REVISTA CIÊNCIAS EM SAÚDE
HEALTH SCIENCES JOURNAL e-ISSN 2236-3785

ORIGINAL ARTICLE

Spinal muscular atrophy: health-related quality of life and burden to parents

Atrofia muscular espinhal: qualidade de vida relacionada à saúde e sobrecarga aos pais

Lucas Sinesio Santos[1], Vinícius Lopes da Silva[1], Vanessa Ariane Neves[1], Emmily Santos Ribeiro[1], Maria Heloyse Martins de Lima Silva[1], Gabriela Lopes Gama[1,2,*]

[1]*UNIFACISA University Center. Campina Grande, Paraíba, Brazil.*
[2]*Research Institute Professor Joaquim Amorim Neto. Campina Grande, Paraíba, Brazil.*

Received 24 Aug 2022, accepted 27 Nov 2022, published 10 Dec 2022.

KEYWORDS

Caregivers
Neuromuscular diseases
Physical therapy specialty

ABSTRACT

Objective: To analyze the relationship between the quality of life (QoL) of children and adolescents with Spinal Muscular Atrophy (SMA) and the burden on their parents.
Methods: A cross-sectional study with 64 parents (53 women) of children and adolescents with SMA was conducted through an online questionnaire. Health-related QoL of children and adolescents with SMA according to the parents was evaluated using PedsQL 4.0, and Zarit Burden Interview (ZBI) was used to assess the burden on the parents. Correlation and association tests evaluated the relationship between the QoL of individuals with SMA, the burden on parents, and the factors related to these variables.
Results: Parents aged between 21 and 52 years (mean 36.9 ± 7.3 years) were evaluated, of which 62.5% had a moderate burden. PedsQL 4.0 total score ranged from 19.6 to 93.5 points, and ZBI from 8 to 57 points. A negative correlation was observed between these variables ($r = -0.4$; $p = 0.001$). Furthermore, ZBI scores were related to the education level of parents (rho = 0.3; $p = 0.02$), changes in emotional or psychological health caused by SMA diagnosis in parents (rho = -0.4; $p = 0.004$), and family income (rho = 0.3; $p = 0.03$).
Conclusion: Health-related QoL in children and adolescents with SMA was related to the burden on their parents. This highlights the importance of therapeutic programs focused on individuals with SMA, as well as the needs of their parents.

*Corresponding author:
Centro Universitário UNIFACISA
Addr.: Rua Rodrigues Alves, 413, Apto. 1506, Prata. Campina Grande, Paraíba, Brazil | CEP: 58.400-550
Phone: +55 (83) 99615-3555
E-mail: gabilopes_@hotmail.com (Gama GL)

The study was conducted at UNIFACISA University Center.

https://doi.org/10.21876/rcshci.v12i4.1340

How to cite this article: Santos LS, Silva VL, Neves VA, Ribeiro ES, Silva MHML, Gama GL. Spinal muscular atrophy: health-related quality of life and burden to parents. Rev Cienc Saude. 2022;12(4):35-41. https://doi.org/10.21876/rcshci.v12i4.1340

PALAVRAS-CHAVE

Cuidadores
Doenças neuromusculares
Especialidade de fisioterapia

RESUMO

Objetivo: Analisar a relação entre a qualidade de vida (QdV) de crianças e adolescentes com Atrofia Muscular Espinhal (AME) e a sobrecarga em seus pais.
Métodos: Estudo transversal com 64 pais (53 mulheres) de crianças e adolescentes com AME avaliados por meio de questionário online. A QdV relacionada à saúde de crianças e adolescentes com AME na percepção dos pais foi avaliada por meio do PedsQL 4.0, e a Zarit Burden Interview (ZBI) foi utilizada para avaliar a sobrecarga nos pais. Testes de correlação e associação foram utilizados para avaliar a relação entre a QdV dos indivíduos com AME e a sobrecarga dos pais, bem como fatores relacionados.
Resultados: Foram avaliados pais com idade entre 21 e 52 anos (média de idade 36,9 ± 7,3 anos), dos quais 62,5% apresentavam sobrecarga moderada. O escore total do PedsQL 4.0 variou de 19,6 a 93,5 pontos e o ZBI de 8 a 57 pontos. Foi observada correlação negativa entre essas variáveis (r = -0,4; p = 0,001). Além disso, os escores do ZBI foram relacionados com a escolaridade dos pais (rho = 0,3; p = 0,02), alterações na saúde emocional e/ou psicológica causadas pelo diagnóstico de AME nos pais (rho = -0,4; p = 0,004) e renda familiar (rho = 0,3; p = 0,03).
Conclusão: A QdV relacionada à saúde em crianças e adolescentes com AME esteve relacionada à sobrecarga em seus pais. Destaca-se a importância de programas terapêuticos focados em indivíduos com AME, bem como as necessidades de seus pais.

INTRODUCTION

Spinal Muscular Atrophy (SMA) is an autosomal recessive neuromuscular disease related to a mutation of SMN1 and SMN2 genes responsible for producing SMN protein, which is needed for motor neuron survival[1]. This genetic mutation led to lower motor neuron degeneration in the spinal cord anterior horn and brainstem nuclei, modifying functions of many organs and systems[2]. Its most evident clinical sign is symmetrical proximal weakness or paresis of peripheral and trunk muscles, which can lead to activity limitations, participation restrictions, and impairment in quality of life (QoL)[3].

SMA classification is based on the age of symptoms onset and motor milestones reached during the infant's neuromotor development. The symptoms of SMA type I can be observed before 6 months of life, marked by children's inability to sit. Those individuals with SMA type II can sit; however, they do not get independent gait, and symptoms usually start between 6 and 18 months of life[4]. SMA type III is characterized by the child or adolescent independent gait once symptoms begin after 18 months of life. In SMA type IV, symptoms begin only in adulthood, and life expectancy is longer when compared to individuals diagnosed with SMA type I[5].

Individuals with neuromuscular diseases often require continuous care from family or caregivers. Such care demands changes in the professional and social routine of family and caregivers, which can be related to serious physical, mental, emotional, and socioeconomic consequences[6,7]. Alternatively, these diseases can directly compromise the QoL in diagnosed individuals. A study conducted by Yao et al.[8] observed that children with SMA type I and II had a greater QoL impairment than those with SMA type III. However, no study has focused on the relationship between QoL in individuals with SMA and the burden on their parents, especially in developing countries such as Brazil.

Therefore, this study analyzed the relationship between QoL in children and adolescents with SMA and the burden on their parents. A relationship between these variables is hypothesized, which may suggest the need for therapeutic interventions focused on individuals with SMA and their parents.

METHODS

This was an exploratory, observational, cross-sectional, and quantitative study. This study was performed according to the principles of the Declaration of Helsinki and Brazilian CNS Resolution 466/2012. Approval was granted by the Ethics Committee of the Center for Higher Education and Development (CESED) (CAAE: 43772321.7.0000.5175; decision nr. 4.626.131/2021) and all participants signed an informed consent form.

Sample

The sample of Brazilian parents of children and adolescents with SMA was selected using non-probability convenience sampling. The inclusion criteria were parents of children or adolescents between 2 and 18 years who had access to social media. Individuals who inappropriately answered the instrument of data collection were not considered in analyses.

Data collection

Data was collected between April and August 2021 using an online questionnaire. The 'snowballing' strategy was used to recruit participants through social media (*Instagram*, *WhatsApp*, and *Facebook*). At first contact, parents were invited to participate in the study. A questionnaire was sent for data collection to those who agreed to participate and signed the consent form.

The questionnaire employed was subdivided into three sections. The first, with questions about general and sociodemographic characteristics of parents, such as date of birth, schooling, and family income. The second, with questions about general and clinical characteristics of the child or adolescent with SMA, such as age, sex, and type of SMA. The third, with questions related to drug treatment, such as access to Spinraza® (Biogen

Idec, Weston, Florida, USA) and the number of received doses, as well as details about physical therapy treatment, such as age at treatment start and importance of physical therapy treatment in the opinion of parents.

The health-related QoL assessment in children and adolescents with SMA, according to the parents' perception, was performed using the Brazilian version of the Pediatric Quality of Life Inventory (PedsQL 4.0) questionnaire. This instrument consists of a 23 items scale divided into four domains: physical (eight items), emotional (five), social (five), and scholar (five). In this questionnaire, participants should indicate how much difficulty their child with SMA had in each domain, using an ordinal scale between 0 (never have difficulty) and 4 (almost always have difficulty). The total score of PedsQL 4.0 could range between 0 and 100, where higher scores are related to better QoL[9].

The Brazilian version of the Zarit Burden Interview (ZBI) scale was used to evaluate the burden on parents. This scale consists of 22 questions that objectively and subjectively measure the burden on parents/caregivers based on self-assessment in domains: health, social and personal life, financial condition, interpersonal relationships, and well-being as emotional and behavioral aspects. Each item should be scored on an ordinal scale between 0 (never) and 4 (always) points, with a higher total score related to a greater burden[10]. Based on this score, the level of burden was classified as low (scores from 0 to 20 points), moderate (21 to 40 points), moderate to severe (41 to 60 points), and severe (61 to 88 points)[11].

Statistical analysis

Descriptive statistics were conducted using mean and standard deviation for continuous, and relative and absolute frequencies for categorical variables. Pearson's correlation test was performed to assess the relationship between health-related QoL in children and adolescents and the burden on their parents. *One-way* analysis of variance (ANOVA) with Bonferroni adjustment was performed to compare the health-related QoL in children and adolescents with SMA and the burden on their parents among individuals diagnosed with different types of SMA. Pearson's correlation and Spearman's association tests were performed to verify factors related to health-related QoL in children and adolescents with SMA (PedsQL total score) and burden in their parents (ZBI total score). Statistical analysis was performed using MedCalc version 17.9.7, and the significance level was established at 5%.

RESULTS

The sample comprised 64 parents of children and adolescents with SMA (53 women) between 21 and 52 years (36.9 ± 7.3 y). Thirty-seven (57.8%) were married, 35 (54.7%) had only one child, 33 (51.6%) had completed higher education, 26 (40.6%) had a monthly income below R$ 1.212,00, and 22 (34.4%) lived in Brazilian Northeast region. Children or adolescents diagnosed with SMA whose parents were evaluated aged between 2 and 17 years (6.3 ± 4.2 y), 32 (50%) were girls, and 40 (62.5%) had SMA type I. SMA diagnosis was confirmed between 1 and 96 months of life (15.2 ± 17.8 months). Table 1 shows the general and sociodemographic characteristics of participants and their children with SMA.

Table 1 — General and sociodemographic characteristics of parents and their children with SMA.

Characteristics	n (%)
Of parents	
Relatives with child	
Father	11 (17.2)
Mother	53 (82.8)
Age (years); mean (SD)	36.9 (7.3)
Range	21-52
Education level completed	
No schooling	6 (9.4)
Elementary school	5 (7.8)
High school	20 (31.2)
Completed university	33 (51.6)
Marital Status	
Single	12 (18.7)
Married	37 (57.8)
Divorced	3 (4.7)
Widower	1 (1.6)
Stable union	11 (17.2)
Region	
North East	22 (34.4)
North	4 (6.2)
Midwest	8 (12.6)
South	9 (14)
Southeast	21 (32.7)
Number of children	
1	35 (54.7)
2	18 (28.1)
3	8 (12.5)
> 3	3 (4.7)
Per capita income (minimum wage*)	
< 1	2 (3.1)
1	26 (40.6)
2 - 4	17 (26.6)
> 5	19 (29.7)
Of children/adolescents	
Sex	
Male	32 (50)
Female	32 (50)
Age (years); mean (SD)	6.3 (4.2)
Range	2-17
Age of diagnosis (months); mean (SD)	15.2 (17.8)
Range	1-96
SMA type	
I	40 (62.5)
II	21 (32.8)
III	3 (4.7)

SD, standard deviation. SMA, spinal muscular atrophy. *Brazilian minimum wage, R$ 1.212,00.

The main challenges reported by parents after SMA diagnosis were dealing with uncertainties about the future of children (64.1%; n = 41), financial conditions to pay for treatments (57.8%; n = 37), understanding what SMA is (57.8%; n = 37), founding specialized physical therapy treatment (43.7%; n = 28), accepting that perhaps their children would never be physically independent (26.6%; n = 17), diagnosis confirmation (21.9%; n = 14), dealing with situations of prejudice and social embarrassment (15.6%; n = 10) and understanding that their children were different (14.1%; n = 9).

SMA diagnosis changed the family routine of 63 (98.4%) and work routine of 51 participants (79.7%); 19 (29.7%) reduced working hours, and 32 (50%) left work to take care of their children with SMA. When asked about their emotional and physical health, 44 parents (68.7%) reported that the diagnosis of SMA negatively affected their emotional or psychological health, and 28 (43.7%) were diagnosed with any physical health problems resulting from the care of their children with SMA.

Regarding treatments currently performed by children or adolescents with SMA, 58 (90.6%) are attended by physical therapists, 48 (75%) by nutritionists, 47 (73.4%) by speech therapists, 40 (62.5%) by occupational therapists, 17 (26.6%) by educational psychologists and 2 (3.1%) by physical education professionals. Physical therapy started on average at 11.3 ± 11.1 months of life, and 62 participants (96.9%) considered this treatment very important for their children.

Regarding physical therapy results, 54 parents (84.4%) reported that the health status of their children improved significatively, 8 (12.5%) reported a reasonable improvement and only 2 parents (3.1%) reported little improvement. The drug Spinraza® was used by 52 (81.2%) children or adolescents, taking an average of 7.3 ± 4.9 doses.

Analyzing the health-related QoL in children and adolescents with SMA, the total score of PedsQL 4.0 ranged from 19.6 to 93.5 points (51.7 ± 16.6 points). The mean scores for each domain were 31.1 ± 24.6 for physical health, 55.2 ± 20.1 for psychosocial health, 69.3 ± 7.6 for emotional aspects, 55.2 ± 20.1 for the social aspect, and 64.7 ± 34.4 for the school aspect. Children and adolescents with SMA type I had significantly lower scores in the school aspect compared to those diagnosed with SMA type II.

The burden on parents assessed by the ZBI scale presented a total score ranging from 8 to 57 points (30.1 ± 11.9 points). Based on these scores, 12 participants (18.8%) were classified as low, 40 (62.5%) as moderate, and 12 (18.8%) with moderate to severe burden. No significant differences were observed in the ZBI scores between the parents of children and adolescents diagnosed with different types of SMA. Table 2 presents PedsQL 4.0 and ZBI scores according to the SMA type.

A negative correlation was observed between the ZBI total score and the PedsQL 4.0 total score (r = -0.4; p = 0.001) when a better health-related QoL was related to a lower level of burden of parents. In addition, evaluating each PedsQL 4.0 dimension, the burden in parents was related to health-related QoL domains: physical (r = -0.4; p = 0.003), psychosocial (r = -0.3; p = 0.01), emotional (r = -0.4; p = 0.002) and social aspect (r = -0.3; p = 0.007).

Considering other factors related to burden in parents and their children health-related QoL only the education level of parents (rho = 0.3; p = 0.02), changes in emotional or psychological health caused by SMA diagnosis (rho = -0.4; p = 0.004) and family income (rho = 0.3; p = 0.03) were related to total ZBI score. None of the analyzed factors were related to PedsQL 4.0 total score (Table 3).

Table 2 — Quality of life and parent's burden according to the type of SMA.

Variable	Types of SMA			p-value
	Type I	Type II	Type III	
Quality of life				
Physical health	30.9 ± 24.7	30.4 ± 25.6	38.5 ± 20.8	0.9
Psychosocial health	60.5 ± 16.6	67.6 ± 15.6	71.1 ± 16	0.2
Emotional aspect	71.1 ± 16.7	65.2 ± 18.6	73.3 ± 23.6	0.4
Social aspect	53.1 ± 19	57.4 ± 23	66.7 ± 5.8	0.4
School aspect	55.9 ± 37.4	80.1 ± 23.6	73.3 ± 20.2	0.03
Total score	49.7 ± 16.5	54.5 ± 17.7	59.8 ± 7.1	0.4
Parents burden				
Total score	30.8 ± 12.1	29.7 ± 12.3	24.3 ± 0.6	0.7

SMA, spinal muscular atrophy. *One-way* ANOVA.

DISCUSSION

This study aimed to analyze the relationship between health-related QoL in children and adolescents with SMA and the burden on their parents. From the parents' perspective, children with SMA had a satisfactory health-related QoL, and most parents had a moderate burden. In addition, the burden on parents was related to health-related QoL in the child, the parent's education level, changes in emotional or psychological health in parents, and family income. Therefore, the hypothesis initially raised was confirmed when a better health-related QoL of children and adolescents with SMA was related to a lower level of burden on their parents.

According to Lin, Kalb, and Yeh (2015), the time of SMA diagnosis seems to be decisive for the children's development, and the level of burden on caregivers

Table 3 — Factors related to the ZBI scale and PedsQL 4.0 questionnaire scores.

Evaluated factors	ZBI Score			PedsQL Score		
	Rho/r	CI 95%	p-value	Rho/r	CI 95%	p-value
Gender	0.1	-0.1 - 0.3	0.4	-0.1	-0.4 - 0.1	0.3
Child/adolescent age	0.1	-0.2 - 0.3	0.6	0.04	-0.2 - 0.3	0.8
Parents age	0.1	-0.1 - 0.3	0.4	0.1	-0.2 - 0.3	0.6
Age at diagnosis	-0.03	-0.3 - 0.2	0.8	0.2	-0.1 - 0.4	0.2
Age of physical therapy initiation	-0.1	-0.3 - 0.1	0.4	0.03	-0.2 - 0.3	0.8
Education level of parents	0.3	0.1 - 0.5	0.02	-0.03	-0.3 - 0.2	0.8
Family income	0.3	0.03 - 0.5	0.03	-0.1	-0.3 - 0.1	0.4
Change in the family routine	-0.2	-0.4 - 0.03	0.1	0.2	-0.1 - 0.4	0.1
Change in the work routine	-0.1	-0.4 - 0.1	0.4	0.004	-0.2 - 0.3	0.9
Number of children	-0.2	-0.4 - 0.1	0.2	-0.007	-0.3 - 0.2	0.9
SMA type	-0.1	-0.3 - 0.2	0.5	0.2	-0.1 - 0.4	0.2
Social support	-0.03	-0.3 - 0.2	0.8	-0.03	-0.3 - 0.2	0.8
Acess to Spinraza® drug	-0.1	-0.3 - 0.2	0.5	-0.2	-0.4 - 0.03	0.1
Access to physical therapy	0.04	-0.2 - 0.3	0.8	-0.05	-0.3 - 0.2	0.7
Emotional impact	-0.4	-0.6 - -0.1	0.004	0.01	-0.2 - 0.3	0.9
Physical impact	-0.2	-0.4 - 0.04	0.1	0.2	-0.1 - 0.4	0.1
Accept dependency of children	-0.2	-0.5 - 0.004	0.1	0.1	-0.2 - 0.3	0.6

SMA, spinal muscular atrophy. ZBI, zarit burden interview scale. PedsQL 4.0, pediatric quality of life inventory questionnaire. rho, Spearman's correlation coefficient. r, Pearson's correlation coefficient. CI, confidence interval.

seems to be related to the type of SMA. Furthermore, according to these authors, most individuals are diagnosed with SMA type I, and the average date of diagnosis confirmation is 6.3 ± 2.2 months of life[12]. In the present study, however, children and adolescents whose parents were evaluated had an average of 15.2 ± 17.8 months of life at diagnosis confirmation. A hypothesis that may explain this delay is the family's financial conditions, which makes accessing specialized health services complex and can improve the burden on parents. This hypothesis, however, cannot be confirmed based on the present study results, suggesting the need for future studies that analyze the influence of socioeconomic factors on the diagnosis and treatment of individuals with SMA in developing countries such as Brazil.

Most parents reported that understanding SMA was one of the difficulties faced after diagnosis confirmation. This difficulty was previously described not only by parents of individuals with SMA[13] but also by caregivers of children with Duchenne and Becker Muscular Dystrophy[14] and Autism Spectrum Disorder (ASD)[15]. Specifically regarding SMA, there is insufficient knowledge of its characteristics which can have consequences for the affected individuals and their families. This is because the lack of knowledge can limit the continuity of care, increase the burden on parents, and compromise diagnosed individual health-related QoL[16]. On the other hand, in-depth knowledge about this disease may favor searching for specialized treatment, improve family communication and reduce suffering in parents[17].

Another difficulty reported by evaluated parents was dealing with uncertainties regarding their children's future. The birth of a child is involved in many expectations; however, the diagnosis of a progressive disease requires readaptation of the family and is associated with frustration and sadness feelings[18]. These feelings were also reported by parents of children with ASD[19] and can be aggravated by a lack of knowledge about the disease, pointing out the importance of expanding discussions about this topic[20].

Dunaway et al.[21] mentioned physical therapy as a promising intervention for individuals with SMA and recommended that therapeutic programs should contain sessions of at least 30 minutes with a minimum frequency of two sessions per week. Perhaps, for this reason, most children and adolescents, whose parents were evaluated here, are accompanied by physical therapists, and started treatment with this professional even before the diagnosis confirmation. This seems to be a typical attitude in parents of children and adolescents with progressive diseases when any delay in motor development or motor function is identified[22]. Specifically for individuals with SMA, early physical therapy may also be related to the best therapeutic window described in the literature[23]. Those benefits can be reinforced by the results of this study, where most parents felt satisfied and classified physical therapy treatment as very important for their children.

Despite the increase in men's participation in family routines, women are still considered the main caregivers and responsible for most tasks related to the care of their children with some type of illness[24]. Specifically for parents of children and adolescents with SMA, mothers' dedication to children's care can increase their risk for health problems and reduce productivity at work[25]. This is because the progressive and degenerative nature of SMA requires active caregiver participation in care, often demanding dealing with social, financial, and

emotional difficulties[26]. In this way, the emotional impact of SMA related to higher levels of burden observed in parents in this study suggests being considered in treatment programs of individuals with SMA once the level of burden in parents can directly reflect on the care of their child.

The impacts of chronic and progressive pediatric diseases represent a global public health problem, with severe repercussions on the psychosocial health of parents, being associated with exhaustion and sleep disturbance[27]. In the study of McMillan et al., which evaluated SMA individuals and their caregivers, a high level of burden in caregivers and impaired QoL in parents and children were observed. However, the relationship between these variables was not reported[28]. Previous studies also reported the need to understand this relationship[29], which was analyzed in the present study and showed that health-related QoL in individuals with SMA is inversely related to the physical and psychosocial burden on their parents.

These findings point to the importance of creating therapeutic programs not just for individuals with SMA but also for their parents and caregivers. Have a welcoming look at the needs of parents seen as essential for upgrading the quality of health care, which can directly interfere with health-related QoL in individuals with SMA. Thus, it is suggested actions that minimize the multidimensional impacts arising from SMA not only for the diagnosed individuals but also for their parents.

Despite the relevance of these results, this study has some limitations. First, as this was an online survey, parents who did not have access to virtual media were not included. Second, the age-related eligibility criteria excluded parents of older individuals with SMA. Third, the small number of participants may limit generalizations. Despite these limitations, this study highlights essential repercussions of SMA on physical, emotional, and social aspects of affected individuals and their parents, in addition to highlighting the need for therapeutic actions focused not only on diagnosed individuals but also on their parents.

CONCLUSION

Health-related QoL in children and adolescents with SMA was related to the burden on their parents. The main difficulties reported by parents after SMA diagnosis were the lack of knowledge, financial condition to pay for the child's treatment, and uncertainties about their child's future with SMA. Thus, effective health education actions and interventions focused on parents are necessary to minimize the impacts of SMA diagnosis and consequently improve the health status of children and adolescents with this diagnosis.

REFERENCES

1. Kolb SJ, Kissel JT. Spinal Muscular Atrophy. Neurol Clin. 2015;33(4):831-46. https://doi.org/10.1016/j.ncl.2015.07.004
2. Ross LF, Kwon JM. Spinal Muscular Atrophy: Past, Present, and Future. Neoreviews. 2019;20(8):e437-e51. https://doi.org/10.1542/neo.20-8-e437
3. Nash LA, Burns JK, Chardon JW, Kothary R, Parks RJ. Spinal Muscular Atrophy: More than a Disease of Motor Neurons? Curr Mol Med. 2016;16(9):779-92. https://doi.org/10.2174/1566524016666161128113338
4. Oskoui M, Kaufmann P. Spinal muscular atrophy. Neurotherapeutics. 2008;5(4):499-506. https://doi.org/10.1016/j.nurt.2008.08.007
5. Schorling DC, Pechmann A, Kirschner J. Advances in Treatment of Spinal Muscular Atrophy - New Phenotypes, New Challenges, New Implications for Care. J Neuromuscul Dis. 2020;7(1):1-13. https://doi.org/10.3233/JND-190424
6. Martínez-Jalilie M, Lozano-Arango A, Suárez B, Born M, Jofré J, Diemer M, et al. Sobrecarga del cuidador de pacientes con atrofia muscular espinal. Rev Med Clin Condes. 2020;31(3-4):358-66. https://doi.org/10.1016/j.rmclc.2020.04.006
7. Pousada T, Groba B, Nieto-Riveiro L, Pazos A, Diez E, Pereira J. Determining the burden of the family caregivers of people with neuromuscular diseases who use a wheelchair. Medicine (Baltimore). 2018;97(24):e11039. https://doi.org/10.1097/MD.0000000000011039
8. Yao M, Ma Y, Qian R, Xia Y, Yuan C, Bai G, et al. quality of life of children with spinal muscular atrophy and their caregivers from the perspective of caregivers: a Chinese cross-sectional study. Orphanet J Rare Dis. 2021;16(1):7. https://doi.org/10.1186/s13023-020-01638-8
9. Klatchoian DA, Len CA, Terreri MTR, Silva M, Itamoto C, Ciconelli RM, et al. Qualidade de vida de crianças e adolescentes de São Paulo: confiabilidade e validade da versão brasileira do questionário genérico Pediatric Quality of Life InventoryTM versão 4.0. J Pediatr (Rio J). 2008;84:308-15. https://doi.org/10.1590/S0021-75572008000400005
10. Scazufca M. Brazilian version of the Burden Interview scale for the assessment of burden of care in carers of people with mental illnesses. Braz J Psychiatry. 2002;24:12-7. https://doi.org/10.1590/S1516-44462002000100006
11. Barros ALO, Barros AO, Barros GLdM, Santos MTBR. Sobrecarga dos cuidadores de crianças e adolescentes com Síndrome de Down. Cienc Saúde Colet. 2017;22:3625-34. https://doi.org/10.1590/1413-812320172211.31102016
12. Lin CW, Kalb SJ, Yeh WS. Delay in Diagnosis of Spinal Muscular Atrophy: A Systematic Literature Review. Pediatr Neurol. 2015;53(4):293-300. https://doi.org/10.1016/j.pediatrneurol.2015.06.002
13. Hjorth E, Kreicbergs U, Sejersen T, Jeppesen J, Werlauff U, Rahbek J, et al. Bereaved parents more satisfied with the care given to their child with severe spinal muscular atrophy than nonbereaved. J Child Neurol. 2019;34(2):104-12. https://doi.org/10.1177/0883073818811544
14. Ahmed HM, Advani R, Arif AA, Khan S. An Assessment of the Knowledge, Attitudes, and Practices of Patients and Families with Diagnoses of Hereditary Neuromuscular Disorders. Neuroepidemiology. 2020;54(3):265-71. https://doi.org/10.1159/000505330
15. Soares APT, da Silva BM, Santos LS, Gama GL. Transtorno do Espectro Autista (TEA): Conhecimento e Sobrecarga dos Pais. Rev Saúde Desenvol Humano. 2020;8(3):9-16. https://doi.org/10.18316/sdh.v8i3.6971
16. Meldrum C, Scott C, Swoboda KJ. Spinal muscular atrophy genetic counseling access and genetic knowledge: parents' perspectives. J Child Neurol. 2007;22(8):1019-26. https://doi.org/10.1177/0883073807305672
17. Pieper E, Sexton A, Ryan MM, Forbes R. Communication about spinal muscular atrophy and genetic risk within families: An Australian pilot study. J Paediatr Child Health. 2020;56(8):1263-9. https://doi.org/10.1111/jpc.14915
18. Caicedo C. Families with special needs children: family health, functioning, and care burden. J Am Psychiatr Nurses Assoc. 2014;20(6):398-407. https://doi.org/10.1177/1078390314561326
19. Gomes PT, Lima LH, Bueno MK, Araujo LA, Souza NM. Autism in Brazil: a systematic review of family challenges and coping

strategies. J Pediatr (Rio J). 2015;91(2):111-21. https://doi.org/10.1016/j.jped.2014.08.009
20. Qian Y, McGraw S, Henne J, Jarecki J, Hobby K, Yeh WS. Understanding the experiences and needs of individuals with Spinal Muscular Atrophy and their parents: a qualitative study. BMC Neurol. 2015;15:217. https://doi.org/10.1186/s12883-015-0473-3
21. Dunaway S, Montes J, McDermott MP, Martens W, Neisen A, Glanzman AM, et al. Physical therapy services received by individuals with spinal muscular atrophy (SMA). J Pediatr Rehabil Med. 2016;9(1):35-44. https://doi.org/10.3233/PRM-160360
22. Lawton S, Hickerton C, Archibald AD, McClaren BJ, Metcalfe SA. A mixed methods exploration of families' experiences of the diagnosis of childhood spinal muscular atrophy. Eur J Hum Genet. 2015;23(5):575-80. https://doi.org/10.1038/ejhg.2014.147
23. Govoni A, Gagliardi D, Comi GP, Corti S. Time Is Motor Neuron: Therapeutic Window and Its Correlation with Pathogenetic Mechanisms in Spinal Muscular Atrophy. Mol Neurobiol. 2018;55(8):6307-18. https://doi.org/10.1007/s12035-017-0831-9
24. Khanna AK, Prabhakaran A, Patel P, Ganjiwale JD, Nimbalkar SM. Social, Psychological and Financial Burden on Caregivers of Children with Chronic Illness: A Cross-sectional Study. Indian J Pediatr. 2015;82(11):1006-11. https://doi.org/10.1007/s12098-015-1762-y
25. Riffin C, Van Ness PH, Wolff JL, Fried T. Multifactorial Examination of Caregiver Burden in a National Sample of Family and Unpaid Caregivers. J Am Geriatr Soc. 2019;67(2):277-83. https://doi.org/10.1111/jgs.15664
26. Toledano-Toledano F, Moral de la Rubia J. Factors associated with anxiety in family caregivers of children with chronic diseases. Biopsychosoc Med. 2018;12:20. https://doi.org/10.1186/s13030-018-0139-7
27. Toledano-Toledano F, Luna D. The psychosocial profile of family caregivers of children with chronic diseases: a cross-sectional study. Biopsychosoc Med. 2020;14:29. https://doi.org/10.1186/s13030-020-00201-y
28. McMillan HJ, Gerber B, Cowling T, Khuu W, Mayer M, Wu JW, et al. Burden of Spinal Muscular Atrophy (SMA) on Patients and Caregivers in Canada. J Neuromuscul Dis. 2021;8(4):553-68. https://doi.org/10.3233/JND-200610
29. Messina S, Frongia AL, Antonaci L, Pera MC, Coratti G, Pane M, et al. A critical review of patient and parent caregiver oriented tools to assess health-related quality of life, activity of daily living and caregiver burden in spinal muscular atrophy. Neuromuscul Disord. 2019;29(12):940-50. https://doi.org/10.1016/j.nmd.2019.10.001

Conflicts of interest: No conflicts of interest declared concerning the publication of this article.

Author contributions:
Conception and design: LSS
Analysis and interpretation of data: GLG
Data collection: LSS, VLS, VAN, ESR, MHMLS
Writing of the manuscript: LSS
Critical revision of the article: GLG
Final approval of the manuscript*: LSS, VLS, VAN, ESR, MHMLS, GLG
Statistical analysis: GLG
Overall responsibility: LSS, GLG
*All authors have read and approved of the final version of the article submitted to Rev Cienc Saude.

Funding information: Not applicable.