most meta-analyses where culture has been examined were conducted only using international databases of articles, which leans on Western contexts of individualism and low power distance (Triandis, 2004). We addressed our cross-cultural aim by including relevant studies from a Chinese database; including these articles emphasizes our intention to interpret our focus through a specific example of non-Western culture (Hodges & Oei, 2007) that reflects complementary aspects in relation to its counterpart. This study thus aimed to foster a more global perspective when examining the associations between loneliness and TSRs.

1.4. Study purpose

The present meta-analytic study examined the associations between loneliness and TSRs among children and adolescents and explored the moderating role of culture for these associations. More specifically, we conducted the meta-analyses to (a) estimate an overall correlation between loneliness and affective TSRs; (b) determine whether the magnitude of these associations was moderated by culture factors (i.e., cultural dimensions, Western/non-Western culture dichotomy, and region), study characteristics (i.e., publication type, publication year, published language, and study quality), sample characteristics (i.e., age, gender, school type, and socioeconomic status), and measurement characteristics (i.e., loneliness measurement [type, number of items], TSR measurement [TSR indicators, measurement type, number of items, reporter type, and measurement levels]); all moderators were selected based on the prior literature with the aim of exploring how certain factors condition or influence the strength of the association between teacher-student relationships and loneliness; and (c) to examine the over-time cross-lagged effects of TSRs on loneliness in longitudinal studies.

In the present study, we conducted two main meta-analyses. First, we explored (a) the cross-sectional associations between TSRs and loneliness and (b) the longitudinal associations between TSRs and loneliness, including the two cross-lagged effects, the stability of loneliness, and the stability of TSRs across measurement waves. The role of culture in cross-sectional studies was also examined.

2. Method

2.1. Literature search

To identify all studies examining the associations between loneliness and TSRs, a systematic literature search was conducted in international databases (i.e., the Education Resources Information Center [ERIC], Web of Science, Psych INFO, British Education Index, PubMed) and Chinese databases (i.e., China National Knowledge Infrastructure [CNKI], WanFang Data, and China Science and Technology Journal Database [CQVIP]). We focused on studies published from January 2005 to December 2023. This data range was chosen for several reasons. In their review, Galanaki and Vassilopoulou (2007) critically assessed the research literature from 1982 to 2005, focusing on the connections between teachers and students' loneliness. Recognizing the evolution of teaching methods, educational practices, and educational systems over time, our objective was to investigate whether changes in these associations have occurred. We also aimed to offer targeted suggestions within the context of the current education system and identify educational implications grounded in the latest research findings. Search terms reflected loneliness (Lonel* OR "Social Isolat*" OR "Emotional Isolat*"), student (Student* OR Pupil* OR Child* OR Adolesc*), teacher (Teach* OR "Head Teacher*" OR Instructor* OR Tutor*), other school staff ("School Staff*" OR "School Principal*"), and relationship (Relation* OR Association OR Connect* OR Interaction OR Correlat*). The search terms were applied to the "Any Field" option in the literature search without restrictions to specific sections (e.g., title/abstract). The initial literature search was completed in November 2021 and yielded 2205 results (1641 studies in English and 564 studies in Chinese), from which 466 duplicates were removed.

2.2. Inclusion criteria

2.2.1. Participants

To be included in the meta-analysis, the study needed to have examined school children or adolescents ages 5–18 years. Given that entrance ages to primary school vary between countries and regions, we chose the age range of 5–18 years to cover all eligible sample groups in accordance with internationally comparable data collected by UNESCO Institute for Statistics.[1] Furthermore, the participating students needed to be considered as typically developing children and adolescents enrolled in mainstream school settings. Participants who were considered to have special needs were excluded; studies where data collection occurred during the COVID-19 pandemic or other emergency periods were not included due to the present specific foci.

2.2.2. Studies

Research Type. To be included, the study needed to be an original empirical study. Reviews, research proposals, and grey literature were excluded. In addition to published literature, dissertations were included to mitigate the effects of publication bias, thus producing more accurate estimates of effect sizes (McLeod & Weisz, 2004).

Research Design. All included studies needed to have used a quantitative research design. Our meta-analysis also included studies that used a mixed-method research design but only if the quantitative data could be separately extracted. For inclusion, the study had to report quantitative relationships (i.e., Pearson's r or any other coefficient that can be converted to Pearson's r) between TSRs and loneliness. We excluded studies that utilized self-developed questionnaires to measure loneliness or TSRs to minimize the risk of methodological bias and to uphold the overall methodological rigor, ensuring the robustness of the included studies.

Research Focus. The study needed to examine the association between loneliness and affective TSRs (including teacher support and other related terms); these associations needed to be the primary focus or one of the primaries foci in all eligible studies. These associations could have been present anywhere within the study and was not necessarily limited to the study's stated objectives. We also excluded studies that solely reported objective phenomena (e.g., aloneness) rather than the subjectively perceived experience of

[1] See http://data.uis.unesco.org/Index.aspx?DataSetCode=NATMON_DS.

loneliness.

Publication Language. The study needed to be written in English or Mandarin. For works published in both international and Chinese databases using the same data set, we selected versions written in English to promote replicability.

2.3. Study selection

The study selection was managed via EndNote. After discarding duplicates, 1739 studies (1210 in English and 529 in Chinese) were screened by the first author. To check the clarity of the eligibility criteria, the sixth author independently reviewed 20% of the English papers and the fifth author reviewed the same proportion of those studies written in Chinese. Reviewers achieved 79% agreement with studies written in English and 85% agreement for studies written in Chinese. Disagreements and uncertainties were discussed between the reviewers and studies that did not meet the inclusion criteria were removed. Subsequent discussion confirmed 100% agreement at the title-abstract coding stage. At the full-text level, 69 studies (29 in English and 40 in Chinese) were screened against the inclusion and exclusion criteria using the same procedure used during the title-abstract coding stage. The 29 studies published in English were screened by the first and third authors whereas the 43 studies published in Chinese were separately screened by the first and fifth authors. Agreements between reviewers were 86% for English studies and 88% for Chinese studies. After further discussions and review, agreement rates reached 100%. Twenty-five studies were aligned with the inclusion criteria (16 English articles and nine Chinese articles).

To identify missing studies from the first round of database searching, we manually searched the Meta-Analytic Study of Loneliness (MASLO) database that includes 3658 studies utilizing one of the main standardized loneliness measures (see Maes, Qualter, et al., 2019, for more details). We used "Cat2 = 1704" (i.e., associations between loneliness and "teacher-related-variables") and key terms related to "teacher". The search of MASLO identified an additional six international articles. Furthermore, manual forward (i.e., citation) and backward (i.e., reference) tracking of the latest set of included studies was undertaken to identify other potentially eligible studies. An additional nine studies (five English and four Chinese articles) were identified from forward and backward citation chasing, bringing the total to 40 studies for final review (27 in English and 13 in Chinese). With the aim of maintaining the currency, reliability, and validity of the findings, we updated the search and selection in December 2023 by employing the same strategy across both international and Chinese databases. Among the total updated works meeting the inclusion criteria, we excluded two articles due to the utilization of identical participant samples found in other included studies. We retained works that provided more comprehensive information or were better aligned with our cross-cultural objectives. This process yielded an additional seven studies in international databases. Therefore, 47 studies were identified as fully eligible for inclusion in our meta-analysis. The complete screening process is presented in the PRISMA (Page et al., 2021) flowchart in Fig. 1.

2.4. Quality assessment

We used the Mixed Methods Appraisal Tool (MMAT; Hong et al., 2018) to critically assess the quality of each eligible study.[2] Quality assessment can be regarded as a systematic process to evaluate the completeness, validity, and strengths of research methodologies and designs (Young & Solomon, 2009). The MMAT is designed for targeted appraisal of five specific methodological characteristics regarding each included study (i.e., sampling strategy, sample representativeness, measurement, nonresponse bias, and statistical analysis). In the present meta-analysis, the first author appraised the methodological quality of each study; the third and fifth authors independently conducted the assessment of 35% of the studies, either in English or Chinese. The results of each appraisal were compared and any disagreements were resolved through discussion among reviewers.

In the MMAT, each criterion is scored using categorical approach consisting of *yes*, *no*, and *can't tell*. According to the MMAT supplement, the number or proportion of yes responses reflects the quality of each retained study. We synthesized quality results into three different categories as follows: Low Quality = MMAT score $\leq$ 35%; Medium Quality = MMAT score 36%–70%; High Quality = MMAT $>$ 70% (D'Amen et al., 2021).

2.5. Data extraction and coding

Data were extracted and coded to obtain sufficient information for effect size calculations and moderator analyses. In cross-sectional meta-analyses, we extracted data relating to (a) effect size, (b) cultural characteristics (i.e., Culture Dimensions, Western/non-Western culture dichotomy, and region), (c) study characteristics (i.e., publication year, publication type, published language, and study quality), (d) sample characteristics (i.e., age, gender, school type, and socioeconomic status), (e) loneliness measure (i.e., measurement type and number of items), and (f) teacher-student relationships (i.e., TSR indicators, measurement type, number of items, reporter type, and measurement level). We recorded Pearson's *r* as the effect size to calculate cross-sectional associations; of note, effect sizes from Wave 1 among longitudinal studies were also included.

Regarding longitudinal analyses, three zero-order correlations were extracted for the computation of effect sizes (see Longitudinal Analysis Plan). We contacted corresponding authors if a study did not provide essential data for us to calculate an effect size. Authors of two reports were contacted and one responded; thus, we were able to retrieve the required information to compute additional effect

[2] We initially intended to include quantitative and qualitative studies in our meta-analysis.

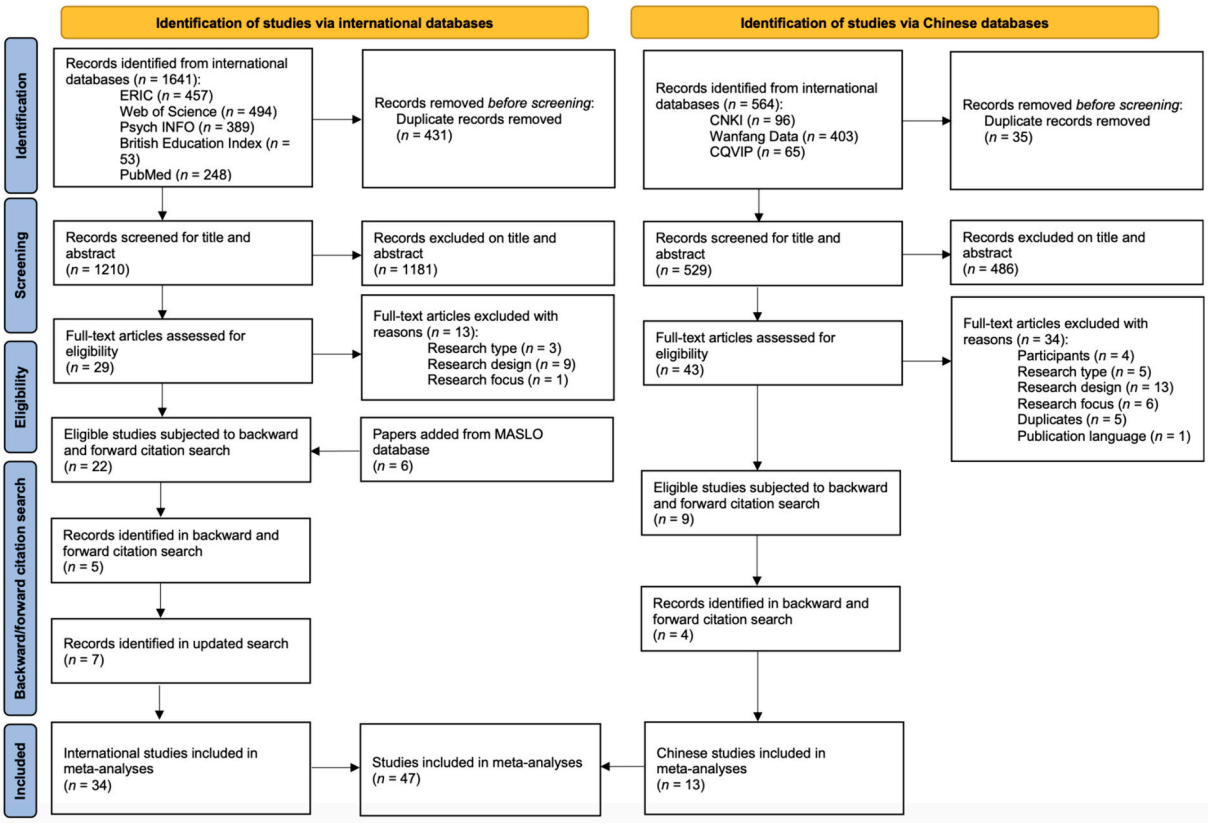

Fig. 1. PRISMA Flow Diagram for Systematic Review Process.

sizes.

2.6. Potential moderators

We investigated the influence of cultural characteristics, study characteristics, sample characteristics, and measurement characteristics that may moderate the cross-sectional associations between loneliness and TSRs. We were not able to explore these moderators for the longitudinal studies because there were so few papers ($n = 6$).

2.6.1. Cultural characteristics

Three types of culture characteristics were coded in the present study to explore whether relationships varied across cultures.

Cultural Dimensions. Cultural Dimensions (Hofstede, 1986) were included in the moderator analysis as categorical variables, including *Power Distance* (PDI; 0 = high, PDI score > 55 [$k = 45$]; 1 = low, PDI score ≤ 46 [$k = 34$]; or 2 = medium, PDI score 47–55 [$k = 4$]); *Uncertainty Avoidance* (UAI; 0 = low, UAI score ≤ 46 [$k = 48$]; 1 = high, UAI score > 55 [$k = 22$]; or 2 = medium, UAI score 47–55 [$k = 13$]); *Individualism/Collectivism* (IDV; 0 = collectivism, IDV score ≤ 46 [$k = 43$]; 1 = individualism, IDV score > 55 [$k = 36$]; or 2 = medium, IDV score 47–55 [$k = 4$]); *Motivation towards Achievement and Success* (MAS; 0 = decisive, MAS score > 55 [$k = 57$]; 1 = medium, MAS score 47–55 [$k = 19$]; or 2 = consensus, MAS score ≤ 46 [$k = 7$]); *Indulgent/Restraint* (IVR; 0 = restraint, IVR score ≤ 46 [$k = 44$]; 1 = indulgent, IVR score > 55 [$k = 19$]; or 2 = medium, IVR score 47–55 [$k = 4$]); and *Long-term/Short-term Orientation* (LTO; 0 = long-term orientation, LTO score > 55 [$k = 42$]; 1 = medium, LTO score 47–55 [$k = 31$]; or 2 = short-term orientation, LTO score ≤ 46 [$k = 10$]). Cultural scores, ranging from 0 to 100, were obtained based on the country where each study was conducted and were sourced from the updated Hofstede's cultural dimensions database[3]. Although a score of 50 is often seen as the midpoint of a cultural dimension, categorizing medium strictly at 50 would be too restrictive and not fully representative of the cultural variations. Instead, we defined the medium range as 47–55, aligning with Hofstede's real-world descriptions of what specific scores represent. This broader definition allows for a more balanced interpretation that captures a reasonable spread around the midpoint. In one study sampled from Latina/o schools in the US (Heredia et al., 2017), we averaged the cultural scores of 10 Latin American countries. In a study conducted across European schools (Schnepf et al., 2023), we computed the average cultural scores from 28 sampled countries.

[3] See https://www.theculturefactor.com/country-comparison-tool.

Culture Dichotomy. The culture distinction was divided as 0 = non-Western ($k = 44$) or 1 = Western ($k = 39$).

Region. The moderator reflecting the continent was coded. Due to the small number of effect sizes available for some countries, the moderator reflecting continent was coded as 0 = Asia ($k = 52$), 1 = North America ($k = 16$), 2 = Europe ($k = 11$), or 3 = Africa ($k = 4$).

2.6.2. Study characteristics

Publication Type. Studies were coded as 0 = journal article ($k = 66$) or 1 = dissertation ($k = 17$).

Publication Year. The year of publication was recorded as a continuous variable.

Published Language. The subgroups for testing published language as a moderator were 0 = published in English ($k = 52$) or 1 = published in Mandarin ($k = 31$).

Study Quality. The subgroups for study quality were 0 = middle quality ($k = 45$), 1 = high quality ($k = 38$), or 2 = low quality ($k = 3$).

2.6.3. Sample characteristics

Age. According to participants' mean age, we examined whether the associations we explored varied across different development periods. Age was coded as a continuous variable and categorized as follows: 0 = early adolescence (10–14 years; $k = 37$), 1 = childhood (5–9 years; $k = 25$), or 2 = late adolescence (15–18 years, $k = 21$). If the original study did not report the specific age range of participants, we imputed the mean age according to the grade level reported.

Gender. The participation of female and male students in the studies was coded as follows: 0 = more male ($k = 41$) when there was a higher proportion of male students compared to female students, or 1 = more female ($k = 39$) when there were more female students than male students. Only one effect size reported overall balanced gender distribution, indicating an equal representation of boys and girls. Therefore, it was not included in the moderator analysis. For two studies, this information was missing, so they were also excluded in the moderator analysis regarding gender.

School Type. Based on the school system of participants' country, studies were classified as follows: 0 = secondary/high school ($k = 48$), 1 = primary school ($k = 30$), or 2 = kindergarten ($k = 4$). We excluded one study whose outcome didn't clarify primary or secondary school.

Socioeconomic Status. Regarding the socioeconomic status (SES) of the participants, studies were coded as 0 = low SES samples (i.e., > 75% of the participants were low SES; $k = 19$), 1 = high SES samples (> 75% of the participants were high SES; $k = 12$), 2 = mixed SES (participants came from mixed SES with each category accounting for < 75% of the sample; $k = 11$), or 3 = middle SES samples (i.e., > 75% of the participants were in middle SES; $k = 8$). In eight papers, SES could be inferred from information provided by studies, such as district (urban/rural), household income, or family education level. For 32 studies, we couldn't extract exact information regarding participants' socioeconomic status; therefore, these studies were not included in the analysis on this moderator.

2.6.4. Measurement characteristics

Loneliness Measurement. The moderator reflecting the *measurement type* was coded as 0 = the Children's Loneliness Scale (Asher et al., 1984) or any revised version ($k = 48$), (1) = other scales ($k = 25$), or 2 = the UCLA Loneliness Scale (Russell et al., 1980) or any revised version ($k = 10$). Other loneliness measurements were categorized as "other scales" due to the relatively small number of studies in the sample that used these measures of loneliness, including the Loneliness and Aloneness Scale for Children and Adolescents (LACA; Marcoen et al., 1987), the Peer Network and Dyadic Loneliness Scale (Hoza et al., 2000), the Perth A-loneness (PAL) Loneliness scale (Houghton et al., 2014), the Prediction Test of Problem Children (Zhou, 1991), and the Relational Provisional Loneliness Questionnaire (RPLQ; Hayden-Thomson, 1989). Effect sizes based on single-item measures were also included.

We included the *number of items* in the moderator analysis as a continuous variable. Including the number of items in the moderator analysis was grounded in the following reasons: (a) existing literature has demonstrated that the number of items can impact the construct validity and reliability of a measurement instrument (Abdelmoula et al., 2015) and is also associated with response rate (Rolstad et al., 2011), and (b) in the present meta-analysis, different versions of the same loneliness measure were utilized across studies, resulting in variations in the number of items employed. Consequently, there is a rationale to believe that item numbers may influence the strength of the overall association between loneliness and TSRs. The findings may also serve as a reference for researchers in selecting among different versions of loneliness scales for their empirical studies.

Teacher-Student Relationships Measurement. The TSR *indicators* were coded as 0 = high quality ($k = 63$) or 1 = low quality ($k = 20$). We included this as a potential moderator to examine whether the strength of associations differed across high-quality TSR indicators (e.g., close, supportive, intimate) and low-quality indicators (e.g., conflict, rejective). This investigation stems from the recognition that young people, like adults, may also demonstrate a negativity bias in the emotional realm, indicating a preference for focusing on and learning from negative information over positive information (Vaish et al., 2008).

TSR *measurement types* were coded as 1 = the Student-Teacher Relationship Questionnaire (STRS; Pianta, 1992) or any revised version ($k = 18$), or 0 = other scales ($k = 65$) such as the Children's Appraisal of Teacher as a Secure Base Scale (CATSB; Al-Yagon & Mikulincer, 2006), the Young Children's Appraisals for Teacher Support (Y-CATS; Mantzicopoulos & Neuharth-Pritchett, 2003), and the Teacher Support and Satisfaction Scale (Richman et al., 2004). In addition, as previously mentioned, we excluded papers where self-developed scales of TSRs were used.

We included the *number of items* in the moderator analysis as a continuous variable.

The moderator reflecting the *reporter type* was coded as 0 = student report ($k = 73$) or 1 = teacher report ($k = 10$).

Information on the TSR *measurement level* was coded as 0 = group level ($k = 53$) or 1 = dyadic level ($k = 30$).

2.7. Analysis Plan

2.7.1. Cross-sectional associations

Calculation of Effect Sizes. Pearson's *r*, which is the correlation coefficient between loneliness and TSRs, was used as the effect size metric in this meta-analysis because it was reported in most of the final studies. Regarding the evaluation of effect size magnitude, widely accepted criteria were proposed by Cohen (1969) for Pearson's *r, including* small = 0.10–0.29, medium = 0.30–0.49, and large >0.49. However, concerns have been raised that "'small,' 'medium,' and 'large' are relative, not only to each other, but to the area of behavioral science or even more particularly to the specific content and research method" (Cohen, 1988, p. 25). Consequently, in the present meta-analysis, the interpretation of effect sizes was based on more contemporary benchmarks aligned with psychological research (Funder & Ozer, 2019). Specifically, we interpreted *r* effect sizes as follows: 0.05 = very small, 0.10 = small, 0.20 = medium, 0.30 = large, and 0.40 or greater = very large.

In cases where studies that did not report Pearson's *r*, we transformed the given statistics to *r* values. For instance, we converted standardized regression coefficients ($k = 3$) into correlation coefficients using the formula from Peterson and Brown (2005). One study ($k = 1$) reported odds ratios, so we transformed the logarithm of the odds ratio into *d* and then into *r*. To correct potential skewness in the sample distribution of Pearson's *r*, we transformed all correlations using Fisher's *Z* transformation (Lipsey & Wilson, 2001). Subsequently, we converted all Fisher's *Z* values back to correlation coefficients (*r*) for ease of interpretation (Field, 2001).

Pearson's *r* can capture the direction and magnitude of the association between loneliness and the quality of TSRs. Negative values of *r* indicate negative directions (i.e., higher TSRs and lower levels of loneliness) in this meta-analysis. To maintain consistency and compute the overall effect size, we reversed the directions of correlations obtained from negative scales (e.g., TSRs conflict scale), ensuring that all effect sizes reflect the association between loneliness and high-quality TSRs.

Moreover, effect sizes are assumed to be independent of each other in meta-analysis (Lipsey & Wilson, 2001). However, many included studies reported multiple correlation coefficients across TSR indicators or based on different measurement scales, resulting in dependencies between effect sizes within a single study. In traditional meta-analysis, common approaches to handling this dependency involve either averaging the statistical data to compute the effect size or selecting a single effect size per study. However, these methods may inevitably lead to a reduction in statistical power due to the loss of information (Cheung, 2014). Thus, the present analysis adopted a multilevel approach to model the dependency of effect sizes.

Specifically, a three-level structure was implemented within the meta-analytic model whereby three sources of variances were distributed: (a) the sampling variance for the observed effect sizes at Level 1, (b) the variance between effect sizes from the same study at Level 2, and (c) the variation of effect sizes across studies at Level 3 (Assink & Wibbelink, 2016). The three-level random effects model was conducted in the Metafor package (Viechtbauer, 2010) with the R language. We used restricted maximum-likelihood (REML) to estimate the model parameters (Hardy & Thompson, 1996).

In the present analysis, we first estimated the overall mean effect size of the association between loneliness and TSRs; the calculation of standard error, *t* value, *p* value, and 95% confidence interval were also included. To quantify the distribution of total variance across the three distinct variance components, we conducted two log-likelihood ratio tests to evaluate the significance of within-study variance (Level 2) and between-study variance (Level 3). The sampling variance of observed effect sizes (Level 1) was calculated using the formula proposed by Cheung (2014). If significant variance at Level 2 or Level 3 was detected, meta-regression analyses were conducted, utilizing the designated variables to explore the influence of the potential moderators. For a particular category to be included in the moderator analyses, it was required to have a minimum of three effect sizes (Spruit et al., 2016).

Furthermore, given that the presence of outliers may potentially distort the validity and robustness of the conclusions drawn from a meta-analysis (Viechtbauer & Cheung, 2010), we investigated whether any studies were highly influential on the pooled effect. To detect potential outliers that could bias the results, we employed the influence function of the Metafor package to compute leave-one-out diagnostics, such as externally standardized residuals, difference in fits (DFFITS), and Cook's distance (Viechtbauer & Cheung, 2010). The report on overall effect sizes and moderator analyses involved both datasets, with and without the inclusion of the outliers.

Publication bias is a significant concern in meta-analysis as it can skew the overall conclusions by overrepresenting the positive findings (Rosenthal, 1979). To statistically examine the influence of publication bias on the current meta-analysis, we created funnel plots using Fisher's *Z* transformations (Torgerson, 2006) and applied Egger's regression test (Egger et al., 1997). If asymmetry of the

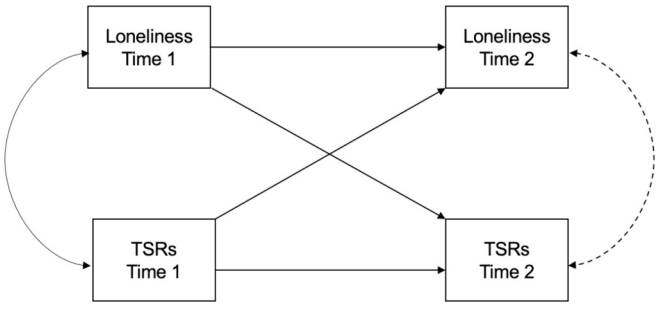

Fig. 2. The Illustration of the Cross-Lagged and Stability Effects between Loneliness and Teacher-Student Relationships across Two Measurement Waves.

plot is detected (i.e., publication bias influences the data), a trim-and-fill procedure can be applied to generate an adjusted effect size (Duval & Tweedie, 2000; Mavridis & Salanti, 2014).

2.7.2. Longitudinal associations

We utilized a cross-lagged regression approach to conduct longitudinal analyses (Giletta et al., 2021; Maes, Nelemans, et al., 2019; Sowislo & Orth, 2013). This approach can reveal the prospective direction of effects between loneliness and TSRs, controlling for prior levels of the variables. Furthermore, this approach offers researchers the possibility of examining the cross-lagged effects that were not the initial focus of the original study (Maes, Nelemans, et al., 2019). Additionally, the present meta-analyses involved the first two consecutive waves of data because only one included study (i.e., Cao, 2017) collected data for three time points.

Standardized regression coefficients were used to represent the effect sizes. We examined the regression coefficients, as illustrated in Fig. 2, for the following four models: (a) the cross-lagged effect of TSRs at Time 1 on loneliness at Time 2, which is controlled for Time 1 loneliness (i.e., the stability of loneliness over time and the cross-sectional correlation between loneliness and TSRs at Time 1); (b) the cross-lagged effect of loneliness at Time 1 on TSRs at Time 2, controlling for Time 1 TSRs; (c) the stability coefficient for loneliness (i.e., the effect of loneliness at Time 1 on loneliness at Time 2 adjusting for Time 1 TSRs); and (d) the stability coefficient for TSRs (i.e., the effect of TSRs at Time 1 on TSRs at Time 2 controlling for Time 1 loneliness).

For the computation, we extracted three within- and across-time correlations from initial studies for each model, using the following equation (Becker, 1992, p. 359):

$$\beta_1 = \frac{r_{yx1} - r_{yx2}r_{x1x2}}{1 - r_{x1x2}^2}$$

β_1, in this equation represents the standardized weight of *X1* predicting *Y*, controlling for the effect of *X2*. For instance, to examine the effect of TSRs on subsequent students' perceived loneliness, we can utilize the equation with *X1* being TSRs at Time 1, *X2* representing loneliness at Time 1, and *Y* representing Time 2 loneliness.

Following a designated R code (Fernández, Constantin, Giletta, & Maes, 2020), standardized regression coefficients reflecting the effect sizes and their sampling variances can thus be computed (Becker, 1992, 2009). Subsequently, we implemented four separate sets of meta-analyses, as mentioned above, using the Metafor package (Viechtbauer, 2010) in the R program, including cross-lagged and stability effects between the two variables across time. The meta-analyses were conducted under the random effects model and the restricted maximum-likelihood (REML) procedure. We further examined the influences of publication bias consistent with the approaches adopted in cross-sectional associations.

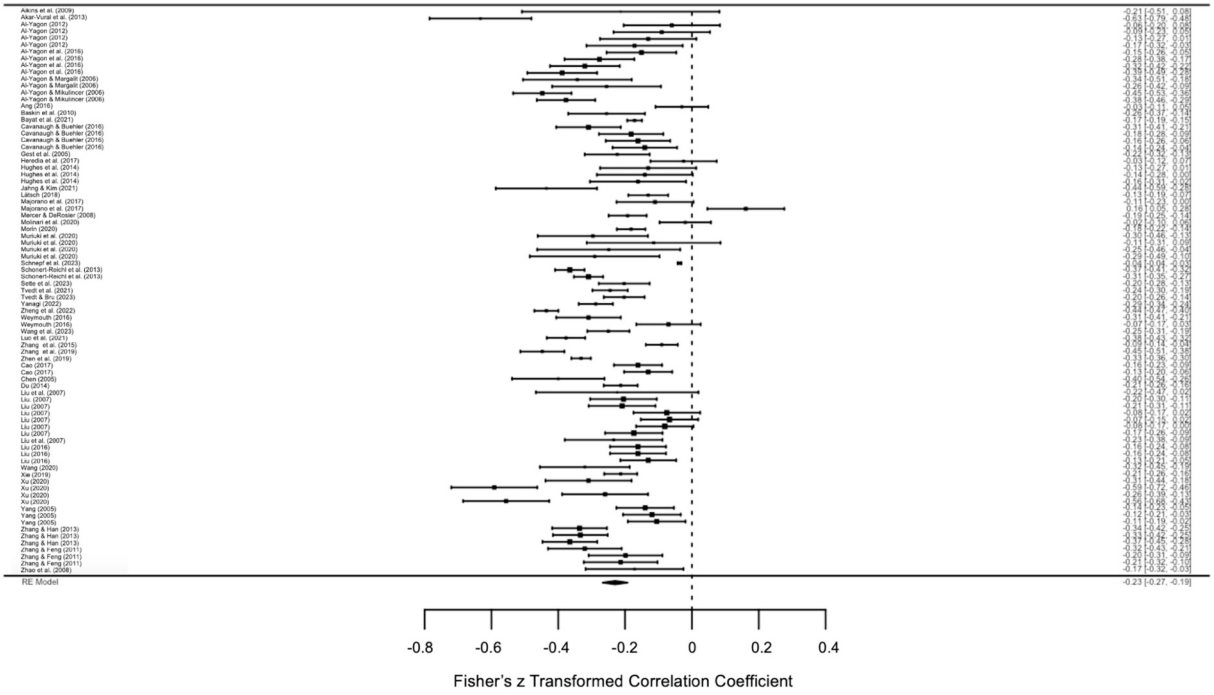

Fig. 3. Forest plot of the Observed Effect Sizes with 95% Confidence Intervals.

3. Results

3.1. Cross-sectional associations

3.1.1. Study characteristics

The final dataset included 83 effect sizes (*k*) from 47 studies (*n*) published between 2005 and 2023 (*Mdn* year = 2016). Thirty-three (70.21%) studies were screened from international databases and 14 (29.79%) studies were screened from Chinese databases. A total of 163,283 children and adolescents (49.25% males) were included in the present meta-analysis, with sample sizes ranging from 47 to 118,698 participants. The individuals' mean age varied between 5.34 and 17.09 years ($M = 14.49$, $SD = 3.34$, $Mdn = 13.25$). Detailed information on the studies is provided in the Supplementary Materials.

3.1.2. Overall association between loneliness and teacher-student relationships

Based on the random effects model, results indicated an estimated mean Fisher's $Z = -0.2298$ ($SE = 0.0188$, $p < .0001$, 95% CI [−0.2671, −0.1924]). After being back transformed into Pearson's correlation coefficients with the aim of interpretability (Field, 2001), the overall effect size was $r = -0.226$, 95% CI [−0.261, −0.190]. This result shows a significant medium correlation between loneliness and TSRs (Funder & Ozer, 2019). The negative direction indicates that higher-quality TSRs were associated with lower levels of loneliness. Fig. 3 illustrates the precision and spread of the observed studies and the pooled effect size in a forest plot.

We conducted additional tests to examine the significance of both within-study and between-study variances and explored the distribution of total variance across three different sources of variance. The results indicated significant heterogeneity among effect sizes extracted from the same study at Level 2 (i.e., within-study variance) and across studies at Level 3 (i.e., between-study variance). Analysis of the total effect size variance showed that 5.13% of the total variance was attributed to sampling variance, 22.81% to differences between effect sizes within studies at Level 2, and 72.06% to between-study variance. According to Hunter and Schmidt (2004), heterogeneity can be considered as substantial if < 75% of the total variance can be attributed to sampling variance at Level 1. Therefore, it was beneficial to investigate the potential moderating effect of different characteristics on the overall effect under these conditions.

3.1.3. Moderators of the association between loneliness and teacher-student relationships

Most results obtained from the moderation analyses did not reach statistical significance (see Table 1). However, two of the moderators (i.e., gender and Hofstede's Power Distance Dimension) significantly affected the strength of the association between teacher-student relationships and loneliness ($p < .05$). The Power Distance Dimension represents the degree to which individuals acknowledge and accommodate inequalities (e.g., in power, status, wealth) as unavoidable. Gender in the present study was considered as binary.

In terms of Hofstede's Cultural Dimensions, the moderator reflecting Power Distance was found to be a significant moderator ($p = .0456$). More precisely, samples under high Power Distance contexts exhibited a significant and largest estimated mean correlation, $r = -0.248$, 95% CI [−0.294, −0.201]. None of the other moderators of Hofstede Cultural Dimensions (i.e., Uncertainty Avoidance, Individualism/Collectivism, Motivation towards Achievement and Success, Indulgent/Restraint, and Long-term/Short-term Orientation) were significant. We also investigated the influence of culture by testing the samples' Western or non-Western backgrounds and continents as moderators. No statistically significant moderation of the overall association was found among these variables.

For sample characteristics, we observed a significant moderating effect of participants' gender ($p = .0443$). Notably, the influence of a larger proportion of male students ($r = -0.246$, 95% CI [−0.345, −0.140]) on the association between loneliness and TSRs was stronger than that of a larger proportion of female students, $r = -0.186$, 95% CI [−0.232, −0.139]. Additionally, participants' age, socioeconomic status, and school type were found to be nonsignificant moderators.

Furthermore, all moderators in relation to study characteristics (i.e., publication type, publication year, published language, and study quality) were non-significant. We also found that none of the measurement characteristics (e.g., measurement type, TSR indicators, reporter type) were significant effect size predictors.

3.1.4. Publication bias

A funnel plot of the effect sizes by their standard errors (see Fig. 4) showed a roughly symmetrical shape, suggesting that publication bias was unlikely to influence our findings. Furthermore, the result of the Egger's regression test also indicated that there was no strong funnel plot asymmetry, $z = -0.6596$, $p = .5095$.

3.1.5. Outlier and influence analyses

To assess whether the computed summary effect estimate was influenced by a single study with extreme effect sizes, we used the Metafor package (Viechtbauer & Cheung, 2010) to perform an analysis using the influence function. This analysis calculated leave-one-out diagnostics (e.g., externally standardized residual, DFFITS value, Cook's distance, and covariance ratio for each case). No outliers or influential cases were detected (see Fig. 5). Moreover, we examined the mean meta-analytic effect and re-ran the moderator analyses after excluding the study with the maximum effect size (> 3 *SD* from the mean; i.e., Akar-Vural et al., 2013). Upon omitting Akar-Vural et al. (2013), the pooled effect size changed to $r = -0.219$, 95% CI [−0.253, −0.185]. Thus, we can conclude that this specific value hardly biased the pooled effect compared to the initial summary effect size, $r = -0.226$, 95% CI [−0.261, −0.190]. The re-run moderator analyses revealed changes in the *p*-values of existing significant moderators for Power Distance Dimension ($p = .0491$) and gender ($p = .0443$; see Table 2). No other moderators showed significant effects, except for Long-term/Short-term

Table 1
Moderator analyses of the association between teacher-student relationships and loneliness.

Model	Moderator	*k*	*b*	*SE b*	95% CI	*F* (df1, df2)	*p*
	Cultural Characteristics						
	Cultural Dimensions						
1	Power Distance Dimension (PDI)	83				3.2091 (2, 80)	0.0456
	High PDI	45	−0.2531	0.0248	[−0.3025, −0.2037]		
	Low PDI	34	−0.2254	0.0373	[−0.3491, −0.1016]		
	Medium PDI	4	−0.0623	0.0755	[−0.2620, 0.1374]		
2	Uncertainty Avoidance Dimension (UAI)	83				0.3026 (2, 80)	0.7397
	Low UAI	48	−0.2426	0.0443	[−0.4030, −0.0821]		
	High UAI	22	−0.2097	0.0363	[−0.2820, −0.1374]		
	Medium UAI	13	−0.2196	0.0602	[−0.4116, −0.0275]		
3	Individualism/Collectivism (IDV)	83				2.9512 (2, 80)	0.0580
	Collectivism	43	−0.2456	0.0258	[−0.2970, −0.1942]		
	Individualism	36	−0.2357	0.0372	[−0.3612, −0.1102]		
	Medium	4	−0.0623	0.0761	[−0.2651, 0.1405]		
4	Motivation towards Achievement and Success (MAS)	83				0.1624 (2, 80)	0.8503
	Decisive	57	−0.2299	0.0562	[−0.4435, −0.0164]		
	Medium	19	−0.2128	0.0681	[−0.4500, 0.0245]		
	Consensus	7	−0.2516	0.0511	[−0.3533, −0.1499]		
5	Indulgent/Restraint (IVR)	67				0.6881 (2, 64)	0.5062
	Restraint	44	−0.2238	0.0467	[−0.3943, −0.0532]		
	Indulgent	19	−0.2039	0.0387	[−0.2812, −0.1265]		
	Medium	4	−0.2959	0.0785	[−0.5301, −0.0616]		
6	Long-term/Short-term Orientation (LTO)	83				1.0309 (2, 80)	0.3614
	Long-term Orientation	42	−0.2494	0.0256	[−0.3005, −0.1984]		
	Medium	31	−0.2219	0.0409	[−0.3543, −0.0895]		
	Short-term Orientation	10	−0.1661	0.0594	[−0.3354, 0.0031]		
7	Culture dichotomy	83				3.1357 (1, 81)	0.0804
	non-Western	44	−0.2622	0.0261	[−0.3141, −0.2103]		
	Western	39	−0.1967	0.0370	[−0.3222, −0.0712]		
8	Region	83				1.9183 (3, 79)	0.1334
	Asia	52	−0.2650	0.1234	[−0.7516, 0.2217]		
	North America	16	−0.1997	0.1283	[−0.6960, 0.2968]		
	Europe	11	−0.1598	0.1273	[−0.6542, 0.3347]		
	Africa	4	−0.2423	0.1210	[−0.4832, −0.0013]		
	Study Characteristics						
9	Publication Year	83	0.0001	0.0033	[−0.0066, 0.0067]	0.0019 (1, 81)	0.9839
10	Publication Type	83				0.2695 (1, 81)	0.6051
	Journal Article	66	−0.2255	0.0523	[−0.4253, −0.0259]		
	Dissertation	17	−0.2527	0.0481	[−0.3484, −0.1571]		
11	Published Language	83				0.0396 (1, 81)	0.8428
	Published in English	52	−0.2274	0.0227	[−0.2725, −0.1822]		
	Published in Mandarin	31	−0.2356	0.0415	[−0.3632, −0.1080]		
12	Study Quality	83				0.2724 (2, 80)	0.7623
	Middle Quality	45	−0.2431	0.0388	[−0.3761, −0.1101]		
	High Quality	38	−0.2148	0.0280	[−0.2705, −0.1591]		
	Low Quality	3	−0.2441	0.0388	[−0.5495, 0.0614]		
	Sample Characteristics						
13	Age	83	0.0102	0.0062	[−0.0021, 0.0224]	2.7325 (1, 81)	0.1022
14	Age Category	83				1.1748 (2, 80)	0.3142
	Early Adolescence	37	−0.2256	0.0457	[−0.3878, −0.0635]		
	Childhood	25	−0.2720	0.0358	[−0.3433, −0.2008]		
	Late Adolescence	21	−0.1962	0.0498	[−0.3667, −0.0258]		
15	Gender	80				4.1783 (1, 78)	0.0443
	More Male	41	−0.2507	0.0307	[−0.3602, −0.1414]		
	More Female	39	−0.1880	0.0242	[−0.2363, −0.1398]		
16	School Type	82				2.0190 (2, 79)	0.1396
	Secondary/High School	48	−0.1992	0.0956	[−0.5739, 0.1754]		
	Primary School	30	−0.2779	0.0980	[−0.6574, 0.1016]		
	Kindergarten	4	−0.2625	0.0926	[−0.4469, −0.0782]		
17	Socioeconomic Status (SES)	50				0.3209 (3, 46)	0.8102
	Low SES	19	−0.2227	0.0590	[−0.4569, 0.0114]		
	High SES	12	−0.2184	0.0574	[−0.3339, −0.1030]		
	Middle SES	11	−0.2579	0.0971	[−0.5687, 0.0529]		
	Mixed SES	8	−0.1762	0.0745	[−0.4417, 0.0892]		
	Measurement Characteristics						
	Loneliness Measurement						
18	Type	83				2.3111 (2, 80)	0.1057
	CLS	48	−0.2412	0.0255	[−0.2919, −0.1906]		

(*continued on next page*)

Table 1 (*continued*)

Model	Moderator	*k*	*b*	*SE b*	95% CI	*F* (df1, df2)	*p*
	Other Scales	25	−0.1819	0.0422	[−0.3165, −0.0474]		
	UCLA	10	−0.2716	0.0478	[−0.4175, −0.1258]		
19	Number of Items	83	−0.0033	0.0028	[−0.0089, 0.0023]	1.3486 (1, 81)	0.2489
	TSRs Measurement						
20	TSRs Indicators	83				0.6021 (1, 81)	0.4400
	High Quality	63	−0.2333	0.0192	[−0.2716, −0.1951]		
	Low Quality	20	−0.2128	0.0264	[−0.3036, −0.1222]		
21	TSRs Measurement Type	83				0.0635 (1, 81)	0.8017
	Other Scales	65	−0.2322	0.0212	[−0.2743, −0.1901]		
	STRS	18	−0.2201	0.0479	[−0.3575, −0.0827]		
22	Items Number	83	0.0016	0.0014	[−0.0013, 0.0045]	1.2511 (1, 81)	0.2666
23	Reporter Type	83				0.1255 (1, 81)	0.7240
	Student Report	73	−0.2321	0.0201	[−0.2720, −0.1922]		
	Teacher Report	10	−0.2100	0.0623	[−0.3738, −0.0462]		
24	Measurement Level	83				0.0058 (1, 81)	0.9397
	Group Level	53	−0.2289	0.0431	[−0.3885, −0.0694]		
	Dyadic Level	30	−0.2322	0.0370	[−0.3059, −0.1585]		

Note. *k* = numbers of effect sizes; *b* = regression coefficient. *SE* = standard error; CI = confidence interval; *F* (df1, df2) = omnibus test; SES = Socioeconomic Status; CLS = Children's Loneliness Scale; UCLA = UCLA Loneliness Scale; TSRs = Teacher student relationships; STRS = Student-Teacher Relationship Questionnaire. For the categorical variables, the provided regression coefficients reflect the mean effect sizes (Fisher's *Z*) for each category.

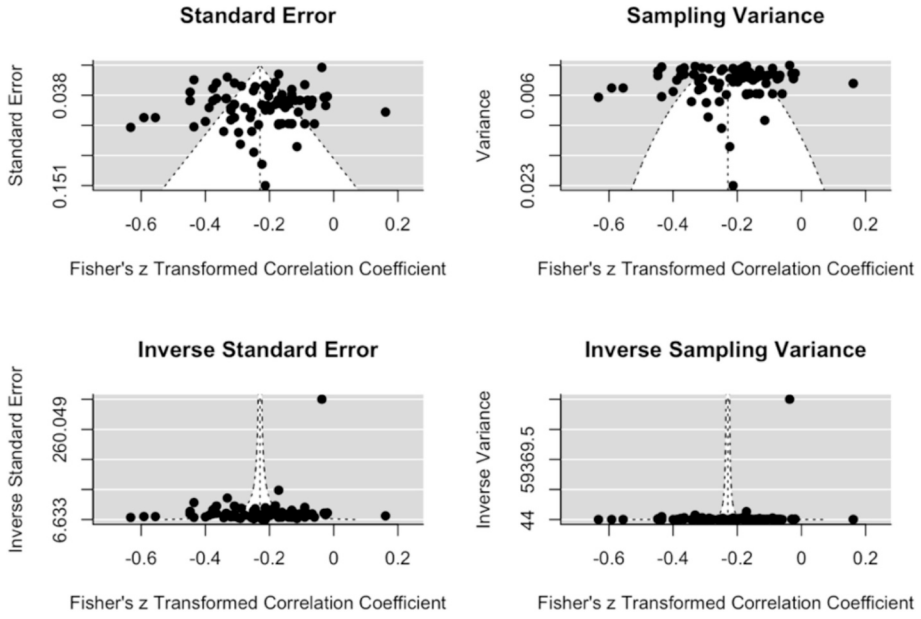

Fig. 4. Funnel Plot for the Associations between Loneliness and Teacher-Student Relationships in Cross-Sectional Studies.

Orientation, which reached significance ($p = .0315$). Specifically, samples from Long-term Orientation contexts exhibited the most substantial estimated mean correlation, $r = -0.244$, 95% CI [−0.286, −0.200].

3.2. Longitudinal associations

3.2.1. Study characteristics

Overall, six reports published between 2005 and 2020 (*Mdn* year = 2021) were included in the longitudinal analyses. Sample sizes varied from 340 to 2099 participants with the total being 5792 participants (48.8% males). On average, participants' mean age at baseline was 12.92 years (*SD* = 2.52, *Mdn* = 12.7, range = 10–16.5). These studies were conducted in the United States ($n = 2$), Norway ($n = 2$), Germany ($n = 1$), and China ($n = 1$). The length between measurement waves ranged from 6 to 18 months ($M = 12.33$, $SD = 6.95$, *Mdn* = 15).

Six reports were included to examine (a) the cross-lagged effects of Time 1 TSRs on Time 2 loneliness and (b) the stability effects for loneliness. Given that we were unable to extract essential information for the calculations from Cavanaugh and Buehler (2016), five

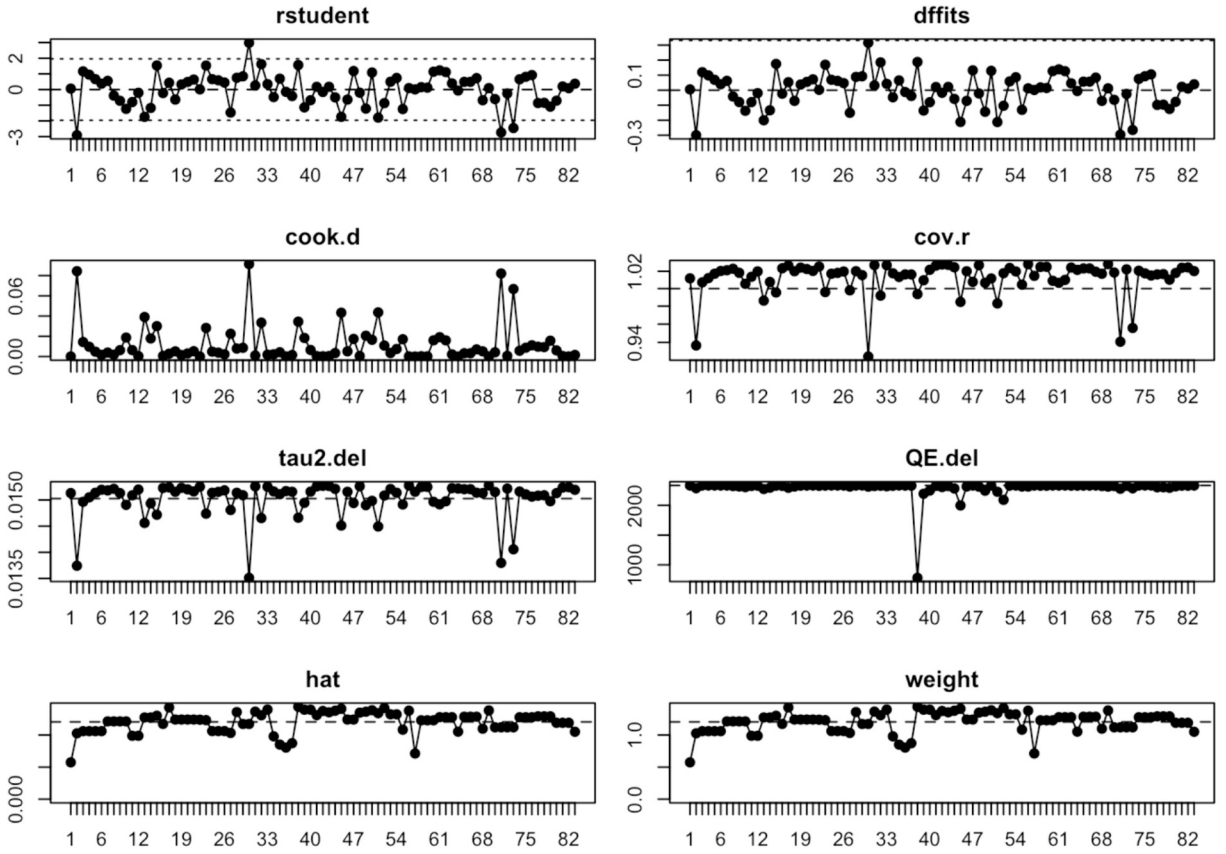

Fig. 5. Influence Analysis for the Associations between Loneliness and Teacher-Student Relationships in Cross-Sectional Studies.

reports were eligible for examining (a) the cross-lagged effects of Time 1 loneliness on Time 2 TSRs and (b) the stability effects for TSRs. Table 3 displays the correlations and standardized regression coefficients for each study, representing the correlation coefficients required for effect size computations, the cross-lagged coefficients between loneliness and TSRs (controlling for the predicted variables at Time 1), and the stability coefficients of these two constructs.

3.2.2. Longitudinal associations between loneliness and teacher-student relationships

Four meta-analyses were conducted based on the eligible longitudinal studies to investigate the cross-lagged relations between loneliness and the quality of TSRs through different time points. Due to the limited number of included studies, we were unable to conduct moderator analyses to explore whether the strengths of the longitudinal associations were moderated by the time interval that separated the measurements. Effect sizes reflecting the longitudinal associations between loneliness and TSRs are illustrated in Table 4.

Cross-Lagged Effects: TSRs Time 1 → Loneliness Time 2. The weighted cross-lagged effect of TSRs on subsequent loneliness was statistically significant, $\beta = -0.0917$ ($SE = 0.0127$, $p < .001$, 95% CI [−0.1165, −0.0668]). Our result supports the argument that earlier higher quality of TSRs serves as a protective factor for later loneliness. When examining heterogeneity among the true effects, the result of the Q-test indicated nonsignificant effects ($Q = 6.6006$, $p = .2521$). Specifically, the I^2 statistic estimated 12.68% of the total variability in the effect size estimates was attributed to heterogeneity among the true effect sizes.

Stability Effects: Loneliness Time 1 → Loneliness Time 2. The standardized regression coefficients were calculated to examine the stability of loneliness. The overall effect size of longitudinal stability for loneliness was $\beta = 0.4615$ ($SE = 0.0273$, $p < .001$, 95% CI [0.4080, 0.5149]), indicating a stable path of loneliness across different time lags. Furthermore, we found there was significant between-study variance for effects ($Q = 28.4054$, $p < .001$).

Cross-Lagged Effects: Loneliness Time 1 → TSRs Time 2. The mean estimated cross-lagged effect of loneliness at Time 1 on subsequent TSRs was based on a small number of studies ($k = 5$). The effects between these two constructs were marginally significant, $\beta = -0.1661$ ($SE = 0.0903$, $p = .0659$, 95% CI [−0.3431, 0.0109]). This can be expected with the low statistical power based on the much smaller number of studies (Borenstein et al., 2021). The results suggest the possibility that students who reported higher levels of loneliness at baseline experienced decreases in their TSR quality from baseline to a later time point (Ganesh & Cave, 2018; Visentin et al., 2020). The Q-test indicated a significant homogeneity figure of effect size distributions ($Q = 314.7124$, $p < .001$).

Stability Effects: TSRs Time 1 → TSRs Time 2. The mean estimated stability coefficient was 0.4673 for teacher-student relationships ($SE = 0.0514$, $p < .001$, 95% CI [0.3665, 0.5681]), indicating the effect of the baseline TSRs on the quality of TSRs at a later

Table 2
Moderator analyses of the association between teacher-student relationships and loneliness (outlier removed).

Model	Moderator	*k*	*b*	*SE b*	95% CI	*F* (df1, df2)	*p*
	Cultural Characteristics						
	Cultural Dimensions						
1	Power Distance Dimension (PDI)	82				3.1321 (2, 79)	0.0491
	High PDI	44	−0.2409	0.0238	[−0.2883, −0.1935]		
	Low PDI	34	−0.2254	0.0355	[−0.3434, −0.1073]		
	Medium PDI	4	−0.0620	0.0716	[−0.2518, 0.1279]		
2	Uncertainty Avoidance Dimension (UAI)	82				1.0029 (2, 79)	0.3714
	Low UAI	48	−0.2423	0.0421	[−0.3955, −0.0891]		
	High UAI	21	−0.1828	0.0349	[−0.2522, −0.1134]		
	Medium UAI	13	−0.2198	0.0566	[−0.4018, −0.0378]		
3	Individualism/Collectivism (IDV)	82				3.0345 (2, 79)	0.0537
	Collectivism	42	−0.2324	0.0248	[−0.2817, −0.1831]		
	Individualism	36	−0.2355	0.0354	[−0.3552, −0.1158]		
	Medium	4	−0.0620	0.0720	[−0.2545, 0.1305]		
4	Motivation towards Achievement and Success (MAS)	82				0.1682 (2, 79)	0.8455
	Decisive	57	−0.2298	0.0555	[−0.4418, −0.0177]		
	Medium	19	−0.2136	0.0662	[−0.4468, 0.0197]		
	Consensus	6	−0.2007	0.0510	[−0.3022, −0.0991]		
5	Indulgent/Restraint (IVR)	66				0.0999 (2, 63)	0.9050
	Restraint	44	−0.2234	0.0440	[−0.3843, −0.0624]		
	Indulgent	19	−0.2042	0.0365	[−0.2772, −0.1312]		
	Medium	3	−0.2097	0.0809	[−0.4444, 0.0250]		
6	Long-term/Short-term Orientation (LTO)	82				3.6149 (2, 79)	0.0315
	Long-term Orientation	41	−0.2486	0.0232	[−0.2947, −0.2025]		
	Medium	31	−0.2222	0.0369	[−0.3418, −0.1026]		
	Short-term Orientation	10	−0.0951	0.0571	[−0.2549, 0.0646]		
7	Culture dichotomy	82				2.2156 (1, 80)	0.1406
	non-Western	43	−0.2496	0.0252	[−0.2997, −0.1995]		
	Western	39	−0.1969	0.0354	[−0.3175, −0.0762]		
8	Region	82				1.6576 (3, 78)	0.1830
	Asia	51	−0.2541	0.1171	[−0.7516, 0.2073]		
	North America	16	−0.1999	0.1217	[−0.6705, 0.2707]		
	Europe	11	−0.1598	0.1207	[−0.6285, 0.3089]		
	Africa	4	−0.2423	0.1147	[−0.4707, −0.0139]		
	Study Characteristics						
9	Publication Year	82	−0.0005	0.0032	[−0.0068, 0.0058]	0.0212 (1, 80)	0.8845
10	Publication Type	82				0.4820 (1, 80)	0.4895
	Journal Article	65	−0.2176	0.0493	[−0.4055, −0.0296]		
	Dissertation	17	−0.2518	0.0452	[−0.3417, −0.1619]		
11	Published Language	82				0.01991 (1, 80)	0.6566
	Published in English	51	−0.2177	0.0216	[−0.2607, −0.1746]		
	Published in Mandarin	31	−0.2352	0.0392	[−0.3561, −0.1141]		
12	Study Quality	82				0.6921 (2, 79)	0.5035
	Middle Quality	45	−0.2426	0.0367	[−0.3689, −0.1163]		
	High Quality	37	−0.1999	0.0267	[−0.2531, −0.1468]		
	Low Quality	3	−0.2441	0.1171	[−0.5304, 0.0422]		
	Sample Characteristics						
13	Age	82	0.0098	0.0058	[−0.0018, 0.0213]	2.8384 (1, 80)	0.0959
14	Age Category	82				1.5086 (2, 79)	0.2275
	Early Adolescence	36	−0.2100	0.0431	[−0.3622, −0.0575]		
	Childhood	25	−0.2715	0.0335	[−0.3382, −0.2048]		
	Late Adolescence	21	−0.1959	0.0467	[−0.3556, −0.0362]		
15	Gender	80				4.1783 (1, 78)	0.0443
	More Male	41	−0.2507	0.0307	[−0.3602, −0.1414]		
	More Female	39	−0.1880	0.0242	[−0.2363, −0.1398]		
16	School Type	81				3.0740 (2, 78)	0.0519
	Secondary/High School	47	−0.1874	0.0891	[−0.5365, 0.1618]		
	Primary School	30	−0.2777	0.0912	[−0.6310, 0.0757]		
	Kindergarten	4	−0.2591	0.0863	[−0.4308, −0.0873]		
17	Socioeconomic Status (SES)	49				0.3445 (3, 45)	0.7933
	Low SES	19	−0.2260	0.0557	[−0.4438, −0.0081]		
	High SES	12	−0.2131	0.0524	[−0.3187, −0.1074]		
	Middle SES	10	−0.1536	0.0953	[−0.4511, 0.1439]		
	Mixed SES	8	−0.1770	0.0678	[−0.4191, 0.0653]		
	Measurement Characteristics						
	Loneliness Measurement						
18	Type	82				1.6901 (2, 79)	0.1911
	CLS	48	−0.2411	0.0239	[−0.2887, −0.1934]		

(*continued on next page*)

Table 2 (*continued*)

Model	Moderator	*k*	*b*	*SE b*	95% CI	*F* (df1, df2)	*p*
	Other Scales	25	−0.1768	0.0399	[−0.3039, −0.0497]		
	UCLA	9	−0.2393	0.0470	[−0.3805, −0.0981]		
19	Number of Items	82	−0.0020	0.0027	[−0.0074, 0.0033]	0.5689 (1, 80)	0.4529
	TSRs Measurement						
20	TSRs Indicators	82				0.5365 (1, 80)	0.4660
	High Quality	62	−0.2264	0.0184	[−0.2630, −0.1898]		
	Low Quality	20	−0.2074	0.0259	[−0.2955, −0.1193]		
21	TSRs Measurement Type	82				0.0088 (1, 80)	0.9255
	Other Scales	64	−0.2239	0.0202	[−0.2640, −0.1837]		
	STRS	18	−0.2197	0.0452	[−0.3498, −0.0894]		
22	Items Number	82	0.0015	0.0014	[−0.0012, 0.0042]	1.1995 (1, 80)	0.2767
23	Reporter Type	82				0.0583 (1, 80)	0.8098
	Student Report	72	−0.2245	0.0191	[−0.2625, −0.1865]		
	Teacher Report	10	−0.2103	0.0588	[−0.3652, −0.0554]		
24	Measurement Level	82				0.0909 (1, 80)	0.7638
	Group Level	52	−0.2197	0.0407	[−0.3701, −0.0694]		
	Dyadic Level	30	−0.2320	0.0348	[−0.3013, −0.1627]		

Note. k = numbers of effect sizes; b = regression coefficient. *SE* = standard error; CI = confidence interval; *F* (df1, df2) = omnibus test; SES = Socioeconomic Status; CLS = Children's Loneliness Scale; UCLA = UCLA Loneliness Scale; TSRs = Teacher student relationships; STRS = Student-Teacher Relationship Questionnaire. For the categorical variables, the provided regression coefficients reflect the mean effect sizes (Fisher's *Z*) for each category.

time point. Regarding between-study homogeneity, we found significant differences among the true effects ($Q = 154.4830$, $p < .001$), suggesting that there was substantial between-study variability.

3.2.3. Publication bias

Four funnel plots (see Fig. 6) were created to visually explore whether there was any asymmetry in the scatter graphs and to inspect for signs of publication bias. However, with a small number of studies, such subjective assessments may lead to misinterpretation (Lau et al., 2006; Marks-Anglin & Chen, 2020). A recommendation is that the minimum number of studies for funnel plot asymmetry testing should be > 10 (Sterne et al., 2011). To statistically detect the asymmetry, we conducted Egger's regression test for each longitudinal meta-analysis. The results revealed no significant asymmetry for three sets of meta-analyses and significant asymmetry for the loneliness stability effect ($z = -2.4151$, $p = .0157$). Accordingly, the trim-and-fill correction method was applied, resulting in an adjusted effect size of $\beta = 0.4615$.

The number of missing studies was estimated as 0 using this algorithm. Given the unchanged adjusted summary estimates, we can conclude that the effect of publication bias was not substantial and that the result of stability coefficient for loneliness was relatively robust.

4. Discussion

The present meta-analyses investigated the associations between loneliness and affective TSRs during the child and adolescent years. To our knowledge, no comprehensive meta-analyses of the extensive literature regarding this topic has been conducted. Specifically, we examined the relations between loneliness and TSRs in young people ages 5.34–17.09 years, analyzing 83 effect sizes from 47 studies using a cross-sectional design based on a multilevel model and cross-lagged effects from six longitudinal reports. Our findings suggested that (a) loneliness shared a moderate negative cross-sectional relationship with the quality of TSRs among school-aged children and adolescents; (b) the magnitude of this association was significantly moderated by sample gender and cultural background (i.e., Hofstede's Power Distance and Long-term/Short-term Orientation Dimensions), such that stronger negative correlations were observed in cultures characterized by high power distance and long-term orientation, and a larger proportion of male students was associated with an increase in the strength of the association; and (c) there are reciprocal prospective relationships between loneliness and TSRs over time; that is, adolescent's relationship with teachers predicted subsequent loneliness and vice versa. Such findings have important implications for research on loneliness and for teachers and schools wishing to mitigate loneliness among their students.

4.1. Cross-sectional association between loneliness and teacher-student relationships

Consistent with our hypothesis, the three-level meta-analysis revealed a significant negative concurrent association between loneliness and TSRs, indicating that higher-quality TSRs were related to lower levels of loneliness. Our finding affirms the psychological role teachers play in young people's social and emotional development, among which is loneliness (Galanaki & Vassilopoulou, 2007). In detail, the affectionate and close bonds established between classroom teachers and their students can serve as a buffer against loneliness, whereas less supportive or even conflicting relationships between these two figures contributes to increased loneliness. These results are consistent with previous research that has proposed that teachers can be considered as one of the most prominent characters within the school environment, exerting proximal influence on young people (Bond et al., 2007; Kiuru et al.,

Table 3
Longitudinal studies of the association between loneliness and teacher-student relationships.

Study id	Author	Published year	Sample characteristics			Correlations (r)					Effect sizes (β)			
			Sample size	Age baseline (years)	Time lag (months)	TSRs1L2	L1L2	L1TSRs2	TSRs1TSRs2	TSRs1L1	TSRs1 → L2	L1 → L2	L1 → TSRs2	TSRs1 → TSRs2
1	Cavanaugh & Buehler	2016	340	11.86	24	−0.24	0.37	NA	NA	−0.29	−0.145	0.328	NA	NA
2	Gest et al.	2005	383	10	6	−0.27	0.52	−0.17	0.46	−0.22	−0.164	0.484	−0.072	0.444
3	Lätsch	2018	845	13.7	18	−0.11	0.42	−0.57	0.44	−0.13	−0.056	0.413	−0.522	0.372
4	Morin	2020	2099	15.5	6	−0.17	0.55	−0.165	0.656	−0.18	−0.073	0.538	−0.048	0.647
5	Tvedt et al.	2021	1379	16.5	8	−0.22	0.49	−0.19	0.50	−0.24	−0.109	0.464	−0.074	0.482
6	Cao	2017	746	10	12	−0.155	0.51	−0.165	0.396	−0.145	−0.083	0.498	−0.111	0.380

Note. NA = Not Available; L = loneliness; TSRs = teacher-student relationships. The reported numerical values, specified to two or three decimal places, adhere to the figures presented in the original studies included in the meta-analysis. If calculations were required, precision was maintained at three decimal places.

Table 4
Results from random effects models examining average effect size of longitudinal studies.

Path	*k*	Average effect size			
		β	*SE β*	95%CI	*p*
TSRs1 → L2	6	−0.0917	0.0127	[−0.1165, −0.0668]	< 0.0001
L1 → L2	6	0.4615	0.0273	[0.4080, 0.5149]	< 0.0001
L1 → TSRs2	5	−0.1661	0.0903	[−0.3431, 0.0109]	0.0659
TSRs1 → TSRs2	5	0.4673	0.0514	[0.3665, 0.5681]	< 0.0001

Note. L = loneliness; TSRs = teacher-student relationships.

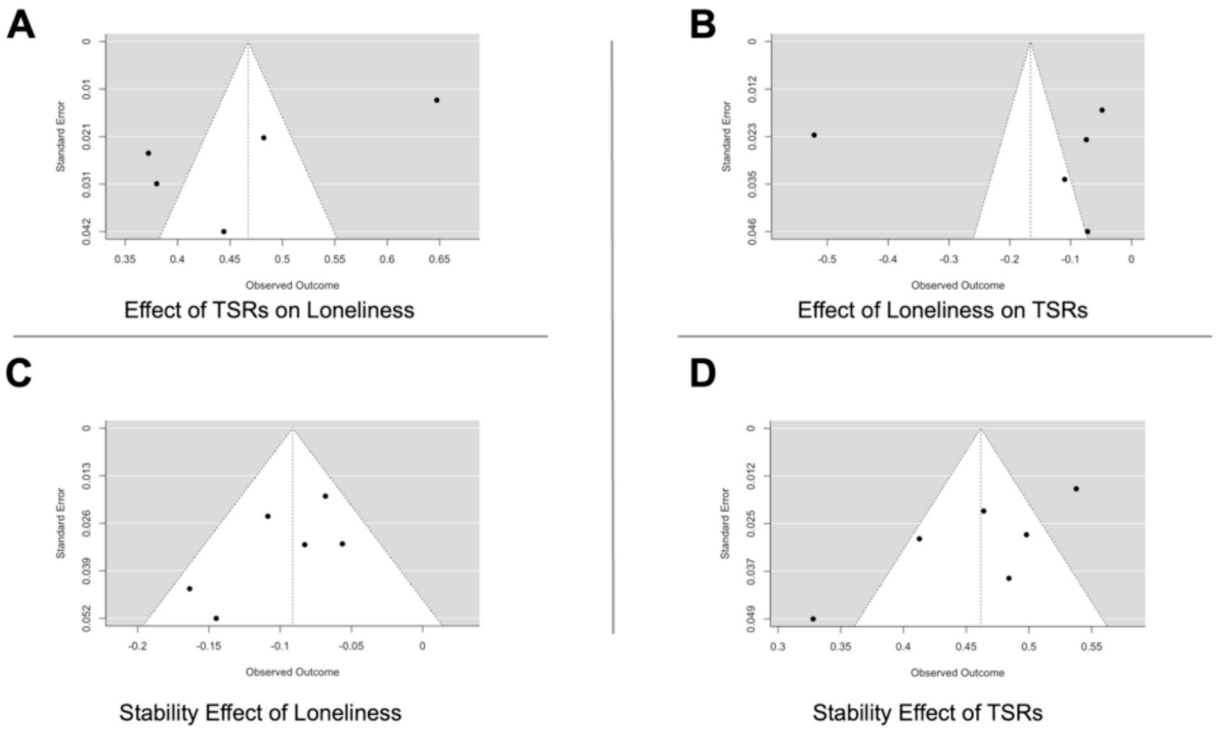

Fig. 6. Funnel Plots for the Associations Between Loneliness and Teacher-Student Relationships in Longitudinal Studies.

2020; Moore et al., 2018).

4.1.1. Moderators (cultural characteristics)

Our analyses indicated the moderating role of culture in the association between loneliness and TSRs based on cross-sectional studies. Indeed, individuals are rooted in particular social and cultural contexts and our findings support previous thinking that culture shapes people's perceptions of loneliness and their expectations of interpersonal relationships (van Staden & Coetzee, 2010).

We investigated the cultural impact using the six national-level Cultural Dimensions outlined by Hofstede et al. (2010). Our findings suggest that the Power Distance Dimension of a student's residing culture plays a role in influencing the strength of this association. Specifically, countries characterized by high power distance exhibited a significant and substantial estimated mean effect size. A high score in power distance reflects that less powerful members of society expect and accept unequal distribution of power (Hofstede, 2011). Simply put, individuals in cultures characterized by high power distance are more inclined to believe that authority figures should be respected and less challenged (Yang et al., 2007). In such scenarios, teachers hold significant authority over students and students may be more likely to comply with these authority figures (Aruta et al., 2019), wherein TSRs play a critical role in students' loneliness. Establishing and maintaining positive relationships with teachers is widely recognized as fundamental principles within the educational system (Chen et al., 2019). Students with high frequency of quality interactions with teachers may foster a sense of belonging and involvement (Johnson et al., 2023), leading to happiness, trust, and opportunities for social interaction (Wilkinson & Pickett, 2009), thereby reducing loneliness. Conversely, when such connections are not formed, youth may face heightened prejudice and discrimination from their surroundings, subsequently evoking more frequent experiences of loneliness.

Students in low power distance countries potentially have considerable freedom of action in school environments (Yang et al., 2013), leading to a perception among students that they possess greater control over their social interactions, including those with

their teachers. Consequently, the perceived influence of TSRs on mitigating feelings of loneliness may be diminished because students may rely less on these relationships for social support and validation compared to their counterparts in high power distance contexts. Interestingly, the lowest estimated mean association was observed in studies conducted within medium power distance countries. However, given the limited number of effect sizes contributing to this finding, it is important to interpret it with caution. The scarcity of data underscores the need for further research to clarify the complex relationship between cultural dimensions and the impact of TSRs on students' loneliness.

Consistent with our analyses, the Long-term/Short-term Orientation Dimension also demonstrated significant moderating effects on this association after the removal of an outlier. A higher level of association was found in studies conducted within long-term orientation contexts. The possible interpretation of our finding is the influence of Confucian heritage in long-term oriented countries (Hofstede, 2011), which emphasizes the hierarchical but harmonious TSRs (Xu et al., 2023). In these cultural contexts, maintaining respectful and harmonious interactions with teachers is highly valued and dissonant relationships can be perceived as violations of these cultural norms. Such breaches may lead to heightened social and emotional disconnection, thereby exacerbating feelings of loneliness among students. In contrast, in short-term oriented contexts, where immediate results and less emphasis on hierarchical relationships are prioritized, students may face fewer such considerations.

4.1.2. Moderators (study, sample, and measurement characteristics)

The present study suggested that the link between loneliness and TSRs was moderated by gender; the negative association was significant and stronger for male participants. The findings from Maes, Qualter, et al.'s (2019) relatively recent meta-analysis did not identify notable gender differences in loneliness during childhood and adolescence, but our findings suggest that male students may be more influenced by the TSRs, leading them to report more loneliness. Another possible interpretation of our finding is the gender differences in teacher-student interaction patterns and social expectations. In contrast to female students, the literature so far has indicated that male students are more likely to adhere to masculine stereotypes (Bem et al., 1976). This implies that they often feel pressured to project an image of independence and self-sufficiency while also being socialized to restrain their emotional expression and seek less emotional support (Knox, 2006; Rosenfield & Smith, 2010). Therefore, the quality of their relationships with teachers may have a more pronounced effect on their social well-being. Hence, strengthened bonds between teachers and their students will be important for mitigating loneliness among children and adolescents, particularly for boys.

Except for students' gender, other moderators such as TSR indicators (high quality/low quality) or measurement level (group/dyadic level) were non-significant in our analyses. This suggests that TSRs may be perceived as a continuum wherein individuals tend to view interactions comprehensively. Considering the dyadic nature of TSRs, it is possible that teacher characteristics (e.g., age, gender) might be significant moderators. However, we were not able to extract that information from eligible studies. Thus, future empirical research in school settings is advised to include detailed information on the characteristics of the samples' teachers where possible.

4.2. Longitudinal associations between loneliness and teacher-student relationships

To determine whether TSRs were a predictor or outcome of loneliness, we utilized a novel meta-analytic method to quantify the longitudinal associations between loneliness and TSRs. The results yielded support that these two constructs were reciprocal relations; that is, students who initially had lower-quality relationships with their teachers experienced an increase in loneliness over time and where loneliness then contributes to a subsequent decrease in the quality of TSRs. A vicious circle may thus arise with a worsening of these associations and detrimental implications to youth development, which is aligned with our original hypothesis.

These findings emphasize the significant role of school-based intervention, as emphasized by Qualter et al. (2015), particularly in (a) shaping inclusive school ecology (i.e., the overall dynamics within the classroom/school, encompassing positive interactions between students and teachers) and (b) practicing students' social skills that can assist in fostering emotional connections with teachers and peer groups (Jefferson, Barreto, Verity, & Qualter, 2023). Furthermore, to increase the effectiveness of interventions, teachers could be well-equipped to maintain high-quality relationships with lonely students and support them in reconnecting with other social relationships. Consequently, this contribution can help break the vicious circle associated with loneliness.

4.2.1. The effect of TSRs on loneliness

Our findings revealed that the quality of students' relationships with their teachers has a significant prospective impact on loneliness, although with a relatively small effect size. These results corroborate Galanaki and Vassilopoulou's (2007) argument that the quality of TSRs could be the vehicle that aggravates or alleviates students' loneliness. Indeed, individuals experience loneliness not solely due to the low number of people surrounding them as qualitative deficiencies in their social relationships also play an essential role (Tzouvara et al., 2015). High-quality TSRs can serve as accessible sources of belonging and attachment, contributing to the decrease in children's loneliness. Conflictual relationships with teachers can have a negative impact on students' sense of school connectedness and affiliative needs (Corso et al., 2013) that subsequently leads to the emergence and deepening of loneliness, which is one of the adverse emotional responses.

Another possible explanation for the results is that teachers undertake the role of socializers in the school context, shaping students' emotional-related outcomes alongside their academic achievement (Denham et al., 2012; Valiente et al., 2020). Teachers' supportive connections to students can facilitate a caring classroom climate where students can foster and maintain positive peer relationships with great confidence. By contrast, unsatisfactory TSRs hinder the development of a classroom committed to fostering students' social-emotional needs. Teachers as socializing figures are vital in this regard given that considerable evidence has shown peer relations are

highly correlated with loneliness (Asher & Paquette, 2003; Asher & Wheeler, 1985; Vanhalst et al., 2014; Woodhouse et al., 2012). This view is supported by Carney et al. (2020) who indicated that school connectedness buffered the relationship between peer victimization and loneliness. Furthermore, with the proliferation of social networks, periodic positive face-to-face interactions with teachers might provide young people with the chance to engage in real life considering that online contact is not an effective substitute for tackling loneliness (Zheng et al., 2024).

4.2.2. The effect of loneliness on TSRs

In this study, loneliness was found to be associated with subsequent TSRs quality. This result can be unpacked through the perspectives from students and teachers. Loneliness is proposed to be the key to triggering social withdrawal in adults (Wu et al., 2020). Lonely individuals are inclined to "turn themselves off" from the social world through withdrawal and the rejection of others (Cacioppo & Hawkley, 2009; Jones, 1990). In an educational context, children and adolescents with high levels of loneliness are at risk of losing motivation and energy to maintain, restore, or renew interpersonal relationships, including their relations with teachers. This finding is supported Qualter et al. (2013) who indicated that children who reported high levels of loneliness exhibited higher rejection sensitivity that minimized the opportunity to develop positive relationships with others.

Conversely, not all teachers are equipped with sufficient strategies to deal with students' loneliness (Stoeckli, 2009) within the achievement-focused school environment. Under work-related stress loads, they may struggle to devote sufficient attention to the social and emotional connections of young people (Keller et al., 2014). Moreover, there could be dissonance between lonely students' expectations and their actual experiences of teachers' support (Verity et al., 2024). Teachers face challenges in identifying lonely children and providing appropriate comfort and emotional care to this target group (Qualter, 2003). There is a necessity for school psychologists, who are mental health professionals within schools, to foster connections between students experiencing loneliness and teachers; they can deliver efficient services to teachers, including individual consultation and training (Eklund et al., 2020). Nonetheless, teacher groups have a restricted understanding regarding the helpfulness of school psychology services (Gilman & Medway, 2007). To sum up, lonely students are more likely to experience the deterioration of TSRs over time.

4.3. Limitations and future research suggestions

There are several limitations and suggestions for future work. First, although we included longitudinal meta-analyses, the correlational study design precludes us from drawing causal inferences. Nevertheless, the exploration of longitudinal studies is of importance because it indicates that the quality of TSRs can act as both a risk factor and outcome of loneliness. Additionally, the study number for the longitudinal analyses was small ($n = 6$), leading to very low statistical power, which meant we could not explore moderator effects (Borenstein et al., 2021). More longitudinal research is needed to investigate the prospective relations between loneliness and TSRs. The second limitation relates to the culture moderators. It is noteworthy that cultural heterogeneity exists in almost every country for several reasons, such as ethnicity/race, immigration, and international finance (Heydari et al., 2021). Future research should utilize qualitative methods to explore individual's lived experiences of loneliness and TSRs and to examine whether this is shaped by factors at the individual and group levels, including cultural background. Moreover, although the present meta-analyses included study samples from diverse regions, the scope was confined to those written in English and Mandarin, restricted by our language proficiency. Future research is encouraged to encompass studies published in other languages to enhance the generalizability of the findings. The third limitation of this study, as we mentioned before, is that teacher characteristics were not considered in the moderation analyses. Future quantitative studies should report adequate information relating to teacher characteristics, such as teachers' age, gender, and teaching experience to develop a more holistic picture of these associations. This could be complimented by additional qualitative research exploring teachers' perspectives of loneliness among young people and their recommendations for improving young people's experiences. Furthermore, although the school environment is a primary setting in which mental health concerns can arise, these concerns can also be effectively remediated through early-intervention support within the school environment (Brown, 2018); consequently, there is need for future research to delve deeper into the prevention of loneliness, which we know is associated over time with depressive symptoms and increases in anxiety within education settings. As part of such an initiative, the pivotal role of the TSRs in relation to the provision of screening, assessment, intervention, and consultation/collaboration services must be considered within school settings.

4.4. Implications

The present meta-analyses have important empirical implications. The findings contribute to the loneliness literature by quantifying the significant negative within-time association between loneliness and TSRs within contemporary research studies. Moreover, our use of longitudinal data highlights the existence of a vicious circle where loneliness and the quality of TSRs reciprocally influence each other over time. Our findings emphasize the significant role of teachers in alleviating loneliness among children and adolescents; by developing affable communications with their students, teachers can enable cooperation, effective working, and inclusion in their classrooms. Furthermore, we provide a broader evidence base by including studies from Chinese databases as an example of non-Western culture. We found that the strength of these associations was influenced by different cultural contexts (i.e., Power Distance and Long-term/Short-term Orientation), but the benefit of trusting relationships between teachers and their students is likely universally important for youth loneliness.

The findings also have practical implications as they underscore the importance of fostering a schoolwide inclusive ethos to address loneliness among youth. Various scholars have indicated that a sizeable proportion of students encounter difficulties when attempting

to develop more positive relationships with their teachers (Bosman et al., 2018). First, there is a need to promote school-based interventions aimed at aiding teachers and young people build meaningful relationships with the other to help students manage negative emotions and enhance their sense of school connection. Secondly, teachers should be encouraged to act as facilitators in alleviating students' loneliness within the school setting. To do this, teachers need to be equipped with skills to cultivate favorable relationships with their students and assist young people in maintaining or promoting affirmative social connections (Jefferson, Barreto, Verity, & Qualter, 2023). School psychologists are well-positioned to apply their expertise in empowering teachers to identify and provide appropriate support for lonely students under such circumstances (Eklund et al., 2017). Teachers, in turn, should be encouraged to engage in collaboration with counselors and school psychologists to screen students for loneliness and implement assessments and school-based interventions to ensure management of loneliness for all students (Qualter, 2003). Moreover, we recommend that the design and implementation of a loneliness intervention should be culturally sensitive consistent with recent calls (e.g., Jefferson, Barreto, Jones, et al., 2023). Indeed, an individual's personal social and emotional development does not emerge in a vacuum and is shaped by socio-cultural factors that need to be considered; such factors include how loneliness occurs in certain school contexts and what the most effective role is that teachers can play in supporting students. Finally, teachers are recommended to be aware of gender differences to offer appropriate emotional support for young people experiencing loneliness.

5. Conclusion

The present meta-analyses indicated (a) a significant negative concurrent association between loneliness and the quality of TSRs among children and adolescents and (b) students' gender and cultural background can serve as moderators that affect the strength of the association. Furthermore, the longitudinal meta-analyses showed reciprocal relationships between these two constructs that can result in a vicious circle between loneliness and TSRs. This study highlighted the pivotal role of TSRs and the importance of an inclusive school climate in combatting youth loneliness and provided valuable insights into how culture affects loneliness and teacher connectedness. Future longitudinal research investigating the association between loneliness and TSRs is needed, as is qualitative research to explore lived experiences within specific cultural settings.

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Data sharing

Supplemental materials are available on https://osf.io/uz5e6/.

CRediT authorship contribution statement

Yixuan Zheng: Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Cecilia Rollano:** Methodology, Formal analysis, Data curation. **Charlotte Bagnall:** Writing – review & editing, Supervision, Data curation, Conceptualization. **Caroline Bond:** Writing – review & editing, Supervision. **Jia Song:** Data curation. **Pamela Qualter:** Writing – review & editing, Supervision, Methodology, Data curation, Conceptualization.

Declaration of competing interest

There are no conflicts of interest for any of the authors.

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Appendix A. Supplementary data

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