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DESCRIPTIVE RESEARCH

Impact of COVID-19 Pandemic on the Development of Children's Executive Functions: Implications for School-Based Interventions

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Abstract

The pandemic of COVID-19 has had a significant impact on children's lives. Worldwide, there has been evidence of a decline in children's mental health, well-being, and quality of life. Few studies, however, have reported the pandemic's impact on children's cognitive functioning. Executive Functions (EFs) are a set of high-order cognitive functions involved in behavior and emotions self-regulation. EFs are powerful predictors of school performance, child's well-being and health. During crisis and disaster, EFs are critical resources to cope with unusual and complex situations, and to find novel solutions to problems. Because of EFs' extensive growth, there are many time periods during which experience has the greatest effect on brain development. Therefore, EFs are among the cognitive systems that are most vulnerable to environmental stress. As a result, children's emotional distress has been related to concentration and memory problems, difficulties managing impulses and emotions, and difficulties in planning ahead. Recent research has found executive dysfunction in children and adolescents during pandemic. Adopting an ecological contextual model, this study aimed to identify factors associated to pandemic that may affect children's performance and development of EFs, as well as, to propose a set of evidence-based strategies for teachers to assist children manage stress and promote EFs during crisis. Peer-reviewed academic articles, books, and web resources published between 2010 and 2023 were chosen for review in this study. As a result, child stress, family stress, school closure, changes in child-teacher interactions, and unhealthy habits are highlighted as potential factors influencing child EF development. In response to the Sustainable Development Goals agenda, a set of strategies was developed that may be easily included into the school curriculum. Creating school-based interventions to develop students' EFs is one approach to improve children's crisis-response resources.

Introduction

The COVID-19 pandemic has caused crisis and significant changes in people's lives. It resulted in significant morbidity and mortality rates among the global population, as well as increasing risk factors for healthy growth and development in children.

Families have experienced economic and social challenges, which have generated crisis and emotional stress in both adults and children. Numerous stressors associated with the pandemic have been identified,

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including: fear of illness, loss of family members or friends, quarantine, loneliness, social isolation, job loss, financial instability, exposure to news about the severity of the virus and the high rate of infections, the uncertainty about the length of the lockdown, the requirements of social distancing, and the unwanted changes in daily life [1-4].

The COVID-19 pandemic continues to present many problematic consequences for society, and it has been predicted that recovery from these consequences will take years. Prolonged psychological stress can negatively affect physical and psychological health, well-being and quality of life. Consequently, it is urgent to assist the most vulnerable populations, such as children and adolescent.

Beyond the immediate stress and suffering, youth are at the greatest risk during catastrophes [5]. Although the coronavirus tends to produce less physical pathology in children than in adults, special consideration must be paid to the implications and long-term effects on children's growth and development.

During COVID pandemic, children have experienced significant changes in their daily routines and activities, as well as long periods of confinement and social isolation. Facing pandemic, children have experienced a broad of reactions, including emotional distress, attention difficulties, behavioral changes, sleep disturbances, physical symptoms and fears [6-11]. Systematic review studies have reported that anxiety, depression, loneliness, stress, and tension are the most commonly seen symptoms in children and adolescents during COVID-19 which have negatively impacted children's mental health [12-15]. On the other hand, school closures and distant education have resulted in academic delay and school dropout [9,16,17]. Similarly, prolonged confinement has limited children's peer relationships and participation in group activities, which may have an impact on children's socio-emotional, cognitive, and linguistic development trajectories [6,18-20].

Regarding cognitive development, it has been observed that the SARS-CoV-2 infection can affect the functioning of the nervous system (CNS). Although SARS-COV-2 predominantly affects the respiratory system, it has effects on multiple organ systems, including the CNS [21]. Between 36-84% of cases present neurological symptoms [22]. Among the neurological symptoms associated with COVID-19, mild symptoms have been identified: loss of smell

and taste, headaches, fluctuating consciousness, dizziness, muscle weakness, dysexecutive syndrome. More serious symptoms have included: polyneuropathy, myositis, encephalitis, thrombosis and stroke [1, 22-24]. If the virus enters the CNS, it has the potential to cause neuropsychiatric and neurological complications [1,23,24]. This may include loss of inhibitory control, apparent unconcern, loss of normal fear and anxiety, and social disinhibition [25]. Cognitively, impacts might be expected on inhibitory control systems, executive functions and memory [22].

Although children have been the least affected by SARS-CoV-2, some studies report neurological effects in newborns infected by the virus such as irritability, difficulty feeding and hypotonia [22]. One of the most common complications is preterm birth. Some studies have documented intergenerational transmission through the mother, and others speculate the possibility that COVID can be transmitted by the father [22]. Maternal infection could lead to neurodevelopmental changes in the fetus and increase neuropsychiatric incidence rates. Based on these preliminary results, there is an urgent need to analyze the longitudinal effects of COVID-19 on brain function, behavior and cognition.

However, in children, the presence of chronic psychological stress is one of the most powerful ways in which the consequences of the pandemic can affect their neurocognitive functioning and perhaps slow down or alter their development. Stress affects the immune system, hormonal system and can raise the risk of neuro-inflammation, increasing the possibility of damaging the CNS and altering cognitive functioning [1,26]. In line with this approach, there have been reports of an increase in attention and memory problems, increased irritability and alterations in Executive Functions (EFs) in children and adolescents [6,9-11,27].

Executive Functions (EFs) are a set of high-order cognitive functions involved in behavior and emotions self-regulation. EFs are powerful predictors child's well-being and health. During crisis and disaster, EFs are required to self-regulate behavior, adjust to changes, and solve problems. Nevertheless, EFs are among the cognitive systems that are most vulnerable to environmental stress [28]. As a result, children's emotional distress has been related to concentration and memory problems, difficulties managing impulses and emotions, and difficulties in

planning and in organizational skills. Scare studies have reported the pandemic effect on children EFs, therefore, it is important to analyze how children EFs has been affected by COVID pandemic.

In accordance with the Sustainable Development Goals (SDGs), children's rights to equality, health, education, and well-being are top on the agenda list. As a result, it is critical to take immediate steps to aid children and adolescents in order to mitigate the impact of the pandemic's consequences on their overall development. In line with this agenda, the goals of this study are to: 1) to identify factors associated with the pandemic wich may impact on children's performance and development of EFs, and 2) to propose a set of evidence-based strategies for teachers to assist children manage stress and promote EFs during crisis.

Method

A theoretical design [29] was used to address the study problem: to identify factors associated with the COVID-19 pandemic that may have affected the development of children EFs. To address the problem under study, the contextual ecological model of human development [30] was adopted, focusing on micro and mesosystem factors. Consequently, a review and integration of peer-reviewed academic publications, books and web resources, published between 2010 and 2023, was carried out on the following topics: pandemic's impact on children's mental health and family functioning, parental stress, child stress, homeschooling, restriction of social interactions, confinement, change in teacher-child interactions, changes in teaching-learning processes, increase in unhealthy habits in children.

Given that family and school are the contexts that most influence children development, implications for school-based interventions are presented. It is proposed a set of strategies and activites that are easily integrated in the school curriculum in order to help children lower stress and strengthen their EFs in crisis situations. To develop these strategies, peer-reviewed academic publications, books and web resources, published between 2010 and 2023, on the following topics were reviewed and integrated: school sensitive-trauma interventions, SBFC crisis interventions, programs aimed to strengthen children EFs in sociovulnerable contexs, school-based interventions to promote children self-regulation.

Executive Functions

EFs play a critical role in cognitive, social and emotional development of children, and predict many life outcomes [31,32]. Executive Functions (EFs) describe a set of high-order cognitive abilities that control behaviors, emotions, and cognitions necessary to achieve goals, solve problems, and provide adaptive responses to novel or complex situations [31]. EFs enable the ability to act with purpose and in a self-regulating manner in the various contexts of social interaction [32,33].

Three core EFs have been identified: inhibitory control, working memory and cognitive flexibility. During the developmental process, these three basic executive functions mature, differentiate and enable the development of more complex ones, such as planning, organization, metacognition, monitoring, fluency and decision-making [31,34]. These functions act in an interrelated way, enabling flexible, propoitive and self-regulated behavior.

Executive functions emerge in early childhood and present a protracted development that continues into adulthood [35,36]. This development is associated with the late maturation of a set of neural networks coordinated by the prefrontal cortex [37].

The extensive development of the neural networks that make up cognitive control creates several sensitive periods, in which the plasticity of the brain is increased and the brain is more susceptible to the environmental experience [38]. It has been documented that environments that promote healthy child development can help children to strengthen their EFs [28]. However, EFs can be negatively affected both by stressful environments and by the lack of quality and proactive interactions with adult caregivers. Consequently, gains in children's executive abilities should be interpreted as resulting from the delicate and sustained interaction between brain maturation and the influence of the environment.

Based on these reports, the neurosciences have attempted to specify the factors that mediate the impact of the environment on children's cognitive development. During the last two decades, environmental factors that model the EF development have been studied, identifying factors from the family, school, and community. For family, they are rearing practices [39,40], cognitive stimulation [41], parenting stress [28], parental education level [28,42] and caregiving [43]. For school, they are classroom

management, classroom climate, resources for learning [44], teacher modelling and scaffolding of EFs [45,46], and peer relationships [47]. For community, they are cultural norms, ethical values and social practices [48,49].

Children who show a greater capacity for self-regulation are better able to regulate their emotions, establish positive relationships with peers and adults, tolerate frustrations, expect rewards, adjust their behavior to the demands of the context, be more creative, be flexible, and present a better school performance. EFs are considered critical for school readiness, future academic performance, and successful learning [50].

These achievements in childhood predict better health, better quality of life, greater academic success, better employment status and a lower incidence of conduct problems, in adolescence and adulthood [31,51]. From there, the importance of identifying the factors that shape EFs development arises, in order to estimate how the consequences of COVID pandemic may affect it.

COVID-19 Pandemic Pathways that May Alter the Development of Children's EFs

Child anxiety, stress and depression have been associated with executive dysfunctions [6,9-11,27]. In the face of a crisis, it is probable that attentional and memory problems occur. Similarly, anxiety and fear can impair strategic planning skills and cognitive flexibility, making it difficult to find novel solutions to problems.

From April 2020 to October 2021, a study examined parents' perceptions of the presence of anxiety, sleep disorders, and executive dysfunction in 953 Spanish children and adolescents. The main results showed that the rates of anxiety, sleeping habits, and executive functioning impairments in children and adolescents appear to have deteriorated over time [27]. In terms of EFs, results revealed a decline in global executive functioning as well as deterioration in emotional regulation, cognitive flexibility, and planning and organizational skills [27]. Other authors have reported a worsening in executive and academic functioning during the COVID-19 confinement period, which is consistent with these findings [20,52-54]. A longitudinal study discovered that the COVID-19 has a direct effect on children's executive performance.

Children's organizational skills declined during the lockdown, but they struggled with strategic planning skills afterward [55]. The quarantine process has also been connected to problems with self-control, discipline, and hyperactivity in youngsters [56].

Few studies have analyzed factors associated with the pandemic that may impair child EFs. A research study found that state anxiety explained the decline in children and teenage executive functioning during pandemic [27]. More research is needed. According to an ecological contextual model of child cognitive development [30,57], several pandemic-related factors that can impair children's executive functioning and potentially interfere with their development trajectory are presented (Figure 1).

Child stress

EFs constitute one of the cognitive processes most vulnerable to stress [28,58]. Poverty studies have documented that the presence of chronic stress in children is associated with neurodevelopmental disorders (i.e. hippocampus and amygdala reduction), higher incidence of mental illnesses, poor school performance, memory problems, inattention and behavior problems [26,58-60]. Similarly, when children face a disaster, such as the COVID pandemic, they may experience a broad range of stress reactions. It has been documented that child emotional distress is linked with attention problems, memory failures, difficulties in managing impulses and emotions, and difficulties planning ahead and setting goals [6,7,9-11]. Psychological reactions to a pandemic appear to be acute, and long-term emotional consequences can be observed. Therefore, chronic stress and trait anxiety may impair executive functions performance and slow their developmental trajectory. Recent studies have found positive and moderate associations between anxiety, depression, sleep disturbance, and executive dysfunctions in children during pandemic [20,27].

Family stress

Stressors that COVID-19 brings to families, such as health concerns, financial difficulties, job loss, lockdown and challenges of homeschooling, have generated a significant increase in parental stress [61,62]. Parental stress decreases the involvement, the sensitivity to the needs of the children, resulting in a lower quality of parental care [63,64]. Parents with high levels of stress are less predisposed to interact and communicate with their children, which negatively affects the development of child cognitive

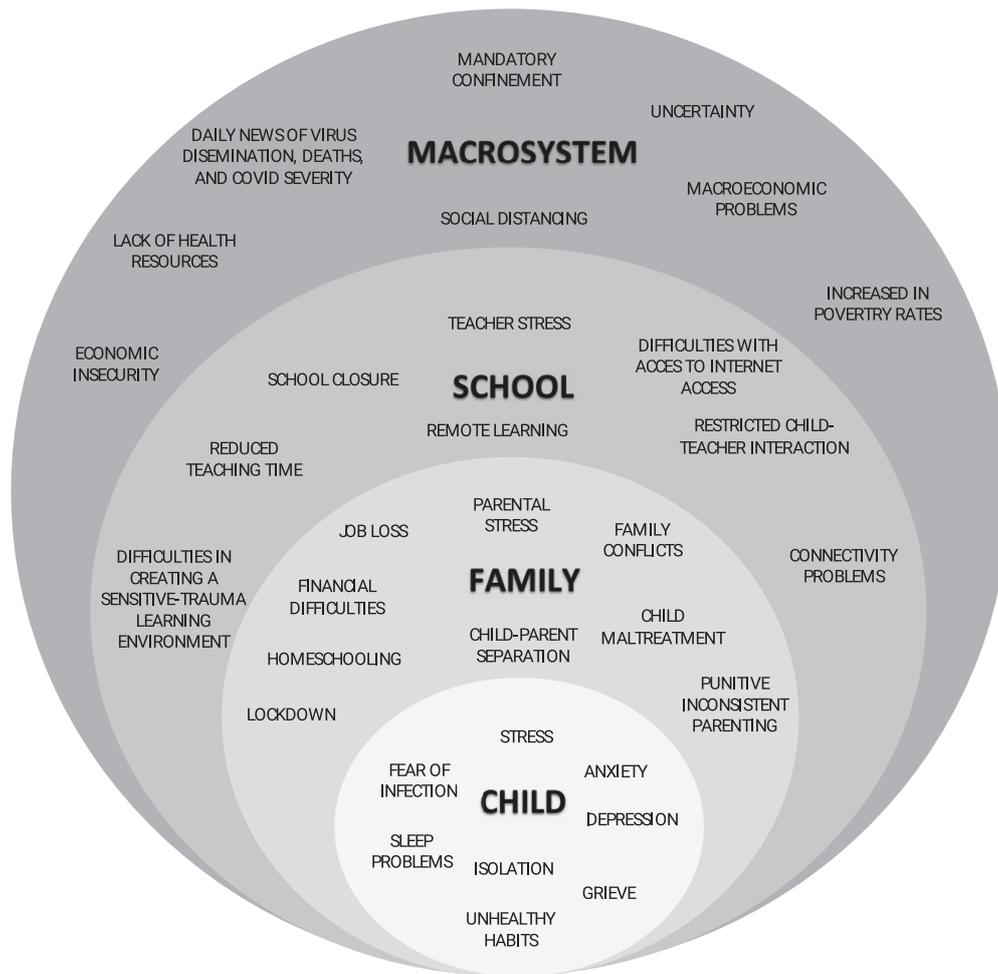


Figure 1 COVID-19 related factors that can impair children's EFs performance and development.

and emotional self-regulation abilities. Likewise, the presence of stress in parents has been linked to the use of punitive and inconsistent parenting strategies, greater neglect, greater frequency of family conflicts, and family violence, all of which promotes emotional and behavioral problems in children [28,64,65]. There have been reports of increase in child maltreatment during the periods of self-isolation, quarantine and lockdowns [64,66]. Nevertheless, the impact of the pandemic in the family context varies, depending on contextual stressors that family members experience, and the family's internal and external resources to cope with them.

It's important to highlight some positive family and child experiences during lockdown. Some studies have reported positive experiences among families during the confinement. A research study found that low-income families spent most of their time together engaging in mealtime activities, and this time was associated with pleasant interactions between parents

and children [67]. Another study surveyed Turkish and Chinese parents about their positive experiences with their children while in quarantine. More than half of parents rated activities such as playing, cooking, drawing, reading, watching films/TV, singing, and physical exercise as enjoyable during quarantine [68]. Portuguese and Brazilian parents observed gains in proximal relationships with their children, between couples, and among family members [69]. An intercultural study research [70] done in five cultures described parental features during the first COVID lockdown (March-May 2020). The key finding revealed that love expression was the most prominent parenting behavior, demonstrating its importance in parenthood regardless of culture [70]. In conclusion, these research illustrate certain families' ability to modify family dynamics to crisis. As a result, positive parenting amid a crisis is an excellent resource for enhancing children's socioemotional and cognitive development. Being calm, sympathetic, supportive, and finding alternative solutions to situations model

autoregulatory competence to youngsters. As a result, certain parenting behaviors may encourage the development of EF in children.

Closures of schools

Prolonged school closure and remote learning has had a significant impact on children's school learning trajectories, and has expanded the academic gap between the most and least favored children [9,16,71]. Recent research has made predictions about the impact that the COVID-19 pandemic has had on children's learning trajectories. Kuhfeld M, et al. [16] estimated that children have achieved 63% to 68% gains in reading, and 37% to 50% gains in math, compared to a typical year of schooling. Another study found that second graders in the first 200 days of the 2020–2021 school year had poorer oral fluency gain compared to prepandemic years [72]. However, those estimates will vary significantly if other factors are included in the predictive model, such as differential access to parent and teacher supports for learning during the school closure months, health issues related to the virus, and access to technology and remote instruction. Likewise, homeschooling has posed responsibilities and challenges for parents, who have had to create a structured environment for learning, organize a daily routine and schedule of activities for children, in order to provide children with academic and emotional support [73–75]. The ability of the family to overcome these challenges and the parental involvement in learning tasks have been affected by multiple factors, such as: internet access, available parent's time for homeschooling, parent's educational resources and knowledge, and home environmental conditions. According to one study, children who received more need-oriented help from their parents developed their math skills more favorably throughout the lockdown [76].

Schooling is an experience that affects many aspects of child development, including the development of EFs. The literature reports that the schooling experience is a factor that contributes to the promotion of EFs [77,78]. Recent research has documented bidirectional relationships between EFs and reading, writing, and math skills, indicating a mutual influence between both processes [79]. Furthermore, it has been documented that children who learn school content and skills more quickly are more willing to participate in increasingly demanding academic activities, which stimulate the development of EFs [78]. In sum, children's gains in school learning

will lead to improvements in their self-regulation abilities. Therefore, the loss of months of schooling can negatively affect the development of children's self-regulation abilities.

Changes in teacher-child interactions

Distance education has established new educational practices, in which the interactions between children and their teachers have changed dramatically. Teaching instances have been reduced, communication has been affected by connectivity problems, and learning mediation has become a challenge for teachers [17,80]. On the other hand, it has been documented an increase in teacher's stress and a decrease in teacher's well-being associated with COVID-19 pandemic [81]. Stress and well-being influence the quality of teacher-child interactions and teachers' delivery of emotional and instructional support [81]. The quality of teaching is one of the most important school variables influencing children achievement [82]. It has also been established that exposure to teachers and educational activities is crucial for children's learning. Teachers with higher job commitment, executive functioning, classroom instruction, and organizational quality dedicate more time to remote teaching and teaching-related tasks during lockdown [83]. Therefore, it is estimated that the reduction of interactions between teachers and children is a factor that will negatively impact learning, and child cognitive and social-emotional development. The teacher has a critical role as a mediator of the cognitive development of children, especially of the EFs [45,46,84]. Two ways have been identified by which teachers promote the development of children's EFs: one, implicit, from modeling the use of EFs in daily school activities; and, the other, explicit, through scaffolding the development of the children's self-regulatory capacities [45,46]. Therefore, distance education, which has restricted collaborative interactions between children and teachers, is another avenue that may have affected the development of children's self-regulation capacities.

Limits to social interactions

Children have been the most affected by lockdown measures, and the resulting restriction limits to interactions. Children develop in everyday interaction with important others, such as peers [85]. Peer bonds nurture children emotionally, and help them to create friendships, engage in leisure activities, group games, learn social skills, and learn how groups work [18]. Children's active engagement with peers serves as a

rich resource for their cognitive, emotional, and social development [18,86]. In everyday interaction with peers, children put their EFs into play by regulating their emotions, practicing attentive listening, solving interpersonal problems, and being flexible by taking the other's point of view. Likewise, when they participate in group activities, children must adjust their behavior to the rules of the activity, wait their turn, memorize instructions, and solve problems, among many other actions. Therefore, restricted social contact is another avenue that can impact the development of EFs.

Unhealthy habits

A significant increase in the use of screens, a reduction in outdoor activities, a reduction in physical activity, an increase in unhealthy eating habits has been observed, which has been associated with weight gain, boredom, increased stress and alterations in sleep [11,87-90]. These factors impact cognitive performance, with greater problems focusing and sustaining attention, memory problems and alterations in child EFs.

Impact of the pandemic on the macro and exosystem

The COVID-19 pandemic forced governments to take measures to prevent the spread of the virus, including: mandatory confinement and school closures. The least developed countries had to prolong the application of these measures due to a lack of health and economic resources to face the pandemic [1-4]. Consequently, the pandemic generated more devastating consequences in the countries with the highest poverty rates, accentuating their social and economic inequalities. The loss of jobs, financial instability and prolonged confinement significantly affected families, generating stress and crisis. On the other hand, the daily exposure of news about mortality rates, about the rapid proliferation of the virus and the lack of appropriate therapeutic approaches, generated fear and insecurity [1-4]. These are some of the macro and exosystem factors that must be analyzed to understand their impact on the comprehensive development of children.

In sum, these are some factors associated with the pandemic that may affect the development of EFs. However, it is important to note that the impact of these factors will vary depending on various aspects, such as the internal and external resources of children, family resilience, the academic, cognitive

and emotional support that children receive to cope with the pandemic.

Implications for School-based Interventions: Teacher's Strategies to Foster child EFs

Returning to face-to-face classes poses numerous challenges for teachers, who will encounter greater variability in learning [16]. Added to these challenges is the need to provide academic, social and emotional support to children.

Teachers are in an excellent position to help children after disasters as they are significant adults in children's lives; they are familiar with developmental processes; and, they are likely to notice emotional and behavioral changes, academic difficulties, and functional impairment in their students [8]. They are critical in recognizing the signs of traumatic stress, promoting resilience and helping children to manage reactions to stress.

Though, teachers need guidance and additional coping strategies for assisting children to overcome pandemic's emotional distress. School-Based Family Counseling (SBFC) is an excellent framework and approach for helping teachers to implement crisis interventions. SBFC crisis intervention refers to remedial interventions that focus on creating a responsive trauma-learning environment, in order to helping children, succeed academically, and personally through mental health approaches [91]. Therefore, SBFC practitioners collaborate with teachers in designing and applying coping strategies to help children manage stress and foster well-being.

Another excellent approach is neurosciences school-based interventions [31,32,45,46,92], which has been applied to strengthen EFs in children living in sociovulnerable contexts. Worldwide evidence has documented that EFs can be trained, and its gains are associated with better school performance, and with an increase in children social and emotional resources to face sociovulnerable living conditions. Teachers play a key role in those interventions, because the cognitive strategies are embedding into school curricula, and teachers are trained to apply them.

According those frameworks, a set of evidence-based approaches and strategies for teachers to help children lowering stress and promote EFs during the COVID-19 pandemic, have been selected. Those strategies have been chosen from: peer-reviewed

academic publications, books and web resources, published between 2010 and 2021: For lowering children stress: [8,26,89,93-99] and for promoting children EFs [100-108]. As a result, a collection of techniques was created that can easily be embedded into the school curriculum, while also encouraging cooperation between teachers, and between teachers and families.

Lowering children stress

Identifying children's symptoms of stress

The first step in applying stress management strategies is to assess stress levels of a student group. For identifying child stress, a teacher should use children prior knowledge to identify changes in their behavior associated with stress trauma, and identify child risk factors –isolation, domestic violence, episodes of depression. Some children may be more vulnerable than others to a disaster and need further intervention during crisis. Teachers can create a checklist of stress symptoms, and use it to guide their observation of children's behavior in the classroom and follow up signs of children's stress, to verify their magnitude and duration over time.

Creating a structured and predictable learning environment

Exposure to the pandemic creates feelings of unpredictability and uncertainty. That is why it is important to create a school environment that allows children to regain a sense of stability and foresight. Teachers may help children by:

- **Creating a school routine:** Assist children in the use of the school agenda and calendar, so that they organize and plan their daily and weekly activities. It is important to create rituals to start and end the class, to regain a sense of foresight. For example, teachers may share with children one grateful moment, give a positive message or practice a mindful activity before or after checking assignments.
- **Maintaining clear and fluid communication:** Children should feel that they can communicate with their teachers with ease. Also, it is important to provide information as clearly as possible, and in children-manageable amounts. Using visual schematics, images, and reminders to make it easier for children to get information.

- **Being flexible:** Adapt the tasks and assessments. Address academic and behavioral issues with empathy and support. During crisis, children can feel assignments are more overwhelming. Present instructions in smaller bites when necessary, and encourage children to ask clarifying questions.
- **Communicating the school's emergency response plan:** Children may not want to go to school for fear of contracting COVID-19 disease, and infecting their loved ones. Children may feel insecure and worry about not knowing if the health situation may worsen and how this will affect their daily lives. That is why teachers have to communicate to children and their families that the school has a plan to handle the changes associated with pandemic evolution.
- **Strengthening relationships:** Restricted contact with loved ones and other people is one of the greatest stressors for human beings. That's why it is important to: 1) let children know that they can discuss their concerns and fears with teachers, counselors or parents; 2) provide moments when children can enjoy the company of their peers; 3) consider putting children together in small groups to work on projects or activities; and 4) encourage children to connect with their friends and loved ones. Peer interactions play a critical role in fostering socio-emotional and cognitive development. Therefore, a teacher can use groups interaction to propose child activities to foster EFs, such as: creating a plan to reach a goal; exercising the ability to put oneself in the others' shoes to understand their perspective; taking turns to talk; and, establishing rules for regulating emotions and behaviors.
- **Fostering regulation of emotions:** Emotions are a way of reacting to situations, so it is important to recognize them in order to be able to control them later. Therefore, teachers may promote and value self-expression through different channels. Encourage children to express themselves by art, such as drawing a picture about how their day is going or role-playing the most important thing that happened to them that day. Also, teachers can teach children techniques to control their emotions: counting 10 to 1 before saying or doing something, using deep breathing,

focusing their attention on an object to calm down.

- **Using mindfulness and relaxation techniques:** Using these effective methods can help children to relax and cope with tension, anxiety or fear. Using a three-minute mindfulness exercise at the beginning of the school day or when children are tired or restless, help them to regain calm and improve their attention performance.
- **Promoting healthy habits:** Help children identify and practice healthy habits, such as: balanced diet, sleep hygiene, exercise and contact with nature. Include in school activities a walk in the park, an outdoor activity, introducing the practice of mindfulness in contact with nature. Take time out of your class to help children establish a healthy daily routine, in which they can balance their schedules for study, rest, exercise, eating, and sleep. Talk to their parents or caregivers about the importance of maintaining a routine and suggest activities that parents can share with their children: go for a walk in the park, watch a movie, share a board game or go biking.

Strategies to foster EFs

Learning to face a crisis such as the COVID-19 pandemic implies putting self-regulation capabilities into play. Hence, it is necessary to embed educational practices with specific activities that foster children's EFs.

Improving attention performance: Attention is one of the cognitive functions most affected by stress, and consequently, schoolchildren will experience difficulties in focusing and sustaining their attention. Therefore, the following are recommended:

- Observing the children attentional process to identify what captures their attention and what types of activities help them to stay focused longer:
- Varying the stimuli and teaching methods
- Providing clear instructions
- Shortening the duration of activities and introducing breaks and
- Encouraging self-assessment of attention.

Improving inhibitory control: The measures to contain the pandemic have imposed new action protocols in order to regulate activities within the school context. Children must learn new rules of behavior, and this can be a unique opportunity to promote inhibitory control. Measures could include:

- Placing posters, visual signs, reminders to facilitate the internalization of the new rules: the use the role-playing technique to exemplify the new norms of behavior and how children can play an active role in their compliance
- Fostering initiative: teachers are likely to encounter children with difficulty starting tasks, so it is recommended to use activities that increase their motivation: play a game at the beginning of class, do stretching activities, a special welcome greeting
- Carrying out activities that allow children to reflect on their behavior and emotions, -self-awareness, self-expression and self-control techniques can be used
- Using relaxation techniques.

Improving working memory: Working memory plays a critical role in learning and could be stimulated in the following ways:

- Starting a new topic updating content learned
- Practicing mental calculations
- Using comprehensive reading techniques, such as summarizing the main ideas of the text in a paragraph or making a diagram with the central ideas and
- Proposing playful activities, in which children must memorize multiple steps or actions to reach the goal.

Improving cognitive flexibility: Cognitive flexibility is an indicator of mental health and a valuable resource in dealing with changing situations:

- Modeling flexibility use in times of crisis by adapting tasks, activities and evaluation to changing circumstances
- Encouraging children to think of different approaches to problems
- Training perspective taking

- Using problem-solving techniques and
- Use brainstorming and roleplaying.

Improving planning and organization abilities: Provide strategies for organizing school activities, planning time, and selecting materials. Suggestions include:

- Creating a monthly or weekly school calendar that helps children visualize deadlines for homework and important school activities
- Assisting children in the use of the school planner and checking lists
- Using route maps to diagram for children the stages of the tasks to be carried out, making it easier to see the whole and its parts
- Encouraging children to carry out projects, with the teacher able to scaffold the children's planning skills by: a) helping children to identify goals; b) dividing complex goals into sub-goals that are measurable, achievable, and specific; c) helping children identify the steps necessary to achieve the goal, manage time, and identify the materials needed for each step; d) helping them to foresee obstacles to reach goals and to identify the resources to overcome them; e) helping them to monitor progress in achieving the goal; and, f) graphing the steps to achieve a goal.

Finally, it is recommended that teachers take every opportunity to highlight the progress of children in the management of stress techniques and in improvements of EFs. In a crisis, teachers should help children treasure their good deeds and achievements. It is necessary to reinforce their value and their active role in the face of the pandemic. Also, it is recommended to create partnership between school and family in order to help children to cope with the pandemic. Maintaining a clear and fluid communication with parents, including parents in school activities, providing support to parents when struggle with homeschooling, and listening to parents when they feel overwhelmed, are some strategies to foster bounds between family and school.

Limitations and recommendations

The theoretical nature and bibliographic integration of this study is recognized, and future scholars are encouraged to do a systematic review study. It is acknowledged as a study constraint that

only studies published in English, Spanish, and Portuguese were included, with no consideration given to others published in other languages. At the moment of conducting this study, it was observed that few studies report empirical data about difficulties in children EFs during pandemic, and even fewer point out reasons that could explain them. Therefore, it is recommended that researchers continue to investigate the influence of the pandemic on children's cognitive development and analyze studies on the subject that have been published globally.

Despite these limitations, this research discusses various contextual factors that may have mediated the pandemic's impact on EFs performance and development in children. Future longitudinal investigations are intended to put these potential explanatory pathways to the test. On the other hand, this study suggests implications for school-based interventions targeted at creating a sensitive trauma learning environment in order to mitigate the pandemic's impact on children's mental health and improve their cognitive functioning. It would be interesting to examine the efficacy of the recommended strategies to support children in crisis situations. It is also suggested that school-based interventions be developed to establish partnerships among family, school, and community in order to improve resources in the face of crisis and disasters.

Conclusion

The pandemic has had a significant impact on children's lives. The deterioration in the mental health, well-being and quality of life of children have been widely documented worldwide. However, few studies have reported the impact of the pandemic on the executive functioning of children. EFs are responsible for the self-regulation of behavior, cognitions and emotions, and are critical resources for facing novel and complex situations. From an ecological contextual model of cognitive development, this paper identifies contextual factors that may have mediated the impact of the pandemic on the performance and development of EFs in children. Given that family and school are crucial contexts that model children development, school-based interventions are proposed in order to support children during times of crisis.

Children's ability to overcome challenges will depend on their internal resources and the support they obtain from their families and school. In the school context, the teacher plays a key role in identifying the symptoms of stress in children, in

helping them manage stress, gain calm, promote resilience and strengthen their EFs. Therefore, it is necessary to train teachers in the application of evidence-based techniques and strategies aimed at strengthening child EFs and lowering stress. This challenge requires partnerships between mental health professionals, teachers, and families. It also requires listening to children's voices, stimulating their active participation and empowering them as agents of change.

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