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Repercussions of a pandemic outbreak on the motor and linguistic development of infant from 18 to 24 months

Repercussões de um surto pandêmico no desenvolvimento motor e linguístico de crianças de 18 a 24 meses

Repercusiones de un brote de pandemia en el desarrollo motriz y del lenguaje de niños de 18 a 24 meses

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ABSTRACT

Objective: To evaluate and compare the motor and linguistic development of neurotypical infantren aged 18 to 24 months, who were born in a period of pandemic outbreak (Study Group - SG), with the Control Group (CG), that were evaluated pre-pandemic. Iniciar com o verbo no infinitivo, de forma clara quais são os objetivos do trabalho. **Methods:** Analytical cross-sectional study, the data collection was carried out using the collection instruments used: interviews with parents and a self-completed questionnaire; Hearing Assessment; in addition to this, cognitive screening and complete batteries of motor and language scales from the Bayley Scales of Infant and Toddler Development®, Third Edition (Bayley III), were used. **Results:** A total of 44 infants participated in the study (22 in the Study Group - SG, evaluated in the post-pandemic period; and 22 in the Control Group - GC, evaluated in the pre-pandemic period). The SG showed a tendency towards an advantage over the CG in language-related outcomes, despite possible restrictions associated with social distancing and the use of masks. On the other hand, the CG performed better in terms of gross motor skills, possibly associated with circulation restrictions and increased use of screen devices. The maternal schooling and family income differed between groups, being favorable to the SG, which may have represented protective factors, attenuating the restrictive effects of social distancing measures and minimizing greater impacts on this sample. **Conclusion:** The studied sample (SG) that experienced the restrictions imposed by the pandemic outbreak may have been protected by other factors such as higher family income and maternal education.

Keywords: Pandemic, Infant, Motor development, Language development.

RESUMO

Objetivo: Avaliar e comparar o desenvolvimento motor e linguístico de crianças neurotípicas na faixa etária de 18 a 24 meses, que nasceram em um período de surto pandêmico (Grupo Estudo), com o do Grupo Controle (com avaliação pré-pandemia). **Métodos:** Estudo transversal analítico que comparou o desempenho motor e linguístico de lactentes neurotípicos, nascidos a termo, de 18 a 24 meses através da Bayley Scales of Infant and Toddler Development®, Third Edition (Bayley III). **Resultados:** Participaram do estudo 44 lactentes (22 no Grupo Estudo e 22 no Grupo Controle). O Grupo Estudo apresentou uma tendência de vantagem em relação ao Grupo Controle nos desfechos associados à linguagem, apesar das possíveis restrições associadas ao distanciamento social e uso de máscaras. Por outro lado, o Grupo Controle teve melhor desempenho em termos de motricidade grossa, possivelmente associado às restrições de circulação e ao aumento do uso de dispositivos de tela. A escolaridade materna e a renda familiar diferiram entre os grupos, sendo favoráveis ao Grupo Estudo podendo ter representado fatores de proteção, atenuando os efeitos restritores das medidas de distanciamento social e minimizando impactos maiores sobre essa amostra. **Conclusão:** A amostra que vivenciou as restrições impostas pelo surto pandêmico pode ter sido protegida

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por outros fatores como uma maior renda familiar e escolaridade materna. Mais estudos, com delineamentos longitudinais e amostras maiores, podem ser interessantes para dimensionar os efeitos das restrições sobre essa população.

Palvaras-chave: Pandemia, Criança, Desenvolvimento motor, Desenvolvimento da linguagem.

RESUMEN

Objetivo: Evaluar y comparar el desarrollo motor y lingüístico de niños neurotípicos de 18 a 24 meses, que nacieron en período de brote pandémico (Grupo de Estudio - GE), con el Grupo Control (GC), que fueron evaluados pre-pandemia. Iniciar con el verbo no infinitivo, de forma clara quais son los objetivos del trabajo. **Métodos:** Estudio analítico transversal, la recolección de datos se realizó mediante los instrumentos de recolección utilizados: entrevistas a padres de familia y cuestionario autocumplimentado; Evaluación de la Audición; además de esto, se utilizó tamizaje cognitivo y baterías completas de escalas motoras y de lenguaje de las Bayley Scales of Infant and Toddler Development®, Tercera Edición (Bayley III). **Resultados:** Participaron del estudio un total de 44 infantes (22 en el Grupo de Estudio - SG, evaluados en el período pospandemia; y 22 en el Grupo Control - GC, evaluados en el período prepandemia). El GE mostró una tendencia hacia una ventaja sobre el GC en los resultados relacionados con el lenguaje, a pesar de posibles restricciones asociadas al distanciamiento social y el uso de mascarillas. Por otro lado, el CG tuvo un mejor desempeño en términos de motricidad gruesa, posiblemente asociado con restricciones de circulación y mayor uso de dispositivos de pantalla. La escolaridad materna y el ingreso familiar difirieron entre grupos, siendo favorables al GE, lo que pudo haber representado factores protectores, atenuando los efectos restrictivos de las medidas de distanciamiento social y minimizando mayores impactos en esta muestra. **Conclusión:** La muestra estudiada (GE) que experimentó las restricciones impuestas por el brote pandémico puede haber estado protegida por otros factores como mayores ingresos familiares y educación materna.

Palabras clave: Pandemia, Niño, Desarrollo motor, Desarrollo del lenguaje.

INTRODUCTION

COVID-19 pandemic was one of the most serious health crises that has ever hit the world's population and the biggest humanitarian crisis since World War II (SEN-CROWE, et al., 2020; NASERI & HOSSEINI, 2020). As an attempt to minimize the decease's spreading, considering the high rates of transmission and morbidity and mortality, the World Health Organization (WHO) issued an international emergency declaration and a series of recommendations to which all countries had to adapt within their social and economic perspectives (WHO, 2020; AQUINO et al., 2020; SEN-CROWE et al., 2020; KUPFERSCHMIDT & COHEN, 2020). These measures, although necessary, also led to restrictions on services considered "non-essential", with a strong economic and social impact, mainly on vulnerable populations (AQUINO et al., 2020; MASONBRINK & HURLEY, 2020; YOSHIKAWA et al., 2020; WHO & UNIECF, 2020; ZAR et al., 2020).

In this uncertain context, children, although less vulnerable to the clinical effects of this virus (SARS-CoV-2), started to be affected by other indirect contexts, such as decrease in maternal and child health services coverage, pregnancy stress, the closure of day care centers and schools, risk of poor nutrition and domestic violence, social isolation and other environmental factors that could compromise their full development (ARMITAGE & NELLUMS, 2020; MASONBRINK & HURLEY, 2020; GHOSH et al., 2020; BUFFA et al., 2018; YOSHIKAWA et al., 2020; ZAR et al., 2020; WHO & UNIECF, 2020). Child development has been a recurring research topic due to the importance it has throughout an individual's life, in physical, psychological and social aspects (GLEASON, 2018; LU et al., 2016; CLAYPOOL & PERALTA, 2021). The most solid foundations are formed especially in the first two years of life, when changes in brain development occur at a much higher rates than in other ages (GLEASON, 2018; CLAYPOOL & PERALTA, 2021).

These solid bases are modulated by biological, social and environmental factors, and will command a continuous and sequential maturation process of acquiring skills that evolve in complexity, in a process of interdependence amongst motor, social, linguistic and cognitive functions (MARIA-MENGEL & LINHARES, 2007; HAYWOOD & GETCHEL, 2016; DIAS et al., 2013; TEIXEIRA et al., 2016).The more adverse the experiences, besides the greater risk of development delays and health issues in adulthood which can be related to that, such as cognitive impairment, the more prevalent become psychological conditions and non-communicable chronic diseases (REMESH, 2022). Besides the risks to child development, epidemics or

pandemics such as COVID-19 can also increase the risk of illness, protective confinement, social isolation and increased stress levels for parents and caregivers, as participants in these situations, which are not observed under usual circumstances (ARAÚJO et al., 2021). Even short-term exposure, as was this pandemic outbreak, can lead to long-term negative impacts, particularly the earlier age at which potentially negative exposures were experienced (SEIVWRIGHT et al., 2022).

Still in relation to the public calamity caused by the pandemic, health professionals need to pay attention to child development, that is, observe the milestones of linguistic and motor development to understand the profile of children who spent important years of their development in the pandemic phase. Multidisciplinary care and the study of this population is extremely important to understand the future consequences that the impact of the pandemic may have influenced on child development. For these reasons, there is great concern with this age group, especially in terms of development, due to the pandemic event and the remaining questions regarding its potential consequences, especially those in the long term. Thus, the aim of this study was to compare the motor and linguistic development of typical infants (18-24 months), born during the pandemic outbreak, with a control group (pre-pandemic), considering a potential harmful effect of the changes imposed by the pandemic outbreak on the development possibilities of the individuals born in this period.

METHODS

A quantitative cross-sectional study was performed, comparing a group of 22 infants (Study Group - SG) of 18 to 24 months, born during the COVID-19 pandemic period, with a control group from a previous database, evaluated two years before the pandemic with the same methods, also with 22 infants (Control Group - CG) of the same age range. Both samples were evaluated at the same institution, fulfilling all ethical procedures and approved by Ethics Committee of Federal University of Santa Maria, process number 3.505.454, and by the number 18419319300005346. The total sample consisted of 44 neurotypical infants who met the same criteria of been born full-term, discarding conditions such as genetic syndromes, malformations and congenital heart diseases, congenital pathologies of the respiratory tract, hypoxic-ischemic encephalopathy, has suffered traumatic injuries or needed surgical interventions in a period immediately before the evaluation, as well as those with diagnosed visual impairment and/or alterations detected in hearing tests.

The Modified Checklist for Autism in Toddlers (M-CHAT) was also applied to detect Autism Spectrum Disorder (ASD) risk. To minimize selection bias as much as possible, different invitation processes were considered, such as promotion in social media, as well as random search in the birth lists of obstetric centers followed by telephone invitation. However, it was noticed a tendency to form a sample whose parents are more concerned and enlightened about development issues, in detriment of those that may actually be at risks, assessed in this study. Another form of selection was done by convenience sampling at children care institutions (educational institutions, health centers and neighbourhood associations - public and private) with different socioeconomic realities.

This selection allowed to reduce the biases previously mentioned, as well as to evaluate the association of the socioeconomic and cultural component in the impacts generated by the pandemic. However, many families did not accept the invitation, maintaining the bias related to more concerned families. After having agreed to participate, parents signed a Term of Acceptance, and then became registered to take part in the evaluation stages.Interviews with parents (anamnesis) and self-completion surveys for Bayley-III Scale and Modified Checklist for Autism in Toddlers (M-CHAT) were remotely carried out, in order to minimize the presence of subjects in the research environments, respecting COVID-19 restriction norms.

The face-to-face assessments (hearing tests and the Bayley-III Scale) were carried out individually, in neutral rooms, and in the presence of the child's parents and/or caregivers. The Bayley-III Scale was applied for the screening assessment, for the cognitive domain, in order to confirm its integrity. The complete test was applied only for the target domains of this study: motor and language. If the assessed infant showed signs of tiredness and/or discomfort during the test, it was suspended and resumed at a later time, as soon as possible. Individuals were evaluated using procedures detailed in the test administration manual.

Analysis of the motor and language domains used a scaled score based on the age-weighted scaled score, and a descriptive classification based on the combined score, according to the test manual. The collected data were inserted in an Excel spreadsheet and analyzed in the R statistical environment (R Core Team). Parametric and non-parametric methods were used, according to the distribution of each variable. The statistical techniques used were Chi-square test for association, Fisher's exact test, and one-way and two-way ANOVA for comparisons between groups, followed by the Tukey's post hoc test for multiple comparisons. The adopted nominal level of significance was 5%.

RESULTS

Because of the pandemic period difficulties, there were countless attempts to contact families of eligible infants, however, there were little acceptance to the invitations, resulting in a sufficient sample of 22 individuals, compatible with the 22 collected prior to the pandemic. **Table 1** presents the characterization of the two samples for the different periods: pre-pandemic period (n = 22), called of Control Group (CG) and pandemic period (n = 22), called Study Group (SG). Since for no variable p<0.05, there is no significant difference for these variables, denoting the homogeneity between the samples.

Table 1 - Results for the control variables for the groups.

Groups	Control Group (n=22)		Study Group (n=22)		p
Variable	Mean	SD	Mean	SD	
Age	20.3	1.6	20.6	3.3	0.278
APGAR 5th min	9.9	0.3	9.7	0.9	0.268
Mother age	29.5	6.0	32.2	6.6	0.153
Father age	32.7	8.0	34.5	10.8	0.519
Birth Weight (g)	3,265	460.1	3,406.9	398.9	0.281

Note: n= sample size; SD=Standard Deviation; g=grams.
Source: Hermes L, et al.,2024.

Table 2 presents the results of the test for association between selected categorical variables and the collection period. Association was observed for Maternal Education (p=0.001) and Household Income (p<0.001). These associations might contain confounding factors regarding the pandemic and, for this reason, they will be further analyzed in relation to the groups.

Table 2 - Qualitative distribution for control and study groups and their significance level (p).

Variable	CG (n)	SG (n)	p
Sex			
Male	11	9	0.762
Female	11	13	
Ethnicity			
White	20	18	0.660
Other	2	4	
Maternal Education			
Elementary	8	3	0.001
High School	13	6	
Graduate	1	13	
Paternal Education			
Elementary	10	6	0.174
High School	9	7	
Graduate	3	8	
Household Income (per month)			
up to BRL 2,000.00	13	8	0.000
up to BRL 4,000.00	6	1	

up to BRL 5,000.00	3	1	
up to BRL 6,000.00	0	5	
> BRL 7,000.00	0	7	
Delivery Method			
Vaginal	7	8	1.000
Cesarean	15	14	
Breastfeeding			
Exclusive	15	12	0.648
Mixed	5	7	
Artificial	2	3	
Pre-natal			
Yes	22	22	-
No	0	0	
Planned Pregnancy			
Yes	13	12	0.708
No	7	10	

Note: n= sample size; CG=Control Group; SG=Study Group.
Source: Hermes L, et al.,2024.

Table 3 presents the quantitative aspects of the main outcome characteristics for the two periods studied.

Table 3 - Significance levels for CG and SG samples in the outcome for language and motor skill development.

Group	**CG (n=22)**		**SG (n=22)**		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p**
RC	9.7	6.5	11.0	3.0	0.134
EC	7.9	3.4	9.6	3.3	0.087
FMot	10.0	3.0	11.5	1.8	0.054
GMot	10.6	2.0	9.5	1.1	0.029

Note: n=sample size; CG=Control Group; SG=Study Group; RC=Receptive Communication; EC=Expressive Communication; FMot=Fine motor skill; GMot=Gross motor skill.
Source: Hermes L, et al.,2024.

Direct analysis of each tested variable for both groups showed a significant difference only for gross motor skill (p=0.029), with advantage for the group born before the pandemic, although all other variables showed higher means for the study group, born during the pandemic (p<0.100). Additionally, the variables analysis has been made for outcomes related to the main categorical variables that showed significant difference between groups. This work presents the complementarity of two quantitative analyses, proposed in **Table 4** and designated as **4A** and **4B**, in order to favor understanding and numerical design.

Table 4A presents the results of the two-way analysis of variance for Maternal Education (ME) and Household Income (HI), for these variables between groups and for the interaction of these variables within each group (intragroup). Also, 4B, complementary to the previous one, indicates in which of the periods (or both) the interaction with Maternal Education and Household Income showed differences in their levels.

Table 4A –Significance levels for the difference in the outcome variables between groups (CG and SG) and between variables (Maternal Education and Household Income) within each group (Two-Way ANOVA with interactions).

Maternal Education (ME)			**Household Income (HI)**	
Group		**Group (ME)**	**Group**	**Group (HI)**
RC	0.387	0.104	0.426	0.789
EC	0.090	0.472	0.057	0.024
FMot	0.023	0.002	0.044	0.162
GMot	0.030	0.670	0.023	0.197

	Maternal Education (ME)		Household Income (HI)	
Variable	CG	SG	CG	SG
RC	0.145	0.203	0.634	0.306
EC	0.830	0.191	0.254	0.011
FMot	0.003	0.305	0.290	0.025
GMot	0.540	0.649	0.090	0.646

Note: ME=Maternal Education; HI=Household Income; CG=Control Group; SG=Study RC=Receptive Communication; EC=Expressive Communication; FMot=Fine motor skill; GMot=Gross motor skill.
Source: Hermes L, et al.,2024.

The exact significance levels of the ANOVA coefficients, i. e., those values accepted as significant, denote a difference between the groups in the outcome variable (left column), as well as an interaction with the explanatory variable (right column). In cases where there was a significant difference in the outcome variable and not in the explanatory one, it can be explained by other factors, unrelated to Maternal Education (ME) and Household Income (HI), that is, great possibilities that there is an interference from the period itself.

For Expressive Communication (EC) between CG and SG groups, there was no significant difference, that is, the experienced period was not decisive for this outcome. However, regarding intragroup incomes, there is an effect of the HI factor associated with the experienced period. There were also significant differences in the FMot variable for the Group (p=0.023) and for ME within the groups (p=0.002), however, with no effect from HI, in this case. GMot is the variable in which the effect of the pandemic period is clearer, where the effect of the explanatory variables was not associated with the significance between the groups (CG and SG).

Therefore, the complement of table **4B**, complementary to the previous one, indicates in which of the periods (or both) the interaction with Maternal Education and Household Income showed differences in their levels. Analyzes of the results from Table 4A and 4B they are complementary, allowing to identify which explanatory variables are associated with the outcome variables and in which period this association occurs. In Table 4, it is noticed that Maternal Education, depending on the group, is associated with Fine Motor Skills. In Table 5, however, the association of ME and FMot is occurring only in the Control Group (pre-pandemic).

Looking at the Household Income variable, which in Table 4 showed statistical significance in the interaction of Expressive Communication with the Group (p=0.024), the complementary analysis of Table 5 shows that this difference in EC depends on Income only in the pandemic group (p=0.011), where there was a difference in EC in the income levels of the pandemic group, between levels up to BRL 6,000.00 and up to BRL 4,000.00 per month and, with a highly possible significant difference also between income levels up to BRL 6000.00 and up to BRL 2,000.00 per month.

The Multiple Discriminant Analysis (MDA) model was applied to the main outcome variables mentioned in Table 3 in order to obtain a better classification of subjects than would be obtained simply using the original variables values. MDA operates a data linear transformation, where the number of transformed variables is limited to the smallest value between the number of subjects minus one and the number of groups minus one. The analyzed results, listed as coefficients in Table 6, show that Language (LGG) contributes positively to the discriminative function, while GMot is the variable that contributes most negatively to the subjects final score in the discriminant function. Variables with intermediate coefficients, closer to zero, have less influence on the scores of this transformation.

Table 4B- Significance levels for the difference in the outcome variables between ME and HI within each group (One-Way ANOVA).

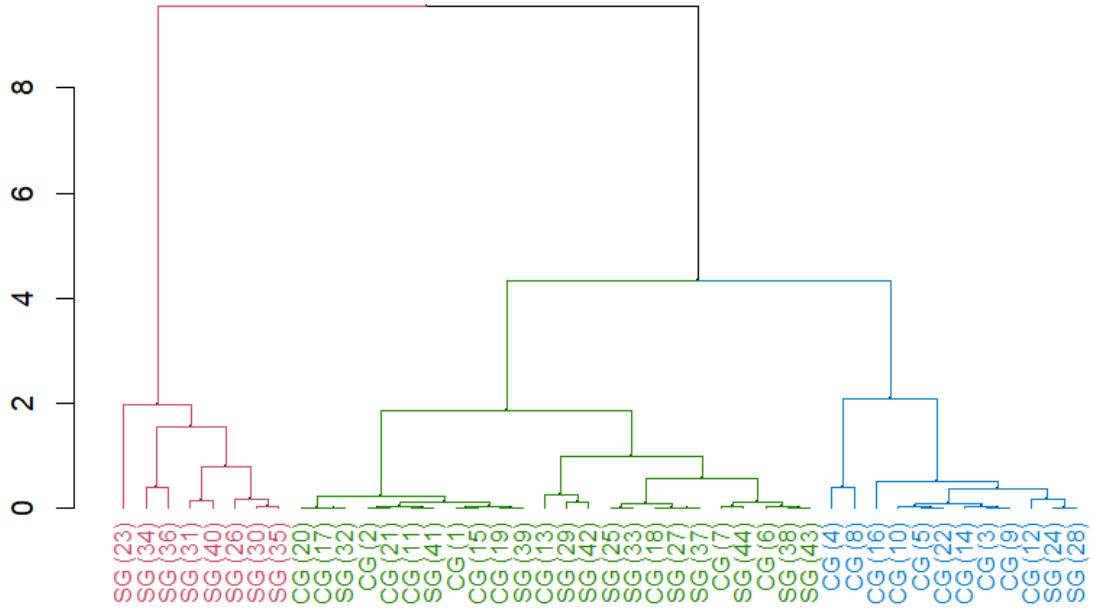
Variable	Coefficient
LGG	0.281
MotP	0.070
PLGG	-0.026
FMot	-0.061
EC	-0.066

RC	-0.116
Mot	-0.200
GMot	-0.724

Note: LGG=Language; MotP=Motor Percentile; LGGP=Language Percentile; RC=Receptive Communication; EC=Expressive Communication; FMot=Fine motor skill; GMot=Gross motor skill; Mot=Motor skill.
Source: Hermes L, et al.,2024.

To complement the analysis, the classification of subjects was performed using the hierarchical grouping method based on the scores of the previously described discriminant analysis (MDA). The result of the classification is shown in the dendrogram of Figure 1, where two or three groups of subjects are identified with score above two. Given this configuration, such subjects could be analyzed qualitatively to suggest what points they have in common.

Figure 1 - Grouping of subjects according to the score in the discriminant function of the outcome variables.



Note: CG=Control Group; SG=Study Group.
Source: Hermes L, et al.,2024.

It is noteworthy that the dendrogram presents a discrimination where the subjects, characterized in the periods in which they experienced their development (prior and post pandemic outbreak), are distributed with a certain grouping tendency, marked by pink and blue colors, where the variables that most discriminate individuals are Gross Motor Skill and Language (including RC and EC), respectively. The first group is formed only by subjects from the control group, differing in GMot performance, possibly resulting from freer experiences, prior to the restrictions of the pandemic, and the third, predominantly by subjects from the study group, with better performance in language (including RC and EC), due to possible interference of the Household Income factor.

DISCUSSION

The evolution of the pandemic has shown that children are less likely to becoming infected by the SARS-CoV-2 virus or developing severe symptoms or comorbidities related to it. However, they may have been directly and indirectly affected, mainly in their development processes (IRWIN et al., 2022). The results of this study showed that the effects of restrictions caused by the COVID-19 pandemic did not have an overall impact

on development of the analyzed sample, but some damage on gross motor skill might have occurred, and some advantages due to the socioeconomic reality experienced by the SG sample. Even considering the same age groups, such as the target group in this study, infants of 18 to 24 months, the impact of the pandemic probably varies due to cultural and socioeconomic issues that interfere with opportunities for experiences, events perception, and environmental conditions (IRWIN et al., 2022).

Authors have already reinforced that this impact might not be uniform across the entire child population, mainly due to the multifactorial nature of biological and socio-environmental issues that permeate child development (GOLDFELD et al., 2022). Infants tend to be more affected because they are more dependent on the frequency and quality of care given to them and on characteristics related to caregivers. On the other hand, older children are exposed to information and understanding processes that generate other responses in their learning and development processes (IRWIN et al., 2022).

Infants evaluated in this study were living in an age where the variety of experiences is essential to determine how they will react to the environment where they are immersed and, consequently, generate development responses marked by processes of acquisition of broad motor skills, according to the difference observed between the groups. In this sense, overloaded parents may have left their children restricted to activities with little exploratory experience (motor and sensory) for even longer periods, allowing more screen time and keeping them in spaces were movement were restricted and lack of interactions (SEIVWRIGHT, CALLIS, FLATAU, 2022; ARAÚJO et al., 2021; LANCKER, PAROLIN, 2020; REMESH, 2022).

Test performances, in most of the domains, except the GMot, did not show a trend in relation to the collection period, which may indicate that performance differences of the analyzed sample are due to other factors unrelated to the pandemic. Factors such as maternal education and household income favored the group born during the pandemic and may have repercussions on aspects inherent to care provision, not revealing the real impact of the pandemic on this age group. If care is predominantly provided and guided by mothers at this stage of life, having better conditions can indeed interfere the analysis and prevent the generalization of these results to the population, regardless of sample size.

Maternal education can be a determining factor for a better knowledge and understanding of mothers about the development of their children, enabling tools for detection of inconsistencies with the typical acquisition sequences, as well as looking for adequate stimulation strategies. A study of Alvarenga et al., 2020, analyzing the level of mother's knowledge about child development and their children's developmental indicators, pointed out that such knowledge is a pure mediator variable in the relationship between maternal education and outcome indicators, considering motor and language domain, as the findings of our study.

The fear of the residual repercussions of the social isolation period can be mitigated, in theory, by the neuroplasticity process. This characteristic is configured as a capacity of the central nervous system to develop evolutionary mechanisms to adapt to changes in the environment, so it could explain the performance of infants who experienced restrictions in the pandemic, even residual (PASCUAL-LEONE et al., 2005; TOGA et al., 2006; SILVA & SANTOS, 2022).

This neuroplasticity mechanism can compensate deprivation periods or previous damage through appropriate incentives and richer environmental experiences, offered by families with higher incomes and mothers with higher education levels (SILVA & SANTOS, 2022). It is still difficult to predict the long-term impact on infants who were exposed to the impacts of the pandemic (REMESH, 2022), but it is possible that longitudinal studies will be developed to monitor the outcomes related to the development of this population. Despite all the alternatives for minimizing biases, some limitations need to be assumed for the proper interpretation of the presented results.

Despite all efforts to expand sample recruitment, adherence was restricted to apparently more aware and interested parents who had probably already adopted strategies to mitigate the effect of restrictions. Biosafety protocols that delayed the start the collections in academic spaces, especially due to the delay in adequate vaccination coverage of the population, may have diluted the effects with the gradual return to pre-pandemic conditions. Furthermore, the lack of access to other children who could participate in the research, but who,

due to the context of the pandemic, were unable to access the research and many were still afraid of contamination, even with all the precautionary measures adopted in the methodological follow-up.

CONCLUSION

Worse outcomes in gross motor skills may be related to social isolation restrictions. Nevertheless, the study group seems to have been protected from greater harm by factors such as higher household income and maternal education. Such protective factors prevent us from generalizing the data reported here, as they are not representative of the general population reality.

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