

Impact of COVID-19 lockdown on children with neurodevelopmental disorders

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Abstract

Introduction and objectives: Neurodevelopmental disorders (ND) affect the maturation of the central nervous system, leading to abnormal brain functioning which may affect a child's social, cognitive, and emotional capacities. The coronavirus disease 2019 (COVID-19) pandemic, and particularly the lockdown period, resulted in indisputable changes in the lives of children, especially those with disabilities. The purpose of this study is to determine the impact of the lockdown period on these children and their parents in terms of therapies, mental and physical health, isolation, school performance, and the impact on family dynamics and relationships. **Methods:** A cross-sectional study compared the effect of the COVID-19 pandemic lockdown on the health of children with neurodevelopmental disorders with that of healthy children, using two anonymous surveys. Parents were asked to answer the survey from June 2020 to July 2021. **Results:** Out of 191 questionnaires obtained, 93 referred to parents in the Neurodevelopmental Disorder Group (NDG) and 98 to parents in the Control Group (CG). A total of 50.5% of parents in the NDG believed that their child's school performance improved when compared to the pre-pandemic period vs. 23.5% in the control group ($p < 0.001$). In terms of their overall health, 30.1% of the NDG parents reported that their child had been much better at home, compared to 9.2% of the CG parents ($p = 0.001$). There was a statistically significant improvement in family dynamics and relationships in the NDG, with 31.2% vs. 15.3% in the CG ($p = 0.007$). **Discussion:** This study portrays the impact of the lockdown and its consequences on children with ND. Parents in the NDG reported an improvement in their child's academic performance and in intra-family relationships. We found that most parents believed that access to schooling was insufficient with remote learning as well as access to therapies. There should be more measures and alternative strategies to minimize the impact that a lockdown has on children with special needs, especially among those in need of therapies. This study also emphasizes the importance of parents having an active role in the life of children with ND and achieving work-family balance. Further studies are needed to evaluate the real long-term impact of this period on children with neurodevelopmental disorders.

Keywords: Child. Pediatrics. Growth and development. Coronavirus infections. COVID-19. Health impact assessment.

Impacto do confinamento durante a pandemia COVID-19 em crianças com perturbações do neurodesenvolvimento

Resumo

Introdução e objetivos: As patologias do neurodesenvolvimento afetam a maturação do sistema nervoso central, resultando em alterações da função cerebral que podem comprometer as capacidades sociais, cognitivas e emocionais da criança.

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A pandemia COVID-19 e, principalmente, o período de confinamento resultaram em mudanças indiscutíveis na vida das crianças, especialmente nas crianças com perturbações do neurodesenvolvimento. O objetivo deste estudo é determinar o impacto do período de confinamento nestas crianças relativamente às terapias, saúde mental e física, isolamento, desempenho escolar e impacto na dinâmica familiar e nas suas relações. **Métodos:** Foi realizado um estudo retrospectivo de modo a comparar os efeitos do período de confinamento durante a pandemia COVID-19 entre crianças com perturbações do neurodesenvolvimento e um grupo de controlo de crianças saudáveis, através da aplicação de dois questionários anónimos aos pais. Os questionários foram preenchidos no período compreendido entre junho de 2020 e julho de 2021. **Resultados:** Dos 191 questionários obtidos, 93 foram referentes ao grupo de crianças com Perturbações do Neurodesenvolvimento (NDG) e 98 relativos ao grupo de controlo (CG). 50.5% dos pais das crianças no NDG considerou que o desempenho escolar dos seus filhos melhorou em relação ao período pré-pandémico vs. 23.5% no CG ($p < 0.001$). Relativamente à saúde global das crianças, 30.1% dos pais no NDG afirmou que esta melhorou durante o período de confinamento, comparativamente a 9.2% no CG ($p = 0.001$). Houve uma melhoria estatisticamente significativa na dinâmica familiar e relacionamentos no NDG 31.2% vs. 15.3% no CG ($p = 0.007$). **Discussão:** Este estudo permite avaliar as consequências do impacto do confinamento em crianças com perturbações do neurodesenvolvimento. No NDG, os pais relataram uma melhoria do desempenho escolar dos seus filhos, assim como nas relações intrafamiliares. Constatámos que a maioria dos pais considera que o acesso à escola foi insuficiente no ensino remoto bem como no acesso às terapias. A implementação de medidas futuras para minimizar o impacto que um confinamento tem neste grupo particular de crianças é essencial. Este estudo enfatiza, igualmente, a importância dos pais desempenharem um papel ativo da vida dos seus filhos, encontrando um equilíbrio adequado entre trabalho-família. São necessários estudos adicionais para avaliar o impacto a longo-prazo que o confinamento terá nas crianças com perturbações do neurodesenvolvimento.

Palavras-chave: Criança. Pediatria. Crescimento e desenvolvimento. Infecções por coronavírus. COVID-19. Avaliação impacto na Saúde.

Keypoints

What is known

- Children with neurodevelopment disorders were at high risk of significant emotional and behavioral problems during the COVID-19 pandemic due to school closures.
- During the lockdown period, the family burden was high, especially in families with children with neurodevelopment disorders.
- The lockdown period during the COVID-19 pandemic led to an unavoidable disruption in children's usual dynamics, which was more significant among children with neurodevelopmental pathologies, who frequently need more support and attention.

What is added

- About 30% of the parents in the neurodevelopment group reported an improvement in their child's overall health as well as in intra-family relationships during the lockdown period. When compared with the control group, these results were statistically significant.
- Children with neurodevelopment disorders are more anxious, *per se*, mostly when there is a change of routine, but our results revealed that the perceived anxiety was similar in the control group and in the group with neurodevelopment disorders during the lockdown period.
- Parents of children with neurodevelopmental disorders believed that their child's school performance improved when compared to the pre-pandemic period.

Introduction

Neurodevelopmental disorders (ND) are a group of pathologies that usually manifest early in a child's life, affecting their functional capacity¹. These disorders affect the maturation of the central nervous system, leading to abnormal brain functioning which may affect a child's social, cognitive, and emotional capacities. Its prevalence is around 15% in the general population aged between three and 17²⁻⁴. These children were at high risk of significant emotional and behavioral problems, particularly during the coronavirus disease 19 (COVID-19) pandemic and due to school closures⁵⁻⁷.

On March 11, 2020, the World Health Organization (WHO) declared the novel coronavirus SARS-CoV-2 outbreak a global pandemic⁸.

Two lockdowns were implemented in Portugal during the pandemic. During these two periods, schools were closed, forcing students to stay at home, some of whom started to take classes through remote technologies, such as videoconferences, email, or television.

Undoubtedly, there were enormous changes in family dynamics and the management of daily activities. In Portugal, there are already some studies that point out the impact of the pandemic on children's health, including psychological, social, and physical consequences⁹⁻¹¹.

Concerning children with ND, some studies focused on children diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD), showing that they encountered significant difficulties regarding their behavior during the lockdowns^{12,13}. Based on an online survey aimed at parents of children with Autism Spectrum Disorder (ASD) at the beginning of the pandemic, Colizzi M and colleagues mentioned the increased effort in managing daily activities and more severe behavioral problems¹⁴.

Our study aims to analyze how children with ND and their parents experienced the lockdown period and school closures. We hypothesized that school deprivation could have a remarkably negative impact on these children when compared with children without ND.

Material and methods

We conducted a cross-sectional study in a level II hospital in Portugal. The sample included two groups: the first consisted of children that were followed up at neurodevelopmental appointments with a pre-established ND diagnosis as classified by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)¹, whom we designated the Neurodevelopmental Disorder Group (NDG), and the second group consisted of a control group of healthy children with no ND diagnosis, whom we named the Control Group (CG).

Two anonymous surveys were used, which were drafted by the authors. The first one comprised a 45-item questionnaire applied to parents whose children had a pre-established ND diagnosis. The second survey, a 32-item questionnaire, was applied to parents whose children went to the Emergency Department during the selected time period (control group); these children did not present with a ND diagnosis or any chronic pathology that could interfere with the study. Questionnaires that were not fully answered, as well as questionnaires related to children under three years of age or over 17 years and 364 days were excluded.

Parents were asked to answer the survey between June 28, 2020 and July 28, 2021.

We collected information regarding the parents' level of education, whether parents continued to work during the lockdown, who took care of the children during the day, the need and access to therapies during the lockdown period, children's personal background, school characteristics, mental and physical health aspects, anxiety, isolation, and the impact on family dynamics and relationships during this time period. Regarding the impact on their overall health, the impact on physical activity was characterized in the questionnaire as "None" (children maintained pre-lockdown physical activity

levels or there was an absence of pre-lockdown physical activity); "Little" (25% decrease in the number of hours spent on physical activity compared to pre-lockdown period); "Some" (50% decrease in the number of hours spent on physical activity compared to the pre-lockdown period); "Significant" (ceased physical activity during lockdown).

Statistical analysis was performed using IBM SPSS® version 26. Since some of the variables under study are categorical, absolute and relative frequencies were used for their characterization. To compare the distribution of responses concerning the CG vs. the NDG, the Chi-square Independence Test and Fischer's Exact Test were used when appropriate. Standardized adjusted residues were also used to identify cells with a frequency higher (> 1.96) and lower than expected (< -1.96) with a significance level of 5%. We used Student's t-Test for independent samples to compare the mean ages of children and parents between the two groups. A significance level of 5% was considered so the associations and differences between groups were considered statistically significant when the significance value was less than 0.05 ($p < 0.05$).

The study was approved by our Institution's Ethics Committee, with a National Registry for Clinical Studies (RNEC) registration number (20170700050) and approval number of 2109.

Results

Our initial sample of 200 questionnaires was reduced to 191, since six were not fully answered and three had more than one answer to unique possibilities. From the 191 questionnaires, 93 refer to children in the NDG and 98 to children in the CG.

The children included in the study had a mean age of 9.8 years ($SD = 4.0$) ranging from three to 17 years old. The mean age of the children in the CG was 10.2 years ($SD = 4.1$) and 9.4 years in NDG ($SD = 3.7$) (Table 1). In both groups, children aged between six and 14 predominated (66.4% in the CG and 71.0% in the NDG) with a greater preponderance of the group aged between 10 and 14 (42.9% in the CG and 40.9% in the NDG). Both groups were homogeneous in terms of age distribution ($p = 0.493$) and average age ($p = 0.177$). The social-demographic characteristics of the participants are demonstrated in table 1.

During the lockdown period, most children were under their parents' care (58.1%). However, this percentage was significantly higher in the NDG (66.7%) than in the CG (49%) ($p = 0.005$). However, the percentage of children left alone during the day was higher in the CG (11.2%)

Table 1. Characterization of children and comparison by group, in terms of age, gender, household, and other social-demographic characteristics

Characteristics	Total (n = 191)	Control Group (CG) (n = 98)	Neurodevelopment Disorders Group (NDG) (n = 93)	p
Gender				
Female	65 (34.0%)	32 (32.7%)	33 (35.5%)	0.680 [‡]
Male	126 (66.0%)	66 (67.3%)	60 (64.5%)	
Age (years)				
3-5	33 (17.3%)	16 (16.3%)	17 (18.3%)	0.493 [‡]
6-9	51 (26.7%)	23 (23.5%)	28 (30.1%)	
10-14	80 (41.9%)	42 (42.9%)	38 (40.9%)	
15-17	27 (14.1%)	17 (17.3%)	10 (10.8%)	
Median	10.0	11.0	10.0	0.177 [§]
Mean (SD)	9.8 (4.0)	10.2 (4.1)	9.4 (3.7)	
Siblings				
Singleton	85 (44.5%)	45 (45.9%)	40 (43.0%)	0.599 [‡]
1 sibling	82 (42.9%)	43 (43.9%)	39 (41.9%)	
2 siblings	24 (12.6%)	10 (10.2%)	14 (15.1%)	
Type of housing				
Apartment without balcony	94 (49.2%)	44 (44.9%)	50 (53.8%)	0.156 [‡]
Apartment with balcony	62 (32.5%)	31 (31.6%)	31 (33.3%)	
House/villa	35 (18.3%)	23 (23.5%)	12 (12.9%)	
Household				
Nuclear family	142 (74.3%)	75 (76.5%)	67 (72.0%)	0.780 [¶]
Single parent family	30 (15.7%)	14 (14.3%)	16 (17.2%)	
Extended family	16 (8.4%)	7 (7.1%)	9 (9.7%)	
Step-family	3 (1.6%)	2 (2.0%)	1 (1.1%)	
Person responsible for taking care of the child during the day				
Both parents	111 (58.1%)	48 (49.0%) [†]	63 (67.7%)*	0.005 [¶]
Mother	32 (16.8%)	20 (20.4%)	12 (12.9%)	
Grandparents	22 (11.5%)	13 (13.3%)	9 (9.7%)	
Alone	12 (6.3%)	11 (11.2%)*	1 (1.1%) [†]	
Aunt	7 (3.7%)	3 (3.1%)	4 (4.3%)	
Father	5 (2.6%)	1 (1.0%)	4 (4.3%)	
Nanny	2 (1.0%)	2 (2.0%)	0 (0.0%)	
Did the child go outside during the lockdown period?				
No	83 (43.5%)	46 (46.9%)	37 (39.8%)	0.319 [‡]
Yes	108 (56.5%)	52 (53.1%)	56 (60.2%)	
Maternal age (years)				
20-30	24 (12.7%)	14 (14.3%)	10 (11.0%)	0.322 [‡]
31-40	91 (48.1%)	45 (45.9%)	46 (50.5%)	
41-50	62 (32.8%)	30 (30.6%)	32 (35.2%)	
51-60	12 (6.3%)	9 (9.2%)	3 (3.3%)	
No information/no response	2	0	2	0.393 [§]
Median	39.0	40.0	38.5	
Mean (SD)	38.7 (7.2)	39.2 (7.9)	38.1 (6.4)	
Paternal age (years)				
20-30	16 (8.8%)	10 (10.9%)	6 (6.7%)	0.042 [‡]
31-40	70 (38.5%)	26 (28.3%) [†]	44 (48.9%)*	
41-50	78 (42.9%)	45 (48.9%)	33 (36.7%)	
51-60	17 (9.3%)	11 (12.0%)	6 (6.7%)	
60+	1 (0.5%)	0 (0.0%)	1 (1.1%)	0.312 [§]
No information/no response	9	6	3	
Median	41.0	43.0	40.0	
Mean (SD)	40.9 (7.8)	41.5 (8.4)	40.3 (7.2)	
Maternal level of education				
Primary school (1 st to 9 th grade)	56 (29.6%)	27 (27.6%)	29 (31.9%)	0.496 [‡]

(Continues)

Table 1. Characterization of children and comparison by group, in terms of age, gender, household, and other social-demographic characteristics (*continuation*)

Characteristics	Total (n = 191)	Control Group (CG) (n = 98)	Neurodevelopment Disorders Group (NDG) (n = 93)	p
Secondary school (10 th to 12 th grade)	82 (43.4%)	41 (41.8%)	41 (45.1%)	
Bachelor's degree or higher	51 (27.0%)	30 (30.6%)	21 (23.1%)	
Paternal level of education				0.878 [‡]
Primary school (1 st to 9 th grade)	94 (51.9%)	47 (51.1%)	47 (52.8%)	
Secondary school (10 th to 12 th grade)	58 (32.0%)	31 (33.7%)	27 (30.3%)	
Bachelor's degree or higher	29 (16.0%)	14 (15.2%)	15 (16.9%)	
Parents who continued to work				< 0.001 [‡]
Both	96 (50.3%)	63 (64.3%)*	33 (35.5%) [†]	
Only one	66 (34.6%)	22 (22.4%) [‡]	44 (47.3%)*	
None	29 (15.2%)	13 (13.3%)	16 (17.2%)	
Maternal workplace**				0.325 [‡]
Out of home	57 (44.5%)	37 (48.1%)	20 (39.2%)	
Teleworking	71 (55.5%)	40 (51.9%)	31 (60.8%)	
Paternal workplace**				0.291 [‡]
Outside the home	77 (59.2%)	45 (63.4%)	32 (54.2%)	
Remote working	53 (40.8%)	26 (36.6%)	27 (45.8%)	

*Standardized adjusted residues > 1.96.

†Standardized adjusted residues < -1.96.

‡Significance value of the Chi-square test.

§Significance value of Student's t-test.

¶Significance value of Fisher's Exact Test.

**Among those who work.

than the NDG (1.1%) ($p = 0.005$). The only child who was left alone in the NDG was 16 years old, and of the 11 children in the CG (11.2%) who were left alone, 27.3% were 14 years old and 72.7% were ≥ 15 years old.

As for the age of the parents, the same age groups predominated (38.5% from 31 to 40 years and 42.9% from 41 to 50 years) with a mean age of 40.9 years ($SD = 7.8$). It should be noted that the percentage of parents aged between 31 and 40 years was significantly higher in the NDG (48.9%) than in the CG (28.3%) ($p = 0.042$). In regard to their work during the lockdown, all the parents worked prior to the lockdown period and the percentage of children whose parents continued to work was significantly higher in the CG (64.3%) compared to the NDG (35.5%) ($p < 0.001$). Among those who worked, 55.5% of the mothers and 40.8% of the fathers were working remotely (Table 1).

More than half of the children in each group had periods when they went outside regardless of the lockdown, which was not statistically significant between the two groups (Table 1).

Regarding only the NDG (Table 2), the most prevalent diagnoses were Attention-Deficit/Hyperactivity Disorder (ADHD) (44.1%), Specific Learning Disorder (SLD) (36.6%) and Language Disorder (LD) (25.8%), as shown in Table 2.

Most of the children in the NDG needed therapies (82.8%). Among those, most children required special education (62.4%), speech therapy (54.5%), psychotherapy (28.6%), and occupational therapy (19.5%) (Table 2).

About half had access to therapies during the lockdown period, most of which were online therapies (95%). Among those in need of therapies, most parents believed that not having therapies, or having online therapies, had some negative impact (26%) or a significant negative impact (53.2%) (Table 2).

In the group of 98 children with ND, 31.2% had a development appointment during the lockdown period, most of which were remote-based appointments (82.8%). Among those who had a remote-based appointment, the majority mentioned that they would have preferred to have had a face-to-face appointment (82.8%). It should be noted that nine children (14.3%) had an appointment scheduled but it was canceled by the hospital (Table 3).

About one in four (28.0%) patients were taking medication in relation to their ND, mostly methylphenidate (80.8%). As for the need to taper down or stop medication during the lockdown period, six (23.1%) reported that there was a need to adjust medication (Table 3). No parents said that there was a need to increase the medication.

Table 2. Characterization of children with ND regarding diagnosis and therapy needs (n = 93)

Characteristics	n	%
Neurodevelopmental diagnosis*		
ADHD	41	44.1%
Specific learning disorder	34	36.6%
Language disorder	24	25.8%
ASD	7	7.5%
Intellectual developmental disorder	5	5.4%
Global developmental delay	5	5.4%
Cerebral palsy	4	4.3%
Down syndrome	2	2.2%
Tuberous sclerosis	2	2.2%
Rett syndrome	1	1.1%
Smith-Magenis syndrome	1	1.1%
Noonan syndrome	1	1.1%
Need for therapies		
No	16	17.2%
Yes	77	82.8%
Types of therapies [†] (among those in need of support)		
Special education	48	62.4%
Speech therapy	42	54.5%
Psychotherapy	22	28.6%
Occupational therapy	15	19.5%
Physical therapy	5	6.5%
Family therapy	5	6.5%
Hippotherapy	1	1.3%
During the lockdown, did the child have access to therapies? (among those in need of support)		
No	37	48.1%
Yes	40	51.9%
Were the therapies online or in-person? (among those who had therapies)		
Online	38	95.0%
In person	2	5.0%
What was the negative impact of not having therapies or therapies having been online? (among those in need of support)		
No impact	12	15.6%
Little impact	4	5.2%
Some impact	20	26.0%
Significant impact	41	53.2%

*Possibility of more than one diagnosis.

[†]Possibility of more than one type of therapy.

ADHD: attention-deficit/hyperactivity disorder; ASD: autism spectrum disorder.

More than three quarters of the children had access to school during the lockdown. The percentage of parents who stated that the access the children had was sufficient for learning was significantly higher in the CG (24.5%) than in the NDG (12.9%) ($p = 0.041$). Overall, most parents spent more than one hour a day helping their child with schoolwork. It should be noted that the percentage of children who did not need support was significantly higher in the CG (18.4%) than in the NDG (6.5%), and the percentage of parents who spent three

Table 3. Characterization of children with ND regarding medical follow-up (n = 93)

Characteristics	n	%
Did your child have scheduled development appointments during the lockdown period?		
No	64	68.8%
Yes	29	31.2%
Why did you not have an appointment? (among those who did not have an appointment)		
It was not scheduled	52	81.2%
It was scheduled but was cancelled	12	18.8%
Type of appointment (among those who had an appointment)		
In-person appointment	5	17.2%
Remote-based appointment	24	82.8%
What kind of appointment would you have preferred? (among those who had a remote-based appointment)		
Remote-based appointment	4	16.7%
Face-to-face appointment	20	83.3%
Does your child take any medication regarding ND?		
No	67	72.0%
Yes	26	28.0%
Type of medication (among those who took medication)		
Methylphenidate	21	80.8%
Risperidone	3	11.5%
Aripiprazole	2	7.7%
Was there a need to adjust the medication? (among those who took medication)		
No	20	76.9%
Yes	6	23.1%

to four hours a day supporting their child was significantly higher in the NDG (19.4%) than in the CG (8.2%) ($p = 0.030$), as shown in [table 4](#). About half of the NDG's parents believed that their child's school performance improved, compared to the pre-pandemic period (50.5%), a percentage that was significantly higher than that registered in the CG (23.5%) ($p < 0.001$).

Regarding the impact on physical activity, more than 50% of the parents stated that the pandemic had some (34.7%) or a significant negative impact (24.2%) on their child's physical activity. It should be noted that the perceived impact on physical activity was higher in the CG than in the NDG ($p = 0.010$): 15.3% of the CG answered "no impact" (vs 33.7% in NDG) and 30.6% of the CG answered, "a significant impact" (vs. 17.4% in NDG) ([Table 5](#)).

In regard to overall health, parents were asked to consider the child's state of physical, mental, social, and emotional well-being overall, compared to the pre-lockdown period. The percentage of those who reported

Table 4. Characterization of children and comparison by group regarding school data

Characteristics	Total (n = 191)	Control Group (CG) (n = 98)	Neurodevelopment Disorders Group (NDG) (n = 93)	p
Education level				
Kindergarten	36 (18.8%)	16 (16.3%)	20 (21.5%)	0.125 [‡]
1 st to 4 th grade	60 (31.4%)	27 (27.6%)	33 (35.5%)	
5 th to 6 th grade	38 (19.9%)	22 (22.4%)	16 (17.2%)	
7 th to 9 th grade	45 (23.6%)	23 (23.5%)	22 (23.7%)	
Secondary school (10 th to 12 th grade)	12 (6.3%)	10 (10.2%)	2 (2.2%)	
Access to school during lockdown				
No	40 (20.9%)	24 (24.5%)	16 (17.2%)	0.216 [‡]
Yes (TV, e-mail, SMS or videocalls)	151 (79.1%)	74 (75.5%)	77 (82.8%)	
Was the access to school sufficient for learning?				
No	155 (81.2%)	74 (75.5%) [†]	81 (87.1%)*	0.041 [‡]
Yes	36 (18.8%)	24 (24.5%) [†]	12 (12.9%) [†]	
Hours per day in need of parental support (school-related)				
No need for support	24 (12.6%)	18 (18.4%)*	6 (6.5%) [†]	0.030 [‡]
< 1 hour per day	21 (11.0%)	9 (9.2%)	12 (12.9%)	
1-2 hours per day	99 (51.8%)	53 (54.1%)	46 (49.5%)	
3-4 hours per day	26 (13.6%)	8 (8.2%) [†]	18 (19.4%)*	
≥ 5 hours per day	21 (11.0%)	10 (10.2%)	11 (11.8%)	
School performance compared to the pre-lockdown period				
Worsened	28 (14.7%)	15 (15.3%)	13 (14.0%)	< 0.001 [‡]
Remained the same as before	93 (48.7%)	60 (61.2%)*	33 (35.5%) [†]	
Improved	70 (36.6%)	23 (23.5%) [†]	47 (50.5%)*	

*Standardized adjusted residues > 1.96.

†Standardized adjusted residues < -1.96.

‡Significance value of the Chi-square test.

that they had been much better at home was significantly higher in the NDG (30.1%) than in the CG (9.2%) ($p = 0.001$). In contrast, the percentage of those who said that their overall health was the same was higher in the CG (59.2%) than in the NDG (44.1%). The percentage of those who stated that their overall health got worse was similar in the two groups: 31.6% in the CG and 25.8% in the NDG (Table 5).

As for anxiety, overall, 61.3% stated that their child was more anxious than usual, which was similar in both groups. Regarding difficulty in imposing rules, 44% said it was more difficult than usual, 49.2% said it was the same as usual, and 6.8% said it was easier than usual. Half of the CG parents stated that their children were more isolated than usual (50.0%), a percentage that is significantly higher than that registered in the NDG (22.6%) ($p < 0.001$). There were no differences between groups concerning levels of anxiety ($p = 0.123$) or parents' difficulty in imposing rules ($p = 0.560$) (Table 5).

More than half of the caregivers stated that the family burden was higher than usual during lockdown, with no

significant differences between the two groups ($p > 0.05$). The influence of the lockdown period on family dynamics and relationships is shown in table 5. There was a statistically significant improvement on family dynamics and relationships in the NDG (31.2% answered "relationships improved significantly") than in the CG (15.3%) ($p = 0.007$), and the impact on family relationships was more negative in the CG than in the NDG, as shown in table 5. The percentage of those who answered that they "remained as usual" was similar in both groups (42.9% in the CG and 45.2% in the NDG) (Table 5).

Discussion

Our study aimed to describe and understand the consequences of the lockdown period imposed by the COVID-19 pandemic on children with ND. This is one of the first studies in Portugal to compare children with ND to healthy children, concerning this issue.

The changes that the COVID-19 pandemic brought about worldwide were massive and the measures taken

Table 5. Characterization of children and comparison by group concerning data on overall health data and family environment

Characteristics	Total (n = 191)	Control Group (CG) (n = 98)	Neurodevelopment Disorders Group (NDG) (n = 93)	p
Negative impact on physical activity				
None	46 (24.2%)	15 (15.3%) [†]	31 (33.7%)*	0.010 [‡]
Little	32 (16.8%)	15 (15.3%)	17 (18.5%)	
Some	66 (34.7%)	38 (38.8%)	28 (30.4%)	
Significant	46 (24.2%)	30 (30.6%)*	16 (17.4%) [†]	
How were the child's anxiety levels during the lockdown?				
Less than usual	15 (7.9%)	4 (4.1%)	11 (11.8%)	0.123 [‡]
Same as usual	59 (30.9%)	30 (30.6%)	29 (31.2%)	
More than usual	117 (61.3%)	64 (65.3%)	53 (57.0%)	
Was it more difficult to impose rules than before the lockdown?				
Less than usual	13 (6.8%)	8 (8.2%)	5 (5.4%)	0.560 [‡]
Same as usual	94 (49.2%)	45 (45.9%)	49 (52.7%)	
More than usual	84 (44.0%)	45 (45.9%)	39 (41.9%)	
Did your child become more isolated than before the lockdown?				
Less than usual	17 (8.9%)	6 (6.1%)	11 (11.8%)	< 0.001 [‡]
Same as usual	104 (54.5%)	43 (43.9%) [†]	61 (65.6%)*	
More than usual	70 (36.6%)	49 (50.0%)*	21 (22.6%) [†]	
Influence on child's overall health				
Worsened	55 (28.8%)	31 (31.6%)	24 (25.8%)	0.001 [‡]
Remained the same	99 (51.8%)	58 (59.2%)*	41 (44.1%) [†]	
Since he/she has been at home, he/she is much better	37 (19.4%)	9 (9.2%) [†]	28 (30.1%)*	
Family burden				
Less than usual	5 (2.6%)	3 (3.1%)	2 (2.2%)	0.314 [‡]
Same as usual	28 (14.7%)	12 (12.2%)	16 (17.2%)	
Some days more, others unchanged	46 (24.1%)	24 (24.5%)	22 (23.7%)	
Higher than usual	112 (60.2%)	59 (60.2%)	53 (57.0%)	
Impact of COVID 19 on family dynamics and relationships				
Negative impact	63 (33.0%)	41 (41.8%)*	22 (23.7%) [†]	0.007 [‡]
Remained the same	84 (44.0%)	42 (42.9%)	42 (45.2%)	
Relationships have improved a lot	44 (23.0%)	15 (15.3%) [†]	29 (31.2%)*	

*Standardized adjusted residues > 1.96.

[†]Standardized adjusted residues < -1.96.[‡]Significance value of the Chi-square test.

to prevent the dissemination of the virus, namely remote working, school closures, and the prohibition of going outside for great distances, had a significant mental impact on families worldwide¹⁵⁻¹⁸.

During this period, most children had to completely change their routines and habits. They had to respect new rules that were being implemented, often without understanding them. This led to an inevitable disruption of their usual dynamics, which was more significant for children with neurodevelopmental pathologies who frequently need more support and attention^{15,19,20}.

In our study, we identified that during the lockdown period ND children were in the care of their parents during the day more than the CG. Since the age distribution was similar in the two groups, the ND group

probably needed more support given the overall difficulties and lack of autonomy²¹. Despite the lockdown requirements, both groups had periods when they went out, regardless of the type of housing, as shown by Amorim R²⁰. In the NDG, at least one parent did not work, which was statistically significant compared to the CG, in which most parents continued to work. Parents had to reorganize their family dynamics, and given the inherent needs of children with ND, it was frequently impossible for both parents to work.

As for access to therapies, similarly to other studies, about half of the children in the NDG did not have access to these during the lockdown period²². Among those who had, the vast majority could only have access to online therapies. More than half of the

parents felt that this lack of access had a major impact on their child's overall functioning. In fact, maintaining the child's regular therapies and special education routines creates a daily strategy and improves learning, along with cognitive and adaptive development^{21,23,24}.

Of the children in the NDG who had scheduled appointments during the lockdown periods, 19% had the appointment canceled and the rest had mostly remote-based appointments. Most parents (83.3%) said that they would have preferred to have had a face-to-face appointment, which demonstrates the importance of implementing a guidance plan for these children, as parents often felt unaccompanied without the option for face-to-face interaction. This demonstrates the importance of the doctor-patient relationship and the need for a more humanized interaction in supporting families during these times^{25,26}.

When we analyzed the impact on learning, despite most children in both groups maintaining online school activities, most parents considered the support provided was insufficient for learning. This negative impact was significantly higher in the NDG.

However, and surprisingly, in the NDG, even though parents thought that access to school and tools necessary for learning were insufficient, these parents believed that their child's school performance improved compared to the pre-lockdown period, which allows us to infer that parental support was essential to fill these gaps. Time was not scarce and according to the child's needs, they could assist them by revising school content, helping them focus, and they could also guide them with their home assignments and in acquiring new learning skills. These are children who, regardless of the diagnosis, have greater educational needs and to whom face-to-face and individualized support is essential for favorable development²⁷. This is corroborated by international studies that show how individualized education plans for children with special needs are crucial^{20,21,28,29}. Online school lacks face-to-face interaction, it is more difficult to remain motivated, and sometimes there are technical problems. Moreover, caretaking responsibilities provided only by the family can be overwhelming and have a negative impact on remote learning in this group^{30,31}. Parental support for school learning was more necessary in the NDG, which would be expected, given the inherent needs of this group with lower cognitive abilities, less autonomy, and more inattention. We can speculate that the presence and involvement of parents in school tasks may have been an important factor in the empowerment and academic performance improvement of children as well as the reduction in school-related anxiety. As already demonstrated in other studies, parental involvement

could be a significant predictor of a child's academic performance, as a higher parental involvement contributed to an increase in a child's perceived level of competence³². Parents also noticed minor learning improvements that otherwise would not have been perceived by caregivers in a normal daily routine.

When we evaluated the impact of the lockdown on physical activity, we found that the group without ND reported a statistically significant negative impact, similarly to what was observed in other studies^{10,33,34}. This may likely have an impact on obesity in future studies. The COVID-19 pandemic disrupted eating behaviors, as many children rely on school meals to ensure adequate nutrition and these meals came to an end during the lockdown period^{35,36}. A study conducted by the Center for Disease Control in a population between two and 19 years of age showed that the body mass index ratio doubled from pre-pandemic to pandemic periods, with a greater increase in children with pre-pandemic obesity or overweight than in healthy children³⁷. The group without pathologies may have had more investment in pre-lockdown physical activity, making parents feel a major impact, which corroborates the studies that describe the caregivers' perceptions of new acute-onset obesity³⁸.

Concerning changes in behavior during the lockdown, we found that the CG was more isolated compared to the group with pathologies. In children with ND, there are often socializing problems that lead to isolation³⁹. We could consider different features of the NDG to explain this result. For example, children with ADHD may have difficulties in socialization *a priori*⁴⁰, given that one of the main consequences of ADHD is inattention that ends up causing poor school results, difficulties in maintaining friendships, and being neglected or ignored, resulting in isolation. Therefore, the perception that parents had of isolation was no different from usual. Children with ASD have persistent deficits in social communication and social interaction⁴¹, which could enlighten us as to why having less contact with peers did not make them more isolated, since these children have a lower interest in maintaining relationships³¹.

The COVID-19 pandemic drastically changed the routines of both the children and their parents. Undoubtedly, the lockdown period contributed to increased parental anxiety and disruption in family relationships⁴²⁻⁴⁵. However, this time of adversity could also be seen as a way to create new opportunities, strengthen relationships, and have positive effects on children and adolescents.

Contrary to what we initially believed, our results revealed that, despite the unfavorable conditions

expected from the lockdown, about 30% of the parents in the NDG reported an improvement in the child's overall health, as well as in intra-family relationships. When compared with the CG's results, these were statistically significant. These results differed from those of another study, regarding the impact of the first lockdown on healthy children aged one to three, which stated that 95.4% of parents claimed that their child's overall health improved or remained the same as in the pre-lockdown period⁴⁶. Another study, regarding the impact on relationships in families with children with ASD found that 44.2% of the parents reported a positive impact on family relationships, compared to 18.6% who perceived a negative impact²⁰. One could hypothesize that being a child with a ND requires more attention, and being able to spend more time with a parent could have improved the relationship. A recently published study compared psychological distress caused by COVID-19 in parents of children with normal developmental progress with that in parents of children with ASD, and the latter group revealed more symptoms of depression and anxiety during the pandemic period⁴⁷. However, as our study showed, some parents stated that, in some cases, a lockdown period could be perceived as a positive experience from which conclusions could be drawn to lessen the impact on mental wellbeing⁴⁸. Parents could identify more rewarding aspects versus challenging or negative aspects of the lockdown, improving their resilience, and thus protecting against the potential negative psychological impact of the lockdown. If the caregiver had psychological flexibility, he or she would be able to cope better with the stressful events of the pandemic and this attitude would improve their capacity to recognize positive feelings in the "minor things"⁴⁸.

A pandemic may increase parents' risk for stress, social distancing, and loss of assurance⁴⁹. Similarly to our results that stated that there was a negative impact on family dynamics and relationships in the CG, other published studies showed that, due to the lockdown, there was an increase in depressive symptoms and a high prevalence of emotional disturbance, stress, low mood, irritability, and insomnia in parents, which could negatively influence family dynamics⁵⁰⁻⁵². In addition, unemployment or a change of work organization, the inability to cope with new routines, and online teaching without adequate equipment or learning tools can trigger stressful events and worsen family relationships and create emotional disturbances.

Although children with ND are more anxious *per se*, especially when there is a break in routine^{21,41}, our results revealed that the perceived anxiety was similar in both groups. These results were somewhat

surprising. Some studies, one of which took place in Portugal, showed that children with ASD revealed statistically significant higher anxiety levels compared to those of a control group, which also had a direct impact on their behavior²⁰.

As expected, our results showed that the family burden was high in both groups during the lockdown period and it may reflect external family stress, as well as financial difficulties, lack of external support, mental health issues, increased everyday responsibilities, and these results were similar to what some studies stated^{21,53,54}. Therefore, better guidance about suitable and supportive practices, medical care, and school services could be needed in order to improve coping strategies and to manage a lockdown situation²³.

Our findings will hopefully help improve further strategies implemented in a hypothetical future lockdown period. They will also be important in understanding the potential consequences of the pandemic in this vulnerable group.

Nonetheless, our study also presented some limitations. The data collected was answered by parents rather than reported by children directly, which can be biased because there is always a subjective perception. Moreover, during the implementation of our questionnaire, there were two lockdown periods, and the questionnaires did not specify which period the parents were responding to. Also, we did not evaluate each neurodevelopmental disorder separately, but rather as a group, despite the large heterogeneity between ND. Furthermore, when we assessed the impact of the lockdown period on therapies, we did not individualize each type of therapy, but approached therapies in general because our objective was to assess the impact from therapies having been online instead of face-to-face.

Conclusion

This study provided evidence of the impact of the lockdown period and its consequences on children with ND. A pandemic can create unexpected problems but also unforeseen solutions.

The COVID-19 pandemic caused unparalleled health and humanitarian crises, affecting all aspects of everyday life. In short, our study showed it was the group of children with ND that needed more parental care, and in which at least one parent did not work, becoming fully available for overall care. Although access to face-to-face therapeutic intervention was deficient and had an impact on general functioning, parental involvement in supporting children with pathologies was perceived

as positive and decisive for the child's overall health. We can speculate that the opportunity for family involvement had a positive effect on overall functional performance and on intra-family relationships, particularly on children with pathologies, which emphasizes the need to rethink the organization of family working time. There should be more measures in place to minimize the impact that a lockdown has on children with special needs, especially among those in need of therapies.

Further studies are needed to evaluate the real long-term impact of the lockdown period on children with ND.

Authors' contribution

For all: Idea behind, and design of, the study, report, review or other type of paper. Data acquisition from patients, research studies, or literature. Analysis or interpretation of data from patients, research studies, or literature. Drafting the article. Critical review of the article for important intellectual content. Final approval of the version to be published. Agreement to be held accountable for the accuracy or integrity of the paper.

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Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

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Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

Use of artificial intelligence for generating text. The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript, nor for the creation of images, graphics, tables, or their corresponding captions.

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