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Preschool structural quality and student–teacher closeness are related to children's adjustment: sibling-informed design

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ABSTRACT

This study aims at examining whether children's adjustment, social play behavior and Early Childhood Education and Care (ECEC) program-liking in universal ECEC are associated with the quality of student–teacher relationships and structural quality features of the classrooms they attend. The sample includes 7,436 5-year-old children (50% girls) and 195 sibling pairs (48% girls) participating in the nationwide Norwegian Mother, Father and Child Cohort Study (MoBa). Three sets of findings are presented. First, student–teacher closeness is associated with children's adjustment ($\beta = .47$; $SE = .01$), ECEC liking ($\beta = .14$; $SE = .02$) and social play behavior ($\beta = .06$; $SE = .02$) in the between-child analysis. Second, associations of student–teacher closeness with children's adjustment and ECEC liking are evident even after accounting for all confounders shared by siblings in the within-family analysis (sibling fixed effects). Third, structural quality indicators are related to the children's outcomes primarily via quality of student–teacher relationships.

1. Introduction

As the majority of children in Western countries attend Early Childhood Education and Care (ECEC) (Organisation for Economic Co-operation and Development [OECD], 2021), ECEC is becoming one of the most prominent environmental contexts for children's development. Yet whether ECEC promotes positive development is conditional on the quality of the ECEC environment and children's experiences (van Huizen & Plantenga, 2018; Burchinal, 2018). To ensure optimal ECEC quality for child development, it is essential to understand the underlying mechanisms behind different aspects of quality and child outcomes.

Structural quality, that is, regulatable characteristics of staff and physical environment, is presumed to facilitate positive experiences and development for children through the interactions and relationships with their teachers that are central elements of process quality (National Institute of Child Health and Human Development [NICHD] Early Child Care Research Network [ECCRN], 2002). However, empirical evidence supporting the claim of these indirect mechanisms between structural quality and child outcomes via process quality is scarce (Burchinal, 2018; Slot, 2018).

Accumulated evidence suggests that the quality of relationships with teachers, characterized by levels of closeness, that is "the degree of warmth and positive affect" (Sabol & Pianta, 2012) has potential to contribute to children's emotional, behavioral and academic adjustment from preschool to high school (Hughes, 2012; Roorda et al., 2017). Nevertheless, evidence on the role of relationship quality in some essential aspects of children's early emotional development, such as

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positive experiences about being in ECEC, referred to in the literature as "well-being", "liking" or "enjoyment", is somewhat scarce. Existing studies incorporating outcomes, such as "liking" were primarily conducted in school settings often considering "liking" as an indicator of a broad construct of school engagement, and adjustment (see e.g., Birch & Ladd, 1997; Portilla et al., 2014; Roorda et al., 2017 for a review). Another outcome receiving less attention in the literature, compared to behavioral and academic outcomes, is early social adjustment, particularly as reflected in social play behavior characterizing child involvement in interactions with peers. Yet existing evidence shows a promising potential of relationship quality to promote such interactions, presumably by providing children with a sense of security to explore their social environment, positively shaping children's attitudes and expectations and teaching appropriate strategies and skills (e.g., Zhang & Nurmi, 2012; Baardstu et al., 2022).

Importantly, the internal validity of the research on relationship quality and child development is limited due to the assumption that statistical adjustment is efficient in isolating the effect of ECEC quality on child outcomes, and that unobserved factors (e.g., characteristics of parents) are negligible (Duncan & Gibson-Davis, 2006). This means that the observed associations might be the product of external mechanisms involving unobserved confounding factors. A notable exception in this research is a within-child study by Maldonado-Carreño and Votruba-Drzal (2011) conducted in the U.S. context. Within-subject or within-family designs (i.e., sibling fixed effects) allow partial remediation of concerns related to unobserved confounders (omitted variable bias), thereby strengthening the internal validity of the findings (Foster, 2010). In other words, such designs increase the plausibility of causal inferences in observational data, with important implications for policy.

We address the gaps in the literature by: 1) examining less studied, but essential for child development outcomes: ECEC liking, social play behavior, as well as socio-cognitive aspects of ECEC adjustment; 2) accounting for potential unobserved confounders with sibling analysis; 3) investigating the indirect links between structure→ process (relationship quality)→ child outcomes. The study is conducted in Norway, where access to ECEC is universal. Considering the rising participation rates across nations (OECD, 2021) and an increasing interest in universal preschool, including in the United States (The White House, 2021), the timing and national context of the current study are particularly relevant.

1.1. Theoretical Insight and Empirical Evidence on Student–Teacher Closeness and Child Outcomes

The central role of student–teacher relationships for child development is widely acknowledged. However, there are different theoretical views on the associations between student–teacher relationships and children's outcomes, including relationship-driven, child-driven and bidirectional perspectives (for a review, see e.g., Pakarinen et al., 2021, who have recently provided support for the relationship-driven model). The relationship-driven perspective that we follow in this study is grounded in attachment theory (Bowlby, 1969). Close student–teacher relationships may serve as a "secure base" (Verschueren & Koomen, 2012) and "external source of stress regulation" (Hughes, 2012). The resulting sense of security will enable children to positively engage in and explore their environment and acquire essential skills for school adjustment (Hughes, 2012; Mashburn & Pianta, 2006; Sabol & Pianta, 2012).

Following a theoretical view of the relationship-driven model, a large body of empirical research has emerged. In the United States, studies covering children from preschool or kindergarten to middle school have reported positive, but mostly modest, associations between a high level of closeness and children's academic, social and behavioral functioning (e.g., Ansari et al., 2020; Birch & Ladd, 1997; Maldonado-Carreño & Votruba-Drzal, 2011; McCormick et al., 2013; O'Connor & McCartney, 2007; Pianta & Stuhlman, 2004). However, this evidence is not entirely conclusive, as there are variations within and across the studies in the conceptualization and the associations of relationship quality with different measures of child outcomes. Moreover, some studies find no significant relations between closeness and any child outcomes (e.g., Varghese et al., 2019).

The validity of this research base is also limited as few studies have employed rigorous statistical techniques to reduce potential omitted variable bias. Specifically, using longitudinal data from the NICHD Study of Early Child Care and Youth Development, Maldonado-Carreño and Votruba-Drzal (2011) studied within-child associations. Following children from kindergarten into 5th grade, these authors found significant associations between the overall relationship quality and teacher-reported reading and math skills, but not standardized achievement test scores. The relationship quality in this study was also related to behavioral problems. Beyond research from the United States, evidence is more limited, yet also pointing towards positive benefits of student–teacher closeness.

There are a few studies from European contexts characterized by universal and subsidized public ECEC. For example, in Belgian data, including observed and teacher-reported measures, the relationship closeness was found to predict higher levels of behavioral engagement in learning in kindergarten and in first grade (Cadima et al., 2015; Doumen et al., 2012). In Norway, Skalická et al. (2015) examined bidirectional associations and found that higher levels of closeness predicted reduced behavioral problems in the first grade when children attended preschool with smaller groups. In the same national context but using data from a larger population-based study: Mother, Father and Child Cohort Study (MoBa), Wilhelmsen et al. (2022) also found a beneficial effect of closeness in preschool for children's behavioral problems in school.

On the other hand, a recent study from Finland, focused on bidirectional links between student–teacher relationships and children's pre-academic skills, found only concurrent, but not longitudinal, positive associations (Pakarinen et al., 2021). Importantly, almost all of these studies were limited to one region or city and, except for Skalická et al. (2015) and Wilhelmsen et al. (2022), were based on a small sample of children, thereby potentially limiting the statistical power and generalizability of the results.

To sum up, there is evidence, although not entirely consistent, that higher student–teacher closeness relates to better child outcomes from preschool through school years. This evidence can be linked to social and cognitive (social play behavior and adjustment), as well as emotional (ECEC liking or positive experience/feelings about ECEC) aspects of child development examined in this study. Yet most of the research comes from the United States, a sociopolitical context that is quite different from European countries. Even though evidence from other contexts appears to point in the same direction, this is largely based on regional studies with small samples. Finally, few studies have attempted to address omitted variable bias using rigorous statistical methods. Altogether, this raises concerns about the external and internal validity of existing evidence, thereby warranting larger population-based studies employing robust statistical methods within broader sociopolitical contexts.

1.2. Addressing Omitted Variable Bias—Sibling Design

In non-experimental research, associations might be biased due to selection and endogeneity, when variables influencing the exposure and the outcome (i.e., confounders), are not accounted for in the model. This may threaten the internal validity of the study and limit the opportunity to draw causal inferences (Duncan & Gibson-Davis, 2006).

Sibling designs eliminate bias due to constant, unobserved, parental and family characteristics (e.g., stable characteristics of parents and the home environment). This is achieved by exploiting variation within a family in both the exposure and the outcome (i.e., comparing siblings to each other), so that unobserved constant factors within the same family

cannot bias the associations, as these are shared by the siblings. All between-family heterogeneity, which can bias the estimates (e.g., differences in attitudes towards child care and parenting aspects not varying across siblings, which may affect both selection into a particular center and child outcomes) is parceled out of the sibling fixed effects model.

However, it is important to account for confounders, due to child-specific characteristics and unshared family environment, as this may represent a potential source of bias threatening the internal validity. While not remedying all potential confounders, sibling design can substantially minimize confounding and thereby the number of alternative explanations, thereby providing a robust, quasi-experimental alternative to randomized experiments (Lahey & D'Onofrio, 2010). Despite its potential, sibling design has hardly been used in ECEC research (see Zachrisson et al., 2013 as an example and for additional references).

1.3. Linking Structural Classroom Context With Student–Teacher Relationships and Child Outcomes

Recognizing the complexity of student–teacher relationships, research in the field has also gained insight from developmental or ecological systems theory (Mashburn & Pianta, 2006; O'Connor & McCartney, 2007; Pianta et al., 2003; Sabol & Pianta, 2012). Within this developmental framework, it is argued that student–teacher interactions shaped by the interplay of the within- and cross-level factors (such as individual, family and classroom) form the basis for student–teacher relationships (Sabol & Pianta, 2012). This suggests that structural classroom characteristics, such as overall staff competence, stability, physical environment and group size, can be important for the quality of student–teacher interactions and relationships. The review below partly draws on evidence related to overall observed classroom quality (i.e., combined measures of structural and process quality) and interaction quality, due to limited evidence on the corresponding links with the relationship quality.

Staff's specialized competence (i.e., competence within specific areas related to child socioemotional development, such as social skills and behavioral problems) may shape teachers' ability to establish close relationships with children (Wilhelmsen et al., 2022). Related to this, meta-analytic evidence indicates that specialized training can increase caregivers' competence and enhance their performance, providing significant potential for improving the quality of teachers' interactions with children (Fukkink & Lont, 2007). Hamre et al. (2012) focused on the effects and underlying mechanisms behind the practice-focused professional development intervention (i.e., in-service training of staff to enhance competence) targeting teacher–child interactions and children's literacy and language outcomes. The study demonstrated beneficial effects of the intervention on teachers' competence and the quality of observed interactions with children. Furthermore, teachers' self-efficacy beliefs are also linked to higher interaction and relationship quality (Hajovsky et al., 2020). Staff instability has been argued to affect children's comfort in interactions with teachers and their ability to establish secure attachments, as well as staff's ability to provide a stimulating learning environment and one-on-one interactions (Drange & Rønning, 2020; Skalická et al., 2015).

A physical and learning environment of higher quality, including safe, less-crowded settings with a greater variety of developmentally appropriate toys and learning materials, has been found to relate to observed positive caregiving (NICHD ECCRN, 2000). Yet the direction of such associations is ambiguous. Crowded settings with limited space for children to play and rest can cause stress and insecurity, affecting children's attachment to teachers. At the same time, in smaller spaces, children and teachers might naturally feel closer to each other. Similarly, while the availability of learning and developmental materials may assist teachers in positive and stimulating interactions, more sensitive teachers may establish a better physical and learning environment (NICHD ECCRN, 2000).

Larger groups may contribute to a more diverse socioemotional climate in the classroom and make it challenging for teachers to provide responsive and sensitive interactions and form close relationships. In addition, larger groups may affect children's comfort and make it more difficult to form attachments with teachers. Indeed, Skalická et al. (2015) found that closeness predicted more positive child behavior in small groups, arguing that smaller groups increase the likelihood of positive one-to-one child–teacher interactions. In a recent literature review, Slot (2018) concluded that a smaller group size was generally related to higher observed process quality. However, the associations between group size and observed quality of interactions between teachers and children are not consistently supported (e.g., Slot et al., 2018) and appear to differ across different national contexts (Cryer et al., 1999).

Empirical evidence on the indirect mechanisms between structural quality, interaction quality and child outcome is limited (Burchinal, 2018; Slot, 2018). In the U.S., there was evidence of small indirect effects of caregiver education and child–staff ratio on children's cognitive and social outcomes via observed interaction quality (e.g., NICHD ECCRN, 2002). In Denmark, Slot et al. (2018) found no indirect effects of teachers' qualifications, group size or child–staff ratio via observed process quality on children's cognitive outcome. There is even more limited knowledge regarding the potential mediating role of teacher-perceived relationship quality.

To conclude, viewing student–teacher relationships within a broader system of multilevel influences, as suggested by the developmental framework, points to the importance of the structural classroom context. Empirical evidence provides support, although not entirely consistent, for the link between structural quality characteristics and the quality of teachers' interactions and relationships with children. Evidence on the subsequent indirect mechanisms is scarce and inconclusive, and there is a need to account for the complexity of these mechanisms by examining multiple structural indicators (Slot, 2018).

1.4. The Institutional Context: ECEC in Norway

Norway has a universal model of ECEC whereby all children from the age of 1 have a legal right to a place in ECEC (The Kindergarten Act, 2005). ECEC (including private centers, which constitute around 50% of the centers) is subsidized; there are capped monthly fees (NOK 3,000 or approx. USD 300 as at January 2023), which are further reduced for siblings and low-income families (Ministry of Education and Research, 2022; Norges Bank, 2023). The enrollment rates are among the highest in the OECD countries (OECD, 2021), with 97% of 3–5 year old children attending full-time ECEC (Statistics Norway, 2023).

ECEC in Norway is organized as a unitary setting covering children aged 1 to 5–6 years and is a non-compulsory part of the educational system under the governance of the Ministry of Education and Research. ECEC centers in Norway (called kindergartens) are most commonly divided into departments for younger children (under 3 years of age) and for older children (from 3 to 5–6 years of age); there is no shift in ECEC classrooms when children turn 5 years. While there is educational content throughout the entire ECEC period, ECEC centers are not part of formal education in Norway and are therefore more comparable to preschool, than kindergartens, in the United States. Children start formal education at around 6 years of age, entering the first grade of primary school.

Quality is considered to be high, particularly with regard to clear educational content, educational requirements for staff and consistent policies for the entire ECEC period (European Education and Culture Executive Agency, Eurydice, 2019). The national regulations on structural quality include staff–child ratio (1:3 for children under 3 years and 1:6 for older children), formal ECEC teacher education (i.e., a tertiary teaching degree specialized in early childhood) for the pedagogical leader, and pedagogue–child ratio (1:7 and 1:14, respectively) (The Kindergarten Act, 2005, Norwegian Directorate for Education and

Training, 2017). Staffing according to these ratios typically includes one pedagogical leader who works with two assistants, for whom there are no strict skill requirements. The pedagogical leader is responsible for implementing and overseeing the pedagogical practices, offering guidance to the assistants, and ensuring implementation of the Kindergarten Act and the framework plan in the ECEC center's pedagogical practices (see Ministry of Education and Research, 2017 for details).

The framework plan for the content and tasks of kindergartens (Ministry of Education and Research, 2017) provides guidance for the operations of public and private ECEC, underscoring a continuous holistic approach to child development and the importance of children's ECEC liking, experiences and opinions in the planning and evaluation process. Play and social competence developed through social interactions have a central role in the framework plan and in the Norwegian ECEC system. Staff are expected to facilitate an inclusive and enriching play environment and to support children in their social interactions.

Yet there are weaknesses in the ECEC system, which allow variations in quality, particularly a shortage of qualified staff and exemptions from the educational requirements, as well as the lack of specific regulations for maintaining and enhancing process quality (Engel et al., 2015). Parents cannot directly select the ECEC center they prefer but can rank the centers by preference in the application to the municipality. A lack of easily comparable quality ratings for ECEC centers (e.g., Quality Rating and Improvement System in the U.S.), deficiencies in the existing regulations, together with geographical challenges and a relatively high degree of decentralization, might give an unintended advantage to parents with higher education in accessing ECEC of higher quality. Indeed, higher parental SES is related to children's attendance of somewhat higher quality ECEC (Alexandersen et al., 2021).

1.5. The Present Study

The overall goal of this study is to expand and strengthen the knowledge base on the quality of student–teacher relationships, the structural quality of the classroom and the children's adjustment in the last year of a universal ECEC. The study's specific aims are as follows. First, to extend the evidence on the between-child associations of student–teacher relationships and child outcomes by focusing on ECEC liking, social play behavior, and socio-cognitive aspects of ECEC adjustment. Second, to strengthen the internal validity of these associations and increase the plausibility of causal links by employing within-family analysis (i.e., sibling fixed effects), which reduces the risk of omitted variable bias. Third, to extend the evidence on the indirect mechanisms between structural quality and child outcomes by examining a broader range of structural quality features and exploring a potential mediating role of student–teacher relationship (closeness). Drawing on the theoretical and empirical insights provided above, we argue that different structural features in the classroom may promote a favorable or unfavorable climate for the establishment of individual student–teacher relationships that will contribute to children's development (i.e., socio-cognitive aspects of ECEC adjustment, social play behavior and ECEC liking). We use data from a nationwide cohort study in Norway (N = 7,436 including siblings n = 393), where ECEC is universally accessible and heavily subsidized, and where structural quality is regulated according to national standards.

2. Methods

2.1. Study Population

This study is based on a sub-cohort of children from the Norwegian Mother, Father and Child Cohort Study (MoBa). MoBa is a population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health (Magnus et al., 2016). Participants (children's mothers) were recruited from all over Norway in 1999–2008. Women consented to participation in 41% of the pregnancies. The cohort now includes 114,500 children, 95,200 mothers and 75,200 fathers. The current study is based on the 12th version of the quality-assured MoBa data files released for research in 2020. The establishment of MoBa and the initial data collection were based on a license from the Norwegian Data Protection Agency and approval from the Regional Committees for Medical and Health Research Ethics (REC). The MoBa cohort is now based on regulations appertaining to the Norwegian Health Registry Act. This study was approved by REC (2018/1918/REK sør-øst).

When the children from MoBa born in 2006–2009 were 5 years old, ECEC teachers (in most cases pedagogical leaders) were invited to complete a questionnaire (Q-Cc), including questions about their relationship with the child, structural quality in the unit, which the child attended, and different aspects of the child's development and functioning in ECEC (response rate 41%). Q-Cc was administered at one time point meaning that all data from ECEC teachers were collected concurrently. Children with valid responses on Q-Cc constituted the sample for this study (N = 7,436), including the siblings used in the next set of analyses. All parents have consented to the collection of data from the ECEC teachers.

There was some evidence of statistically significant differences between the MoBa children participating in this study and the overall MoBa population in terms of higher proportions of children with parents in the highest educational and income categories. The sibling subsample (n = 393) that is, families with at least two siblings in the study sample (both born in the period 2006–2009 and with valid responses on Q-Cc), included 195 families (primarily with two siblings, and only three families with three siblings), 96 of which were families with twins, while there were two families with triplets. The third family with three siblings had twins and one other child. The gender distribution in the sibling subsample was nearly equal, with 204 boys and 189 girls (48%), similar to the full sample (50% girls). The majority of the children were born in 2007 and 2008, both in the sibling subsample (36% and 33%, respectively) and the full sample (45% and 38%, respectively). The rest of the children (31% in the sibling subsample and 17% in the full sample) were distributed equally or nearly equally (7.8% and 9.68% in the full sample) between 2006 and 2009. Around 11% of children in the full sample and around 9% of children in the sibling subsample had a non-native speaker parent (of these children, around 37% and 33%, respectively, reported speaking another language in addition to Norwegian, Danish or Swedish). Comparison of the sibling subsample with the overall sample for this study in terms of parental demographic characteristics (e.g., education, income, single mother, non-native speaker parent) revealed statistically significant differences in the proportion of children with parents in the highest income categories in favour of the sibling subsample. There were 4,476 children distributed over 1,441 ECEC, with two or more children in each ECEC (1,296 ECEC centers in the study sample had only one child per ECEC). In the sibling subsample, 244 children (90% of those with available ECEC IDs for both siblings [n = 270] were identified as attending the same ECEC centers), 156 (58%) of the children were twins/triplets.

2.2. Measures

2.2.1. Student–Teacher Closeness

The student–teacher closeness was measured using a subscale (eight statements) from the Student–Teacher Relationship Scale–Short Form (STRS–SF; Pianta, 2001). STRS comprises subscales of closeness and conflict, and there is support for the use of these subscales as separate elements of the relationship quality (e.g., Ansari et al., 2020). The ECEC teachers rated their relationship closeness with children on a scale from 1 (*not true at all*) to 5 (*very true*). The Closeness subscale included eight questions, for example, "I share an affectionate, warm relationship with this child", "If upset, this child will seek comfort from me", "This child openly shares his/her feelings and experiences with me". The scale had good reliability in our sample (Cronbach's α = .76). Teacher-perceived

relationships measured with STRS have also been shown to relate to the observed student–teacher interactions, with positive interactions predicting a higher degree of teacher-perceived closeness (e.g., Hartz et al., 2017).

2.2.2. Structural Quality in ECEC

The ECEC teachers reported availability and sufficiency of space (for different learning activities, play and rest) (Cronbach's α = .77) and developmental material (to accommodate a diversity of children's interests and stimulate different skills) (Cronbach's α = .70) using a scale of 1 to 5 (5 being the highest). The teachers also rated the overall staff's stability and competence on a scale from 1 to 5 (5 denoted the highest level in the analysis). To indicate staff competence, teachers answered the question: "To what extent do you agree that the employees in the project child's unit have sufficient competence within the thematic areas: social competence, bullying among children, behavior problems, language competence and shy children?" (Cronbach's α = .85). Group size was based on the number of reported girls and boys in the unit. Child–staff ratio and the share of staff with formal ECEC teacher education were also defined, based on the teachers' reports, but were not included in the final analyses, as these variables were not related to closeness and had almost no relation to the children's outcomes. Child–staff ratio and staff's education are also the most regulated features of ECEC in Norway.

2.2.3. Child Outcomes

Child adjustment in ECEC, also reflecting social skills and approaches to learning, was measured using selected items from a Norwegian version of the School Readiness Questionnaire (SRQ; Prior et al., 2011). The SRQ scale describes different aspects of functioning (personal social, cognitive, physical maturity) in ECEC. Based on a sample of Australian 5- to 6-year-old children, Prior et al. (2011) indicated that the SRQ scale was a unidimensional construct with a high internal consistency (Cronbach's α = .95). The six selected items in our study included aspects of personal social and cognitive development: "settling into the child care center", "co-operation with other children", "use of play materials", "confidence", "speaking in groups of children" and "coping with personal needs". These items were rated by teachers on a scale from 1 (*considerable difficulty*) to 5 (*very well*) (reversed from the original scale). The items which could be attributed to the shared variance in teachers' reporting of relationship quality and child school readiness ("relationship with the adults at the unit", "agreeableness" and "following instructions") were not included. We also excluded items describing child characteristics which are less likely to be linked to the quality of the relationships ("concentration", "motor coordination" and "fine motor skills"). Finally, the question about the overall "adaptation to the child care center", which is conceptually similar to the "settling into the child care center" item, was not included. The short scale still showed high reliability in our sample (Cronbach's α = .84).

Child ECEC liking was measured by asking mothers "How does your child enjoy/like being in the current child care?", with answers ranging from 1 (*not at all*) to 5 (*very much*). This item is substantially similar to a question regarding child well-being in ECEC used by the Norwegian Directorate for Education and Training (2023) in their annual ECEC monitoring. Social play behavior was based on mothers' rating of six statements in the social play subscale from the Preschool Play Behavior Scale (PPBS; Coplan & Rubin, 1998) on a scale from 1 (*never*) to 5 (*very often*). The statements described the child's engagement in group play (e.g., "Plays in groups with (and not just beside) other children") and communication with other children (e.g., "Engages in active conversations with other children during play") (Cronbach's α = .76 in our sample).

2.2.4. Control Variables

The rationale for including control variables is to adjust for potential confounders and thereby reduce the effects of children's and parental characteristics on the associations between ECEC quality and child outcomes. Child temperament at 6 months was rated by mothers on a scale from 1 (*completely disagree*) to 7 (*completely agree*) using seven items from the Infant Characteristics Questionnaire (ICQ; Bates et al., 1979) (fuzzy/difficult subscale) and three items added by MoBa on the advice of the pilot group. We reversed positively loaded questions, and a higher overall score indicated a more fuzzy/difficult temperament (Cronbach's α = .75 in our sample). Child externalizing behavior (related to inattention and hyperactivity/impulsivity) at age 5 was measured by seven items from the Conners' Parent Rating Scale–Revised (CPRS-R; Conners et al., 1998) on a scale from 1 (*never/seldom*) to 4 (*very often*) and reported by the ECEC teachers (Cronbach's α = .88 in our sample). Child language difficulties in ECEC were measured by eight statements from the Norwegian checklist about language-related difficulties (semantics subscale) (Språk20; Ottem, 2009) on a scale from 1 (*doesn't fit the child, absolutely wrong*) to 5 (*fits well with the child, absolutely right*) (Cronbach's α = .89 in our sample). See the supplementary material for a detailed overview of the items included in the various scales. The ECEC teachers also reported for how long (years and months) they had known the child at the time of filling out Q-Cc. Child gender was reported by mothers.

Parental education was first reported by mothers (for both parents); later, fathers were also asked about their own educational level. When the father's report was missing, we used the mother's reporting of her own and the father's educational level. We defined parental education as the highest education attained in the family, divided into four categories ranging from '*Up to vocational high school*' to '*University, technical college, more than 4 years*' (Master's or PhD degree). The child's mother also indicated whether she or the child's father had a mother tongue other than Norwegian.

2.3. Analytical Strategy

We used Stata (Version 17) for data preparation and preliminary analyses and Mplus (Version 8.5) for the main analyses. We ran two versions of the models: unadjusted and adjusted for observed family and/or child covariates. First, we examined associations of student–teacher closeness and the child outcomes in between-child analysis (i.e., controlling only for observed factors, which may confound the associations, such as ECEC and family characteristics). See details regarding this analysis below, where we describe how we proceeded with examining associations of structural quality, student–teacher closeness and the child outcomes.

Second, we tested the internal validity of these associations with within-family analysis (i.e., sibling fixed effects), addressing omitted variable bias due to stable within-family confounders either unobserved or omitted from the model. The sibling analysis was performed within a multilevel structural equation modeling (SEM) framework and provided estimates for within- (i.e., sibling fixed effects) and between-family associations. As a first step, we examined variation within families for the main variables (i.e., student–teacher relationship and child outcomes). Our primary focus was to estimate the associations between closeness and child adjustment, social play behavior and ECEC liking, by exploiting the variation that exists within a family. The scale variables for student–teacher closeness, child adjustment, social play, child temperament, externalizing behavior and language difficulties were analyzed as continuous variables, based on the mean score of all items previously included as indicators for latent variables. As expected, the mean scores were highly correlated with corresponding latent variables. MLR estimator (maximum likelihood with standard errors robust to non-normality) and TYPE=TWOLEVEL command were used, with family ID as a cluster variable. We estimated a random intercept model, allowing the intercept (child outcomes) to vary across the clusters (families), and using the latent group-mean centering of the covariates (latent decomposition approach) to identify the within slope β. The latent decomposition approach produces two uncorrelated latent variables by modeling

individual level covariates on the within and between levels (Muthén & Muthén, 1998-2017). This approach has been demonstrated to be particularly advantageous with a small number of repeated measurements, resulting in unbiased estimates for the within slope β, identical to the estimates obtained from the fixed effects model (Hamaker & Muthén, 2019).

The within slope β is interpreted as a regression coefficient in standard fixed effects models. In the current study, this is the expected change in child adjustment in ECEC, given a unit (standard deviation) increase in student–teacher closeness, when all factors constant within the family/shared by siblings that can provide alternative explanations for the relation between closeness and child adjustment, are controlled for. Child-level control variables were included in the adjusted model to account for potential bias arising from children's individual differences and to improve the precision of the estimates.

Third, we examined associations of structural quality, student–teacher closeness and the child outcomes, as well as the extent to which the associations between structural quality and the child outcomes were indirect, via student–teacher closeness (i.e., a mediating role of closeness). The between-child analysis and the analysis of indirect associations were conducted with the full ECEC sample, using SEM, which provided evidence for the between-child associations and the total, direct and indirect effects. We used Weighted Least Squares estimator (WLSMV) to address the categorical nature of indicators of the latent variables and the observed variable ECEC liking, with parameterization 'theta'. Note that (ordered) probit regression is estimated for (ordered) categorical dependent variables with WLSMV estimator. In the adjusted model, first the latent variable closeness was regressed on the relevant structural indicators and family- and child-level covariates. The first step provided essential information for examining a mediating role of closeness (i.e., whether there was any relation between structural quality and closeness). Second, child adjustment, social play behavior and ECEC liking were regressed on closeness, structural quality indicators and family- and child-level covariates. The second step in the model provided evidence on the between-child associations of student–teacher closeness and the child outcomes adjusted for observed structural quality characteristics of the classroom and family- and child-level covariates. The same step produced estimates of the associations between the structural quality and the child outcomes, adjusted for closeness and observed family and child covariates, thereby demonstrating the direct effects of structural quality characteristics on the child outcomes, or the extent of a potential *mediating* role of closeness.

Child adjustment, social play behavior and ECEC liking were assumed to correlate. MODEL INDIRECT and CINTERVAL commands were used to obtain the estimated indirect effects with symmetric 95% Confidence Intervals (CIs). Additionally, bootstrapped standard errors and non-symmetric bootstrap CIs for indirect effects were obtained by specifying BOOTSTRAP option in the analysis (1,000 draws) and output command prior to the imputation. Note that we use the terms "total, direct and indirect effects" in line with the results produced from the analysis with MODEL INDIRECT, without imposing unequivocal claims about causality. All control variables were modeled with effects on all dependent variables (Fig. 1).

2.3.1. Accounting for Hierarchical Data Structure

We utilized individual-level data, primarily collected from mothers and ECEC teachers. As data from ECEC are collected on children participating in MoBa (as opposed to recruiting children from selected ECEC centers), children are spread across different ECECs (2,737 unique ECEC IDs identified in the dataset), units and teachers (unidentifiable). We examined standard errors accounting for non-independence of observations within ECEC in the subsample with valid ECEC IDs (n = 5,772) by using SUBPOPULATION with TYPE=COMPLEX command, but there were very minor changes. In the subsample of families with siblings, we modeled non-independence of observations within the family by estimating a random intercept model.

2.3.2. Missing Data

To prevent bias arising due to missing data with the WLSMV estimator, we performed a multiple imputation using Bayesian analysis (Rubin, 1987; Schafer, 1997) of unrestricted (H1) variance covariance model (Asparouhov & Muthén, 2022; Muthén & Muthén, 1998-2017) including all variables relevant for the subsequent analysis as well as variables that could predict missing data. We imputed five datasets, in line with earlier evidence showing that increasing the number of imputed data sets to 50 with the WLSMV estimator does not lead to improved results (Asparouhov & Muthén, 2022). See Table 1 regarding the percentage of missing data for different variables. Note also that we conducted preliminary descriptive and regression analyses for the full ECEC sample on pre-imputation data.

3. Results

Descriptive statistics for the full sample based on crude mean estimates are presented in Table 1. In Table 2, we present overall means and within- and between-family variation (in *SD*s) for the main variables: closeness, ECEC adjustment, social play and ECEC liking in the sibling subsample. Results of the analyses on the pre-imputation data were generally similar to the results obtained after the imputation; here we present all results based on five imputed data sets. Note that coefficients

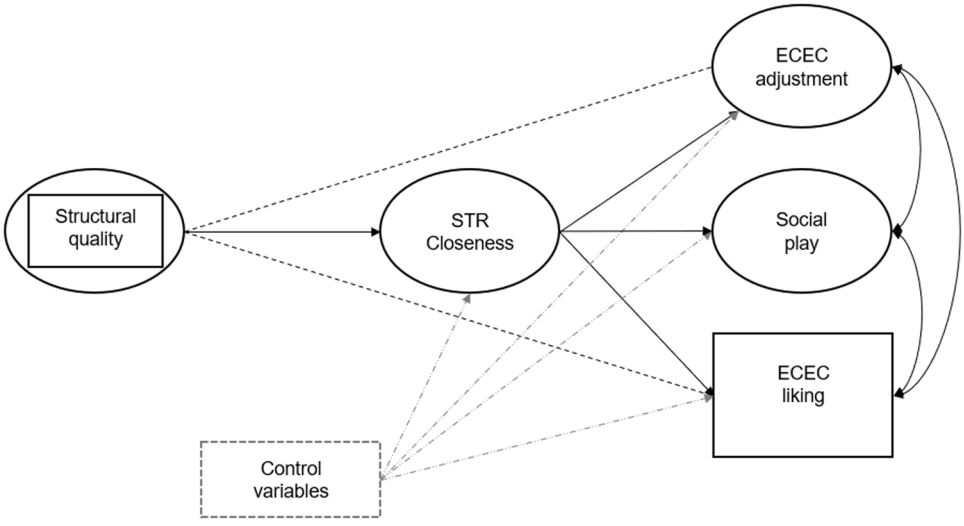

Fig. 1. *Analytical Path Model Illustrating Potential Direct and Indirect Associations Between Structural Quality, Student–Teacher Relationship and Child Outcomes.*
Note. Dashed lines from structural quality depict potential "direct effects" on child outcomes. Structural quality in ECEC (a set of different indicators; includes latent and observed variables) is assumed to exist prior to forming Student–Teacher Relationship (STR): Closeness (latent variable). Child adjustment and social play (latent variables), as well as ECEC liking (observed categorical variable) in ECEC are conceptualized to be predicted by the closeness of the relationship between the student/child and the teacher in ECEC. Control variables are modelled with the effects on the four dependent variables.

Table 1
Descriptive Statistics for the Full Sample N = 7,436.
Means (%) with standard deviations—average results over the five imputed datasets.

Variable	*Mean (%)*	*SD*	Min–Max [b] (original scale)	Missing data (%)
Child outcomes				
ECEC adjustment (SRQ) [a]	4.35	.57	1–5 (1–5)	.22
Social play (PPBS) [a]	4.36	.48	1–5 (1–5)	1.95
ECEC liking	4.62	.61	1–5	1.96
Student–Teacher Relationship				
Closeness (STRS) [a]	4.35	.48	1.75–5 (1–5)	.17
Structural quality				
Space [a]	3.66	.86	1–5 (1–5)	.26
Developmental material [a]	4.20	.52	1–5 (1–5)	.26
Staff competence [a]	3.84	.65	1–5 (1–5)	.69
Staff stability	4.22	.94	1–5	1.75
Group size	20.52	5.62	3–47	4.34
Control variables				
Child temperament (ICQ) [a]	2.18	.72	1–6.2 (1–7)	3.23
Child behavior (CPRS–R) [a]	1.42	.50	1–4 (1–4)	.73
Child language (Språk20) [a]	1.31	.54	1–5 (1–5)	.93
Teacher has known child (years)	2.49	1.37	0–6.5	2.45
Gender (1 = girl)	50%		0–1	.04
Child age Q-Cc [c]	5.54	.22	5.00–6.5	7.52
Child age MoBa 5y Q-re [d]	5.10	.11	4.92–6.08	4.88
Parental education	3.22	.90	1–4	1.41
Parent non-native speaker	11%		0–1	2.66

Note. NA: not applicable. Crude estimates for categorical variables.
SRQ—School Readiness Questionnaire (personal social and cognitive aspects), PPBS—Preschool Play Behavior Scale, STRS—Student–Teacher Relationship Scale, ICQ—Infant Characteristics Questionnaire (mainly from the fuzzy/difficult subscales), CPRS–R—Conners' Parent Rating Scale–Revised (inattention and hyperactivity/impulsivity), Språk20—The checklist of statements about language-related difficulties (semantics subscale).
[a] Scales (for latent constructs) with different items (categorical indicators), mean of all items included [b] Prior to imputation [c] Child's age on filling out the ECEC Questionnaire [d] Child's age on filling out the MoBa 5-year Questionnaire

for the control variables are not presented or discussed, due to MoBa's restrictive policies for preventing infringement of other projects using MoBa data and having the same variables as the primary focus. The correlations between all covariates are provided in the supplementary material. As the results with bootstrapping (bootstrapped standard errors and non-symmetric CIs for unstandardized estimates) were also generally similar to the results obtained without bootstrapping, we present the standardized estimates with symmetric CIs based on the average results of the five imputed datasets. We describe standardized estimates, first unadjusted and then adjusted for additional covariates. Exact *p* values are reported in text when these are equal to or greater than .001.

3.1. Between-Child Analysis: Controlling for Observed ECEC- and Family-Characteristics

3.1.1. Between-Child Associations of Student–Teacher Closeness and Child Outcomes

The unadjusted results (i.e., without family- and child-level covariates) indicated that the strongest association was between the level of student–teacher closeness and child adjustment (β = .64; *SE* .01; $p < .001$). The associations between closeness and social play behavior (β = .19; *SE* .02; $p < .001$), as well as closeness and ECEC liking (β = .18; *SE* .02; $p < .001$) were weaker. One standard deviation increase in closeness was associated with 64% of a standard deviation increase in child adjustment, 19% of a standard deviation increase in social play behavior and 18% of a standard deviation increase in the probit index for child ECEC liking (analyzed as ordered categorical observed variable).

The corresponding adjusted associations were weaker compared to the unadjusted associations, but the association between the level of student–teacher closeness and child adjustment was still the strongest. Covariates in the adjusted model included: parental education, parent non-native speaker, child gender, child temperament at 6 months, teacher-reported externalizing behavior, language difficulties in ECEC, child age at filling out the ECEC and MoBa 5-year questionnaire, and for how long the teacher had known the child. The association between closeness and child ECEC liking was more modest compared to closeness and adjustment, while the association between closeness and social play became the weakest of these associations. The estimates accounted for around 47% of a standard deviation increase in adjustment, 14% of a standard deviation increase in the probit index for child ECEC liking, and 6% of a standard deviation increase in social play behavior when closeness increases by one standard deviation. The highest explained variance was for child adjustment, adjusted for family- and child-level covariates. The standardized estimates adjusted for family- and child-level covariates, R^2 and the model fit, are presented in Fig. 2.

Table 2
Within- and Between-Family Variation on Student–Teacher Closeness and Child Outcomes.

Variable	*n* clusters	*Mean* overall	*SD* within	*SD* between
Closeness (STRS) [a]	193	4.43	.29	.37
ECEC adjustment (SRQ) [a]	192	4.38	.34	.50
Social play (PPBS) [a]	188	4.37	.20	.40
ECEC liking	189	4.65	.32	.43

Note. Crude mean estimates. Different number of clusters due to missing values (handled in the further analysis).
STRS—Student–Teacher Relationship Scale, SRQ—School Readiness Questionnaire, PPBS—Preschool Play Behavior Scale.
[a] Scales (for latent constructs) with different items (categorical indicators), mean of all items included.

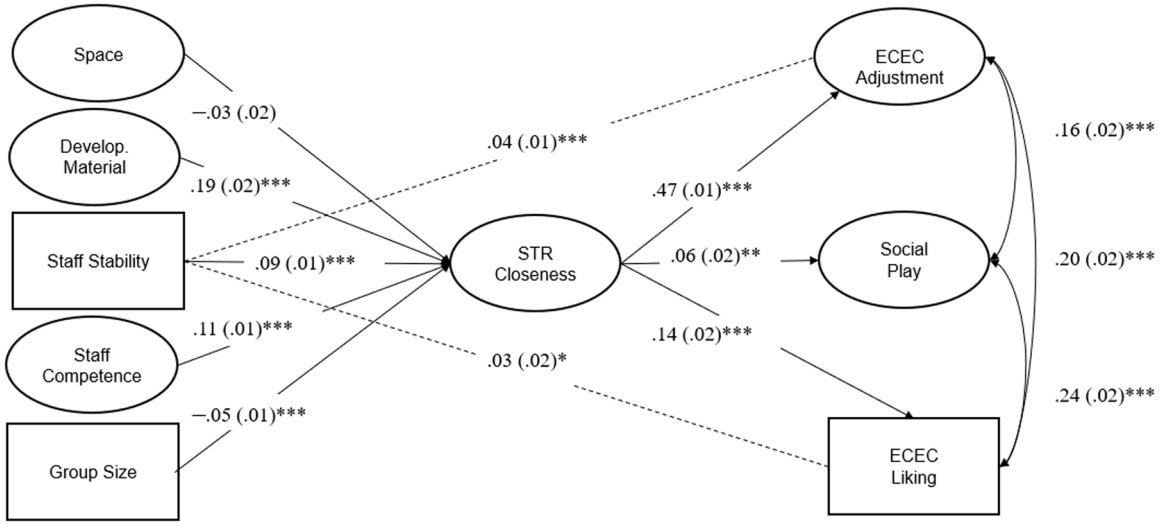

Fig. 2. *Standardized Regression Estimates With Standard Errors for the Associations Between Structural Quality and Student–Teacher Closeness and the "Direct Effects" of Structural Quality on Children's Adjustment and ECEC Liking.*

Note. $n = 7{,}436$ (average results over the imputed datasets). Dashed lines from structural quality depict significant direct effects (i.e., adjusted for the mediating variable closeness) on child outcomes. Weak non-significant direct effects are not shown, to preserve clarity in the Figure. Family- and child-level covariates included: parental education, parent non-native speaker, child gender and temperament at 6 months, teacher-reported externalizing behavior and language difficulties in ECEC, child's age on filling out the ECEC and MoBa 5-year questionnaire and how long the teacher has known the child.

Model fit indices: Root Mean Square Error of Approximation (RMSEA) .03; Comparative Fit Index/Tucker-Lewis Index (CFI/TLI) .96/.95; Standardized Root Mean Square Residual (SRMR) .07. R^2 for the model adjusted and unadjusted for family and child covariates (unadjusted model is not presented here): .60 and .43 for Adjustment, .15 and .03 for Social play, .07 and .04 for ECEC liking, .28 and .11 for Closeness.

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

3.2. Sibling Analysis: Addressing Omitted Variable Bias due to Stable Within-Family Confounders

3.2.1. Within-Family Associations of Student–Teacher Closeness and Child Outcomes

We found that a higher level of closeness was positively related to child adjustment (β = .51; *SE* .07; $p < .001$) and ECEC liking (β = .22; *SE* .07; $p = .002$), when accounting for all family-invariant factors by the sibling fixed effects model. Specifically, a one standard deviation increase in closeness was associated with 51% and 22% of a standard deviation increase in the respective child outcomes. However, there was only a weak non-significant association between closeness and child social play (β = .07; *SE* .09; $p = .454$). Alternative specifications, such as estimating separate models for every measure of child outcome, showed substantially identical estimates. Although a somewhat stronger association between closeness and ECEC liking was observed when using the Bayes estimator, allowing to account for the categorical nature of the child ECEC liking variable (this model is not presented here).

The associations remained relatively strong for closeness and adjustment, and for closeness and ECEC liking, even after controlling for the observed child-level covariates in the between-child analysis. Family-level covariates, that is, parental education and parent non-native speaker, were not included, as these had a limited variation within families/between siblings and had no impact on the results. The standardized estimates from the sibling analysis adjusted for child-level covariates, R^2 and the overall fit of this multilevel model, are presented in Table 3.

Table 3

Standardized Regression Estimates From the Sibling Analysis: Associations Between Student–Teacher Closeness and Child Outcomes, Adjusted for Child-Level Covariates.

Random Intercept Model With Within (fixed effects) and Between Effects n = *393 (195 clusters).*

Variable	ECEC adjustment		Social play		ECEC liking	
	β (*SE*) within	β (*SE*) between	β (*SE*) within	β (*SE*) between	β (*SE*) within	β (*SE*) between
Student–Teacher Closeness	.33 (.07)***	.65 (.16)***	.02 (.08)	–.10 (.19)	.18 (.09)*	.16 (.25)
R^2	.52***	.69***	.09*	.26	.09*	.42

Note. MLR estimator.

Model fit indices (adjusted model): RMSEA .00; CFI/TLI 1/≈1; SRMR: within .02 between .03.

Child-level covariates: child gender and child temperament at 6 months, teacher-reported externalizing behavior and language difficulties in ECEC, child age on filling out the ECEC/MoBa 5-year questionnaire and how long the teacher has known the child.

R^2 within for the model *not adjusted for child-level covariates* (this model is not presented here; this information is intended for the readers interested in the explained variance by child-level covariates): .26 for Adjustment, .01 for Social play and .05 for ECEC liking.

$^*p < .05$. $^{***}p < .001$.

3.3. Total, Direct and Indirect Effects: A Mediating Role of Student–Teacher Closeness

3.3.1. Associations of Structural Quality, Student–Teacher Closeness and Child Outcomes

All structural quality indicators, except for space, were significantly related to closeness (Fig. 2). Yet structural quality indicators only explained a limited amount of variance in closeness ($R^2 = .11$ when not adjusted for family- and child-level covariates). Developmental material, staff competence and stability were also significantly related to child adjustment (i.e., respective standardized total effects $\beta = .09$; $\beta = .07$; $\beta = .09$; $p < .001$), while only staff stability was significantly related to child ECEC liking (i.e., total effect $\beta = .04$; $p = .004$). All other covariate-adjusted (see *Note* in Fig. 2 for details) total effects of structural indicators on child adjustment, social play and ECEC liking were weak and non-significant.

The results suggest that the total effects of the structural quality indicators on child outcomes were either fully, largely or partly explained by the indirect effects via closeness. Specifically, the total effect of developmental material on child adjustment ($\beta = .09$, 95% CI [.05; .13]) was fully explained by its effect via closeness ($\beta = .09$, 95% CI [.07; .11]) (i.e., no direct effect of developmental material was evident, when adjusted for closeness). Of the total effect of staff competence on child adjustment ($\beta = .07$, 95% CI [.04; .09]), 71% was explained by its effect via closeness ($\beta = .05$, 95% CI [.04; .06]). Similarly, of the total effect of staff stability on child adjustment ($\beta = .09$, 95% CI [.06; .11]), 44% was explained by its effect via closeness ($\beta = .04$, 95% CI [.03; .05]). However, of the total effect of staff stability on child ECEC liking ($\beta = .04$, 95% CI [.01; .07]), only 25% was explained by the effect via closeness ($\beta = .012$, 95% CI [.007; .017]). After adjusting for the mediating variable closeness, the only direct effects that remained significant were the effects of staff stability on child adjustment ($\beta = .04$) and ECEC liking ($\beta = .03$; note, this was not significant in the model prior to the imputation).

4. Discussion

The overall goal of this study was to expand and strengthen the knowledge base on the quality of student–teacher relationships, classroom structural quality and the children's adjustment, social play behavior, and ECEC liking in the last year of a universal ECEC. First, we examined the association of student–teacher closeness with the child outcomes in the between-child analysis. Second, we tested the internal validity of these associations by the within-family analysis (i.e., sibling fixed effects), which reduces the risk of omitted variable bias. Third, we examined the associations of structural quality, student–teacher closeness and child outcomes, as well as the extent to which the associations between structural quality and child outcomes were indirect via student–teacher closeness. Student–teacher closeness has emerged as a relatively strong predictor of children's adjustment and ECEC liking, robust to omitted variable bias, providing support for the importance of relationship quality for child development. Overall, we also found support for the assumption that structural characteristics related to child development mainly via the quality of the student–teacher relationship. In other words, structural quality appears to facilitate a close relationship, which is linked to improved child outcomes.

4.1. Student–Teacher Closeness and Child Outcomes

The results of the *between-child analysis* (i.e., the model adjusted for structural quality characteristics of the unit, as well as observed family- and child-level covariates) suggested a strong positive between-child association of student–teacher closeness and child adjustment. Likewise, student–teacher closeness was positively related to child ECEC liking. The sibling analysis indicated a similar positive, but weaker within-family association of closeness and child adjustment, which was further reduced in the model adjusted for observed child-level covariates. Yet this association was still relatively strong and significant. Within-family associations of closeness and adjustment (i.e., sibling fixed effects accounting for family-invariant confounders, whether unobserved or omitted from the model) were weaker and with smaller standard errors compared to *between-family associations*. The results from the sibling analysis also indicated positive and significant within-family associations of closeness and child ECEC liking. Marked differences in effect size for closeness and adjustment in the between-child and within-family analysis (i.e., .47 [*SE* .01] and .33 [*SE* .07], respectively, in the covariate-adjusted models) may, at least partially, reflect omitted variable bias reduced by the sibling fixed effects model. Overall, however, the results indicate that the observed relations between student–teacher closeness and child outcomes are strong and robust.

Our findings generally support the argument that positive student–teacher relationships shape children's ability to acquire essential skills for school adjustment (Mashburn & Pianta, 2006; Hughes, 2012; Sabol & Pianta, 2012). The results also strengthen the earlier evidence on the importance of relationships with staff for children's well-being in ECEC (e.g., Sandseter & Seland, 2018). Our results from the between-child analysis were in line with earlier studies pointing to the importance of close relationships with teachers in preschool for children's social competence in the home context (e.g., Baardstu et al., 2022, Zhang & Nurmi, 2012). However, the current study could not provide consistent support for this claim, as the associations between closeness and social play behavior were not evident in the sibling analysis.

It is noteworthy that the results for the social play outcome in the sibling model may reflect a limited within-family variation. In other words, the lack of statistical relation between closeness and social play behavior could be due to a reduced sample size and limited differences between siblings in the family. Related to this, some of the siblings identified as attending the same ECEC ($n = 244$), particularly twins/triplets ($n = 156$), may share the same classroom and thus have some of their in-class social interactions with each other. Moreover, mothers may have a limited knowledge of children's social play if children are mostly involved in social play in ECEC settings, where mothers do not observe them. In addition, there are contextual differences between ECEC and the home environment, which could shape children's social play behavior observed by mothers. Finally, the associations with mother-reported social play outcome may be more constrained than with teacher-reported measures, which might be subject to shared source variance.

4.2. Structural Quality, Student–Teacher Closeness and Child Outcomes

We found that structural quality characteristics in the unit related to student–teacher relationship quality. Specifically, our results indicated a positive significant relation between higher teachers' ratings of developmental material and student–teacher closeness, supporting earlier results from the NICHD ECCRN (2000) study that found a similar relation with the observed positive caregiving. In our preliminary analyses we also found that higher teachers' rating of space in the unit was weakly negatively related to student–teacher closeness, in line with our alternative argument in the introduction suggesting that, in smaller spaces, teachers and children may feel naturally closer to each other. However, this was not confirmed in the final analyses, suggesting that these associations are not stable. Therefore, we refrain from drawing conclusions and recommendations regarding this aspect of the structural environment.

Earlier evidence on the associations between physical size of classroom and observed quality of interactions between teachers and children is contradictory, with the associations varying across countries (Cryer et al., 1999). Group size was negatively related to closeness, suggesting that larger groups may indeed make it more difficult for teachers and children to form close relationships. While evidence on the association between group size and observed interaction quality is not

conclusive (e.g., Cryer et al., 1999; Slot et al., 2018), our results are in accordance with Skalická et al. (2015), who showed that smaller groups enhanced the benefits of close relationships for children's behavior in Norway. Regarding the staff characteristics in the unit, a higher rating of perceived specialized competence in socioemotional aspects of child development was positively related to student–teacher closeness. This provides additional support for the earlier evidence demonstrating that specialized training increases caregiver competence in interactions with children (e.g., Fukkink & Lont, 2007; Wilhelmsen et al., 2022). Similar associations were observed for staff stability. Drawing on the earlier arguments by Skalická et al. (2015) and Drange and Rønning (2020), one can argue that staff stability may provide children with security in interactions with teachers and facilitate children's attachment. At the same time, staff stability may make it easier for teachers to create a stimulating environment and have one-on-one interactions.

Furthermore, our results indicated that staff stability had direct association with the child outcomes. However, other structural aspects were either explained by their relation with student–teacher closeness, or were not related to the child outcomes at all, including space sufficiency, group size, the share of staff with formal education and the child–staff ratio (the last two aspects were explored in the preliminary analyses). These findings are in accordance with a recent study from the Norwegian context that controlled for parental selection by exploiting a quasi-random assignment of children to child care centers (Drange & Rønning, 2020). The authors found that lower staff stability (i.e., high sickness absence) predicted lower academic functioning in early school years, while the number of children, the child–teacher ratio and teachers' education were not significantly related to child outcomes.

Finally, developmental material, staff competence and stability were indirectly related to the child outcomes via student–teacher closeness. The only direct associations that remained significant were the associations of staff stability with child adjustment and ECEC liking. Overall, our results support the claim that the structural characteristics of the classroom may promote a favorable climate for the establishment of individual student–teacher relationships contributing to children's social, cognitive, and emotional aspects of development (as reflected in our measures of child outcome). Given the limited and inconsistent evidence on the indirect mechanisms between ECEC structure, process and child outcomes (Slot, 2018) and the link between observed and teacher-perceived relationships (Hartz et al., 2017), our study makes an important contribution to the literature. The study lends support to the earlier research finding that structural quality is indirectly linked to children's development via the quality of observed interactions and relationships with caregivers or teachers (e.g., NICHD ECCRN, 2002).

Regarding the effect sizes in our study, these are, in general, comparable to the modest effect sizes found in the international literature (see e.g., Burchinal, 2018 for a review). Similarly to the earlier research, we found variations in the magnitude of the associations across quality indicators and child outcomes. The effect size for the association between student–teacher closeness and ECEC adjustment reported by teachers (.47 in the between-child analysis and .33 in the sibling analysis) was, however, considerably higher than usually reported for observational measures of process quality and child outcome (Burchinal, 2018). Noteworthily, the higher effect size between closeness and child adjustment may also be attributed to shared source variance due to the reliance on the same methodology–survey and the same raters–teachers. A survey also measures process quality in a broader, more generalized and subjective way, in contrast to time-limited observations. Yet our estimates are also higher compared to the findings from studies using the same teacher-reported measure of process quality and conducted within the same institutional context. Specifically, Skalická et al. (2015) reported a standardized coefficient of –.21 for the association between close student–teacher relationship in Norwegian preschool and children's behavior problems in first grade, although adjusted for only observed covariates. Importantly, given all sources of influence on effect sizes, the differences in the estimates should not only be attributed to the sibling fixed effects model.

4.3. Study Limitations and Directions for Future Research

Despite its number of strengths, this study has certain limitations, which should be taken into account when interpreting the results and drawing conclusions. One of the most important limitations is that our quality measures and children's adjustment are teacher-reported. Therefore, we cannot rule out that the observed associations partly reflect a shared variance in teachers' reporting or rater bias. More specifically, teachers that rate structural features higher may also report higher relationship quality. Similarly, teachers may rate students higher on ECEC adjustment when they have more positive relationships with these students. However, we have also observed a consistent relation between student–teacher closeness and child ECEC liking rated by mothers, as well as a significant positive relation between ECEC liking and adjustment. This suggests that it is unlikely that the association between student–teacher closeness and child adjustment is solely attributable to rater bias. Future studies can strengthen the evidence by, for example, examining aggregated ratings for all children by individual teachers and including comparable outcomes for child adjustment reported by mothers and teachers in schools. Furthermore, one may question the construct validity or appropriateness of the term "ECEC adjustment" for the chosen SRQ items. To alleviate this concern, we have been transparent regarding the excluded items.

Another important limitation is that, due to the unavailability of panel data, we were not able to also examine within-child associations between student–teacher closeness and children's outcomes, controlling for all time-invariant child characteristics. It is noteworthy that our findings are consistent with the within-child study by Maldonado-Carreño and Votruba-Drzal (2011). Sibling design does not control for unmeasured differences between siblings, including individual heterogeneity and unshared family environment. While a twin design using monozygotic twin pairs could minimize these concerns, we were limited to a small number of families with twins in our sample. However, we have adjusted for important observed child characteristics, and also substantially reduced the number of alternative explanations by eliminating omitted variable bias due to constant (across siblings) parental and family characteristics. Yet, neither within-child nor within-family analysis addresses concerns of potential simultaneity or reverse causality, which substantially limit causal inferences. Specifically, it may be easier for a teacher to form a close relationship with a child who is not exhibiting adjustment challenges and enjoys being in ECEC.

Relatedly, due to the concurrent nature of our study, we cannot establish directionality and formally conclude that relationship quality mediates the association between structural quality indicators and children's outcomes. However, the results supported this link, based on the reasonable assumption that structural quality exists prior to forming student–teacher relationships, which in turn can be linked to child outcomes. Moreover, our ability to draw causal inferences about the mediation is limited by the fact that we are not able to eliminate all potential sources of confounding and thereby alternative explanations. Unobserved child, family, and teacher factors and other process quality characteristics are matters of concern. Nevertheless, this study has contributed to the existing research by addressing some of the potential

complexities in the associations between structural context and relationship quality. Specifically, we have included multiple structural characteristics and modeled their simultaneous relations. Future research can extend this by considering interactions between different structural aspects and including additional process quality measures. Given the complex nature of child development and the concern of directionality in the current study, it would be important to examine reciprocal and transactional associations over time between student–teacher relationship and child outcome. Specifically, this could focus on positive socioemotional outcomes, such as in the current study, and using designs accounting for potential unobserved confounders in the reciprocal associations (see e.g., Usami et al., 2019).

Finally, an important limitation, which is common to population-based cohort studies, is potential selection bias that may arise due to self-selection and loss to follow-up. Nilsen et al. (2009) found that healthier, older mothers, living with partners and with fewer earlier births, were overrepresented in MoBa. Yet this self-selection did not affect the estimates of the exposure-outcome associations. Other authors have, however, demonstrated that self-selection and loss to follow-up may lead to biased estimates (Biele et al., 2019). The subsample of MoBa participants used in this study, and the subsequent sibling subsample, were also somewhat more advantageous with regard to parental socioeconomic factors, compared to the overall MoBa population and the overall sample for this study, respectively. The socioeconomic advantage in the sibling subsample is in accordance with the evidence showing an increase in fertility with an increase in parental financial resources (Black et al., 2013; Lovenheim & Mumford, 2013, in the U.S. data). Furthermore, considering the importance of fathers' contributions to childcare for women's ability to combine a career with a larger family (Doepke et al., 2022), it is possible that families with multiple close-age children in the sibling subsample have fathers, who are more involved in child care. Both financial resources and fathers' involvement may contribute to a more beneficial family environment.

Yet if the MoBa, ECEC and sibling subsamples were relatively more privileged, it is more likely that we would underestimate the observed associations (i.e., children with more risks may benefit even more from a higher relationship quality). It is therefore unlikely that self-selection will substantially constrain the generalizability of the results to the overall population of children. Another aspect related to generalizability is a universal ECEC context, with strong regulation of some structural aspects, such as formal educational requirements for staff and staff–child ratio. The lack of associations between these structural features, relationship quality and child outcomes should thus not be generalized to other contexts where no such regulation exists.

4.4. Implications for Research and Policy

The study contributes a novel methodological advance to the field by using a sibling design within a multilevel SEM framework. The sibling analysis demonstrates that the associations between student–teacher closeness and the child developmental outcomes are not a result of unobserved stable family environment or parental factors confounding the associations, thereby strengthening the plausibility of the causal links. Given the increasing importance of ECEC in promoting population health and reducing socioeconomic inequalities, the findings of this study should be of interest to scholars and professionals across different disciplines. Moreover, the study has demonstrated that the structural context in which student–teacher relationships are formed should be considered and further examined. Enhanced understanding of the role of these contextual factors may have important implications for the design of policies aimed at improving relationship quality in ECEC. Currently, professional development policies aimed at increasing staff's specialized competence show promising potential (Wilhelmsen et al., 2022).

5. Conclusion

We find evidence of a relatively strong and robust association between the level of student–teacher closeness and child adjustment in ECEC, and a modest association between the level of closeness and child ECEC liking. Both associations persist even after accounting for child-specific characteristics and unobserved family-invariant confounders in the within-family analysis. Structural quality indicators in the classroom appear to relate to children primarily via the quality of student–teacher relationships. Our findings underscore the importance of relationship quality for children's adjustment and ECEC liking and point to potential structural features that might be enhanced to foster closer student–teacher relationships.

CRediT authorship contribution statement

Nina Alexandersen: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Henrik Daae Zachrisson:** Conceptualization, Methodology, Writing – review & editing. **Espen Røysamb:** Conceptualization, Writing – review & editing, Supervision. **Tiril Wilhelmsen:** Writing – review & editing. **Mari Vaage Wang:** Funding acquisition, Project administration, Writing – review & editing. **Ragnhild Eek Brandlistuen:** Conceptualization, Writing – review & editing, Supervision, Funding acquisition.

Data availability

The authors do not have permission to share data.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ecresq.2023.08.009.

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