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Original Research

Reading development of Chinese-English bilingual early elementary children: Variations by student sociocultural characteristics during COVID-19 in Canada

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Abstract: In this two-year longitudinal study, multiple analytical methods of analysis were used to examine the development of reading comprehension, decoding, and oral receptive vocabulary among Chinese-English bilinguals (N = 135) in Canada during grades 2 and 3, as well as the sociocultural factors influencing their academic performance during the COVID-19 pandemic. One-sample t-tests revealed that while Chinese-Canadian children's reading comprehension and decoding skills were comparable to monolingual norms, their English receptive vocabulary significantly lagged behind the normative mean. Independent samples t-tests indicated a pandemic-related decline in reading skills over two years, with significant reductions in decoding, particularly among Mandarin-speaking children. Hierarchical Linear Modeling (HLM) analyses showed that gender significantly moderated reading comprehension development, while family socioeconomic status (SES) was strongly associated with growth in decoding and oral receptive vocabulary. These findings highlight the need for post-pandemic recovery efforts focused on vocabulary development and decoding support, particularly for children from intersectionally disadvantaged backgrounds.

Keywords: Sociocultural factors, Reading comprehension, Decoding, Oral vocabulary, Chinese-English bilinguals, COVID-19

Introduction

An indubitable link between COVID-19-triggered school closures and negative academic consequences has been observed worldwide (UNESCO, 2021) and these achievement gaps are found to persist and even widen during recovery post-pandemic (Dewey et al., 2024; Ross, 2024). For instance, the average fourth grade reading score among English Learners (ELs) in 2022 was lower than that in 2019 and lower than their non-ELs counterparts in public schools in the United States (National Center for Education Statistics or NCES, 2022). In a new report released in June 2024 on the post-pandemic recovery results in the U.S., it is found that academic achievement gaps that widened during the pandemic still remain and have worsened in some states (Dewey et al., 2024; Peters et al., 2024). Similar patterns of learning loss during the pandemic and post-pandemic achievement gaps were also

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reported among vulnerable children and youths in Canada (Bennett, 2023; Whitney et al., 2021)

While strong evidence indicates a persistent slide or lag in the academic achievement of at-risk students in North America and globally—initially triggered early in the pandemic (e.g., Betthäuser et al., 2023; Dewey et al., 2024; Di Pietro et al., 2020; Förster et al., 2022; Kuhfeld et al., 2023; Peters et al., 2024)—large-scale studies on COVID-19's impact on literacy development (e.g., NCES, 2022; Juniper Education, 2022) often exclude Asian children or group them into an undifferentiated category. This is particularly true for Chinese-English bilingual students in North America, who, like other East and South Asian peers, are frequently portrayed as a "model minority" expected to excel academically (Li & Ma, 2016; Li & Wang, 2008). There is also a view that Asian students do better academically during school interruptions even though the commonsense view that school suspensions have a negative effect on students' learning has been supported by research (e.g., Burkam et al., 2004; Cooper, et al., 1996). Some researchers (e.g., Kuhfeld et al., 2021) even argue that Asian students would do even better with less school support because "Asian students generally pull ahead of Whites at a faster rate during summers than during school years" (p. 235). In a study on the impact of the pandemic on students' reading achievement in the U.S., Kuhfeld et al. (2023) further concluded that on average, Asian American students, along with their White counterparts, showed smaller degrees of declines relative to other racial and ethnic minorities such as Hispanic, American Indian and Alaska Native (AIAN), and Black students.

There is ample evidence that the "model minority" stereotype ignores the heterogeneity of individuals in the category, including their educational inequities and struggles (Li & Ma, 2016; Yi & Museus; 2015). The difficulty is that the use of a category such as "Asian" as an independent variable obscures the diversity of the group it is meant to represent. The neglect of their educational needs often results in "intersectional harm" (Li, 2021). The pandemic disrupted face-to-face classroom instruction for significantly longer than two and a half months, increasing the potential for learning loss, particularly among primary students and students from marginalized backgrounds (Kuhfeld et al., 2023; Peters et al., 2024). This learning loss was further compounded by decreased time allocated to early literacy instruction during the pandemic, particularly in language-focused practices such as extended writing, vocabulary development, and reading comprehension strategies (Crosson & Silverman, 2023).

In Canada, Chinese speakers (including Mandarin and Cantonese-speakers), one of the largest visible minority groups, represented about 20% of those who spoke a language other than English or French. The Chinese group, along with other Asian subgroups, have been reported to have the highest rate of opting for remote emergency learning during school closures (e.g., 78% Asian vs. 29% White and 59% Black and Latino students) due to their fear for safety in school during the increasing anti-Asian racism associated with the COVID-19 outbreak (Marcelo, 2021). Yet, we know very little about how the pandemic has impacted this population academically. In this study, we aimed to address these knowledge gaps by exploring Chinese-English bilingual students' English reading development during the pandemic in Canada, which may shed light on how to appropriately support vulnerable student groups to minimize the adverse effects of COVID-19 on academic achievement post-pandemic. Three research questions anchored the study:

1. What were the patterns of English reading achievement among Chinese-Canadian children over two years during the COVID-19 pandemic?
2. How did English reading achievement differ among Chinese-Canadian children based on sociocultural factors (e.g., home language, gender, SES, and immigration status)?
3. How did sociocultural factors (i.e., home language, gender, SES, and immigration status) moderate changes in English reading achievement over time during the COVID-19 pandemic?

Literature review

Impact of COVID-19 on bilingual children's reading development

Since the outbreak of COVID-19 in late 2019, extensive research and reports have documented its negative impact on students' educational progress worldwide (e.g., NCES, 2022; The Bell Foundation, 2021; UNESCO, 2021; Kuhfeld et al., 2023; Peters et al., 2024). Studies examining COVID-19's effects on K-12 reading development have largely focused on older elementary students (4th grade and above). Research on early literacy development in younger elementary grades (e.g., Gray et al., 2023; Segers et al., 2023) has primarily centered on English-speaking children, with or without disabilities.

Among the limited studies on bilingual children, Crosson and Silverman (2021) investigated changes in bilingual instruction during remote teaching. Their mixed-methods study, involving 50 public school teachers of emergent bilinguals (K–2) across 10 U.S. states, found a general decline in literacy instruction, with the largest decreases in language-focused practices related to reading, writing, and vocabulary. These declines were attributed to limited instructional time, technological challenges, and a lack of home learning materials. In another study, Sun et al. (2023) examined the impact of COVID-19 on the literacy development of Spanish-English and Chinese-English bilinguals. While both groups scored lower on passage comprehension tests during the pandemic, only the Spanish-English group showed a statistically significant decline. This finding suggests that the pandemic disrupted reading development more severely for Spanish-English

bilinguals than for their Chinese-English counterparts.

Even fewer studies have examined early literacy development during COVID-19. In Canada, three studies (Dunn et al., 2023; Georgiou, 2021; Zhen, 2025) focused on the impact of the pandemic on English-speaking children with or without special needs in early elementary grades, all of which found significant negative effects on their literacy development. Research on the early literacy development of bilingual children during this period is even sparser. The few studies that included bilinguals suggest that school disruptions "may differently impact children who have a home language different from the language of schooling" (Sun et al., 2023, p. 367). The only Canadian study on bilinguals, conducted by Abuosbeh et al. (2024), examined French-English bilinguals—one of Canada's official bilingual language groups. Their findings indicate that online learning during COVID-19 had a moderately negative impact on L2 vocabulary but no significant effect on word reading. It is noteworthy that both this study and that of Sun et al. (2023) primarily included bilingual children from high socioeconomic (SES) backgrounds.

Few studies have explored how the pandemic has affected bilingual students with diverse sociocultural characteristics, such as varying SES, gender identities, or immigration statuses. As Vaillancourt et al. (2021) emphasize, there is an urgent need for"a precise account of who was impacted, how, and for how long" to understand learning setbacks and develop evidence-informed interventions. To fully understand COVID-19's impact on bilingual children's reading development, it is crucial to examine how their reading skills typically evolve and identify their specific learning needs.

Bilingual children's early reading development

The English reading development of bilingual students appears to follow a pattern similar to that of monolinguals (e.g., Cho et al., 2019; Silverman et al., 2015). Reading development, particularly, reading comprehension has been theorized by some researchers in a "Simple View of Reading" (e.g., Gough & Tunmer, 1986; Hoover & Gough, 1990; O'Brien et al., 2019; Stahl & Murry, 1994) as the product of decoding skills (measured by the ability in word recognition or knowledge of letter-sound relationships) and language (linguistic) comprehension (represented by the ability to understand spoken language such as oral receptive vocabulary) skills.

Studies have found that in both monolingual and bilingual children, letter and word recognition skills and language comprehension (e.g., oral receptive vocabulary) explain most of the variance in reading comprehension (e.g., Kieffer & Vukovic, 2012; Lonigan et al., 2018; Verhoeven & Van Leeuwe, 2012). Early reading achievement is also found to predict reading development in later stages (e.g., Cunningham & Stanovich, 1997; Lyster et al., 2021; Phillips, et al., 2002). For example, similar to the development curve among monolingual children (e.g., Hemphill & Tivna, 2008; Sénéchal et al. 2006; Suggate, et al., 2018), vocabulary knowledge is also a critical factor for L2 reading development among bilingual children (August et al., 2005; Mancilla-Martinez & Lesaux, 2010). Early oral receptive vocabulary in both L1 and L2 is a consistently significant predictor of students' L2 reading accuracy and reading comprehension at all grade levels (Cunningham & Stanovich, 1997; Fraser et al., 2017; Howard et al. 2014). Further, studies of reading development of bilingual children have found that different components may affect bilingual children differently, varying by language groups and grade levels. Cho et al. (2019) compared the reading comprehension of 440 English learners (ELs or bilinguals) and non-ELs (monolinguals) with reading problems in the fourth grade in Texas and found that decoding skills were crucial for both groups' reading comprehension. However, oral receptive vocabulary had a larger effect on bilinguals' reading comprehension than on monolinguals and had a larger effect than decoding skills for bilinguals.

In contrast, Spanish-English bilinguals in the U.S. showed that decoding skills, rather than oral receptive vocabulary, were an essential component for reading development; and decoding skills in both English and Spanish in kindergarten predicted literacy development in third grade (Grimm et al., 2018). In a study of 757 grades 3-5 bilingual children in Florida, Lonigan et al. (2018) found that decoding skills and language comprehension explained most of the variance in reading comprehension. However, children in grade 3 relied more on decoding skills and the reliance switched to language comprehension as they acquired stronger decoding skills as their grade levels increased. These variations suggest that in understanding bilingual children's early reading development, instead of lumping all the literacy components (e.g., reading comprehension, decoding, and language comprehension) together as a composite variable, each component might require separate examination.

Sociocultural factors affecting bilingual children's reading development

Researchers have increasingly called for a broader view of reading development that incorporates more contextual and sociocultural considerations (Duke & Cartwright, 2021; Kim et al., 2020). For bilingual learners, reading achievement in L2-dominated contexts may be affected by a constellation of sociocultural factors, including L1, gender, socioeconomic status or SES, and immigration status, according to Collier & Thomas's (2007) prism model of bilingual education. For example, studies comparing English literacy/language development found different patterns in home language influences between Spanish- and Chinese-speaking children (e.g., Marks et al., 2021; Ramirez et al., 2011; Sun et al., 2022). Sun et al. (2022) explored the diversity in English reading development among bilingual learners with different language backgrounds in Michigan

and found that both phonological and lexical skills in L1 were crucial for bilingual English reading development, but L1 lexical skills had a stronger effect on Chinese-English bilinguals, while Spanish-English bilinguals relied more on L1 phonological skills, suggesting L1 influences.

In another study focusing on linguistic interdependence between Spanish and English among a group of first, second, and third generation immigrant Spanish-English bilingual children in 2nd-4th grade in the U.S., Leider et al. (2018) found that in addition to the powerful influence of L1 on children's L2 English vocabulary and other language skills, L1 also impacted children of different generational statuses differently. Specifically, they found that the crosslinguistic effect of Spanish on L2 English language skills was negative for first-generation students, while it was positive for second and third generation students.

Previous studies have established the important role of family SES (often measured by parental educational level and family income level) in moderating early reading development (Cangelosi et al., 2023; Howard et al., 2014; Uchikoshi, 2018). In Howard's (2014) study with 447 Latino bilingual learners in the US, SES was a statistically significant predictor English word reading ability and English reading-accuracy skills in kindergarten and reading comprehension in third grade. These findings are reflected in two recent studies situated in Italy, in which Bonifacci et al. (2022) and Cangelosi et al. (2023) found that while being bilingual did not influence vocabulary and text-comprehension skills in the age group being tested (9-11 years in 2-5th grade), SES played a significant role in early development with low-SES (both monolingual and bilingual children) underperforming in all core literacy skills including decoding, reading comprehension, and language comprehension compared to those of high-SES backgrounds. There was also a time*group interaction that showed low-SES bilingual children only reached similar performances of low-SES monolinguals in fifth grade.

SES, however, was found to affect different bilingual groups differently. In a study comparing early L2 language development between non-immigrant Danish and immigrant children (age 2-6 years old) from four different regional groups (Western European, Eastern European, Asian, Middle-Eastern and African), Højen et al. (2019) found that compared to the native Danish reference group, the association between SES and language score was not significantly different for the Western group or the Eastern European group but for the Asian and Middle East/African groups, the association between SES and language score was significantly stronger than in the Danish reference group, with the Asian group having the largest SES coefficient.

While many studies find gender differences in favor of girls among bilinguals' literacy development, some also observed the opposite. Lapayese et al. (2014), in their analysis of the standardized reading assessments of 55 Spanish-English bilinguals from grades one to five in California, found that girls consistently outperformed boys in reading across all grades in both English and Spanish. In South Africa, Wilsenach and Makaure (2018) examined gender differences in L2 reading among Northern Sotho 3rd grade children learning to read in English and found girls performed significantly higher than boys on all reading measures. Also focusing on third grade learners of English, Sabra (2018) examined the literacy skills of male and female learners of English in Sweden and found that boys performed slightly higher than girls in language and reading comprehension. In a recent study, Author et al. (2023) found that female Chinese-English bilinguals in grades one to three outperformed their male peers in receptive vocabulary. In-depth interviews further revealed that this achievement gap stemmed from more frequent home literacy practices and parental beliefs in girls' superiority in language learning.

Similarly, studies on the effects of immigration status on reading development have been inconclusive. In a study that examines the early academic achievement of 1,638 low-income Black and Latinx children in kindergarten-grade 4 from immigrant and non-immigrant families in Miami, Florida, De Freyter et al. (2020) found that first-generation immigrant children outperformed second-generation and non-immigrant children on most measures including reading. In another study based on data from ECLS-K (Early Childhood Longitudinal Studies-Kindergarten: 1998 Cohort), Palacios et al. (2008) compared reading achievement among kindergarten-grade 3 language minority children of different generational status (1st generation who were born outside the U.S., 2nd generation who were born in the U.S. to foreign-born parents, and 3rd generation who were born in the U.S. to U.S.-born parents). Their study that 1st generation immigrant children maintained an advantage in early reading achievement from kindergarten to the end of third grade even with race, maternal education, and numerous other key child, family, and school factors controlled.

In a recent analysis of ECLS-K:2011 Cohort data, however, Lee et al (2019) found that an immigrant advantage/paradox was observed in early reading achievement in the ECLS-K 2011 cohort in the early grades, it was not observed by end of 3rd grade, suggesting that immigrant paradox in reading achievement found in the earlier ECLS-K cohort may not apply to a different demographic group. While these two studies confirmed some evidence of the immigrant advantage, studies from other contexts such as Danish context (Højen et al., 2019) found no such advantage with all immigrant groups having lower L2 language skills than native-born children.

In sum, compared with their monolingual peers, different bilingual students may rely on different literacy skills in English reading development. In addition, bilingual students also have unique factors affecting their reading, such as home language, gender, SES, and immigration status. Since most studies conducted in North America have focused on Spanish-English bilinguals in the U.S., it is important to note the heterogeneity of bilinguals

(Lee & Stephens, 2020), as Chinese-English bilinguals may have different development patterns. Against this backdrop, this quantitative, regression analysis aimed to investigate Chinese-English bilingual students' reading development occurring during the pandemic when face-to-face instruction was interrupted in Canada.

Methods

Contexts and participants

In-class instruction was suspended in British Columbia on March 17, 2020 (British Columbia Ministry of Education, 2021), with schools reopening at limited capacity in October 2020. The British Columbia Ministry of Education (2021) reported a higher daily absence rate in the 2020/2021 academic year compared to 2019/2020, with 2.5% of total enrollment shifting to fully online learning or homeschooling. That year, the average class size in British Columbia public schools dropped to 21.4 students—the lowest since 2006/2007.

Most parents canceled their children's in-person extracurricular activities or switched them entirely online. In-person social interactions with peers outside the home were significantly reduced and remained limited even through the 2021/2022 school year (Li & Lin, 2023). The disruption of primary-level in-school literacy instruction likely hindered bilingual students' English reading development. Beyond the reported reductions in language-focused practices—such as extended writing, vocabulary instruction, and reading comprehension strategies—as teachers adapted to emergency remote teaching (Crosson & Silverman, 2023; Doering, 2020), many Chinese-Canadian parents also discontinued or moved their children's extracurricular activities online. Opportunities for in-person social interactions with native English speakers were significantly diminished and had not fully resumed even by the 2021/2022 academic year (Li & Lin, 2023).

By using snowball sampling technique, we recruited 135 Chinese-Canadian bilingual children in grade two to three from various school districts in an urban area in British Columbia. The average age of the children was 7.47 years old (89.61 months) in the first year (2020/2021) and 8.47 years old (101.66 months) in the second year (2021/2022) of the study. Seventy-eight (57.78%) spoke Mandarin at home, while 57 (42.22%) spoke Cantonese at home, 75 (55.56%) were girls, and 60 (44.44%) were boys. Among the 132 families who reported their household income, 34 (25.19%) were categorized as low-income, while 98 (72.59%) were categorized as non-low income. A majority (74.07%) were born in Canada. Detailed information is shown in Table 1.

Table 1. Demographic information of participants

	Second grade				Third grade				Total	
	N	%	Mean	SD	N	%	Mean	SD	N	%
Total	103	100			70	100			135	100
Age (in months)			89.61	4.44			101.66	4.23		
L1										
Mandarin	47	45.63			47	67.14			78	57.78
Cantonese	56	54.37			23	32.86			57	42.22
Gender										
Male	44	42.72			33	47.14			60	44.44
Female	59	57.28			37	52.86			75	55.56
Family SES										
Low-SES	29	28.16			17	24.29			34	25.19
Non-low-SES	71	68.93			53	75.71			98	72.59
Missing	3	2.91			0	0.00			3	2.22
Immigration status										
Immigrant	23	22.33			19	27.14			32	23.70
Born in Canada	77	74.76			51	72.86			100	74.07
Missing	3	2.91			0	0.00			3	2.22

Data Collection

Data was collected from October to May in year 1 (2020/2021, school closure year) and year 2 (2021/2022, the year school resumed normal instruction) via online software with the consent of parents and children. All participating parents and children were clearly informed about the research process before signing their consent forms. Due to the restrictions imposed by the pandemic, we were unable to include school-level contextual factors in this study. Based on the Simple View of Reading, in this study we investigated children's L2 reading comprehension of written texts as well as the two linguistic components that have been shown to influence individual reading comprehension: decoding skills (letter-sound correspondence knowledge and context-free word recognition) and oral language comprehension (i.e., oral receptive vocabulary) (Gough & Tunmer, 1986; Hoover & Gough, 1990). Following Collier and Thomas' (2007) Prism Model for Bilingual Learners, in this study, sociocultural factors that may affect bilingual development in this study include L1, gender, socioeconomic status or SES, and immigration status. 103 children participated in grade 2 assessments; 70 participated in grade 3 assessments; 38 participated in assessments in both grades. All data were de-identified after collection. Each parent and child were assigned an identification number for analyses.

Instruments

Reading comprehension

Reading comprehension was measured by the reading comprehension subtest of the Kaufman Test of Educational Achievement (KTEA-3) (Kaufman & Kaufman, 2014), an assessment battery designed to evaluate academic skills for individuals aged 4 to 25 years and 11 months. This test was chosen because it is widely used in Canada for research and clinical assessments. The overall test-retest reliability of the KTEA-3 is between 0.87 to 0.95. In the reading comprehension test, participants began by reading out loud the words test administrator points, followed by reading out loud short paragraphs, and answering comprehension questions based on the paragraphs they read.

Decoding skills

Decoding skills were assessed by the letter and word recognition subtests of KTEA-3 (Kaufman & Kaufman, 2014). According to administration manual, the letter and word recognition subtest is considered to have high reliability with split-half reliability coefficients falling in the range of 0.80 to 0.89. In subtests, each student was shown letters and words that increase in difficulty and was asked to identify and pronounce the letters and words. According to the test manual, both the reading comprehension and the letter and word recognition tests were normalized among 2,600 test takers in the grade norm sample designed to be representative of the US population. Therefore, the standardized score, with a normative mean of 100 and a standardized deviation of 15, was used in both tests for the analyses.

Oral receptive vocabulary

The Peabody Picture Vocabulary Test (PPVT-5; Dunn & Dunn, 2019) was administered to assess English oral receptive vocabulary. The PPVT-5 is a norm-referenced assessment designed for individuals aged from 2.5 to 90+ with the overall reliability measured by the internal consistency of 0.97 and by the test-retest reliability of 0.88. PPVT-5 was chosen because it is a widely used instrument in research in North America including Canada; and the instrument has been validated for the participants in this study (see Ji et al., 2022). Normalized in the US among 2720 individuals who were representative of the 2017 US census, the test's standardized score (M = 100, SD = 15) is used in the analyses of this study. During the test, the administrator began by selecting a starting word item appropriate for the examinee's age group. Each item consisted of a spoken word and a response board displaying four pictures. The administrator read the word aloud in English, prompting the examinee to respond by either pointing to the corresponding image or stating its associated number. The items were presented sequentially, increasing in difficulty. While there was no time limit for responses, the test was discontinued after six consecutive incorrect answers.

Student sociocultural background data: L1, Gender, SES, and immigration status

Children's demographic information including gender, first language, immigration status, and SES was collected by parental surveys. SES was calculated based on the 2020 low-income cut-offs (LICOs) provided by Statistics Canada (2022). These income cut-offs were estimated based on the year, the number of family members, and the residential areas. Families with an annual household income lower than LICOs in 2020 were identified as low-income families.

Data Analysis

The SPSS Statistics version 28.0 was used in all the data analysis in this study. Descriptive results based on the year and students' sociocultural data in home language, gender, immigration status, and family SES were developed. To gain a comprehensive understanding of the bilingual children's English literacy development, descriptive statistics were calculated for the results of all three assessments—reading comprehension, letter and word recognition, and receptive vocabulary—across each grade. One-sample t-tests were conducted to compare the bilingual children's performance

on the standardized measures to that of the normative samples.

To explore the developmental patterns of reading development over the two years and their variations by student sociocultural characteristics, we conducted independent samples t-tests by comparing children's achievement scores across the two years and across the different sociocultural factors. The kurtosis and skewness of each sub-sample dataset were calculated to examine the distributional normality before conducting the t-tests. Based on the descriptive statistics (Tables 2-4), the skewness of the distributions in each sub-sample dataset was within acceptable ranges, indicating a slight asymmetry but no extreme deviations. The distributions appeared slightly platykurtic, with kurtosis values ranging from -0.79 to 7.36 (Razali & Wah, 2011).

Furthermore, to identify sociocultural factors that facilitated or hindered reading development, a Hierarchical Linear Modeling (HLM) was applied to the longitudinal data (Hox, 2000; Steele, 2008). Extended from the regression model (Kozlowski et al., 2013, Zhou et al., 2023), the HLM technique has the uniqueness of analyzing variables at both the individual level and group levels. It also provides flexibility in dealing with missing data (Kwok et al., 2008; Maas & Snijders, 2003). The full information maximum likelihood technique allows for efficient parameter estimation by using all available information with missing data in the level-1. In our model, the repeated test scores in grade-2 and grade-3 were set as the lowest level nested within individual children. The repeated tests level was set as level one, and the children's level was set as level two. The level-1 model was specified as:

$$Test_{ij} = \beta_{0j} + \beta_{1j}(Grade_{ij}) + \gamma_{ij}$$

In this level, $Test_{ij}$ represented the early literacy tests (i.e., reading comprehension, letter and word recognition, and receptive vocabulary) for the time *i* in child *j*, β_{0j} represented the individual intercepts for child *j*, β_{1j} represented the slope of time (dummy coded as 0 for grade-2 and 1 for grade-3) for child *j*, γ_{ij} was the random error associated with time *i* in child *j*.

The level-2 (children level) model was depicted as:

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Home Language}_j) + \gamma_{02}(\text{Gender}_j) + \gamma_{03}(SES_j) + \gamma_{04}(\text{Immigration}_j) + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Home Language}_j) + \gamma_{12}(\text{Gender}_j) + \gamma_{13}(SES_j) + \gamma_{14}(\text{Immigration}_j)$$

In level-2, γ_{00} was the grand mean of each test over all time points. Home language, gender, SES, and immigration status were added as variables to control for possible differences in each test at baseline (γ_{01}, γ_{02}, γ_{03}, γ_{04}, respectively) and possible growth differences over a year (γ_{11}, γ_{12}, γ_{13}, γ_{14}, respectively). was the random error associated with child j. Combining the individual models gave the following mixed regression model:

$$Test_{ij} = \gamma_{00} + \gamma_{01}(\text{Home Language}_j) + \gamma_{02}(\text{Gender}_j) + \gamma_{03}(SES_j) + \gamma_{04}(\text{Immigration}_j) + \gamma_{10}(Grade_{ij}) + \gamma_{11}(Grade_{ij} \times \text{Home Language}_j) + \gamma_{12}(Grade_{ij} \times \text{Gender}_j) + \gamma_{13}(Grade_{ij} \times SES_j) + \gamma_{14}(Grade_{ij} \times \text{Immigration}_j) + \mu_{0j} + \gamma_{ij}$$

Results

Bilingual children's reading development trends over the two years during COVID-19

As indicated by the descriptive analyses in Table 2, Table 3, and Table 4, there was an overall decrease in the mean reading comprehension scores from grade-2 (M = 104.87, SD = 12.35) to grade-3 (M = 102.51, SD = 14.01), in the mean letter and word recognition scores from grade-2 (M = 115.53, SD = 22.17) to year-2 (M = 109.24, SD = 19.24), and in receptive vocabulary mean scores from grade-2 (M = 96.82, SD = 13.51) to grade-3 (M = 95.96, SD = 18.04).

Based on the independent samples t-tests results, the decrease in letter and word recognition scores between grade 2 and grade 3 is statistically significant ($t = 1.93$, $p < .05$, Cohen's $d = 0.30$) but the changes in the other measures are not statistically significant. Pearson correlation analysis results show that the mean scores of reading comprehension, letter and word recognition, and receptive vocabulary in grade-2 and grade-3 were strongly correlated with each other suggesting a large degree of stability in reading comprehension, decoding, and language comprehension scores across time (Table 5).

To better understand the bilingual children's early literacy performance across the two years, we conducted one-sample t-tests to compare with the normative samples. Based on analysis, in grade-2, the bilingual children had a significantly higher mean score of reading comprehension ($t = 85.77$, $p < .01$, Cohen's $d = 12.35$) and letter and word recognition ($t = 52.90$, $p < .01$, Cohen's $d = 22.17$) than the grade-level normative mean. In contrast, their mean score in English receptive vocabulary was significantly lower than the normative mean: $t = -72.71$, $p < .01$, Cohen's $d = 13.52$.

Bilingual children's reading development by L1, gender, SES, and immigration status

Mandarin and Cantonese participants showed a decrease in reading comprehension (Table 2) and letter and word recognition (Table 3) with Mandarin children's decline reached statistical significance. Mandarin participants' reading comprehension scores decreased from grade-2 (M = 108.41, SD = 14.55) to grade-3 (M = 103.51, SD = 16.31), while Cantonese participants' average scores also decreased from grade-2 (M = 101.96, SD = 9.36) to grade-3 (M = 100.48, SD = 7.30). Mandarin-speaking participants' average letter and word recognition scores decreased in grade-3 (M = 110.19, SD = 22.23) from grade-2 (M = 121.23, SD = 24.64). The decrease was statistically significant: $t = 2.28$, $p < .05$, Cohen's $d = 0.47$. Similar results were found for Cantonese participants whose scores in grade-3 (M = 107.30., SD = 11.05) were lower than those in grade-2 (M = 110.75, SD = 18.77). The receptive vocabulary average score of Cantonese-speaking children also decreased from grade-2 (M = 95.93, SD = 11.91) to grade-3 (M = 91.70, SD = 15.25). However, these decreases were not statistically significant.A similar pattern was

observed in grade-3. The bilingual children had significantly higher mean scores in reading comprehension (t = 61.22, p < .01, Cohen's d = 14.01) and letter and word recognition (t = 47.50, p < .01, Cohen's d = 19.24), but significantly lower mean score in English receptive vocabulary: (t = -44.50, p < .01, Cohen's d = 18.04) than the normative mean. The results indicated that, the reading comprehension and decoding skills of the Chinese-English bilingual children were comparable with English monolinguals in both grades 2 and 3. However, their English receptive vocabulary skills were lower than their English monolingual peers in either grade.

Table 2. Descriptive statistics and independent samples t-test of reading comprehension results in each sociocultural category

	Grade 2					Grade 3					t	Cohen's *d*
	N	Mean	SD	Kurtosis	Skewness	N	Mean	SD	Kurtosis	Skewness		
Total	102	104.87	12.35	0.98	0.82	70	102.51	14.01	3.26	0.90	1.16	0.18
Mandarin-speaking	46	108.41	14.55	0.09	0.65	47	103.51	16.31	1.96	0.70	1.53	0.32
Cantonese-speaking	56	101.96	9.36	-0.37	0.14	23	100.48	7.30	1.20	0.40	0.68	0.18
Male	44	102.05	10.07	0.53	0.51	33	102.39	15.59	2.36	0.60	0.12	0.03
Female	58	107.02	13.52	0.59	0.74	37	102.62	12.65	5.30	1.43	1.59	0.34
Low-income families	29	98.86	10.76	0.88	0.93	17	96.06	11.59	0.96	-1.14	0.82	0.25
Non-low-income families	70	107.10	12.36	1.17	0.89	53	104.59	14.18	3.09	1.21	1.05	0.19
Immigrant	23	105.22	11.54	-0.45	0.35	19	101.16	14.88	0.60	-0.43	0.10	0.50
Born in Canada	76	104.88	12.80	1.22	0.91	51	103.02	13.79	4.53	1.52	0.78	0.14

Note. none of the results are significant at the p < .05 (two-tailed) level.

Table 3. Descriptive statistics and independent samples t-test of letter and word recognition results in each demographic category

	Grade 2					Grade 3					t	Cohen's *d*
	N	Mean	SD	Kurtosis	Skewness	N	Mean	SD	Kurtosis	Skewness		
Total	103	115.53	22.17	-0.21	0.57	70	109.24	19.24	0.15	2.07	1.93*	0.3
Mandarin-speaking	47	121.23	24.64	-0.79	0.10	47	110.19	22.23	1.25	0.07	2.28*	0.47
Cantonese-speaking	56	110.75	18.77	1.39	1.00	23	107.30	11.05	-0.40	-0.36	0.82	0.22
Male	44	112.91	20.92	0.29	0.72	33	108.79	17.42	2.04	0.58	0.92	0.21
Female	59	117.49	23.03	-0.40	0.46	37	109.65	20.97	2.21	-0.08	1.68	0.36
Low-income families	29	107.79	25.08	-0.08	0.82	17	101.00	21.13	2.16	-1.19	0.94	0.29
Non-low-income families	71	118.30	20.65	-0.11	0.75	53	111.89	18.02	1.02	0.97	1.80	0.33
Immigrant	23	111.83	23.53	-0.48	0.00	19	105.63	23.19	1.72	-0.90	0.86	0.27
Born in Canada	77	113.56	21.79	0.19	0.78	51	110.59	17.63	1.56	1.12	0.81	0.15

Note. *: p < .05 (two-tailed).

Bilingual children's reading development by L1, gender, SES, and immigration status

Mandarin and Cantonese participants showed a decrease in reading comprehension (Table 2) and letter and word recognition (Table 3) with Mandarin children's decline reached statistical significance. Mandarin participants' reading comprehension scores decreased from grade-2

(M = 108.41, SD = 14.55) to grade-3 (M = 103.51, SD = 16.31), while Cantonese participants' average scores also decreased from grade-2 (M = 101.96, SD = 9.36) to grade-3 (M = 100.48, SD = 7.30). Mandarin-speaking participants' average letter and word recognition scores decreased in grade-3 (M = 110.19, SD = 22.23) from grade-2 (M = 121.23, SD = 24.64). The decrease was statistically significant: t = 2.28, p < .05, Cohen's d = 0.47. Similar results were found for Cantonese participants whose scores in grade-3 (M = 107.30., SD = 11.05) were lower than those in grade-2 (M = 110.75, SD = 18.77). The receptive vocabulary average score of Cantonese-speaking children also decreased from grade-2 (M = 95.93, SD = 11.91) to grade-3 (M = 91.70, SD = 15.25). However, these decreases were not statistically significant.

Table 4. Descriptive statistics and independent samples t-test of receptive vocabulary results in each demographic category

	Grade 2					Grade 3					t	Cohen's *d*
	N	Mean	SD	Kurtosis	Skewness	N	Mean	SD	Kurtosis	Skewness		
Total	103	96.82	13.51	-0.09	0.00	70	95.96	18.04	3.62	0.82	0.36	0.05
Mandarin-speaking	47	97.87	15.27	-0.42	-0.09	47	98.04	19.07	2.64	1.29	0.05	0.05
Cantonese-speaking	56	95.93	11.91	0.31	0.01	23	91.7	15.25	5.33	-1.55	1.32	0.31
Male	44	94.43	13.06	0.21	0.34	33	96.03	22.03	2.03	0.46	0.40	0.09
Female	59	98.59	13.68	0.11	-0.25	37	95.89	13.87	7.36	1.89	0.94	0.20
Low-income families	29	90.69	13.94	0.15	0.10	17	88.06	17.02	3.14	-1.13	0.57	0.17
Non-low-income families	71	99.18	12.62	-0.16	0.08	53	98.49	17.77	3.34	1.40	0.25	0.04
Immigrant	23	94.96	13.99	-0.05	0.01	19	98.79	20.94	2.71	1.33	0.71	0.22
Born in Canada	77	97.25	13.42	0.02	-0.02	51	94.90	16.95	4.32	0.44	0.87	0.15

Note. none of the results are significant at the $p < .05$ (two-tailed) level.

Table 5. Pearson correlation among each test scores

		Reading comprehension		**Letter and word recognition**		**Receptive vocabulary**	
	Grade	**2**	**3**	**2**	**3**	**2**	**3**
Reading comprehension	2	-					
	3	.63**	-				
Letter and word recognition	2	.60**	.52**	-			
	3	.80**	.72**	.58**	-		
Receptive vocabulary	2	.63**	.48**	.49**	.62**	-	
	3	.66**	.70**	.61**	.63**	.60**	-

Note. ** p < .01 (two-tailed)

Girls gained higher mean scores in all three tests than boys across grades. However, girls' mean scores in all three areas decreased in grade-3, compared to grade-2, though the differences were not statistically significant. Specifically, girls' mean scores in reading comprehension decreased from grade-2 (M = 107.02, SD = 13.52) to grade-3 (M = 102.62, SD = 12.65); their average letter and word recognition scores were lower in grade-3 (M = 109.65, SD = 20.97) than in grade-2 (M = 117.49, SD = 23.03); and they scored averagely lower in receptive vocabulary in the grade-3 (M = 95.89, SD = 13.87) than in grade-2 (M = 98.59, SD = 13.68). In contrast, while boys' mean scores in reading and decoding decreased in Grade 3, their scores in oral receptive vocabulary increased in grade-3 (M = 96.03, SD = 22.03) compared to that in grade-2 (M = 94.43, SD = 13.06) though the changes were not statistically significant.

Participants had lower average scores in grade-3 than in grade-2 on all three tests regardless of their family SES. However, children from non-low-income families scored consistently higher than their peers who were from low-income families, though the differences were not significant. Individuals from non-low-income families decreased in average reading comprehension scores from grade-2 (M =

107.10, SD = 12.36) to grade-3 (M = 104.59, SD = 14.18), and in letter and word recognition scores from grade-2 (M = 118.30, SD = 20.65) to grade-3 (M = 111.89, SD = 18.02), and also in receptive vocabulary from grade-2 (M = 99.18, SD = 12.62) to grade-3 (M = 98.49, SD = 17.77). Children from low-income families scored lower in grade-3 than in grade-2 in reading comprehension (from M = 98.86, SD = 10.76 to M = 96.06, SD = 11.59), letter and word recognition (from M = 107.79, SD = 25.08 to M = 101.00, SD = 21.13), and in receptive vocabulary (M = 90.69, SD = 13.94 to M = 88.06, SD = 17.02).

Immigrant students' average scores decreased in reading comprehension (Table 2), letter and word recognition (Table 3) from grade-2 to grade-3, but not in the receptive vocabulary scores. Children born in Canada had a lower average reading comprehension score (Table 2) in grade-3 (M = 103.02, SD = 13.79) than in grade-2 (M = 104.88, SD = 12.80). Their average letter and word recognition score (Table 3) in grade-3 (M = 110.59, SD = 17.63) was lower than that in grade-2 (M = 113.56, SD = 21.79). They also had a higher average receptive vocabulary score in grade-2 (M = 97.25, SD = 13.42) than in grade-3 (M = 94.90, SD = 16.95). These changes were not statistically significant.

Sociocultural factors moderating the children's reading development

The sociocultural factors affecting reading development were investigated through conducting a multilevel analysis. The initial unconditional model was firstly run to estimate the within-class correlation coefficient (ICC), which measures the proportion of variance between groups (Raudenbush and Bryk, 2002), for each test. Based on the unconditional model results, 60.52%, 54.04%, and 54.58% of the variance in reading comprehension, letter and word recognition, and receptive vocabulary, respectively, were accounted as the between-children variance. Then we added the children-level variables to conduct a two-level full model. By adding all children-level variables (i.e., L1, gender, SES, and immigration status), 14.62% of children-level variance in reading comprehension scores, 10.01% in letter and word recognition scores, and 11.12% in receptive vocabulary scores were explained.

Finally, we estimated the two-level full model by adding children-level variables on the intercept and the slope of each assessment. The children-level variables were retained in the final model for another round of analysis if they had effects in the full model with $p < .10$. The chi-square difference test between the model deviance was conducted to compare the model fit (Zhou et al., 2023) between the full model and the final model. Considering no significant improvement was obtained by adding all the variables in the full model, and most of the final models had comparatively lower Akaike's information criterion (AIC) (Akaike, 1992) and Bayesian information criterion (BIC) (Schwarz, 1978), which indicated a better fit (Hamaker et al., 2011), we developed our study conclusion based on the final model results.

Based on the final model results, at grade 2, the initial scores (γ_{00}) of reading comprehension, letter and word recognition, and receptive vocabulary were 101.46, 150.56, and 88.34, respectively ($p < .01$). Reading comprehension was significantly associated with gender with girls scoring 15.97 points higher than boys ($p < .05$). The SES (γ_{03}) was positively related to the reading scores with children from non-low-income families scoring 3.75 points higher than children from low-income families ($p < .01$). For the receptive vocabulary scores, family SES (γ_{03}) was also a significant moderator. Children from non-low-income families scored 2.84 higher than children from low-income families ($p < .01$).

Discussion

The primary purpose of this study was to investigate Chinese-Canadian bilinguals' English reading development patterns and the role of different sociocultural factors that moderated their development during COVID-19. Descriptive analyses revealed a lag in all three early literacy assessments among participants with the most significant decline in decoding skills even after schools re-opened in the academic year 2021/2022, suggesting that the negative academic effects of COVID-19 school closures reported on children of other ethnic backgrounds also applied to Chinese-Canadian children and that these negative effects had not been remediated one year after school closure. Comparison with the two normative samples also suggested that the children struggled also in vocabulary across the two grades. The multilevel analysis results further reflected a developmental lag in early reading abilities as no significantly positive slope was observed in any of the assessments. Instead, there was a significantly negative slope in letter and word recognition trajectory from grade-2 to grade-3. These results support the notion that participants experienced a decline or stagnation of their English reading development during the school closure. This finding echoes the results of standardized tests (Betthäuser et al., 2023; Dewey et al., 2024; Juniper Education, 2022; NCES, 2022; Peters et al., 2024) from different countries and regions, and supports findings from other research studies on general populations (Gray et al., 2023; Segers et al., 2023) that language minority students were especially vulnerable to the negative effects of school closure.

The significantly lower receptive vocabulary scores of the bilingual children compared to the grade-level normative sample align with previous studies indicating that bilingual children may have smaller vocabularies in each of their languages than monolingual peers (Bialystok et al., 2010; De Houwer et al., 2014; Hoff et al., 2014). This phenomenon may be attributed to reduced exposure to the English language at home compared to monolingual children, as bilingual children split their linguistic input across two languages. Additionally, vocabulary acquisition is closely tied to the frequency and diversity of language exposure, which may be limited in English if the home environment

predominantly supports the heritage language (Hoff et al., 2014). Despite this gap, it is important to note that vocabulary size alone does not fully capture the linguistic and cognitive abilities of bilingual children. Receptive vocabulary represents one aspect of language proficiency, and other domains, such as metalinguistic awareness, may provide compensatory strengths (Bialystok, 2001; Barac & Bialystok, 2012). In contrast to their receptive vocabulary, the bilingual children scored significantly higher than the normative sample mean in letter and word recognition and reading comprehension.

Table 6. Parameter estimates of full and final model of early reading assessments

Fixed effects	Reading comprehension				Letter & word recognition				Receptive vocabulary			
	Full model		Final model		Full model		Final model		Full model		Final model	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Intercept (γ_{00})	106.39**	10.64	101.46**	5.58	151.28**	18.13	150.56**	14.36	79.19**	13.16	88.34**	6.67
L1 (γ_{01})	-9.68	7.56			-20.26	12.95	-20.07	12.70	8.72	9.41	7.58	9.20
Gender (γ_{02})	12.43	7.48	15.97*	7.47	3.51	12.87	2.09	3.40	3.21	9.27		
SES (γ_{03})	2.16	2.53			3.19	4.29	3.75**	1.11	3.27	3.10	2.84**	0.77
Immigration (γ_{04})	-3.83	8.66			-29.79*	15.02	-29.84	14.62	7.57	10.69		
Slope (γ_{10})	-3.25	4.43	1.10	2.28	-18.53**	6.97	-18.23**	5.32	4.64	5.75	1.00	2.82
L1 (γ_{11})	2.90	3.16	-1.62	0.92	7.41	4.96	7.32	4.86	-4.25	4.15	-3.76	4.06
Gender (γ_{12})	-4.41	3.09	-5.69	3.09	-0.54	4.90			-0.62	4.04		
SES (γ_{13})	0.15	1.04			0.21	1.64			-0.23	1.35		
Immigration (γ_{14})	0.89	3.55			10.08	5.66	10.10	5.48	-4.23	4.64	-0.98	1.22
Random effects	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Child level ($\tau_{\beta 00}$)	87.23**	20.89	101.93**	22.19	219.07**	55.00	219.85**	54.77	114.12**	30.18	116.85**	30.31
Residual - grade 2 (δ^2_{G3})	43.68*	18.69	42.55*	18.85	231.41**	57.52	230.86**	57.37	41.25	27.32	40.28	27.34
Residual - grade 3 (δ^2_{G3})	80.30**	23.15	84.08**	25.20	101.65*	51.64	101.25*	51.48	178.18**	40.96	178.12**	41.23
Model fit parameters												
Deviance (*df*)	1296.75 (13)		1311.36 (8)		1473.12 (13)		1473.15 (11)		1363.74 (13)		1365.07 (9)	
AIC	1322.75		1327.36		1499.12		1495.15		1389.74		1383.07	
BIC	1363.37		1352.35		1539.81		1529.58		1430.43		1411.24	

Note. * $p < .05$; ** $p < .01$.
Coeff. = Model Coefficient; AIC = Akaike information criterion; BIC = Bayesian information criterion

These findings confirm previous research suggesting that bilingual children are comparable to monolinguals in reading-related skills, such as reading comprehension (Bonifacci et al., 2020; Peets et al., 2022), and may even surpass them in terms of decoding skills (Papastefanou et al., 2021). The comparable performance in these areas may stem from bilingual children's metalinguistic awareness, a cognitive advantage that enhances their ability to analyze and manipulate language. This increased awareness can facilitate the development of decoding skills and reading comprehension (Bialystok, 2001; Goodrich & Lonigan, 2017; Koda, 2005). Additionally, cross-linguistic transfer (Cummins, 1981) —the process by which skills in one language (e.g., Chinese character recognition) support the acquisition of similar skills in another language (e.g., English decoding)—may also explain these results.

Regarding the developmental trajectories over the two years, our findings of the independent sample t-tests and on the negative slope between the two time points of assessments in the multilevel analyses differed from Sun et al. (2023) finding. In their study, the sample of Chinese-English bilinguals maintained that age-appropriate progress during the pandemic in phonological awareness and word reading tasks and age-adjusted improvements in vocabulary and reading comprehension. In fact, Chinese-English bilinguals (along with Spanish-English bilinguals) surpassed their monolingual English-speaking peers to have "significantly steeper growth in English vocabulary" (p. 368).

The negative slope experienced by our participants also differed from the findings in Abuosbeh et al.'s (2024) study on English-French bilinguals in Canada in which they found that grade 2s significantly outperform grade 1s among their two cohorts of participants (i.e., those attended in-person or online instruction during the pandemic) in all of their L2 measures including letter and word recognition, vocabulary, and reading comprehension. The downward slope in the two-year performance trajectory of our sample suggests that the Chinese-Canadian children in our study were struggling in their English reading development during the pandemic, further confirming that the pandemic may have impacted the bilingual children differently in different contexts. Our sample differed from those in Sun et al. (2023) and Abuosbeh et al. (2024) that a higher percentage of our sample came from diverse intersectional backgrounds (i.e., that of low-SES and/or immigrant backgrounds), which had been reported in other studies to be most severely impacted by the pandemic.

Similar to other studies (Betthäuser et al., 2023; Dewey et al., 2024; Juniper Education, 2022), family SES was found to be a significant factor in moderating the impact of COVID-19 on early literacy development. Children from non-low-income families on scored consistently higher than children from low-income families on all tests at all grade levels, despite the average score decreased observed in both subgroups. The multilevel analysis results further revealed that family SES was significantly associated with decoding skills and receptive vocabulary. These results highlight the effects of SES in early reading development which is widely documented by various studies (e.g., Bonifacci et al., 2020; Hemmerechts et al., 2017; Li et al., 2021). During the pandemic, inequity in education was exacerbated as children from low-SES were less likely to have high-quality education during the school closure. Children from low-income families had limited resources for homeschooling, and limited access to digital devices and internet connections (Hoofman & Secord, 2021; Segers et al., 2023). Therefore, children from low-SES families were more vulnerable to school closure and had more difficulties overcoming the negative effects of the pandemic (see also Bennett, 2023; Whitney et al., 2021).

As well, many of these low-SES children also came from immigrant backgrounds. While all children were impacted by reductions in literacy related instruction (Crosson & Silverman, 2022), reduced language-related teaching and reduced interactions in L2 with teachers or peers likely had impacted immigrant children the most who had limited L2 exposure at home (Li & Lin, 2023). Furthermore, the restriction of other in-person activities outside of school during the pandemic made it difficult for bilingual children to seek support from other sources, such as after-school tutoring. Research on children from mainstream English-monolingual backgrounds (e.g., Dunn et al., 2023; Sun et al., 2024) all revealed that mainstream parents were able to mitigate the negative impact of the pandemic induced school closure by teaching reading and providing reading materials more frequently at home.

The results of the current study also support previous studies (Lapayese et al., 2014; Li et al., 2023; Reilly et al., 2019) showing the superiority of girls in early literacy development, particularly in reading. We found that Chinese-Canadian girls outperformed boys significantly in English reading comprehension but not in decoding skills or oral receptive vocabulary. These findings in part reflected the mixed results in previous studies on gender differences (Lapayese et al., 2014; Sabra, 2018; Wilsenach & Makaure, 2018). Therefore, we argue that gender differences in early literacy may be rooted in various cognitive and sociocultural factors, such as the gender norms and expectations in different cultural contexts (Scholes, 2019) or the gender-specific beliefs of parents or teachers (e.g., Li et al., 2023; Wolter et al., 2015). Future studies are urgently needed to explore the relationship between gender and early reading developmental patterns.

Our findings on the role of the L1 in moderating the reading development of Chinese-Canadian children are intriguing. Our two-year comparison among the various sociocultural groups suggests that Mandarin-speaking children experienced most significant decline in decoding skills. Our multi-level analyses, however, show that the home languages (Mandarin or Cantonese) were not significantly associated with English reading comprehension, decoding skills, or receptive vocabulary, which differed from previous studies (e.g., Marks et al.,

2021; Ramirez et al., 2011; Sun et al., 2022). The non-significant role of the home language factor as well as the different impact on Cantonese-speaking children may suggest that we need to explore other contextual factors as suggested by the Prism Model for Bilingual Learners (Collier and Thomas, 2007) and the Active View of Reading (Duke & Cartwright, 2021). These contextual factors may include nuanced intra-linguistic differences between Mandarin and Cantonese language, intra-cultural differences at home (i.e., home language environments), and other sociocultural factors such as motivations and attitudes that affect reading engagement at home.

Implications and limitations

Findings from this study suggest the educational needs of Asian bilingual students in North America have not been fully explored by researchers and educators. In this study, the Chinese-Canadian participants had lower average scores in all the reading measures in the third-grade than those in the second-grade, which reveals that during COVID-19, their English reading development was hindered possibly by school closures, quality of remote learning, and the isolation from interactions with English speakers such as school teachers and their peers. These reading declines challenge the "model minority" stereotype, which commonly depicts Asian students in the North American context as less likely to struggle in education (Hartlep, 2021; Lee, 1994; Suzuki, 2002) and that "Asians' skill advantages would be even greater if children were exposed to school less" (Kuhfeld et al., 2021, p. 235).

The fact that Chinese-Canadian children scored lower in reading comprehension, decoding skills, and receptive vocabulary in English after school resumed in the academic year 2021/2022 reflects the long-term pandemic effect of school closures in the previous year and a decrease in extra-curricular activities after school resumed. This is especially true for primary-level students who have missed out on the foundational literacy learning activities they would experience in school in face-to-face instruction. In essence, the importance of primary level foundational reading teaching and learning was confirmed.

The fact that teachers of bilingual students may have decreased literacy instruction during the COVID-19 pandemic, particularly language-focused practices such as extended writing, vocabulary knowledge, and reading comprehension strategies (see Crosson & Silverman, 2023) may have also contributed to the decline in reading development, suggesting the need for making up these lost instructional practices post-pandemic. For our sample, the significant decline in letter and word recognition across the two years and their significant lower vocabulary scores compared to the normative groups also suggest more recovery efforts may need to be devoted to decoding and vocabulary post-pandemic.

The strong correlations among decoding skills, oral receptive vocabulary, and reading comprehension underscore the importance of oral language practices in early reading development, especially in primary grades. For Chinese-Canadian bilingual children, the reduction in their interactions with (native) English speakers and their lack of exposure to high-quality English language input was associated with a decrease in their assessment scores. The home literacy environment should also be explored for a more comprehensive understanding of the changes in educational environments during the pandemic, especially among the Mandarin-speaking groups.

The significant effect of gender in reading comprehension suggests that post-pandemic efforts must be devoted to reading comprehension instruction for boys. Further research should also explore whether this initial gender gap will be extended in higher grades (Reilly et al., 2019; Borgonovi et al., 2021) or can be attenuated with formal classroom intervention (McTigue et al., 2021; Robinson & Lubienski, 2011). In addition, the significant effects of family SES on decoding skills and receptive vocabulary reflect the vulnerability of children from low-SES families during school closure. Children from low-SES families were less likely to overcome the negative impact of COVID-19, especially for language-minority children in their English literacy development (Segers et al., 2023). More attention should be paid to underrepresented children in educational mitigation strategies to revitalize education in the post-pandemic period.

The non-significant effect of home languages and immigration status suggests that future studies should include a more diverse sample of participants over a longer period of time. It would be informative to include students' home language use rather than just their home language backgrounds to investigate the difference between the two language-speaking groups. Since participants in this study were either born in Canada or immigrated to Canada at early educational levels, participants who immigrated to English-speaking countries at comparatively higher education levels or received some of their formal education at their country of origin, could provide more meaningful information about the effects of immigration status.

While this study offers valuable insights into the impact of the COVID-19 pandemic on the English reading development of Chinese-Canadian bilingual students, several limitations should be acknowledged. First, the study focuses primarily on Chinese-English bilinguals, limiting the generalizability of the findings to other bilingual groups with different linguistic, cultural, and educational backgrounds. Future research should incorporate a more diverse sample to better understand how the pandemic and other unexpected educational disruptions affect bilingual children more broadly. Second, participant attrition in this longitudinal study may have affected the reliability of the findings, as students who remained in the study could differ systematically from those who dropped out. Future research could address this challenge through strategies such as oversampling or targeted follow-ups to strengthen

the robustness of longitudinal analyses. Finally, the use of snowball sampling and imbalanced representation across certain demographic categories (e.g., socioeconomic status and immigration status) may have compromised the validity of some analyses and limited the ability to draw nuanced conclusions. Expanding sample sizes and ensuring balanced representation in future studies will be essential for improving the generalizability and precision of findings in this field.

Conclusion

Overall, our findings suggest that the pandemic had a significant and detrimental impact on English reading development among Chinese-English bilingual learners in this study. Primary-level bilingual students from intersectionally disadvantaged backgrounds were particularly at risk of not acquiring foundational reading skills during the pandemic. Specifically, the results highlight the substantial and lasting effects of the COVID-19 pandemic on the English reading development of Chinese-Canadian bilingual students, challenging the "model minority" stereotype that often overlooks the educational challenges faced by Asian learners.

The observed declines in reading comprehension, decoding skills, and receptive vocabulary underscore the vulnerability of primary-level bilingual students, especially those from low-SES backgrounds, during periods of school closures and remote learning. These findings emphasize the critical importance of foundational literacy instruction in early grades and the need for targeted post-pandemic recovery efforts. Such efforts should focus on strengthening vocabulary development, decoding skills, and comprehension strategies.

Additionally, the significant gender gap suggests that boys may require more focused attention in reading comprehension instruction moving forward. To develop effective interventions, future research should include more diverse samples, consider home language use alongside language background, and examine the experiences of children with varying immigration histories. Addressing these gaps will be crucial for creating equitable educational opportunities and ensuring that bilingual children, particularly those from underrepresented communities, are not left behind in the post-pandemic recovery process.

Authors' contributions

Conceptualization, G.L.; methodology, G.L. and F.Z.; software, G.L., Z.L., and F.Z; validation, G.L., L.G., Z.L. and F.Z.; formal analysis, G.L. and F.Z.; investigation, G.L.; resources, G.L. and L.G.; data curation, Z.L. and F.Z.; writing—original draft preparation, Z.L., F.Z., and GL; writing—reviewing and editing, G.L. and L.G.; supervision, G.L. and L.G.; project administration, G.L., L.G. and Z.L.; funding acquisition, G.L. and L.G. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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