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EMPIRICAL ARTICLE

CHILD DEVELOPMENT

Profiles of Chinese preschoolers' academic and social–emotional development in relation to classroom quality: A multilevel latent profile approach

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Abstract

Linking classroom quality to separate domains of child development might neglect the transactional interactions across developmental domains. This research utilized latent profiles across academic and social–emotional development to explore which aspects of classroom quality can predict children's profiles at the classroom level. Data were drawn from 96 preschool classrooms and 547 children (3–5 years old) in China in 2020. Multilevel latent profile analysis identified three profiles (entitled low-, average- and high-level development at the individual level), and two classes (entitled average and below-, average and above) at the classroom level. Multinominal logistic regression analyses revealed that instructional quality in math, science, and diversity, and the interactional quality in supporting children's learning and critical thinking, predicted children's profiles.

Following decades of international research, there is now a widespread academic consensus that children who attend quality early childhood education and care (ECEC) programs tend to demonstrate better cognitive-, behavioral-, and social–emotional (SE) outcomes than those who do not (Pianta et al., 2021; Rao et al., 2012; Sylva et al., 2006). Positive impacts are especially robust when early years' settings are high quality (e.g., Melhuish & Gardiner, 2019; Siraj et al., 2018). However, when exploring the associations between classroom quality and child development, most research has adopted a variable-oriented approach and has linked quality measures to children's separate learning domains (e.g., Hu et al., 2020; Siraj et al., 2022; Su et al., 2021). As a result, quality measures found to be related to one developmental domain might or might not be related to other domains. This uncertainty makes it difficult to explain the impacts of classroom quality as children's different learning domains inevitably connect. In contrast, a person-centered approach to detecting transactional interactions across different developmental domains allows for a more aggregated examination (Bergman & Trost, 2006). For example, Gerstein et al. (2021) adopted latent profile analysis (LPA) and observed transactional interactions between language and behavioral development by identifying meaningful groups of children. These were entitled: (1) performing well in language but poor in behavior and (2) performing well in behavior but poor in language, thus extending the discussion on child development.

Furthermore, children are active agents with unique behavioral and reactive patterns, and children learning in the same classroom usually have different characteristics of developmental patterns. This surely requires an individualized approach to develop a nuanced understanding of the relations between children's individualized

Abbreviations: aBIC, adjusted BIC; BIC, Bayesian information criteria; CECERS, Chinese Early Childhood Environment Rating Scale; CFA, confirmatory factor analysis; CFI, comparative fit index; CK, content knowledge; CLASS, Classroom Assessment Scoring System; ECEC, early childhood education and care; ECERS-E, Early Childhood Environment Rating Scale-Extension; EL, emergent literacy; EN, Emergent numeracy; HLE, home learning environment; IDELA, International Development and Early Learning Assessment; LPA, latent profile analysis; MLPA, multilevel latent profile analysis; MLR, multinominal logistic regression; RMSEA, root mean square error of approximation; SE, social–emotional; SSTEW, Sustained Shared Thinking and Emotional Well-being; TLI, Tucker–Lewis index.

profiles and classroom quality. Accordingly, the current research used multilevel latent profile analysis (MLPA) to explore which aspects of classroom quality predict children's profiles across academic and SE domains by creating multiple profiles at the individual and classroom levels.

Rethinking classroom quality: Instruction and interaction

Classroom quality is a multidimensional concept that encompasses structural and process quality. Process quality has a more direct impact on child outcomes than structural quality (Melhuish & Gardiner, 2019), and it refers to the proximal processes of children's classroom experiences that involve interactions with teachers, peers, materials, and daily activities (Su et al., 2021). Current research mainly investigates the process aspect of classroom quality from instructional and interactional perspectives. The instructional quality focuses on capturing the quality of pedagogical practice in different learning domains (i.e., literacy, math, science). Under this perspective, classroom quality is domain-specific and contains elements specific to the intent and content of the learning domains (Shulman, 1986). For example, the Early Childhood Environment Rating Scale-Extension (ECERS-E; Sylva et al., 2003) is widely used to evaluate classroom quality specific to teachers' instructional practice in literacy, numeracy, science, and diversity (e.g., Anders et al., 2012; Howard et al., 2018; Siraj et al., 2022; Sylva et al., 2006). It was developed from the Effective Provision of Preschool Education project, which involved over 3000 children and traced their development longitudinally from age 3 to 7 to investigate the impacts of preschool education and care on child development (Sylva et al., 2006). Research from this perspective shows that high-quality classrooms are characterized by teachers utilizing all resources to promote children's learning in different domains. Whereas low-quality classrooms feature low pedagogical awareness and emphasize materials. Meanwhile, Justice et al. (2008) adopted the Language Modeling and Literacy Focus scale to evaluate process quality specific to children's language and literacy growth. High-quality literacy instruction features direct instruction in phonics and print structures, while language instruction requires open-ended questions, responsiveness, and language modeling. This suggests that educators' competence in engaging children in content-rich activities is essential for instructional quality—as different learning domains contain knowledge and skills unique to teaching (Bruns et al., 2021).

The interactional perspective focuses on the quality of teacher–child interaction regardless of specific learning domains (e.g., Hu et al., 2020; Pianta et al., 2021; Wolf et al., 2018). High-quality interaction is characterized by emotionally supportive connections between teachers and children that facilitate children's concept development across learning domains in well-organized classrooms (Hamre et al., 2007). For example, the Classroom Assessment Scoring System (CLASS; Pianta et al., 2008) was developed to measure the quality of teacher–child interaction in three aspects: (1) Emotional support—this includes positive classroom climate, adverse climate, and teacher sensitivity; (2) Classroom organization—this refers to behavior management, productivity, and instructional learning formats; and (3) Instructional support—this features concept development and quality of feedback, rather than specific to learning domains. Similarly, the Sustained Shared Thinking and Emotional Well-being (SSTEW; Siraj et al., 2015) scale, based on the national-wide UK study—Researching Effective Pedagogy in the Early Years (Siraj-Blatchford et al., 2002), was designed to differentiate more- and less-effective interactions and teacher–child co-regulation practices in preschools. According to this scale, high-quality classrooms embody both relational pedagogy (that requires responsive, warm, and affectionate teacher–child interactions) and intentional pedagogy (that encourages children's critical thinking, reasoning, and problem-solving skills; Siraj-Blatchford et al., 2002). Both scales emphasize the role of daily interactions in driving learning and development by capturing the quality of the classroom climate, teacher sensitivity, behavioral management, concept development, and language modeling. The interactional perspective in both scales is grounded in developmental theories, and directly targets practices that support children's SE and cognitive development through a child-centered and developmentally appropriate approach.

These two perspectives reflect continuous discussions about process quality which is indexed by (1) teachers' sensitivity and responsiveness in interaction and (2) how children are instructed during instruction (Burchinal et al., 2008). The interactional perspective emphasizes pedagogical knowledge that refers to knowledge about developmentally appropriate teaching practice. Teaching and learning are embodied in daily life, such as learning activities, play situations, transitions, and daily routines. Teachers are encouraged to use spontaneous phenomena and activities in children's daily life to promote child development (Bruns et al., 2021). However, practitioners with insufficient content knowledge (CK) can miss teachable moments, and worse, teach the wrong information (Siraj-Blatchford et al., 2002). The instructional perspective, thus, regards specific CK as an influencing factor of teaching quality and emphasizes knowledge related to different domains or domain-specific teaching strategies—such as CK (Shulman, 1986). Despite the distinctions between the two perspectives, teacher–child interaction connects with instruction and enables it to run smoothly by increasing learners' communication and facilitating teacher–child information

exchange (Burchinal et al., 2008). Although the developers of the various measures aim to capture classroom quality, each measurement does reflect a unique aspect of quality—whether it be an aspect of the instruction or daily interactions (Hestenes et al., 2015). However, only a few research has combined the two perspectives in measuring classroom quality to explore their associations with child development. Therefore, one of the research aims is to contribute to current discussions on quality measures by taking into account various ways of measuring classroom quality.

Linking classroom quality to children's academic and SE development

The effective preparation of preschoolers for primary school is an important indicator of classroom quality. Two essential components of school readiness are academic and SE readiness, and children need both to adjust to, and learn in school. Both components have gained mounting interest in ECEC quality research (Duncan et al., 2007). In particular, academic skills, which involve emergent competencies in literacy and mathematics, have been identified as showing the greatest predictive power for later school achievement (Duncan et al., 2007). Alongside this, SE development features how children recognize and regulate their emotions, think from others' perspectives, act in an ethical and responsible manner, and build positive relationships (Haynes et al., 2003). It supports children in managing pressure, processing information in learning, and getting along with their peers and teachers (Pakarinen et al., 2020). This suggests that SE skills are likely to contribute to children's school adaptation and academic success.

A number of large-scale studies, experimental research, and longitudinal investigations have reported positive associations between classroom quality and children's academic development (e.g., Hamre et al., 2014; Hu et al., 2020; Su et al., 2021; Wolf et al., 2018). From the instructional perspective, children who experience high-quality literacy instruction (as measured by ECERS-E) are more likely to demonstrate better pre-reading and grasp of mathematical concepts (Sylva et al., 2006). ECERS-E math scores in preschools even predict children's math achievement in grade one (Aboud & Hossain, 2011) and this suggests that preschool teachers can help children sustain their mathematics development in primary school by structuring classrooms with high-quality math instruction. The positive influence of literacy, math, and diversity quality, as measured by ECERS-E on children's early numeracy development, was also identified by Howard et al. (2018) in a more extensive clustered randomized controlled trial study—Fostering Effective Early Learning (Siraj et al., 2018).

From the interactional perspective, Howard et al. (2018) found that the scores in the SSTEW scale of supporting children's learning and critical thinking, and extending language and communication, could influence children's number concept and numeracy skills. These two aspects of SSTEW emphasize enhancing children's thinking and metacognitive development. Other studies have also revealed the importance of facilitating children's thinking through interaction. For example, in Ghana, Wolf et al. (2018) adopted the Teacher Instructional Practices and Processes System scale. They found that supporting children's expression to encourage their higher order thinking skills predicted children's emergent literacy (EL) and numeracy scores. Hu et al. (2020) also found that in China, only the instructional support scores in CLASS which focus on children's thinking and metacognitive skills predicted children's academic growth. This shows that encouraging children's thinking and sensitive response in teacher–child interactions are more likely to lead to academic development (Howard et al., 2018).

Although stimulating children's socioemotional development is an essential issue in ECEC, only a few research highlighted the impacts of classroom quality on children's socioemotional skills, and with complex findings (e.g., Hamre et al., 2014; Rao et al., 2012; Siraj-Blatchford et al., 2002; Sylva et al., 2006). Previous research has identified that children in classrooms with higher CLASS instructional support scores show better social skills (Hestenes et al., 2015) and that children are more willing to be kind and help others in high-quality classrooms as measured by ECERS-E and ECERS-R (Sylva et al., 2006). Despite this, there are concerns that academically oriented preschool curricula may neglect children's socioemotional development. For example, Ishimine et al. (2010) observed the negative associations between the scores of ECERS-E science and children's social skills. As a result, some researchers suggest that facilitating and supporting children's learning through high-quality interactions may be a better way of developing children's persistence and confidence than focusing on instructional quality in different learning domains (Raver et al., 2011). However, prosocial behavior can promote children's academic gains as it can facilitate teacher–child relationships and children's well-being in classrooms and motivate their learning (Hestenes et al., 2015). Given the complex interplay between children's SE development and academic achievement, more research warrants exploring how interactional and instructional quality affects children's development in both domains to fill this research gap, which also informs this research.

Issues in classroom quality and child development and possible solutions

Theoretically, high classroom quality is expected to promote children's learning outcomes, as generally stated

in the literature (Hestenes et al., 2015). However, some empirical studies have demonstrated that a few widely acknowledged quality measures significantly associated with children's outcomes in some research might have moderate or even no associations in other research (Hong et al., 2019; McDoniel et al., 2022). For example, although Burchinal et al. (2008) reported that over 700 children's language skills significantly benefited from high-quality instructional support as measured by the CLASS in six states, Hong et al. (2019) did not identify any significant impacts of instructional support on children's language skills in Head Start settings. These mixed findings imply that measurements based on specific standards may not be appropriate for all contexts (Li et al., 2014). Furthermore, current research rarely combines interactional and instructional measures when examining classroom quality (Hu et al., 2020; Pakarinen et al., 2020). Therefore, these inconsistencies may encourage the use of complementary scales with different foci of classroom quality.

In addition, some widely accepted quality items related to one or two domains of child development (e.g., literacy or numeracy) may be unrelated to other domains (e.g., SE development), thus making it complex to explain the effects of process quality (Su et al., 2021). Moreover, the quality measures specific to a particular domain might have cross-domain associations with child development. For example, scores on the ECERS-E literacy subscale were related to children's mathematics concepts (Sylva et al., 2006). Considering that learning inevitably interrelates across domains but in a complex way, a person-centered approach to integrating diverse developmental domains is necessary to examine the association between classroom quality and child development (Gerstein et al., 2021). In this regard, a more individualized and person-centered approach is recommended to consider the association between process quality and children's development across academic and SE domains.

The LPA approach has been used to reveal the transactional interactions among different developmental domains and identify latent patterns. For example, Gerstein et al. (2021) adopted LPA to explore child development across different domains (i.e., language and behavior) in the early head start program. They identified three distinct profiles: (1) performing well in language development and behavior; (2) performing low-level language competence but with high-level behavior problems; and (3) performing well in language but poor in behavior. As children are nested within classrooms, and it is expected that children within the same classroom tend to perform similar patterns of academic or SE characteristics. For example, students' learning is associated with classroom characteristics (e.g., class size, teachers' attitudes, and self-efficacy). As such, the extension of single-level LPA to multilevel LPA (MLPA) allows researchers to take into account the nested structure of data, and to avoid inaccuracy in parameter estimation and biased standard errors in using the single-level model alone (Finch & French, 2014). Although MLPA has been adopted to explore how school climate influence students' chronic absence (e.g., Van Eck et al., 2017), there is a lack of research exploring children's developmental profiles at the classroom level in preschools. Therefore, this research employed MLPA to differentiate the impacts of various quality measures at the classroom level on specific developmental groups by creating multiple subgroups of children with identical development patterns at both child and classroom levels.

Classroom quality and child development in Chinese ECEC: Settings for the current study

Kindergartens are the primary ECEC institutions for children aged 3–6 years in China. Since the first kindergarten was established in 1903, ECEC in China has undergone a long history of imitation and integration of the Japanese schooling system, the Soviet approach, and American education (Huang et al., 2019). However, before introducing progressive education and contemporary ECEC notions, kindergarten teachers in China were officially required to deliver whole-class, teacher-directed, and academic-oriented instruction (Zhu & Zhang, 2008). Over the past two decades, a promising transformation period has occurred, aiming to replace traditional pedagogy with developmentally appropriate practices. According to the new *Teaching Guidelines for Kindergarten Education* (Ministry of Education of China, 2001), Chinese kindergarten teachers are encouraged to implement play-based, child-centered, and constructive pedagogies (Huang et al., 2019). However, teacher qualifications and training, which have been demonstrated to be associated with process quality (Melhuish & Gardiner, 2019), have not kept up. About 82.7% of kindergarten teachers hold associate college or higher degrees (Ministry of Education, 2020) and studies of kindergarten quality have revealed inadequate teacher–child interaction and low-quality instructions (Rao et al., 2012). Moreover, according to the latest *Educational Statistics Yearbook of China* (Ministry of Education, 2020), around 2 million kindergarten teachers will need to be recruited to meet the demand in the *14th Five-Year Basic Education Plan (2021–2025*; The State Council of the People's Republic of China, 2021). This means there is an urgent need to identify which aspects of classroom quality promote better child outcomes to inform teacher education and professional training.

Despite the perceived importance of classroom quality, only a few empirical research have explored the influence of kindergarten quality on child development. Li et al. (2019) linked kindergarten quality to child development based on a national-wide sample of 2110 kindergarteners in 428 classrooms. They found that Chinese teachers performed good interactional quality of teaching and

interaction as measured by the Chinese Early Childhood Environment Rating Scale (CECERS)—with a mean score of 5.5 on the seven-point scale. The teaching and interaction subscale scores were positively associated with children's language, early math, and social cognition development. In contrast, Hu et al. (2020) found that Chinese kindergarten teachers' scores of interactional quality in instructional support were the lowest among the three subscales in CLASS, scoring below three on the seven-point scale. Meanwhile, only the instructional support score was shown to predict children's academic and cognitive growth. Given the interplay among children's different developmental domains, Su et al. (2021) linked kindergarten quality to children's holistic development with standardized total scores in children's cognitive, SE, language, motor, health, cultural awareness, and learning approaches development. They concluded that children developed better when provided with high instructional quality in math, literacy, language, science, physical and music activities, classroom arrangement, space, and material. School characteristics also affect classroom quality. Public kindergartens in China are generally of higher quality than private kindergartens because they have superior policies. In particular, their government funding means they can provide a well-equipped environment, stable teacher salaries, and opportunities for professional development. In addition to school type, preschool location (rural/urban) has been shown to influence classroom quality, as teachers in rural areas lack adequate preservice education and in-service training (Yang & Rao, 2021).

So far, existing research has attached the importance of high-quality instruction and interaction to child development, even though there has been little historic research into domain-specific instructional quality. However, by employing ECERS-E, this study seeks to extend current findings and provide a nuanced understanding of whether activities in different domains may function differently on child development. The reported inconsistent associations between the quality of interaction and child development (e.g., Hu et al., 2020; Li et al., 2019) could be due to the different focus of measures and contextual characteristics in Chinese kindergartens. For example, most Chinese teachers implement whole-class teaching and rarely conduct one-on-one or small-group pedagogical interactions (Li et al., 2014). Therefore, the CECERS that includes whole-class teaching in the teaching and interaction subscale might result in relatively higher scores (Li et al., 2014). On the contrary, what the CLASS measures, such as the form of interaction and the sensitiveness of teacher behavior, are recognized weaknesses of Chinese kindergartens as the relatively high student–teacher ratio drives teacher-directed teaching and didactic. Furthermore, family and colleague factors play an important role in teacher–child interactions, especially in the examination-oriented educational system; parental expectations about children's academic performance increase teachers' interactions in academic learning (Hu et al., 2016). Despite this, less attention has been paid to these intergenerational elements when examining interactional quality. In this regard, the SSTEW scale captures teachers' work with parents and colleagues on interaction, as well as teacher–child interaction in groups, and may be more appropriate for the Chinese context in assessing interactional quality. To fill the aforementioned research gaps, this research takes an exploratory approach to consider the associations between children's developmental profiles and interactional and instructional aspects of classroom quality; and it does this by adopting MLPA and by employing measurements with different foci on classroom quality. This exploratory research is guided by the following research questions:

1. What are the profiles of children's academic and SE development at both individual and classroom levels?
2. Which aspects of instructional and interactional quality in classrooms predict child developmental profiles?

METHODS

Participants

Shenzhen, China, is a special economic zone for the national experiment in educational reforms and is undergoing a promising transformation in ECEC. It was selected as the social setting for this study. To ensure representativeness, stratified random sampling was conducted to choose six regions (Nanshan, Futian, Luohu, Longhua, Longgang, Pingshan), representing upper-middle, middle-, and lower-middle levels of family social-economic backgrounds. After identifying the regions, invitation letters for principals to participate in the research were posted online. Principals volunteered to participate in this research by completing an online questionnaire that involved their school information. Based on the information, 24 kindergartens that did not participate in other research or were not located in highly advantaged or disadvantaged areas, were randomly selected. Two K1 classrooms (serving 3–4 years old) and two K2 classrooms (serving 4–5 years old) were invited in each kindergarten. K3 classrooms (serving 5–6 years old) were excluded as they are not applicable for SSTEW and ECERS-E scales—which were originally developed for children aged 2–5. Finally, six children in each classroom were randomly selected for child assessment without requiring them to provide family background information.

After receiving the consent forms from their parents, 547 (Nboy = 272, Ngirl = 275) children participated in this study. As shown in Table 1, there were 281 (51.37%) children aged 3–4 years old in K1 classrooms and 266 (48.63%) children aged 4–5 years old in K2 classrooms.

TABLE 1 Demographic information of participating children.

Children characteristics	Total $N = 547$
Gender	
Boy	272 (49.73%)
Girl	275 (50.27%)
Grade	
K1	281 (51.37%)
K2	266 (48.63%)
School type	
Public	300 (54.84%)
Private	247 (45.16%)
Location	
Urban	269 (49.18%)
Sub-urban	278 (50.82%)

More than half (N = 300) were from public kindergartens. The research was approved by the ethical community in the researchers' university.

Procedures

Data collection began after consent forms had been received from participating principals, teachers, and children's parents. Classrooms were measured using ECERS-E and SSTEW on a typical school day. Assessors spent 4 h observing in classrooms and not influencing typical practice. They also spent a further 1 h interviewing the teachers and reviewing relevant materials (e.g., portfolios and teaching records) to index quality ratings. Their interviews aimed to collect information to inform several indicators requiring questions if unwitnessed. Children were administered the International Development and Early Learning Assessment (IDELA) assessment in their kindergartens by trained research assistants. The assessment duration ranged from 30 to 45 min for each child, depending on the children's age and abilities. All of the data was collected in October 2020.

Prior to data collection, one of the authors of both ECERS-E and SSTEW trained the assessors to undertake classroom observations and ensure inter-observer reliability. Four assessors have master's degrees in early childhood education or psychology. In addition, the assessors participated in 2-week-long group discussions and 12 days of rating practicum in 12 classrooms before commencing their observations and data collection. One "gold standard" researcher was paired, in turn, with the other assessors during the rating practicum to ensure inter-observer reliability. When all reached over 80% reliability of the same scores with the gold standard at the item level, they started formal ratings of the participating 96 classrooms. The percentages of the same score in the practicum ranged from 78.57% to 92.86% in ECERS-E, and ranged from 78.57% to 85.71% in SSTEW. The percentages of scores with differences below 1 point ranged from 85.71% to 100% in ECERS-E and SSTEW.

Regarding child assessment, 12 research assistants with bachelor's degrees in ECEC or psychology were recruited and trained to undertake child assessments. They received 2 days of online workshops and rating practice, in which one senior research assistant was paired in turn with other research assistants to practice child assessment. One assessor gave instructions to the child, and both of them recorded the scores separately and then checked the reliability after the assessments. After the research assistants gained 100% exactly the same scores as the senior assessor, they started to conduct the formal assessment individually.

Measures

Classroom quality

Measuring instructional quality with ECERS-E (Sylva et al., 2003)

As stated above, classroom environment influences children's learning experience, while teachers' ability to provide high-quality instructional pedagogy predicts children's developmental outcomes. It has often been demonstrated that this rating scale, which emphasizes curricula and pedagogy (i.e., ECERS-E), is more potent in predicting children's learning outcomes than some other environment rating scales which target mainly structural quality (Howard et al., 2018). Therefore, the Chinese version of ECERS-E was used to measure the quality of instruction in different learning domains, including literacy, numeracy, science, and diversity. Four subscales have 18 items with scores ranging from 1 (inadequate) to 7 (excellent) based on the indicators. After removing two items entitled books and literacy area and gender equality and awareness, the confirmatory factor analysis (CFA) indicated a good validity of this scale (minimum discrepancy function by degrees of freedom divided [CMIN/DF] = 1.102, comparative fit index [CFI] = .939, root mean square error of approximation [RMSEA] = .034, Tucker–Lewis index [TLI] = .919).

Measuring interactional quality with SSTEW

The Chinese version of SSTEW was used to evaluate the interactional quality in classrooms. This scale was developed to support pedagogical practice and to differentiate the quality of interaction linked to children's cognitive and socioemotional development (Howard et al., 2018; Siraj et al., 2015). It consists of five subscales and 14 items rated from 1 (inadequate) to 7 (excellent). Five subscales are (1) building trust, confidence, and independence; (2) social and emotional well-being; (3) supporting and extending language and communication; (4) supporting learning and critical thinking; and (5) assessing learning

and language. After integrating the first two subscales, the four-factor model showed satisfactory validity in the CFA of SSTEW (CMIN/DF = 1.042, CFI = .977, RMSEA = .070, TLI = .970). Consequently, the first two subscales were integrated into one subscale in the following analysis.

Child academic and SE development

IDELA (Save the Children, 2011)

This direct assessment tool was developed by Save the Children, aiming to measure 3–6 years old children's literacy, numeracy, SE, executive function, and motor skills. It has been widely used in lower and middle-income countries and has shown good reliability (Halpin et al., 2019). IDELA was also used in China to assess the situation of early childhood development in Yunnan (Save the Children China, 2016). In this study, IDELA was used to measure children's EL, emergent numeracy (EN), and SE skills, with a maximum score of 100 on each subscale. The scale showed good validity by CFA (CMIN/DF = 2.88, CFI = .915, RMSEA = .057, TLI = .900) and good reliability (Cronbach's α = .858).

Emergent literacy subscale groups 24 items in six sub-tasks: emergent writing, expressive vocabulary, initial word sounds, letter identification, listening comprehension, and print awareness. Children are invited to write their names, describe markets and animals, find out the words with similar sounds, recognize words, and read books with assessors.

Emergent numeracy subscale contains 27 items in six sub-tasks: these include classifying and sorting, comparison, counting, number identification, shape identification, and simple arithmetic. Children are invited to compare the size and length of diverse objects, sort items, identify different shapes and numbers, count by one-to-one correspondence, do addition and subtraction, and complete puzzles.

The SE subscale includes four parts: friends, emotional awareness, empathy, and solving conflicts. Children are invited to name their friends, identify their own feelings in certain situations, recognize others' feelings through watching a picture, and find solutions to solve specific conflicts.

Covariates

This research explored the associations between classroom quality and children's developmental profiles at the classroom level. As stated above, Chinese teachers' qualifications, and school locations and types affect classroom quality and child development. In addition, other factors can make a difference. Older teachers tend to be more goal-oriented and to provide more instructional support than younger teachers (Malmberg et al., 2010), and teachers' working experience and degrees are associated with children's cognitive and SE development, and influence the process quality (Maldonado-Carreño et al., 2022). Therefore, this study collected classroom demographic information as covariates: these included teachers' age, degrees, qualifications, years of working experience, school location (urban/suburban), and school type (public/private).

Data analysis

As children were clustered in classrooms, the MLPA (Vermunt, 2003) was applied to identify the children's developmental subgroups that existed at the individual level (level 1) and the classroom level (level 2)—utilizing Mplus 8.0. The scores of individual children's EL, numeracy, and socioemotional development were entered as observed continuous variables at level 1. If classroom membership affects individual-level profile membership, the distribution of individual-level profiles across classrooms may vary significantly. Therefore, the MLPA can produce higher order classifications representing the different distributions of individual level profiles in the classrooms (Henry & Muthén, 2010).

Latent profile analysis is a model-based technique to identify the best-fit model by comparing the model-fit indices in different numbers of profiles. OR impute and the full information maximum likelihood were included to estimate the number of parameters associated with the variance and covariances. The best-fit solution for level 1 is based on the following model-fit indices: a significant *p*-value of the Lo–Mendell–Rubin likelihood ratio test (Lo et al., 2001); relatively low values of Bayesian information criteria (BIC) statistics and sample-size-adjusted BIC (aBIC; lower values means better-fit model); and a relatively high value of entropy (values larger than 0.70 indicate good fit, Peugh & Fan, 2013). The BIC values were considered for deciding the number of upper-level latent classes (Mäkikangas et al., 2018).

After identifying children's academic and SE development profiles at the classroom level, multinominal logistic regression (MLR) analyses were conducted to examine their associations with classroom quality further. Several additional covariates were entered into the model to control for their effects on the link between class membership and quality indicators. The covariates were teachers' age, degree, qualifications, working experience, and school location and type. The identified class memberships were then entered as dependent variables to explore the relations between different classes and different aspects of classroom quality.

RESULTS

Emergent profiles of child development at the individual and classroom levels

After comparing diverse models by entering different numbers of latent classes, six potentially fit models were established. It is suggested that lower AIC, BIC,

a-BIC, and higher entropy values indicate better model fit (Peugh & Fan, 2013). As given in Table 2, AIC, BIC, and a-BIC values decreased as the number of profiles increased. Meanwhile, the value of entropy decreased dramatically, and the *p*-values became non-significant, when the number of profiles changed from three to four—suggesting that the three-profile solution was sufficient. In addition, compared with the two-profile solution, which only identified the low level and high level of development, the size of the three-profile solution was smaller, and it distinguished one more meaningful group. Although the five-profile solution separated two large groups into four small groups, the average class assignment probabilities for the five-profile solution (.85, .89, .81, .81, .91) were lower than for the three-profile solution (.89, .89, .93). Therefore, it is suggested that the three-profile solution is the best-fit model.

As shown in Table 3 and Figure 1, three profiles have distinct patterns of child development in EN, literacy, and SE areas. More specifically, profile 1 was identified as having low levels of development, as the mean scores of numeracy (M = 28.80), literacy (M = 22.37), and SE development (M = 35.46) were the lowest of the three profiles. Children in the low levels of development occupied 28% of the whole sample. Profile 2 was identified as average levels of development, as the scores of EN (M = 51.02), literacy (M = 42.55) and SE development (M = 54.52) were at medium levels. The average level of development accounts for 47% of the sample. Profile 3 was the high level of development with highest mean scores of EN (M = 77.75), EL (M = 72.30) and SE development (M = 60.42).

The model of Level 2 profiles was estimated to identify the degree to which distinct distributions of individual-level developmental profiles existed among classrooms. The researchers compared the different Level 2 latent class solutions using the BIC criterion (Finch & French, 2014). The corresponding values for the one- to three-class solutions were 14,121.54, 14,070.32, and 14,087.01. Therefore, the two-class solution was sufficient. As shown in Figure 2, the level 2 profile 1 classroom included the majority of children who were in low levels or average-levels profiles (54.7% of all children). These classrooms were thus labeled "average and below classrooms." The Level 2 profile 2 classrooms contained the majority of children in the "average levels" and "high levels" profiles (45.3% of all children). Level 2 profile 2 was thus labeled as "average and above" classrooms. The relations between individual-level profiles and classroom-level profiles were examined further. The result indicated that children in the lower levels of profiles were less likely in average and above classrooms (B = −0.746, SE = .107, p < .001).

The associations between child developmental profiles and instructional quality

As shown in Table 4, a series of MLR analyses were conducted to explore which aspects of domain-specific instructional quality (level 2) can predict children's membership in the level 2 latent classes. After controlling the covariates, MLR analyses revealed that the scores of ECERS-E math (B = 1.186, p < .001, OR = 3.274, 95% CI [0.893, 1.479]), ECERS- E science (B = 0.998, p < .001, OR = 2.714, 95% CI [0.757, 1.240]), and ECERS-E diversity (B = 2.742, p < .001, OR = 15.519, 95% CI [2.191, 3.293]) significantly predicted the average and above classrooms as compared with average and below classrooms. This shows that children with average or high-level

TABLE 2 Latent profile analysis model-fit statistics of competing models.

Model	Log (L)	AIC	BIC	Adjusted BIC	Entropy	p-LMR	Percentage in profiles
C = 1	−7291.187	14,594.375	14,620.201	14,601.155	—	—	—
C = 2	−7085.142	14,190.285	14,233.329	14,201.585	0.777	.000	0.60/0.40
C = 3	−7016.638	14,061.275	14,121.538	14,077.096	0.775	.000	0.28/0.47/0.25
C = 4	−6996.589	14,029.177	14,106.657	14,049.518	0.749	.076	0.26/0.25/0.38/0.11
C = 5	−6963.351	13,970.701	14,065.399	13,995.562	0.782	.002	0.24/0.34/0.15/0.12/0.15
C = 6	−6953.050	13,958.100	14,070.016	13,987.481	0.776	.473	0.23/0.30/0.08/0.11/0.14/0.13

Abbreviations: AIC, Akaike information criterion; BIC, Bayesian information criterion; p-LMR, the p-value for the Lo–Mendell–Rubin likelihood ratio test.

TABLE 3 Means and standard deviations of child development in three profiles.

	Low levels		Average levels		High levels		Total average	
	M	SD	M	SD	M	SD	M	SD
Emergent numeracy	28.80	1.44	51.02	2.18	77.75	1.80	52.52	0.25
Emergent literacy	22.37	1.24	42.55	1.39	72.30	1.63	45.74	0.17
Social–emotional development	35.46	1.94	54.52	1.11	60.42	1.32	50.13	0.21

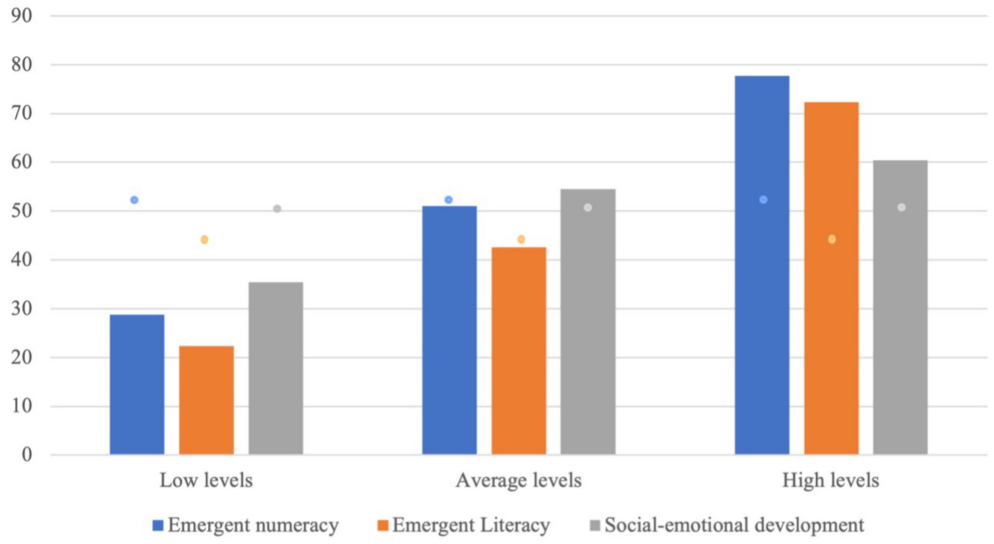

FIGURE 1 The three-profile solution for child development at the individual level.

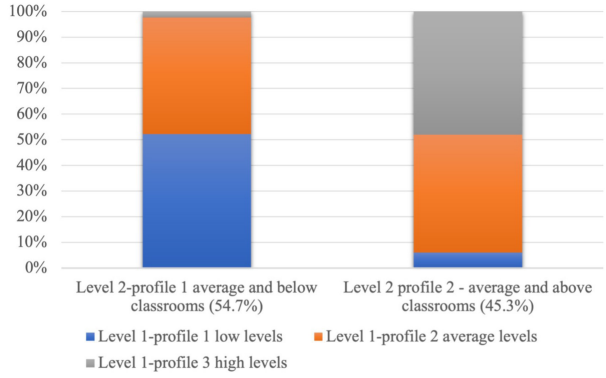

FIGURE 2 Distribution of individual-level child development profiles across classrooms.

developmental profiles were more likely in the classrooms with higher scores in ECERS-E science, math, and diversity. Some covariates were also significant when exploring the relationship between instructional quality and child development, such as teachers' qualifications, working experience, and school location and type.

The associations between child developmental profiles and interactional quality

As shown in Table 5, a series of MLR analyses were conducted to explore which aspects of interactional quality predict children's different profiles. In terms of comparing Level 2 profile1 and 2 (i.e., average and above vs average and below classrooms), supporting learning and critical thinking ($B = 0.728$, $p < .001$, OR = 2.071, 95% CI [0.417, 1.039]) can predict the average and above classrooms as compared with the average and below classrooms. Several covariates (i.e., teacher qualification and age) were significant when exploring the association between interactional quality and child development. The results indicated that average and above classrooms tended to receive relatively higher quality in supporting children's learning and critical thinking.

In summary, children performed higher levels of academic and SE development if they received a higher quality of math, science, and diversity-sensitive instruction. In terms of interactional quality, classrooms with a higher quality of teachers' supporting learning and critical thinking tended to have more children in the average and high-level developmental profiles.

DISCUSSION

By adopting a person-centered approach, this study modeled children's developmental patterns to describe the interrelationships among EL, numeracy, and SE development. The multilevel structure was considered to identify meaningful subgroups of child development at the individual and classroom levels, and to examine how these profiles were related to classroom quality. The current research identified three profiles of child development at the individual level: (1) the high-level profile with the highest scores in literacy, numeracy, and SE skills; (2) the average-level profile, and (3) the low-average profile with the lowest scores in academic and social emotion. Similar to Ren et al.'s (2019) findings, the largest profile at the individual level was children with average-level development. The average-level profile in this study occupied 47% of the sample, while the low level accounted for 28% and the high 25%.

Furthermore, this study extended existing research by conducting a MLPA to identify child development profiles at the classroom level. It demonstrated that children in the high- and low-level profiles were

TABLE 4 Multinominal logistic regression analysis in instructional quality.

	B	SE	OR	95% CI	*p*
Average and above versus average and below classrooms					
ECERS-E	3.062	.291	21.373	[2.584, 3.540]	<.001***
Literacy	−0.005	.204	0.995	[−0.404, 0.393]	.979
Math	1.186	.149	3.274	[0.893, 1.479]	<.001***
Science	0.998	.123	2.714	[0.757, 1.240]	<.001***
Diversity	2.742	.281	15.519	[2.191, 3.293]	<.001***
Teacher degree	0.118	.274	1.126	[−0.420, 0.656]	.666
Teacher qualification	2.908	.383	18.317	[2.156, 3.659]	<.001***
Teacher experience	−0.415	.196	0.661	[−0.799, −0.030]	.035*
Teacher age	0.084	.134	1.088	[−0.179, 0.347]	.531
School location	−1.046	.271	0.351	[−1.578, −0.515]	<.001***
School type	−0.767	.288	0.464	[−1.332, −0.202]	.008**

Note: *$p<.05$, ** $p<.01$, *** $p<.001$.

TABLE 5 Results of multinominal logistic regression analyses regarding interactional quality.

	B	SE	OR	95% CI	*p*
Average and above versus average and below classrooms					
SSTEW	0.198	.144	1.218	[−0.039, 0.434]	.169
BuildTCI and SEWbg	−0.223	.134	0.800	[−0.485, 0.039]	.095
Comm	−0.210	.130	0.811	[−0.465, 0.045]	.106
Crit	0.728	.159	2.071	[0.417, 1.039]	<.001***
Assess	0.134	.124	1.144	[−0.108, 0.377]	.278
Teacher degree	−0.087	.220	0.917	[−0.518, 0.344]	.693
Teacher qualification	1.007	.298	2.738	[0.424, 1.591]	<.001***
Teacher experience	−0.188	.146	0.828	[−0.475, 0.098]	.197
Teacher age	0.332	.113	1.394	[0.111, 0.553]	.003**
School location	−0.220	.193	0.802	[−0.599, 0.159]	.255
School type	−0.183	.211	0.832	[−0.597, 0.230]	.384

Abbreviations: Assessing, assessing learning and language; Build TCT and SEWbg, building trust, confidence and independence and support social and emotional well-being; Lang-Comm, supporting and extending language and communication; Learn-Crit, supporting learning and critical thinking.

distinctly distributed into two types of classrooms, reflecting the essential impacts of classroom environment on child development. Two classes of classrooms were identified at the upper level: (1) average and below classrooms with the majority of children in the low or average levels of profiles; and (2) average and above classrooms with the majority of children in the average or high levels of profiles. Assessing child development at the classroom level revealed unique insights about classroom differences (Van Eck et al., 2017). The findings suggest that simply targeting individual levels for better development might not be enough, and classroom-wide improvement is also important, thus requiring a multi-system perspective on child development. In addition, the evidence from this study suggests that not all aspects of instructional or interactional quality can predict children's developmental profiles. Children were more likely in profiles with higher level of development if their classrooms achieved higher scores in ECERS-E math, science, and diversity and in the SSTEW scale of teachers' support in learning and critical thinking.

Relations between instructional quality and child development

This study adopted ECERS-E to explore the impact of instructional quality on children's membership in different profiles. Consistent with previous literature, the score of the overall ECERS-E was associated with child profiles. Children were likely to perform more gains in academic and SE skills if their teachers intentionally utilized the classroom resources to support children's learning in different domains (Hestenes et al., 2015; Howard et al., 2018; Sylva et al., 2006). Also, teachers'

qualifications, teaching experience, school location, and school type played a significant role in exploring the link between instructional quality and children's developmental profiles. Children were likely to have higher developmental profiles if their classrooms had more qualified and experienced teachers or if they were in public or urban kindergartens. These findings align with existing research, which shows that the structural aspects of quality are associated with child outcomes (Maldonado-Carreño et al., 2022). Future research could usefully explore the association between structural and process quality and child outcomes.

It should also be noted that the quality of science and math predicted children's academic and SE development at the classroom level, whereas literacy scores did not. This result suggests that domain-specific instructional quality has cross-domain associations with child development, which is in line with previous research (e.g., Sylva et al., 2006). The CK and pedagogical process of science and math activities might explain this finding, as they are related to each other and they can influence literacy and SE skills. For example, geometry and measurement in math closely connect with science skills; and hands-on exploratory experiences, hypothesizing, and problem-solving also enrich and embody children's understanding of numbers, shapes, and measurement (van der Aalsvoort et al., 2020). Children also discuss their explorations with teachers and peers, learn about science- and math-related vocabularies, and record their findings in the scientific and mathematical inquiries that can promote literacy skills (Justice et al., 2008). Additionally, in this social process, children learn to recognize and manage their own and others' emotions, care about others, and develop collaborative skills (Ferreira et al., 2020). This result is also supported by Castano's (2012) intervention research, indicating that science education fosters children's moral growth and decreases their aggressive behaviors by promoting children's understanding of their living world.

Furthermore, unlike literacy activities that can arise spontaneously in daily routines, high-quality science and math activities usually happen in classrooms with prepared teachers and high-quality curricula because preschool teachers are generally more reluctant and less confident in teaching math and science than in other content areas (Oon et al., 2019). This could be reflected in the analysis of covariates, as teachers' qualifications and working experiences were significant when exploring the associations between instructional quality and child development. Those prepared teachers are willing to facilitate children's explorations and ability to approach problems logically and scientifically, thus facilitating children's academic and SE development (Oon et al., 2019).

Finally, some special characteristics of the Chinese context may also explain the link between the quality of science and math activities and children's SE development, as Chinese students are culturally expected to listen to teachers and show their respect for authority rather than questioning teachers (Zhu & Zhang, 2008). However, the truth-seeking process in science and math activities advocate confronting distortions and misunderstandings and challenging authority. Only classrooms with respectful and trusting relationships allow children to take risks without concerning teachers' efforts to correct them (Haynes et al., 2003). Therefore, higher quality of science and math activities also indicates a more respectful learning environment (LE), which plays an important role in children's SE development (Ferreira et al., 2020).

Associations were also detected between the ECERS-E diversity and children's developmental profiles. It is not surprising since the diversity subscale examines the extent the curriculum is adapted to children's different gender, cultural backgrounds, and abilities and the teacher's ability to differentiate learning to help children truly access the learning. This may suggest that teachers who tailor their instruction to meet children's individual or small group needs are more likely to foster children's relatively higher attainments in academic and social emotions. According to Vygotsky and Cole (1978) sociocultural theory, which emphasizes scaffolding and the zone of proximal development, teachers' support should be adapted to children's current abilities. Therefore, teachers who respond to children's learning with a good-fit pedagogical approach will lead to better developmental outcomes (Lee et al., 2010). In contrast, if teachers have insufficient awareness of children's diversity, some children might be labeled "tough to teach" and might receive less instruction to master their academic and SE skills that contribute to coping strategies and emotional understandings (Kirk & Jay, 2018). In addition, Lee et al. (2010) found that classroom-based curriculum and instruction adaptations predicted children's behaviors. Students performed fewer behavioral problems in those classrooms with more curriculum modifications. This also suggests that awareness of children's diversity enables teachers to be responsive to children's emotional needs, thus building supportive relationships and facilitating children's SE skills (Pakarinen et al., 2020).

Relations between interactional quality and child development

To date, studies examining the impacts of classroom quality on child development in China (Hu et al., 2020; Li et al., 2019) have identified the critical role of teacher–child interaction. This research further illustrates that the quality of supporting learning and critical thinking through the teacher–child sustained shared thinking

process can predict children's development profiles at the classroom level. Existing research has also observed the impacts of teachers' stimulation of conceptual development and high-level thinking skills on children's literacy or numeracy skills (e.g., Burchinal et al., 2008; Howard et al., 2018). Several studies have identified that effective questioning, informative feedback, and scaffolding increase children's interactions with teachers, thus promoting their use of language and literacy development (Burchinal et al., 2008). Children's mathematical thinking could also be indirectly enhanced during teacher–child interaction, as it assists children in problem-solving and sustaining attention, this cognitive process has been demonstrated to predict children's mathematics skills (Anders et al., 2012).

Furthermore, this finding demonstrates the critical role of sustained shared thinking, where participants' minds meet and extend their thinking on issues of shared interests (Siraj-Blatchford et al., 2002). It is consistent with constructivist learning theories that children learn best when they engage actively in learning. Children's information-seeking questions occur in the sustained shared thinking process, which allows them to construct increasingly complex knowledge based on prior experiences, driven by curiosity and motivation (Haber et al., 2021). Therefore, the intellectual aspects of teacher–child interaction — such as problem-solving, concept clarification, activity evaluation, or narrative extension in supporting learning and critical thinking — might have the most promising links to positive child outcomes than other aspects of interaction. At the same time, teachers' qualifications and age were significant covariates. This indicates their importance in investigating interactional quality and warrants further exploration.

In addition, the positive impacts of supporting learning and critical thinking on children's profiles also resolve the concerns about whether academic-related interaction might neglect children's socioemotional development. This may be due to the sustained shared thinking approach which emphasizes relational pedagogy. Relational teachers are required to build child-centered, respectful relationships with the children to ensure that children feel safe, comfortable, and stimulated in learning (Kingston & Siraj, 2017). This emotionally safe environment enables children to freely join peer interactions and build a sense of being accepted, respected, and supported, thus promoting children's SE development (Pakarinen et al., 2020). Furthermore, children's attainments cannot be fully understood outside the social and cultural context (Bronfenbrenner, 1977). The relations between teachers' intellectual support and children's SE development might be somewhat more robust in China, as Chinese educators and parents generally value children's academic performance (Jerrim, 2015). This means that more academic gains help children receive more admiration, recognition, praise, and positive attention from their teachers and parents, thus enhancing their SE development.

Implications

Findings from this research illustrate four possible theoretical and methodological implications for practice and future research. First, the vital role of process quality in children's development suggests allocating public investment to improve process quality rather than merely expanding the quantity of kindergartens (Hu et al., 2020; Su et al., 2021). Second, although classroom quality has been theoretically expected to predict children's development, this study further reveals that the instructional quality in science, math, diversity, and interactional quality in supporting learning and critical thinking are more effective than other dimensions in predicting children's membership in different developmental profiles at the classroom level. This means that the associations between certain aspects of process quality and child development can sharpen the target of intervention studies in teachers' professional development. Third, given the complex interplay among children's diverse developmental domains, researchers can adopt the person-centered approach to elicit their transactional relations and demonstrate children's development across domains. Last but not least, future research can combine instructional and interactional aspects of classroom quality to provide a whole picture and further explore the nuanced relations in this area.

Limitations

This study has several inevitable limitations. First, according to Vygotsky and Cole (1978) sociocultural theory, home HLE and family demographic characteristics influence child development, but this information was not collected or controlled. Future studies could obtain family background information (e.g., family income, primary caregivers, etc.) or use the home learning environment (HLE) index (Melhuish et al., 2008) to examine the associations systematically. The second limitation lies in the sampling. Although stratified random sampling was conducted to ensure representativeness, the classrooms and children are only from Shenzhen, representing one of China's higher socioeconomic regions. Child development profiles and their relations with classroom quality in rural places need further exploration. Finally, there are concerns about adopting the LPA approach since the researchers might be at risk of subjectivity when selecting the number of profile solutions, which would result in selection bias (Jung & Wickrama, 2008). Therefore, as with all studies, the findings should be interpreted with caution.

CONCLUSION

This study is one of the first to adopt a multilevel person-centered approach, and to employ child developmental profiles at the classroom level as the criteria for examining the aspects of process quality which could predict children's membership. In terms of instructional quality, science, math, and diversity significantly predicted child development compared with literacy quality. In terms of interactional quality, the score of support learning and critical thinking predicted children's academic and SE development. The results indicate the importance of actively promoting scientific and mathematic inquiry, adapting instruction to children's individual and group needs, and engaging in higher order pedagogies such as sustained shared thinking. It also extends the discussion on quality by outlining the need to improve the quality of science and math activities, teachers' awareness of diversity, and the support of children's critical thinking (Siraj et al., 2018; Vygotsky & Cole, 1978). In particular, it informs the focus of teachers' professional development and the direction of relevant intervention studies.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

The data necessary to reproduce the analyses presented here are not publicly accessible. Code and materials necessary to attempt to replicate the findings presented here are available from the first author.

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