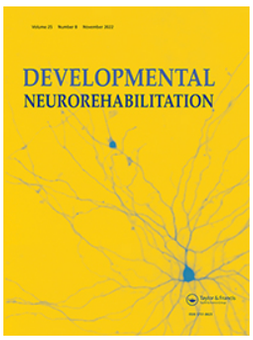

Developmental Neurorehabilitation

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ipdr20

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To cite this article: Gabriela Lopes Gama, Ana Stela Salvino, Jousilene de Sales Tavares, José Geraldo Ribeiro Gregorio, Karinny Michelle Alves Moreira, Melania Maria Ramos Amorim & Adriana Melo (2022): The Impact of COVID-19 Pandemic and Social Distancing on Motor Function and Growth of Children with Congenital Zika Syndrome: A Prospective Cohort Study, Developmental Neurorehabilitation, DOI: 10.1080/17518423.2022.2154399

To link to this article: https://doi.org/10.1080/17518423.2022.2154399

Published online: 04 Dec 2022.

DEVELOPMENTAL NEUROREHABILITATION
https://doi.org/10.1080/17518423.2022.2154399

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The Impact of COVID-19 Pandemic and Social Distancing on Motor Function and Growth of Children with Congenital Zika Syndrome: A Prospective Cohort Study

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ABSTRACT

This article describes the impact of social distancing during the COVID-19 pandemic on the motor function and growth of children with congenital Zika syndrome (CZS). Children's motor function, weight, height and joint range of movement (ROM) were evaluated before the onset of the pandemic and soon after their return to face-to-face activities at a rehabilitation center. Fifty-two children (Mean 46.07 months, SD 3.76 months) were assessed. Results showed a reduction in proportion of children with adequate body mass index ($p = .04$), an increase in proportion with adequate height ($p < 0.001$), deterioration in gross motor function in children with severe motor impairment ($p < .01$), and a reduction in the maximum ROM for shoulder ($p < .01$) and wrist flexion ($p = .046$), elbow ($p = .01$), knee ($p = .03$) and ankle extension ($p < .01$), and an increase in hip flexion ($p = .04$). The social distancing period appears to have contributed to important losses in motor function and joint mobility of children with CZS; however, this period of time appeared to have less impact on their growth.

ARTICLE HISTORY
Received March 11, 2022
Revised November 28, 2022
Accepted November 28, 2022

KEYWORDS
Zika virus infection; child development; social distancing; motor skills disorders

Introduction

Initially registered in the city of Wuhan, China, COVID-19 reached pandemic proportions by March 2020.[1] At that time, the lack of any effective treatment or vaccine resulted in preventive measures such as social distancing, increased hygiene habits and lockdown in some countries.[2] Consequently, in various countries around the world, services considered non-essential including schools and rehabilitation centers temporarily suspended activities.[3] Currently, non-essential services are gradually returning to work and the non-viral consequences of the COVID-19 pandemic are now being examined. Studies have demonstrated the negative effects of lockdowns and social distancing measures on the physical and mental health of children with and without typical development.[4–6]

Children with developmental disabilities, including those with congenital Zika syndrome (CZS), also experienced the effects of the COVID-19 pandemic and public health measures. These children drew attention worldwide during the Zika virus epidemic between 2015 and 2016 as a result of the severe neurological damage caused by intrauterine Zika virus infection.[7,8] Subsequently, researchers have identified wide spectrum clinical abnormalities in this population requiring monitoring and multidisciplinary care including microcephaly, muscle tone abnormalities, dysphagia and seizures, as well as impairments in neuropsychomotor development and growth.[9–11]

The impacts of the COVID-19 pandemic on vulnerable populations as children undernutrition and overnutrition[12] have been well described; however, the impact of social distancing on the development of children with CZS has not been reported to our knowledge. Therefore, the objective of the present study was to describe the impact of social distancing during the COVID-19 pandemic on the motor function and growth of children with CZS.

Materials and Methods

A prospective cohort study was conducted with children affiliated to the *Instituto Paraibano de Pesquisa Professor Joaquim Amorim Neto (IPESQ)* in the city of Campina Grande, Paraiba, Brazil who received care at support center for children with microcephaly. This study is part of a study cohort that follow the neurodevelopment of children with CZS, approved by the ethics committee of the Alcides Carneiro University Hospital. This rehabilitation center is a non-governmental organization that provides multidisciplinary care for children with CZS from several states in Brazil and other countries in Latin America and Africa. For this reason, many mothers reside with their children in rehabilitation center provided housing while their children undergo rehabilitation programs. Even before the COVID-19 pandemic, rehabilitation services were provided to the children and their families as an outpatient service within the rehabilitation center.

Before COVID-19 pandemic, children with microcephaly served by the rehabilitation center performed face-to-face individual sessions of physiotherapy, speech-language therapy and occupational therapy, without their mothers' assistance and with variable frequency according to the availability of a caregiver and the child's clinical condition. In addition,

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children were periodically monitored by a team of doctors, nutritionists and nurses, also during face-to-face consultations.

When public health measures were instituted at the rehabilitation center during the COVID-19 pandemic, all face-to-face activities were suspended between the months of March and September 2020. During this period, all children and their families returned to their homes and multidisciplinary care was only offered remotely and online. Thus, services previously carried out in person by therapists were carried out by the child's mother or other caregiver who received coaching and consultation remotely. Specifically, synchronous audiovisual communication between mothers or other caregivers and the therapists were facilitated through smartphones. In addition, videos and audio messages were sent to mothers or other caregivers through social media such as WhatsApp with activities and guidelines about child care. In order to prevent COVID-19 infection, directions were provided to parents and caregivers to maintain the quarantine not only for children but also for their closest family members.

Sample

Children who receive care at IPESQ were selected using non-probability convenience sampling. The inclusion criteria were confirmed diagnosis of CZS in accordance with the criteria defined by the Centers for Disease Control and Prevention[13] and recipient of care at rehabilitation center prior to the onset of the COVID-19 pandemic. Children with microcephaly and/or brain damage of non CZS causes, children without a confirmed diagnosis of CZS and those who had not returned to the center for rehabilitation activities after the period of social distancing were excluded from the study.

Evaluation and Data Collection Procedures

The children's growth and motor function were evaluated at two different moments: prior to the COVID-19 pandemic in December 2019 (Evaluation 1) and shortly after each child's return to face-to-face activities at the rehabilitation center for children with microcephaly between September 2019 and July 2021 (Evaluation 2).

To enable growth to be evaluated, anthropometric indices such as weight and height were recorded. Based on these indices, z-score values were calculated using the Anthro® 'software program, version 2.2 (WHO Anthro, 2011) and Anthro Plus ® software program, version 1.04. These software programs were used to calculate children's body mass index (BMI) and z-score of this parameter. From these values, children were classified in relation to weight, height and BMI as below expected (z-score between <−2), adequate (z-score between 2 and −2) and above expected (z-score >2).[14]

Motor function was assessed using the Gross Motor Function Measure (GMFM-88), which evaluated gross motor function in children during their performance of 88 tasks divided into five dimensions: A: Lying and Rolling; B: Sitting; C: Crawling and Kneeling; D: Standing and E: Walking, Running and Jumping.[15] In addition, the Gross Motor Function Classification Scale (GMFCS) was used to classify the children with respect to their walking ability and functionality. According to this ordinal scale, children can be classified from level I, corresponding to minimal limitations, up to level V, which reflects severe limitations.[16]

Finally, range of motion (ROM) of hip, knee, ankle, shoulder, elbow and wrist was bilaterally evaluated on sagittal plane using a manual goniometer.[17] Participants' general information including age, presence of microcephaly at birth and information about COVID-19 infections was recorded through interviews with mothers and other caregivers. All the evaluations were performed by trained physical therapists and nurses experienced in caring for children with CZS for at least 2 years and trained to apply all the assessment instruments used. Additionally, these professionals were blinded to the purpose of the study, and the measures used are part of the routine of assessments performed at the rehabilitation center.

Statistical Analysis

A descriptive analysis was performed by calculating measures of central tendency and dispersion. Evaluation 1 and Evaluation 2 were compared using inferential statistics in which continuous variables such as weight, height and ROM were compared using repeated measure analysis of variance (ANOVA). In addition, categorical variables such as total GMFM-88 score, GMFM-88 scores for each dimension and z-scores for anthropometric parameters were compared by paired Wilcoxon test. All the analyses were performed using MedCalc, version 19.0.7 (MedCalc Software bvba, Ostend, Belgium), with statistical significance set at 5%.

Results

Fifty-two children (30 boys) participated in this study. Of these, 74.5% (n = 38) had microcephaly at birth and 90.4% (n = 47) had severe motor impairment, classified as GMFCS level V. The mean age of children was 46.07 ± 3.76 months at the first evaluation and 58.17 ± 5.54 months at the second evaluation. The average time between evaluations was 11.96 ± 3.40 months. Four children (7.7%) and seven mothers of children evaluated (13.5%) had received a confirmed diagnosis of COVID-19; however, only one child required hospital admittance and did not require intubation.

Children classified with GMFCS level different from V (nine boys), three classifieds in level IV and two classifieds in level II, and had a mean time between evaluations of 10 ± 2.34 months. Even before the COVID-19 pandemic, all of these children were able to remain seated without support and two were able to walk independently. Of the children without microcephaly at birth (nine boys) just one was assessed at a GMFCS level different from V and two did not have microcephaly at Evaluation I.

Overall, at Evaluation 1, 46.2% of the children had adequate height, 61.5% adequate weight and 78.8% adequate BMI. At the following evaluation, an increase was found in proportion of children with adequate height (71.2%), and the proportion with adequate weight remained the same, and we observed a reduction in the proportion of children with adequate BMI (59.6%) (Table 1). Regarding z-scores, changes were found in parameters of height from a median of −2.07 to −1.33

Table 1. Distribution of the children according to the classification of anthropometric measurements and z-scores for anthropometric measurements.

Parameter/Evaluation	Above expected n (%)	Adequate n (%)	Below expected n (%)	Z-Score		
				Range	Median	95% CI for the median
Weight						
Evaluation 1		32 (61.5)	20 (38.5)	−5.48 to 1.86	−1.54	−2.13 to −1.19
Evaluation 2	1 (1.9)	32 (61.5)	19 (36.5)	−4.84 to 2.18	−1.25	−2.08 to −0.53
p-value*					0.19	
Height						
Evaluation 1		24 (46.2)	28 (53.8)	−5.61 to −0.14	−2.07	−2.51 to −1.68
Evaluation 2		37 (71.2)	15 (28.8)	−5.45 to 1.28	−1.33	−1.7 to −0.75
p-value*					<0.001	
BMI						
Evaluation 1	4 (7.7)	41 (78.8)	7 (13.5)	−4.81 to 4.28	−0.38	−0.66 to 0.19
Evaluation 2	6 (11.5)	31 (59.6)	15 (28.8)	−4.96 to 4.63	−0.93	−1.67 to −0.04
p-value*					0.02	

BMI: body mass index. CI = confidence interval
* Result of paired Wilcoxon test

(p < .00001) and BMI from −0.38 to −0.93, as shown in Table 1 and Figure 1.

The children whose motor function was most severely impaired (GMFCS level V) had a significant reduction in the total GMFM-88 score between Evaluation 1 and Evaluation 2 (p = .00049). For the remaining children, there was an increase, albeit non-significant, in the total GMFM-88 score when the two evaluations were compared (p = .21). Likewise, statistically significant differences in GMFM-88 score were found for dimensions A and B (p = .001 and p = .01, respectively) only for children classified as GMFCS V. Figures 2 and 3 show the total GMFM-88 score and the scores for each dimension for children classified as GMFCS level V and for those classified as GMFCS level other than V, respectively.

Regarding joint mobility, considering all children, a bilateral reduction was found in maximum flexion of shoulder (Right p = .012 and Left p = .009) and wrist (Right p = .042 and Left p = .046), as well as, in maximum extension of elbow (Right p = .01, Left p = .012), knee (Right p = .001, Left = 0.001) and ankle (Right p = <0.001, Left p = <0.001). Additionally, an increase was observed in hip flexion (Right p = .05, Left p = .043), as described in Table 2.

Discussion and Future Research

Evaluation of the motor function and growth of children with CZS following the period of social distancing showed that motor function deteriorated in children with severe motor impairment, while the proportion of children with adequate height increased and adequate BMI decreased, without changes in the proportion of children with adequate weight. In addition, there was a reduction in maximum ROM for shoulder and wrist flexion, as well as, elbow, knee and ankle extension. Furthermore, there was an increase in flexion at the hip.

Since capacity for neuroplasticity is directly associated with factors such as the intense practice of task-specific activities and enriched environments, children's motor capacity is directly related to their activity level and motor experiences.[18,19] Therefore, possible reduction of movement stimulation and performance during the social distancing period could be related to the decline in motor function seen in children evaluated here, particularly those with severe motor impairment (GMFCS V), whose capacity to explore the household environment is limited. Additionally, for children who are unable to achieve more advanced postures (sitting, crawling and walking),[20] therapeutic environment and therapist's facilitations or support often represent the only opportunity to benefit from these postures. Indeed, a long time without adequate stimulation and movement can result in changes in the muscle structure such as disuse atrophy and reduced muscle mass.[21]

The reduction of movement performance and the potential lack of adequate stimuli in the home environment act together to potentially increase the risk of complications such as limitations in joint mobility and bone deformities.[22] As reported by Biyik et al.,[21] when evaluating children with cerebral palsy, a reduction was also found here in maximum joint ROM, which could increase the risk of joint deformities over the long and short term. What is noteworthy in these findings, however, is the tendency to flexion posture, with limited maximum ROM at elbow, knee and ankle extension, as well as an

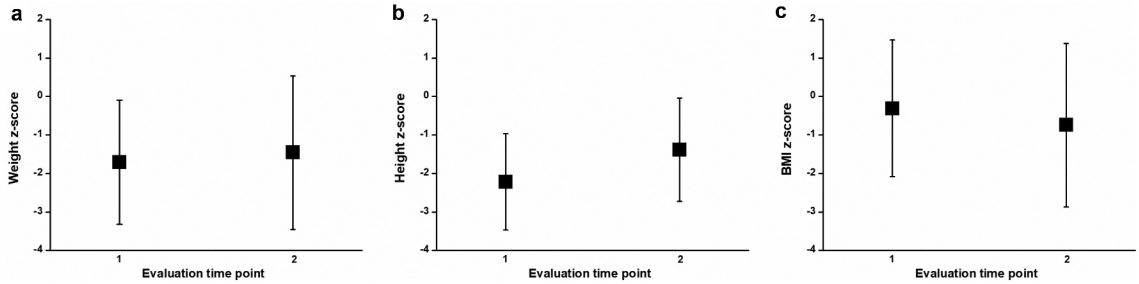

Figure 1. Mean and SD of anthropometric indices of all children. (A) Weight, (B) height and (C) body mass index (BMI).

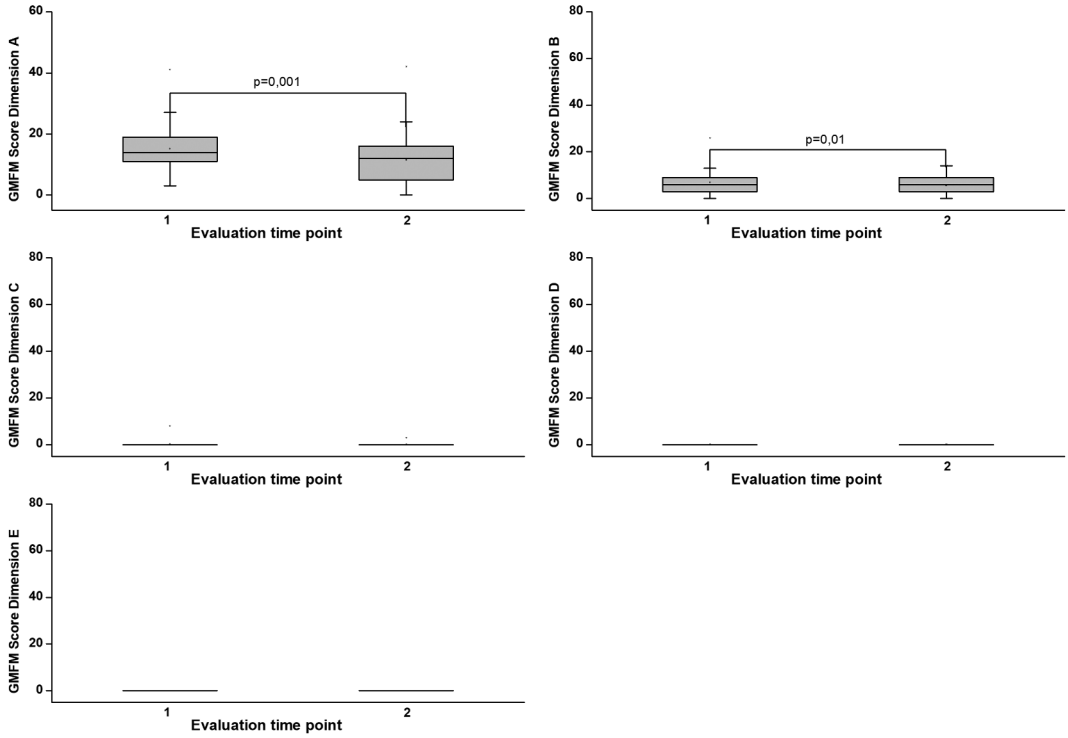

Figure 2. Gross Motor Functions Measures scores at Evaluations 1 and 2 of children with Gross Motor Function Classification Scale (GMFCS) level V.

increase in hip flexion, which could be related to the increase in muscle tone and fixation in appendicular muscles described in this population even prior to the COVID-19 pandemic.[10] These changes in ROM and flexion posture should be avoided as it can negatively affect children's daily care, compromise functionality and motor function improvements and increase risk of bone and joint deformities.[23]

A positive unexpected result was that a greater proportion of children presented adequate height for age after the period of social isolation. Consequently, a smaller proportion of children had adequate BMI, once the proportion of children with adequate weight did not change. Our research group recently evaluated the behavior of anthropometric parameters of children with CZS up to 4 years of age and observed a reduction in

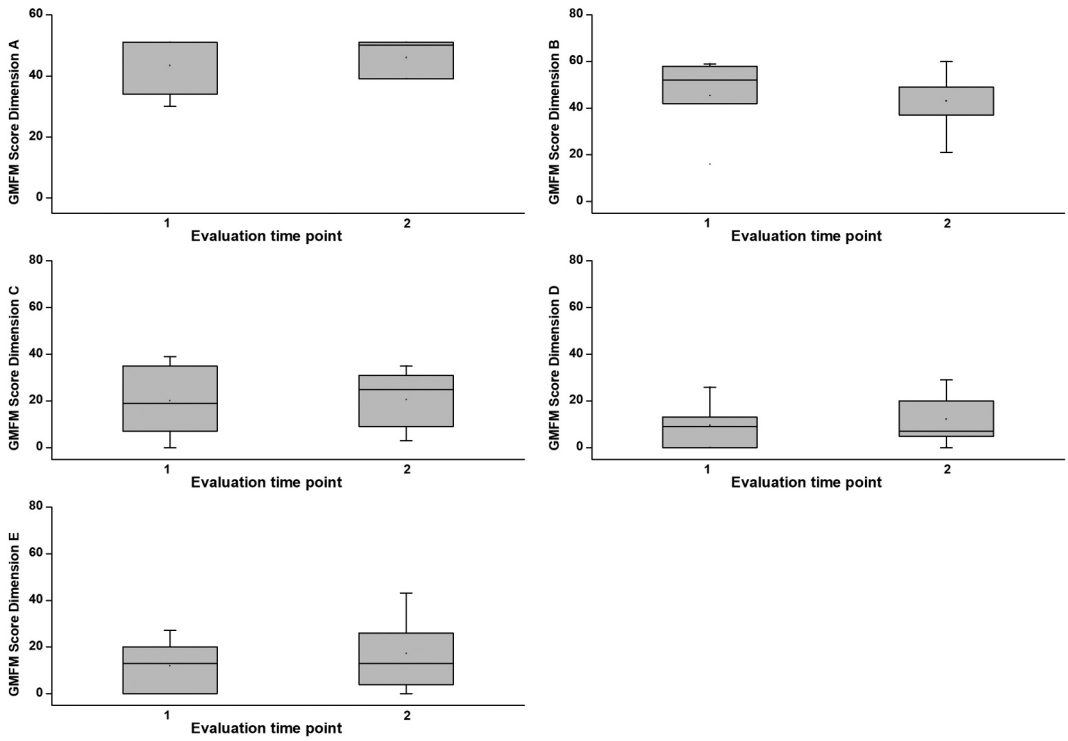

Figure 3. Gross Motor Functions Measures scores at Evaluations 1 and 2 of children with Gross Motor Function Classification Scale (GMFCS) level other than V.

Table 2. Maximum range of motion of the joint at the hip, knee, ankle, shoulder, elbow and wrist in the sagittal plane at Evaluation 1 and Evaluation 2.

	Right			Left		
	Evaluation 1	Evaluation 2	p-value	Evaluation 1	Evaluation 2	p-value
Shoulder flexion (Max. 180°)	172.7 ± 2.1	160.4 ± 4.5	0.012	172.7 ± 2.3	159.4 ± 4.7	0.009
Shoulder extension (Max. 45°)	45.7 ± 0.9	43.8 ± 0.7	0.101	45.7 ± 0.9	44.7 ± 0.3	0.294
Elbow flexion (Max. 145°)	145 ± 0.0	143.1 ± 1.8	0.298	145 ± 0.0	142.2 ± 1.7	0.117
Elbow extension (Max. 180°)	170.7 ± 3.4	158.2 ± 5.6	0.01	170.7 ± 3.4	158.4 ± 5.3	0.012
Wrist flexion (Max. 90°)	91.3 ± 1.1	87.4 ± 1.6	0.042	91.3 ± 1.1	87.6 ± 1.6	0.046
Wrist extension (Max. 70°)	68.6 ± 1.6	66.5 ± 2.4	0.337	68.2 ± 1.9	67.1 ± 2.2	0.618
Hip flexion (Max. 125°)	68.4 ± 3.4	79.5 ± 4.7	0.05	68.1 ± 3.4	79.5 ± 4.6	0.043
Hip extension (Max. 10°)	8.4 ± 4.9	8.2 ± 5.1	0.43	7.6 ± 7.8	8.6 ± 3.81	0.40
Knee flexion (Max. 140°)	140 ± 0.00	139.7 ± 0.4	0.322	140 ± 0.00	139.1 ± 0.4	0.028
Knee extension (Max. 180)	177.8 ± 0.9	162.7 ± 4.7	0.001	177.7 ± 1.1	164.4 ± 4.1	0.001
Dorsiflexion (Max. 20°)	16.5 ± 1.9	15.5 ± 1.9	0.318	16.1 ± 1.6	15.6 ± 1.6	0.658
Plantar flexion (Max. 45°)	46.7 ± 0.9	41.8 ± 1.3	<0.001	46.4 ± 0.8	40.5 ± 1.3	<0.001

Max = maximum range of motion.

the number of children with adequate height between the third and fourth years of life,[24] the age at which children evaluated in the present study were at the first evaluation time point. The results of the present study might be related to the disease's natural progression or even as a result of the greater variability found in the z-score values for height in the study sample. The impact of interrupted rehabilitation programs and the altered daily family routines during the period of social distancing could explain our study's results. Notwithstanding, the possibility that these findings are part of the natural history of CZS cannot be ruled out. This disease has only recently been described, and its natural history has yet to be completely understood.[25] This veracity of these hypotheses should be evaluated in future studies.

Another point that must be taken into consideration when interpreting our findings is that all the participating mothers and children are registered at a specialist center that provides rehabilitation for children with CZS; hence, all received multidisciplinary support, albeit remotely (synchronous and asynchronous) during COVID-19 social distancing. Nevertheless, the support provided was limited since professionals carrying out intervention reported anecdotes that many mothers had restricted access to technological devices and Internet. Many of the mothers who received support remotely reported a lack of confidence in carrying out rehabilitation activities with their child to health professionals during online consultations or even during evaluation 2 and noted difficulty in adjusting family routines for this purpose. Unfortunately, this information was not systematically recorded using specific assessment instruments, which represents a limitation of this study that could explain the efficacy of remote assistance provided during the social distancing period. Vale et al.[26] also reported on difficulties encountered by mothers, who in addition complained of the increased amount of time spent caring for their children, and on their poor level of knowledge regarding the effectiveness of tasks and stimuli aimed at encouraging the child's development. The impact of the COVID-19 pandemic on children with disabilities highlights the need to recognize the importance of the family's participation in rehabilitation programs,[27] with collaborative and strategic practices to keep the child active, exploring and participating in environments that take their disabilities and rehabilitation needs into consideration.

Although the pandemic occurred abruptly and unpredictably, hence presenting a multitude of challenges for professionals and for the mothers and other caregivers of children with CZS, this period is now being viewed as an opportunity to analyze the possibility of implementing a new model of care with greater therapist and parents' interactions and parental involvement, which can change rehabilitation services, particularly in low-to-middle-income countries.[28] This new treatment perspective has shown positive effects on the motor development of children with cerebral palsy[29] and should be considered for children with other disabilities. Further studies are required to evaluate the perception, benefits and repercussions for the child, family and professional team.

Limitations

Despite the importance of these findings, this study involves some limitations that must be taken into consideration. First, the small sample size of children evaluated, which can be explained by the mothers' fear of COVID-19 infection, resulting in the cancellation of scheduled appointments.[32] In the present study, instruments capable of quantifying and classifying possible barriers and facilitators of child development in the home were not applied. The use of such instruments could have led to greater understanding of the factors that may have affected the findings of this study. Finally, the lack of precise control of the synchronous and asynchronous activities performed by the mothers during COVID-19 social distancing also has to be taken into consideration. Thus, the absence of assessments regarding social and communication conditions, as well as daily behavior of children with CZS and their families during the social distancing period should be considered a limitation of this study. In addition, new analyses will be necessary regarding the possible time required to recover motor function and growth after the pandemic and impacts of social distancing on other domains of child development, such as social interaction and cognition.

Conclusion

The effects of the pandemic and social distancing measures required to contain the spread of COVID-19 may have resulted in significant losses in the motor function and joint mobility of children with CZS that could have future impact on their development, activities and participation. Furthermore, although constant face-to-face monitoring conducted by trained professionals is crucial in maintaining the motor function of children with CZS, these findings provide new reflections on the need for greater family participation in rehabilitation programs for children with CZS in order to achieve advances and improvements in outcomes for the child, their family and for specialist services.

Acknowledgments

Authors would like to thank the entire research department at IPESQ, as well as the children for having participated in this study.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

Funding

This study received support from the Coordination for the Improvement of Higher Education Personnel (CAPES.)/Ministry of Education (MEC) (grant no. 443372/2016-0), Technological Development (CNPq) (grant no. 440619/2016-5). This study was also supported by the Department of Science and Technology, Secretariat of Science, Technology and Strategic Supplies, Ministry of Health;CNPQ;

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