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Exploring the impact of the COVID-19 lockdown on pre-reading skills among Portuguese children

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Introduction: Although it could be expected that the COVID-19 pandemic impacted preschool children's abilities associated with later reading skills, research has not yet addressed the topic. Our study focused on the impact of the pandemic on phonological awareness (PA) and rapid automatized naming (RAN) abilities that have been shown to reliably predict later reading skills.

Methods: A cohort of 82 typically developing European Portuguese children (mean age = 64.5 months, *SD* = 3.47), enrolled in their last year of preschool and dramatically affected by COVID-19 lockdowns, were assessed for PA and RAN skills.

Results: Compared to pre-pandemic normative data, our findings revealed lower average scores on the PA subtest ($t = -10.85$; $p < 0.001$; $d = 1.62$) and comparable average scores on the RAN task. A year later, the same group of children still exhibited lower scores on PA skills ($t = 2.87$; $p = 0.005$; $d = 0.41$). Furthermore, their word reading performance was also below the expected according to the normative pre-pandemic dataset ($t = -2.69$; $p = 0.008$; $d = 0.29$). A further comparison between the preschoolers affected by the pandemic and a post-pandemic cohort from the same school setting ($N = 25$; mean age = 72.08 months, *SD* = 3.30) highlighted that the pandemic cohort had lower PA average scores than their post-pandemic peers ($t = 12.27$; $p < 0.001$; $d = 2.66$).

Discussion: These findings underscore the enduring impact of disrupted learning environments on pre-reading abilities among preschoolers. Consequently, they contribute to further the understanding of the effects of the pandemic on the learning progress of young children.

KEYWORDS

pre-reading skills, phonological awareness, rapid automatized naming, preschool, COVID-19

Introduction

Previous research has identified several pre-reading abilities associated with later reading skills. Specifically, phonological awareness (PA; i.e., the ability to identify and manipulate phonological segments in spoken words) and rapid automatized naming (RAN; i.e., the ability to name as quickly as possible an array of highly familiar visual stimuli such as digits, pictured objects, or colors) have been recognized as crucial pre-reading abilities. These two distinct verbal skills play a pivotal role in children's reading development, facilitating comprehension and automatizing the mappings between spoken language and the writing system. Despite the undeniable value of reading and writing in contemporary nations, many children still struggle to master these fundamental skills. Thus, understanding the development of pre-reading skills in early childhood is critical for designing and evaluating early reading interventions.

On March 2020, the World Health Organization declared COVID-19 a global pandemic. To slow the spread of the virus, countries such as Portugal imposed lockdowns and decided to close educational facilities, causing the most significant learning disruption in recent history affecting 1.6 billion students (United Nations, 2020). Previous research has already shown that periods of school closure could lead to irregular sleeping patterns, longer screen time, and less favorable diets that negatively affect child development (Wang et al., 2015; Brazendale et al., 2017). In the particular case of school closure associated with the pandemic, research also found that parents reported higher levels of stress than usual, given the added challenge of educating and caring for children at home and helping them to cope with uncertainty and change (American Psychological Association, 2020; Adams et al., 2021). Thus, the pandemic is a myriad of interactive factors affecting children's families, teachers, social lives, and access to services, contributing to difficulties among children with impact on learning and developmental losses (Ananat and Gassman-Pines, 2020; Rothstein, 2020; Bacher-Hicks and Goodman, 2021). The present study specifically examined the impact of the COVID-19 lockdown on pre-reading skills that reliably predict the developing reading abilities of preschool children, namely PA and RAN.

Research has suggested that the COVID-19 pandemic had a worldwide negative impact on school achievements and could lead to learning losses. These learning losses occur when knowledge and skill gains do not progress at the same level and pace in two subsequent years (Pier et al., 2021). For instance, in cohorts of Uruguayan children, the pandemic had a negative effect on school readiness for those who attended preschool (González et al., 2022). In the Netherlands, the closure of elementary schools for 8 weeks resulted in national examination results showing that students learned less than in a typical year across all three subject areas: maths, spelling, and reading (Engzell et al., 2021). Similarly, in Belgium, scores in maths and Dutch (reading, writing, and language) were lower in a cohort of children in the last year of primary school exposed to the pandemic than in previous cohorts (Maldonado and De Witte, 2022). The consistent pattern of results highlights that students made little progress while learning from home during the COVID-19 pandemic.

As the costs of COVID-19-related school closure have been observed gradually, we expected that preschool-aged children would be particularly affected. As preschool is a stage of rapid development involving many critical growth phases, environmental changes can negatively affect children's developmental growth (Ghosh et al., 2020). Therefore, given the novelty and complexity of the pandemic situation, more research is needed to understand the impact of COVID-19 on young children's development.

During preschool years, children undergo significant cognitive and social development, acquiring knowledge and skills that will play a crucial role in their future learning outcomes, as in the case of literacy. A report by the EU High Level Group of Experts on Literacy emphasized the importance of literacy as a vital life competence. Literacy empowers individuals to develop skills such as reflection, oral expression, critical thinking, and empathy, fostering personal growth, self-confidence, a sense of identity, and enabling full participation in society. Additional studies focusing on preschoolers must be prioritized to understand how the pandemic has affected this specific age group (Benner and Mistry, 2020; Yoshikawa et al., 2020), especially in the case of those abilities associated with later reading skills. In particular, PA and RAN have been identified as pre-reading abilities that are critical to children's reading development (Araújo et al., 2015; Marinus and Castles, 2015 for a meta-analysis). Moreover, PA and RAN have been found to explain unique variance in children's reading skills above and beyond variables such as age and nonverbal IQ (Melby-Lervåg et al., 2012; Norton and Wolf, 2012; Araújo et al., 2015).

The present study

Despite the expected impact of the pandemic context on young children's abilities associated with later reading skills, there is currently a lack of research on this topic. This study aims to fill this gap by investigating the potential effects of the COVID-19 pandemic on pre-reading abilities, with a particular focus on PA and RAN. In Portugal, severe lockdowns affected all schools (nurseries included) in 2020 and 2021, and schools were fully closed during more than 4 months. First, we assessed Portuguese preschoolers (ages 5–6) during the COVID-19 pandemic in 2021, and the data obtained was compared with the pre-pandemic normative data available for this age range. Based on the existing literature, our first hypothesis (H1) posited that preschoolers during the COVID-19 pandemic (Time 1; T1) would show lower scores on PA and RAN tasks compared to pre-pandemic normative data available for this age group.

Furthermore, the same cohort was reevaluated 1 year later (ages 6–7), during their 1st Grade, when pandemic-related restrictions were already over (all restrictions ended by March, 2022). This methodological design allowed for the evaluation of developments in PA and RAN. Word reading skills were also examined during this second assessment to explore potential delays compared with the pre-pandemic normative data for this age range. Two additional hypotheses were formulated: consistent with existing literature, we expected lower scores on this second assessment (Time 2, T2) for the cohort affected by the pandemic, both for PA and RAN skills (H2), as well as for word reading skills (H3).

In 2023, a post-pandemic cohort of Portuguese preschoolers (ages 5–6) from the same school settings as the children assessed at T1 underwent assessments on PA and RAN. This new cohort was evaluated under conditions without the influence of the pandemic, providing a comparison with the group assessed during the pandemic at T1. By including this new cohort, we aimed to gain insight into the potential effects of the pandemic on pre-reading abilities and determine whether any differences exist between the two groups. In particular, we tested a final hypothesis (H4), which proposed that the pandemic-affected cohort (assessed at T1) and the post-pandemic cohort of Portuguese preschoolers would reveal significant differences between PA and RAN skills, with the post-pandemic cohort showing higher scores than the pandemic cohort. This comparison could help us better understand the impact of the pandemic on children's pre-reading skills and contribute to a more comprehensive analysis of the potential effects on their overall reading development.

Therefore, the current study will contribute to further the understanding of the effects of the COVID-19 pandemic on the learning progress of young children. We hope to provide valuable insights that can assist educators, parents, and policymakers in taking informed decisions to support the continued development of essential reading skills for the youngest members of our society.

Context of the study

The measures related to the pandemic varied from country to country. In Portugal, a state of emergency was declared in March 2020. After the initial lockdown, preschool children were allowed to return to school in June 2020; however, the number of children attending preschool until the end of the school year remained relatively small (Woodland et al., 2021). The first approach of the Portuguese National Institute of Health during the gradual lifting of restrictions was restrictive, aimed at safeguarding the rights of children.

In September 2020, a new school year started, and children of all ages returned to school. Unfortunately, in January 2021, schools had to close again. Preschool children were only able to return to in-person teaching in March 2021. In between the two major lockdowns, due to the pandemic schools had to accomplish several health recommendations and simultaneously avoid creating a new form of lockdown in which children could not play with their colleagues. Consequently, schools had to reorganize spaces and practices to promote children's well-being and play opportunities that ensure their health and safety (Moreira et al., 2020), such as reducing the number of children per room, maintaining distance between children, conducting outdoor activities, and implementing routine cleaning and disinfection multiple times per day, beyond the mandatory use of face masks among adults and children from age 10 (Direção Geral da Educação, 2020).

Methods

Participants

The participants in this study consisted of two groups of children recruited from two private schools in the Porto Metropolitan Area, which is located in the North of Portugal and centered on the district of Porto. Although the participants were part of a larger project examining the relationship between executive functions and language development, the hypotheses, measures, and analyses presented in this paper are specific to this study. The recruitment of participants adhered to ethical principles proposed by the Declaration of Helsinki (developed by the World Medical Association). All procedures described in this study were approved by the schools' boards and the Ethical Committee for Research (CEI) of the School of Arts and Humanities of the University of Lisbon.

All children in both groups were native speakers of European Portuguese and none of the participants had been referred for cognitive impairments or language difficulties, based on reports from preschool and primary school teachers. The participants' inclusion in the study was based on obtaining verbal agreement from the children and their parent's written consent.

The first group included 82 typically developing European Portuguese children (41 girls; mean age = 64.5 months, $SD = 3.47$) enrolled in their final year of preschool, who were affected by the COVID-19 pandemic lockdowns. One year later, during their 1st grade, this group was re-evaluated when pandemic-related restrictions were already over. A 4.9% attrition between Time 1 (T1) and Time 2 (T2) was observed due to some families' relocation. Average performance scores on a measure of non-verbal intelligence, the Portuguese version of the Raven's Coloured Progressive Matrices (Raven, 1995), were collected at T1 ($M = 18.25$, $SD = 4.35$) and at T2 ($M = 25.55$, $SD = 4.44$). These scores indicated that the average performance was within the age-appropriate range according to available norms (Portuguese adaptation and norms by Simões, 2000) at T1; at T2, the average score was one standard deviation above the mean (Simões, 2000).

The second group consisted of a new cohort of preschoolers ($N = 25$) assessed in 2023 (13 girls, mean age = 72.08 months, $SD = 3.30$). This group provided a comparison group not exposed to the pandemic context during preschool. Performance scores on the non-verbal intelligence measure, the Portuguese version of the Raven's Coloured Progressive Matrices (Raven, 1995), showed that the average performance ($M = 22.76$, $SD = 5.95$) was within the age-appropriate range according to Portuguese norms (Simões, 2000).

Measures at time 1 (T1)

Phonological awareness

Phonological awareness was assessed using the Syllable Segmentation Task from the Battery of Phonological Tests (Silva, 2002). This task evaluated the individual's ability to segment spoken words into syllabic units in European Portuguese. It was developed following the procedures described by Rosner and Simon (1971) and consisted of 14 items, preceded by two examples. In this task, the children were asked to name the word represented in a drawing. Then, they should delete a syllable from the word and spell the resulting pseudoword (e.g., how "*nota*" is spelled without the "*no*"). Half of the words in the test were disyllabic words and the other half trisyllabic words. Each correct answer was scored with one point. Higher scores indicated higher phonological awareness skills (Cronbach's alpha = 0.89; Silva, 2002). This type of test is considered highly reliable for determining children's metalinguistic ability to manipulate syllabic units (Gombert, 1990).

Rapid automatized naming

To assess the individual's ability to recognize a visual symbol and name it accurately and rapidly, we used the Naming Speed – Colors subtest of the Coimbra Neuropsychological Assessment Battery (BANC; Simões et al., 2016), an assessment tool for European Portuguese speaking children. In this task, children were required to name, as quickly as possible, visual stimuli randomly displayed on a card. The stimuli included yellow, blue, red, black, and green circles. Before the experimental trial, training was conducted to ensure that the children understood the task. The final score was based on the time required to name all the stimuli items. Lower scores were associated with faster naming speed (test–retest reliability $r = 0.82$; Simões et al., 2016).

Measures at time 2 (T2)

At T2, the same measures used at T1 were re-administered, along with a word reading task: the Word Reading subtest of the Reading Evaluation Battery for European Portuguese (ALEPE—Avaliação da Leitura em Português Europeu; Sucena and Castro, 2011). This subtest included four training items and 18 experimental words, which varied in orthographic complexity (i.e., simple, complex, and irregular). Each

item was presented in isolation, and the child was asked to read it aloud. Correct answers were scored with one point and percentage of correct answers was calculated. Higher scores are associated with word reading accuracy. Cronbach's alphas for the ALEPE Word Reading Subtest ranged between 0.46 for first graders and 0.72 for 2nd, 3rd, and 4th graders (Sucena and Castro, 2011).

Procedure

The study was conducted over two phases: T1 from November to December 2021 and T2 from January to May 2023. During T1, the children performed PA and RAN tasks. Subsequently, at T2, the same group of children participated in the follow-up assessment where they completed the same tasks of T1 and additional assessments of word reading. In May/June 2023, the post-pandemic cohort of preschoolers completed the same PA and RAN tasks as those administered at T1. The timeline of the study is presented in Figure 1.

The assessments were conducted by trained researchers in the school settings, ensuring a quiet environment to promote participants' comfort and engagement. The measures at T1 were individually administered during a 25-min session (task order: RAN and PA). The measures at T2 were individually administered in a session lasting 35 min (task order: RAN, PA, and word reading).

Data analysis

We used the parametric independent samples t-tests to compare two independent groups after assessing the assumptions required for their validity. Although the data was not normally distributed, the skewness and kurtosis values were within acceptable ranges. Specifically, these values ranged between −2 and + 2, indicating acceptability for establishing a normal univariate distribution (George and Mallery, 2010).

Results

We first addressed our hypothesis (H1) that preschoolers during the COVID-19 pandemic (at T1) would show lower scores on PA and RAN tasks compared to pre-pandemic normative data for this age group (from Silva, 2002; Simões et al., 2016). As shown in Table 1, the mean average obtained for PA skills from preschoolers during the COVID-19 pandemic (T1) was significantly lower than the pre-pandemic normative data available for this age group ($t = -10.85$; $p < 0.001$; Cohen's $d = 1.62$). However, no significant differences were observed for RAN performance.

We then addressed our second hypothesis (H2), which posited that a year later and under conditions unaffected by the pandemic's influence, the same cohort of children would show lower scores both for PA and RAN skills compared to pre-pandemic normative data for the same age group. At T2 the same cohort of children showed significantly lower scores in the subtest PA ($t = 2.87$; $p = 0.005$; Cohen's $d = 0.41$), but no differences in the RAN task when compared with the pre-pandemic normative data (see Table 1).

The data collected during the second assessment of the cohort affected by the pandemic (T2) was also used to test hypothesis three (H3), according to which lower scores for word reading skills were expected for the cohort affected by the pandemic. The data revealed that the pandemic cohort's word reading skills were lower than the pre-pandemic normative data collected for the same age range ($t = -2.69$; $p = 0.008$; Cohen's $d = 0.29$; see Table 1).

Lastly, our final hypothesis (H4) was that the pandemic-affected cohort (assessed at T1) and the post-pandemic cohort of preschoolers would show significant differences in their PA and RAN skills was addressed. A comparison between the post-pandemic cohort and the cohort affected by the pandemic (assessed at T1) revealed that the post-pandemic cohort exhibited significantly better PA skills ($t = 12.27$; $p < 0.001$; Cohen's $d = 2.66$), but the performance on the RAN task was equivalent (see Table 2).

Discussion

Our study focused on the impact of the COVID-19 pandemic on critical abilities associated with later reading skills. Specifically, we explored phonological awareness (PA), rapid automatized naming (RAN), and word reading skills among Portuguese preschool and school-age children. Four hypotheses were put forward: H1 posited that at the first assessment (time 1) preschoolers during the COVID-19 pandemic would show lower scores on PA and RAN tasks compared

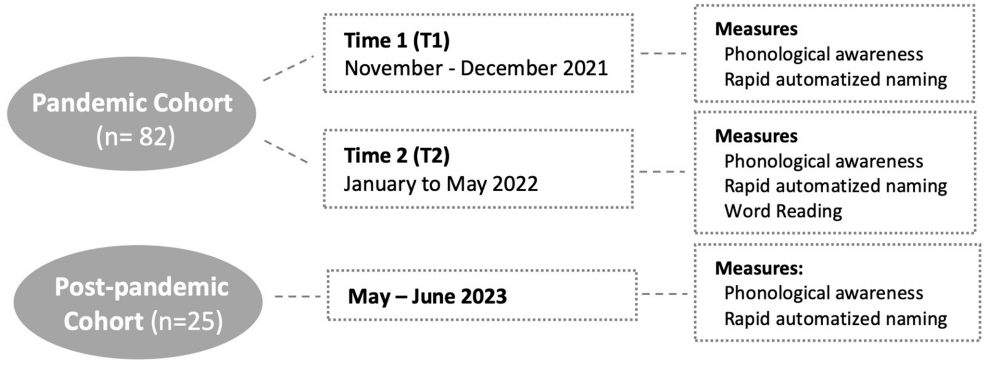

FIGURE 1
Timeline of the study.

TABLE 1 Descriptive statistics and independent *t*-test results for the pandemic cohort and pre-pandemic normative data (T1 and T2).

Measures	Pandemic Cohort *M (SD)*	Pre-pandemic normative data *M (SD)*	*t*	*p*	Effect size Cohen's *d*
Rapid automatized naming (T1)	78.09 (25.04)	78.51 (21.68)*	−0.12	ns	0.02
Rapid automatized naming (T2)	61.35 (17.49)	58.94 (16.46)*	0.95	ns	0.14
Phonological awareness (T1)	1.25 (2.18)	6.8 (4.33)**	−10.85	<0.001	1.62
Phonological awareness (T2)	8.45 (3.03)	6.8 (4.33)**	2.87	0.005	0.41
Word reading (T2)	69.42 (23.71)	74.8 (11.5)***	−2.69	0.008	0.29

T1: Time 1; T2: Time 2; ns: not significant.
*Retrieved from Simões et al. 2016. **Retrieved from Silva 2002. ***Retrieved from Sucena and Castro 2011.

TABLE 2 Descriptive statistics and independent *t*-test results for the pandemic and post-pandemic cohorts.

Measures	Pandemic cohort *M (SD)*	Post-pandemic cohort *M (SD)*	*t*	*p*	Effect size Cohen's *d*
Rapid automatized naming	78.09 (25.04)	71.64 (23.99)	−1.13	ns	0.26
Phonological awareness	1.25 (2.18)	7.68 (2.64)	12.27	<0.001	2.66

T1: Time 1; T2: Time 2; ns: not significant.

to same age pre-pandemic normative data; similarly, H2 advanced that the cohort affected by the pandemic would exhibit lower scores at the second assessment (Time 2) for both for PA and RAN skills compared to same age pre-pandemic normative data; H3 postulated that a similar difference would be found for word reading skills; finally, H4 proposed that the pandemic-affected cohort (assessed at Time 1) would show lower scores in PA and RAN skills than the post-pandemic cohort of Portuguese preschoolers.

As hypothesized, our findings revealed lower mean scores in the PA subtest among preschoolers assessed during the pandemic compared to pre-pandemic normative data, confirming H1. The large effect size underscored the significance of this finding. However, in contrast to our initial hypothesis, the pandemic and the pre-pandemic cohorts revealed equivalent performance in the RAN task, suggesting a particular impact of the pandemic on PA skills. Secondly, our findings showed the persistence of lower scores for PA abilities within the pandemic cohort assessed a year later, even under conditions free of pandemic influence, pointing to the enduring effects of disrupted learning environments. This result supported H2. The moderate effect size emphasizes the relevance of this finding. Taken together, these results underscore the need for ongoing efforts to mitigate the potential long-term consequences of low PA skills on language development. Furthermore, at this second assessment, lower word reading scores compared to the pre-pandemic normative data were found, confirming H3. This result provides further insight into the far-reaching impact of the pandemic on reading abilities. Despite its smaller effect size, this result aligns with concerns about the overarching impact of disrupted learning environments on reading abilities. Lastly, our findings revealed significantly lower scores in the PA subtest for the pandemic group in comparison with a post-pandemic group of the same age (in line with H4), while demonstrating equivalent performance in the RAN task across both groups (contrary to H4). Again, the large effect size emphasizes the disparity in PA skills between the two cohorts.

These outcomes support previous findings suggesting a specific pandemic-induced impact to pre-reading abilities such as PA (González et al., 2022). However, it appeared that RAN abilities remained largely unaffected. These unforeseen findings could be related to the intricate nature of rapid naming, which engages numerous cognitive operations shared with reading skills. These operations encompass attentional processes, bi-hemispheric visual mechanisms, the integration of visual and orthographic attributes, phonological and lexical retrieval, the assimilation and incorporation of semantic information, and ultimately, the formulation of motor plans (Wolf and Bowers, 1999). This multi-componential model could explain the reason behind the minor impact of the pandemic on RAN skills. Indeed, Denckla and Cutting (1999) conducted a thorough examination of the historical evolution of the RAN construct, along with studies probing the relationship between RAN and other cognitive predictors of reading—such as phonological awareness, memory span, orthographic awareness, processing speed, and articulation. Their investigation revealed that while processing speed could account for a considerable portion of the effects of RAN on word reading, none of these variables could comprehensively explain the complexity of RAN itself or its correlation with reading, thus supporting a multi-componential model. Närhi et al. (2005) also found supporting evidence for the complexity of factors behind RAN. Their study demonstrated that RAN exhibited independent associations with diverse cognitive processes, such as processing

speed, verbal acuity, and motor skills, as well as with pseudoword decoding proficiency in children with learning disabilities. Differently from RAN, PA has been clearly directly associated with a language-based ability.

Overall, our findings indicate that the pandemic had a detrimental effect on the PA skills of preschool children and word reading abilities in their 1st Grade. Indeed, school closure imposes a substantial risk burden, that can adversely impact children's well-being in multiple ways. These include physiological effects (such as irregular sleep patterns and less favorable diets; Wang et al., 2015; Brazendale et al., 2017) and psychological risks (such as heightened negative emotions and decreased discipline; Scarpellini et al., 2021). It is plausible that the particular outcome related to PA skills is interconnected with challenges encountered in remote learning scenarios, disruptions to established educational and communication routines, and reduced linguistic interactions, all of which can be attributed to the pandemic. Importantly, the social interactions between kindergarten educators and children changed during the pandemic (Crimon et al., 2022; Mitsven et al., 2022). These interactions typically encompass activities like storytelling, daily topics of discussion, socio-dramatic play, group social games, outdoor activities, and meals. Previous research has consistently demonstrated that such interactions support language development across various domains (Vaknin-Nusbaum and Nevo, 2017; Nevo and Vaknin-Nusbaum, 2018a,b). Attendance at educational institutions before formal reading and writing instruction holds great importance, and its significance has been underscored by the positive correlation observed between such attendance and many outcomes, including children's overall well-being, socio-emotional development, executive functions, and the development of academic skills (Barnett et al., 2018; Ansari et al., 2020; Pramling Samuelsson et al., 2020).

Furthermore, as several studies have suggested that using face masks during the COVID-19 pandemic has led to additional challenges for children, impacting speech understanding and also speech production, it is also reasonable that this factor impacted PA development. Indeed, educators, teachers, and researchers have raised concerns regarding the adverse impact that the use of face masks has on the healthy development of children's social lives, their interactions with others, the growth of language and communication skills, including sound recognition and vocal self-perception, as well as the development of speech skills (Goldin et al., 2020; Wolfe et al., 2020; Atcherson et al., 2021; Green et al., 2021; Lipps et al., 2021; Swaminathan and Meera, 2021; Thibodeau et al., 2021; Frota et al., 2022, 2023; Lalonde et al., 2022; Maftei et al., 2022; Mitsven et al., 2022; Orena et al., 2022; Ribeiro et al., 2022).

By and large, the worldwide impact of the COVID-19 pandemic on learning progress has been a topic of significant interest and concern. Researchers have sought to unravel the complexities of this issue, shedding light on different aspects of the pandemic's effect on education. Among these, a recent systematic review conducted by Betthäuser et al. (2023) grasped the full extent of the pandemic's effect on learning progress across various countries. The authors found a worldwide significant slowdown during the COVID-19 pandemic. However, the pandemic impact varied depending on the specific context being examined, including regional variations and differences in educational infrastructure and resources. Within this line of research, our study underscores the consistency of these concerns with empirical evidence from the Portuguese context, highlighting the importance of addressing the challenges posed by the pandemic on the educational front.

Conclusion and recommendations

Our findings contribute to the understanding of the effects of the COVID-19 pandemic on the learning progress of young children and suggest that prolonged school disruptions may impact children's phonological and word-reading abilities. However, further research is needed to gain a deeper understanding of the specific effects of the pandemic on various aspects of language development in young children. Acknowledging the limitations of our study is crucial. Firstly, the pandemic group was not assessed before the lockdown, which hindered our ability to determine the extent of the negative impacts on pre-reading skills observed in these participants. Secondly, the pandemic and post-pandemic groups were assessed at slightly different points in the school year, potentially contributing to the differences in PA scores. Lastly, differences in the children's socioeconomic status could contribute to variations among the sample groups. The participants in our sample were recruited from private schools, while the normative data, which served as a point of comparison, were collected from private and public settings.

In conclusion, the current study provided new insights into the complex relationship between the COVID-19 pandemic and child development. On the one hand, our findings highlighted the need to interpret carefully test results related to phonological awareness and reading skills in the coming years to avoid diagnostic errors with potential adverse consequences. On the other hand, our findings have implications for educational strategies and interventions to support young learners and mitigate potential long-term impacts on their literacy skills. The observed effects on phonological awareness and word reading abilities emphasize the urgency of comprehensive interventions to support children's holistic growth as well as language development, particularly in the face of unprecedented challenges. It is crucial to have well-planned and well-funded policy initiatives to address these deficits. Policymakers, educational institutions, and families should collaborate to identify opportunities that complement and extend established school-based learning. Moreover, it is vital to gather empirical evidence to evaluate the effectiveness of interventions designed to mitigate these learning deficits. If such interventions demonstrate their effectiveness and the ongoing efforts in education policy are sustained and expanded, the disruptions experienced during the pandemic may eventually be viewed as a chance to enhance the overall quality of education provided to children and support their language development.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors on request, without undue reservation.

Ethics statement

The studies involving humans were approved by Ethical Committee for Research (CEI) of the School of Arts and Humanities

of the University of Lisbon. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

MF: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. SF: Conceptualization, Funding acquisition, Methodology, Supervision, Validation, Writing – review & editing.

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Conflict of interest

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

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References

Adams, E. L., Smith, D., Caccavale, L. J., and Bean, M. K. (2021). Parents are stressed! Patterns of parent stress across COVID-19. *Front. Psychol.* 12:626456. doi: 10.3389/fpsyt.2021.626456

American Psychological Association (2020). Stress in the time of COVID-19. Volume one. Available at: https://www.apa.org/news/press/releases/stress/2020/report (Accessed July 20, 2023).

Ananat, E., and Gassman-Pines, A. (2020). Snapshot of the COVID crisis impact on working families. Econofact, The Fletcher School, Tufts University. Available at: https://econofact.org/snapshot-of-the-covid-crisis-impact-on-working-families (Accessed July 19, 2023).

Ansari, A., Pianta, R. C., Whittaker, J. V., Vitiello, V. E., and Ruzek, E. A. (2020). Persistence and convergence: the end of kindergarten outcomes of pre-K graduates and their nonattending peers. *Dev. Psychol.* 56, 2027–2039. doi: 10.1037/dev0001115

Araújo, S., Reis, A., Petersson, K. M., and Faísca, L. (2015). Rapid automatized naming and reading performance: A meta-analysis. *J. Educ. Psychol.* 107, 868–883. doi: 10.1037/edu0000006

Atcherson, S. R., McDowell, B. R., and Howard, M. P. (2021). Acoustic effects of non-transparent and transparent face coverings. *J. Acoust. Soc. Am.* 149:2249. doi: 10.1121/10.0003962

Bacher-Hicks, A., and Goodman, J. (2021). The Covid-19 pandemic is a lousy natural experiment for studying the effects of online learning. Education Next, Summer, 2021, 21. Available at: https://www.educationnext.org/ covid-19-pandemic-lousy-natural-experiment-for-studying-the-effects-online-learning/ (Accessed June 11, 2023).

Barnett, W. S., Jung, K., Friedman-Krauss, A., Frede, E. C., Nores, M., Hustedt, J. T., et al. (2018). State prekindergarten effects on early learning at kindergarten entry: an analysis of eight state programs. *AERA Open* 4, 1–16. doi: 10.1177/2332858418766291

Benner, A. D., and Mistry, R. S. (2020). Child development during the COVID-19 pandemic through a life course theory lens. *Child Dev. Perspect.* 14, 236–243. doi: 10.1111/ cdep.12387

Betthäuser, B. A., Bach-Mortensen, A. M., and Engzell, P. (2023). A systematic review and meta-analysis of the evidence on learning during the COVID-19 pandemic. *Nat. Hum. Behav.* 7, 375–385. doi: 10.1038/s41562-022-01506-4

Brazendale, K., Beets, M. W., Weaver, R. G., Pate, R. R., Turner-McGrievy, G. M., Kaczynski, A. T., et al. (2017). Understanding differences between summer vs. school obesogenic behaviors of children: the structured days hypothesis. The. *Int. J. Behav. Nutr. Phys. Act.* 14:100. doi: 10.1186/s12966-017-0555-2

Crimon, C., Barbir, M., Hagihara, H., de Araujo, E., Nozawa, S., Shinya, Y., et al. (2022). Mask wearing in Japanese and French nursery schools: the perceived impact of masks on communication. *Front. Psychol.* 13:874264. doi: 10.3389/fpsyg.2022.874264

Denckla, M. B., and Cutting, L. E. (1999). History and significance of rapid automatized naming. *Ann. Dyslexia* 49, 29–42. doi: 10.1007/s11881-999-0018-9

Direção Geral da Educação (2020). Guidelines - Preschool, Reopening Education [in Portuguese]. Available at: https://www.dge.mec.pt/sites/default/files/orientacoes_para_a_reabertura_da_educacao_pre- escolar.pdf (Accessed May 8, 2023).

Engzell, P., Frey, A., and Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proc. Natl. Acad. Sci. U. S. A.* 118:e2022376118. doi: 10.1073/pnas.2022376118

Frota, S., Esteve-Gibert, N., Molnar, M., and Vigário, M. (2023). Editorial: language development behind the mask. *Front. Psychol.* 14:1205215. doi: 10.3389/fpsyg.2023.1205215

Frota, S., Pejovic, J., Cruz, M., Severino, C., and Vigário, M. (2022). Early word segmentation behind the mask. *Front. Psychol.* 13:879123. doi: 10.3389/fpsyg.2022.879123

George, D., and Mallery, M. (2010). *SPSS for windows step by step: A simple guide and reference, 17.0 update* (*10a ed.*) Boston: Pearson.

Ghosh, R., Dubey, M. J., Chatterjee, S., and Dubey, S. (2020). Impact of COVID-19 on children: special focus on psychosocial aspect. *Minerva Pediatr.* 72, 226–235. doi: 10.23736/s0026-4946.20.05887-9

Goldin, A., Weinstein, B. E., and Shiman, N. (2020). How do medical masks degrade speech perception? *Hear. Rev.* 27, 8–9.

Gombert, J. E. (1990). *Le développement métalinguistique*. Paris: Presses Universitaires de France.

González, M., Loose, T., Liz, M., Pérez, M., Rodríguez-Vinçon, J. I., Tomás-Llerena, C., et al. (2022). School readiness losses during the COVID-19 outbreak. A comparison of two cohorts of young children. *Child Dev.* 93, 910–924. doi: 10.1111/cdev.13738

Green, J., Staff, L., Bromley, P., Jones, L., and Petty, J. (2021). The implications of face masks for babies and families during the COVID-19 pandemic: A discussion paper. *J. Neonatal Nurs.* 27, 21–25. doi: 10.1016/j.jnn.2020.10.005

Lalonde, K., Buss, E., Miller, M. K., and Leibold, L. J. (2022). Face masks impact auditory and audiovisual consonant recognition in children with and without hearing loss. *Front. Psychol.* 13:874345. doi: 10.3389/fpsyg.2022.874345

Lipps, E., Caldwell-Kurtzman, J., Motlagh-Zadeh, L., Blankenship, C. M., Moore, D. R., and Hunter, L. L. (2021). Impact of face masks on audiovisual word recognition in young children with hearing loss during the COVID-19 pandemic. *J. Early Hear. Detect. Inter.* 6, 70–78. doi: 10.26077/4fda-c155

Maftei, A., Merlici, I. A., and Roca, I. C. (2022). Implications of the COVID-19 pandemic on children and adolescents: cognitive and emotional representations. *Children* 9:359. doi: 10.3390/children9030359

Maldonado, J. E., and De Witte, K. (2022). The effect of school closures on standardised student test outcomes. *Br. Educ. Res. J.* 48, 49–94. doi: 10.1002/berj.3754

Marinus, E., and Castles, A. (2015). "Precursors to reading: phonological awareness and letter knowledge" in *The Cambridge handbook of child language*. eds. E. L. Bavin and L. R. Naigles. *2nd* ed (Cambridge: Cambridge University Press), 661–680.

Melby-Lervåg, M., Lyster, S. A., and Hulme, C. (2012). Phonological skills and their role in learning to read: a meta-analytic review. *Psychol. Bull.* 138, 322–352. doi: 10.1037/a0026744

Mitsven, S. G., Perry, L. K., Jerry, C. M., and Messinger, D. S. (2022). Classroom language during COVID-19: associations between mask-wearing and objectively

measured teacher and preschooler vocalizations. *Front. Psychol.* 13:874293. doi: 10.3389/fpsyg.2022.874293

Moreira, M., Cordovil, R., Veiga, G., and Lopes, F. (2020). Times change, kindergartens change. The impact of the COVID-19 pandemic on the quality of physical environment and kindergarten practices and its influence on the behavior of preschool children. *Cadernos Educ. Infância* 121, 15–20.

Närhi, V., Ahonen, T., Aro, M., Leppäsaari, T., Korhonen, T. T., Tolvanen, A., et al. (2005). Rapid serial naming: relations between different stimuli and neuropsychological factors. *Brain Lang.* 92, 45–57. doi: 10.1016/j.bandl.2004.05.004

Nevo, E., and Vaknin-Nusbaum, V. (2018a). Joint reading of informational science text versus narrative stories: how does each affect language and literacy abilities among kindergarteners? *Read. Psychol.* 39, 787–819. doi: 10.1080/02702711.2018.1547343

Nevo, E., and Vaknin-Nusbaum, V. (2018b). Enhancing language and print-concept skills by using interactive storybook reading in kindergarten. *J. Early Child. Lit.* 18, 545–569. doi: 10.1177/1468798417694482

Norton, E. S., and Wolf, M. (2012). Rapid automatized naming (RAN) and reading fluency: implications for understanding and treatment of reading disabilities. *Annu. Rev. Psychol.* 63, 427–452. doi: 10.1146/annurev-psych-120710-100431

Orena, A. J., Mader, A. S., and Werker, J. F. (2022). Learning to recognize unfamiliar voices: an online study with 12- and 24-month-olds. *Front. Psychol.* 13:874411. doi: 10.3389/fpsyg.2022.874411

Pier, L., Hough, H. J., Christian, M., Bookman, N., Wilkenfeld, B., and Miller, R. (2021). COVID-19 and the educational equity crisis: evidence on learning loss from the CORE data collaborative. Policy Analysis for California Education Available at: https://edpolicyinca.org/newsroom/covid-19-and-educational-equity-crisis#footnote1_gdx51np (Accessed May 3, 2023).

Pramling Samuelsson, I., Wagner, J. T., and Eriksen Ødegaard, E. (2020). The coronavirus pandemic and lessons learned in preschools in Norway, Sweden and the United States: OMEP policy forum. *Int. J. Early Childh.* 52, 129–144. doi: 10.1007/s13158-020-00267-3

Raven, J. C. (1995). *Manual for the Coloured progressive matrices (revised)*. Windsor, UK: NFRE-Nelson.

Ribeiro, V. V., Dassie-Leite, A. P., Pereira, E. C., Santos, A. D. N., Martins, P., and Irineu, R. A. (2022). Effect of wearing a face mask on vocal self-perception during a pandemic. *J. Voice* 36, 878.e1–878.e7. doi: 10.1016/j.jvoice.2020.09.006

Rosner, J., and Simon, D. P. (1971). The auditory analysis test: an initial report. *J. Learn. Disabil.* 4, 384–392. doi: 10.1177/002221947100400706

Rothstein, R. (2020). The coronavirus will explode achievement gaps in education. Available at: https://www.epi.org/blog/the-coronavirus-will-explo de-achievement-gaps-in-education (Accessed June 5, 2023).

Scarpellini, F., Segre, G., Cartabia, M., Zanetti, M., Campi, R., Clavenna, A., et al. (2021). Distance learning in Italian primary and middle school children during the COVID-19 pandemic: A national survey. *BMC Public Health* 21:1035. doi: 10.1186/s12889-021-11026-x

Silva, A. (2002). *Baterias de Provas Fonológicas*. Lisboa: Instituto Superior de Psicologia Aplicada.

Simões, M. (2000). Investigações no âmbito da aferição nacional do Teste das Matrizes Progressivas Coloridas de Raven (M.P.C.R). Fundação Calouste Gulbenkian & Fundação para a Ciência e Tecnologia.

Simões, M. R., Pinho, M. S., Pereira, M., Seabra-Santos, M. J., Alberto, I., and Lopes, A. F. (2016). Bateria de Avaliação Neuropsicológica de Coimbra (BANC). Cegoc.

Sucena, A., and Castro, S. L. (2011). ALEPE - Avaliação da Leitura em Português Europeu [ALEPE – Reading Assessment in European Portuguese]. CEGOC-TEA.

Swaminathan, D., and Meera, S. S. (2021). Masks mask communication - communicating with children in health care settings. *Indian J. Pediatr.* 88, 283–284. doi: 10.1007/s12098-020-03535-1

Thibodeau, L. M., Thibodeau-Nielsen, R. B., Tran, C. M. Q., and Jacob, R. T. S. (2021). Communicating during COVID-19: the effect of transparent masks for speech recognition in noise. *Ear Hear.* 42, 772–781. doi: 10.1097/AUD.0000000000001065

United Nations (2020) Policy brief: Education during COVID-19 and beyond. Available at: https://www.un.org/sites/un2.un.org/files/sg_ policy_brief_covid-19_and_education_September_2021.pdf [Accessed September 14, 2021].

Vaknin-Nusbaum, V., and Nevo, E. (2017). A joint interactive storybook intervention program for preschool and kindergarten children. *Read. Psychol.* 38, 231–261. doi: 10.1080/02702711.2016.1258376

Wang, Y. C., Vine, S., Hsiao, A., Rundle, A., and Goldsmith, J. (2015). Weight-related behaviors when children are in school versus on summer breaks: does income matter? *J. Sch. Health* 85, 458–466. doi: 10.1111/josh.12274

Wolf, M., and Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexias. *J. Educ. Psychol.* 91, 415–438. doi: 10.1037/0022-0663.91.3.415

Wolfe, J., Smith, J., Neumann, S., Miller, S., Schafer, E. C., Birath, A. L., et al. (2020). Optimizing communication in schools and other settings during COVID-19. *Hear. J.* 73, 40–45. doi: 10.1097/01.HJ.0000717184.65906.b9

Woodland, L., Smith, L. E., Webster, R. K., Amlôt, R., Rubin, A., Wessely, S., et al. (2021). Why did some parents not send their children back to school following school closures during the COVID-19 pandemic: a cross-sectional survey. *BMJ Paed. Open* 5:e001014. doi: 10.1136/bmjpo-2020-001014

Yoshikawa, H., Wuermli, A. J., Britto, P. R., Dreyer, B., Leckman, J. F., Lye, S. J., et al. (2020). Effects of the global coronavirus disease-2019 pandemic on early childhood development: short- and long-term risks and mitigating program and policy actions. *J. Pediatr.* 223, 188–193. doi: 10.1016/j.jpeds.2020.05.020