Journal of Developmental and Physical Disabilities (2021) 33:413–427
https://doi.org/10.1007/s10882-020-09755-9

ORIGINAL ARTICLE

Investigating the Association Between Using Night Braces and Sleep Habits of Children with Cerebral Palsy and Parental Quality of Life

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Published online: 1 June 2020

Abstract

To examine the sleep habits of children with cerebral palsy (CP) and use of night braces and to investigate their association with parental quality of life. The study included 114 children aged 3–6 (57 with typical development (TD) and 57 with CP). The children with CP were grouped according to the Gross Motor Function Classification System (GMFCS) and night brace use (NBU). "Children's Sleep Habits Questionnaire-Abbreviated Form" and "Short-Form Health Survey" were used to investigate the children's sleep habits and the parents' quality of life, respectively. Results were compared for children with CP and TD, and for NBU and non-use (NNBU) in children with CP. All children had sleeping problems, but night waking was more prevalent among children with CP ($p < 0.05$). NBU had no effect on sleep habits of children with CP nor on their parents' quality of life ($p > 0.05$). The quality of life of the parents of children with CP and TD was significantly different ($p < 0.05$). NBU children with CP had lower birth weeks. NBU neither caused sleeping problems in children with CP nor impaired their parents' quality of life and general health.

Keywords Cerebral palsy · Sleep disorder · Night brace · Development

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Introduction

Sleep, which is considered important for development in terms of maturation of children's behaviors, memory, and social skills, is also one of the fundamental physiological needs for brain and body development. Children aged 0–3 years spend 50% of the day asleep and need uninterrupted and high-quality nighttime sleep to develop healthily. An uninterrupted night sleep supports children both mentally and physically. If children cannot get enough sleep, their development, learning potential and physical health may suffer. Sleeping disorders affect children's development and quality of life (Ednick et al. 2009; Eisenhower et al. 2005; Touchette et al. 2007).

Sleeping problems are four times more prevalent among children with cerebral palsy (CP) than among their typically developing (TD) counterparts (Kotagal et al. 1994; Newman et al. 2006). CP refers to a group of permanent but non-progressive disorders causing activity limitations and deterioration in posture and movement development due to disturbances in immature fetal or infant brain (Rosenbaum et al. 2007). Although the main component of CP is motor dysfunction, it is often accompanied by many health issues such as sensory, cognitive, speech/language disorders, auditory, visual, behavioral and learning problems, epilepsy, and sleeping disorders. Depending on the diagnosis, spasms, breathing difficulties, pain, incontinence, difficulty moving or turning over in bed, use of night orthosis, and epilepsy are also considered sleep-related problems (Mol et al. 2012; Valrie et al. 2013; Walco 2008; Wright et al. 2006). Studies report that difficulty in initiating or maintaining sleep increases in line with the severity of CP, and that seizures may predispose sufferers to sleeping problems. In addition, the use of anti-epileptic drugs can cause children to be sleepy and to fall asleep during the day (Kotagal et al. 1994; Newman et al. 2006).

Sleeping disorders are an important factor that not only impairs both the quality of life and development of children with CP but also affects the quality of life of their parents (Clinical Innovation and Governance 2016; Hill et al. 2009).There is a need to investigate the underlying causes of sleeping problems in both children with CP and their parents and to develop relevant assessment methods and intervention approaches (Kotagal et al. 1994; Newman et al. 2006).

The present study investigated the sleep habits of children with CP, and the association between the use of night braces and children's sleep and the quality of life of their parents. The secondary aim of the study was to examine the relationship between children's sleep and their development.

Methods

Ethical approval was obtained from the Nuh Naci Yazgan University Ethics Committee (decision no. 011). The parents participating in the study were informed about its method and aims, and their written informed consent was obtained.

Participants

The study sample consisted of 114 children aged 3–6 years: 57 children with CP (F = 29, M = 28; mean age = 53.5 ± 14.3 months) in an experimental group and 57 children

with TD (F = 33, M = 24; mean age = 55.6 ± 10.6 months) in a control group. The children with CP were also grouped according to the Gross Motor Function Classification System (GMFCS) and NBU. To investigate the association between NBU and parental quality of life, the parents were also included in the study.

The study was completed with the participation of parents and children with CP attending special education and rehabilitation centers in Kayseri province and children with TD attending pre-school education centers in the same city.

Parents of children with TD were reluctant to participate in the study, and out of 92 completed questionnaires only 57 were valid to be used in the study. According to the feedback from the pilot study with 15 families, the parents were unwilling to provide detailed information regarding their socioeconomic level and to fill in the questionnaire; therefore, the preliminary data form was eliminated from the study procedure. Although these socioeconomic data questions were placed at the beginning of the questionnaire, not enough families answered them; hence, the data was insufficient to compare the general characteristics of the families.

Inclusion criteria for the research group were as following: being 3 to 6 years old, having oral feeding, and having no other diagnosis than CP. For the control group, being in the same age range and having no developmental problems were the inclusion criteria. Parents and children who met these criteria were included if families voluntarily agreed to participate in the study. Children with a systemic disease, those who used drugs other than epilepsy drugs that caused sleepiness, those who had experienced pain in the previous 6 months such as surgery, fracture, and injury, and those with visual impairment were excluded from the study.

Study Design

Descriptive characteristics of all children were recorded and evaluated in terms of demographic characteristics and developmental parameters. The 33-item Children's Sleep Habits Questionnaire-Abbreviated Form (CSHQ-AF) was used to examine the children's sleeping habits, and the Short-Form Health Survey (SF-36) was used to determine the effects of their sleep habits on their parents' quality of life. The questionnaires were filled out by the parents. Functionality levels of children with CP were assessed by the first author (an experienced physiotherapist) according to Gross Motor Function Classification System (GMFCS), and the parents were asked whether their child used any night braces. The relationship between the sleeping habits and developmental parameters of the children with CP was examined. All parameters were compared for children with CP and TD (both NBU and NNBU), and children with CP were classified according to the GMFCS.

Measurement Tools

Children's Sleep Habits Questionnaire-Abbreviated Form (CSHQ-AF)

The Children's Sleep Habits Questionnaire-Abbreviated Form (CSHQ-AF) developed by Owens et al. in 2000, was used to investigate the children's sleep habits and sleep-related problems (Owens et al. 2000). Its Turkish validity and reliability study was conducted by Perdahlı Fiş et al. (2010). Consisting of a total of 33 items, the short form

questionnaire examines sleep habits in eight subscales namely bedtime resistance, sleep onset delay, sleep duration, sleep anxiety, night waking, parasomnias, sleep-disordered breathing, and daytime sleepiness.

Parents are asked to evaluate their child's sleep habits over the previous week. A score of 42 and above is considered as "clinically significant". Furthermore, the questionnaire includes three open-ended questions inquiring what time the child goes to bed, what is the total sleeping time during the day and night, and how long the child stays awake when he wakes up at night. The total sleeping time of the children was calculated based on the information their parents provided to the questions.

Short-Form Health Survey (SF-36)

The Short Form Health Survey (SF-36) is a well-known generic health-related quality of life instrument that was developed in the United State of America and is translated into a variety of languages (Ekelund et al. 2006; Koçyiğit et al. 1999; Ware and Sherbourne 1992). Turkish version of the form is reported as valid and reliable and is used to evaluate many health-related situations (Koçyiğit et al. 1999).

Consisting of a total of 36 items, the SF-36 is a general quality of life instrument that measures eight health related concepts: physical functioning, role limitations due to physical problems, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and perceived mental health. It also questions the change in general health perception over the past year. It is used to evaluate the quality of life of parents and caregivers of children with CP (Yun 2017).

Assessments of Functionality Level and Use of Night Brace

The braces that are generally used for children with CP were named, identified and explained to the parents. They were then asked whether their child used any of those braces or perhaps any other brace during sleep. The answers were recorder.

Functionality levels of the children were classified according to the GMFCS, which categorizes each child's level of gross motor function from I to V (Palisano et al. 2000).

Statistical Analysis

G*Power version 3.1.9.2. software was used to evaluate power analysis of the study. Statistical analysis was performed using the SPSS version 22 software. The suitability of the variables to normal distribution was examined using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov and Shapiro-Wilk tests). Descriptive analyses were performed using median-quartiles for non-normally distributed continuous variables and some ordinal variables (using frequency tables for some discrete nominal variables and some discrete ordinal variables).

The Mann-Whitney U test was used in all cases where two groups were compared. The Spearman test was used to calculate correlation coefficients and statistical significance for the relationships between 33-item CSHQ-AF subscales and total scale scores and age, developmental parameters and birth week of children with CP. p-values lower than 0.05 were considered statistically significant.

The Kruskal-Wallis test was used to compare age, development, the 33-item CSHQ-AF subscales and total scale scores of children with CP who were classified according to the GMFCS. Binary comparisons were performed using the Mann-Whitney U test and evaluated using Bonferroni correction. Total type-1 error was regarded as 5% for statistical significance. The p value of 0.005 obtained by Bonferroni correction was used for binary comparisons.

Results

A statistically significant difference was found between the developmental parameters and birth week of children with CP and TD who belonged to the same age groups. Children with CP were born earlier and had lower developmental parameters than children with TD. Children with CP had a statistically significantly higher frequency of night waking than children with TD ($p = 0.022$). Children with CP also obtained higher scores than children with TD on the total sleeping habits scale and other sleeping habit subscales (except for daytime sleepiness), but the difference was not statistically significant (Table 1). Examining the relationship between children with CP developmental parameters and sleeping habits total and subscale scores showed that there was a negative correlation between height and parasomnia, and between weight and sleep-disordered breathing. In addition, a negative correlation was found between height and sleep-disordered breathing (Table 2).

Twenty-six children with CP (45.6%) used a night brace, 24 of them also used a daytime orthosis; 2 (3.5%) used only a night mold, 8 (14%) used no device, and 23 (40.3%) used only daytime orthosis. In addition, 10 (38.5%) of the NBU children with CP were diagnosed with epilepsy, 11 (42.3%) used drugs due to epilepsy, and 4 (15%) had incontinence. For the NNBU children with CP these data were 7 (22.6%), 9 (29%), and 4 (12.9%), respectively.

No statistically significant difference was found between the developmental parameters of NBU and NNBU children with CP (Table 3). Sleeping problems were observed in 43 (75.4%) children with CP (NBU + NNBU) and 35 (61.4%) children with TD, but no statistically significant difference was found between the groups' sleeping habits total scale and subscale scores (except for night waking) (Table 1). The NBU children with CP had significantly lower birth weeks ($p = 0.008$) (Table 3).

There was no statistically significant difference between the sleeping habits total scale and subscale scores of children with CP with respect to NBU and GMFCS level (Tables 3 and 4, respectively).

The parents of children with CP had statistically significant lower quality of life sub-parameters than those of children with TD (Table 1). Although the quality of life sub-parameters of the parents of NBU children were higher than those of the parents of NNBU children, the difference was not statistically significant (Table 3).

Power analysis and effect size results of our study were 0.98, 0.71 for quality of life, 0.43, 0.28 for CSHQ-AF evaluations of children with CP and TD, and 0.29, 0.30 for CSBQ-AF evaluations in comparing NBU and NNBU groups, respectively.

Table 1 Comparison of age, development, CSHQ-AF parameters, and SF-36 parameters of CP and TD children

	Children with cerebral palsy ($n = 57$) M IQR (25–75)	Typically developing children ($n = 57$) M IQR (25–75)	p
Age (months)	56.00 (40.00–66.00)	53.00 (47.00–66.50)	0.458
Height _Z	−0.86 (−2.27–0.51)	0.36 (−0.51–1.20)	**0.001**
Weight_Z	−0.48 (−2.11–0.22)	0.25 (−0.64–1.14)	**<0.001**
BMI_Z	−0.07 (−1.62–0.90)	0.59 (−0.46–1.37)	**0.032**
Birth week	33.00 (29.00–38.00)	39.00 (38.00–40.00)	**<0.001**
CSHQ-AF parameters			
Bedtime resistance	11.00 (8.37–13.00)	9.07 (7.05–12.00)	0.057
Sleep onset delay	1.00 (1.00–2.00)	1.00 (1.00–2.00)	0.052
Sleep duration	4.00 (3.00–5.00)	3.00 (3.00–4.50)	0.077
Sleep anxiety	8.00 (6.00–10.00)	6.58 (4.50–8.00)	0.057
Night wakings	5.00 (4.00–5.00)	4.00 (3.00–5.00)	**0.022**
Parasomnias	9.00 (7.00–10.00)	8.00 (7.00–10.00)	0.574
Sleep-disordered breathing	3.00 (3.00–4.00)	3.00 (3.00–3.08)	0.260
Daytime sleepiness	9.00 (8.00–11.00)	10.00 (8.00–13.00)	0.134
CSHQ-AF total score	47.00 (41.59–52.00)	44.00 (39.00–51.17)	0.097
SF-36 parameters			
Physical functioning	80.00 (55.00–95.00)	95.00 (77.50–100.00)	**0.002**
Role limitations due to physical health	25.00 (0.00–100.00)	100.00 (62.50–100.00)	**<0.001**
Role limitations due to emotional problems	33.33 (0.00–66.66)	100.00 (33.33–100.00)	**<0.001**
Energy/fatigue	50.00 (25.00–62.50)	60.00 (50.00–80.00)	**<0.001**
Emotional well-being	56.00 (42.00–68.00)	68.00 (52.00–80.00)	**0.005**
Social functioning	62.50 (37.50–83.75)	75.00 (60.71–87.50)	**0.039**
Pain	57.50 (41.25–78.75)	77.50 (57.50–90.00)	**0.012**
General health	55.00 (40.00–65.00)	70.00 (55.00–80.00)	**<0.001**

M Median, *IQR* Interquartile Range, *BMI* Body Mass Index, *CSHQ-AF* 33-item Children's Sleep Habits Questionnaire-Abbreviated Form, *SF-36* 36-Item Short Form Survey

Discussion

This study compared the development and sleeping habits of preschool children with a mean age of 4.5 years. The children with CP had lower height, weight, and BMI than the children with TD. This was expected because CP can involve many disorders affecting development such as nutrition, breathing difficulties, drug use, and activity limitations. Children with developmental disorders or CP have lower height and weight than children with TD (Brooks et al. 2011). Although studies have not determined the extent to which sleeping problems or sleep deprivation contribute to developmental disability in multiple disorders, their adverse effects are reported (Hemmingsson et al. 2009; Hill et al. 2009; Pruitt and Tsai 2009). Studies also report that children with CP

Table 2 Relationship between CSHQ-AF, age, and development parameters in CP children

		Bedtime resistance	Sleep onset delay	Sleep duration	Sleep anxiety	Night wakings	Parasomnias	Sleep-disordered breathing	Daytime sleepiness	CSHQ-AF total score
Age (months)	p	0.747	0.765	0.799	0.516	0.201	0.183	0.813	0.933	0.624
	r	−0.044	−0.041	0.035	−0.088	−0.172	−0.179	0.032	−0.011	−0.066
Height _Z	p	0.460	0.710	0.308	0.763	0.122	**0.013**	**0.036**	0.382	0.328
	r	−0.100	0.050	−0.137	0.041	−0.207	**−0.326**	**−0.279**	0.118	−0.132
Weight_Z	p	0.873	0.640	0.514	0.806	0.794	0.321	**0.012**	0.776	0.908
	r	0.022	0.063	0.088	0.033	−0.035	−0.134	**−0.331**	0.039	0.016
BMI_Z	p	0.264	0.714	0.149	0.527	0.589	0.079	0.231	0.645	0.162
	r	0.150	0.050	0.194	0.086	0.073	0.234	−0.161	−0.062	0.188
Birth week	p	0.918	0.921	0.786	0.961	0.176	0.078	0.152	0.531	0.610
	r	0.014	0.013	−0.037	−0.007	−0.182	0.236	0.192	−0.085	0.069

r Spearman correlation test, *CSHQ-AF* 33-item Children's Sleep Habits Questionnaire-Abbreviated Form

Table 3 Comparisons of age, development, CSHQ-AF parameters, and SF-36 parameters of NBU and NNBU children

	Night Brace Use (NBU) ($n = 26$) M IQR(25–75)	Non-Night Brace Use (NNBU) ($n = 31$) M IQR(25–75)	p
Age (months)	59.0 (41.50–68.25)	51.0 (39.0–64.0)	0.189
Height _Z	−2.10 (−2.99–0.51)	−0.65 (−1.68–0.54)	0.082
Weight_Z	−0.90 (−1.99–0.25)	−0.48 (−2.34–0.20)	0.701
BMI_Z	0.09 (−1.50–1.68)	−0.22 (−2.07–0.86)	0.387
Birth week	31.00 (28.00–34.00)	37.00 (29.00–38.00)	**0.008**
CSHQ-AF parameters			
Bedtime resistance	11.50 (9.00–15.25)	11.00 (8.00–13.00)	0.218
Sleep onset delay	1.00 (1.00–2.00)	2.00 (1.00–2.00)	0.327
Sleep duration	3.25 (3.00–5.00)	4.00 (3.00–5.00)	0.489
Sleep anxiety	8.00 (6.00–10.00)	7.00 (6.00–9.00)	0.387
Night wakings	5.00 (4.00–6.00)	5.00 (4.00–5.00)	0.380
Parasomnias	9.00 (7.00–11.00)	8.62 (7.00–10.00)	0.322
Sleep-disordered breathing	3.00 (3.00–4.00)	3.00 (3.00–3.55)	0.129
Daytime sleepiness	10.00 (8.00–11.00)	9.00 (8.00–11.00)	0.667
CSHQ-AF total score	48.00 (41.14–55.25)	45.00 (42.00–51.00)	0.286
SF-36 parameters			
Physical functioning	85.00 (55.00–96.25)	80.00 (50.00–90.00)	0.484
Role limitations due to physical health	37.50 (0.00–100.00)	25.00 (0.00–75.00)	0.527
Role limitations due to emotional problems	33.33 (0.00–100.00)	33.33 (0.00–66.66)	0.718
Energy/fatigue	52.50 (25.00–65.00)	45.00 (25.00–60.00)	0.475
Emotional well-being	60.00 (40.00–80.00)	55.11 (48.00–64.00)	0.323
Social functioning	62.50 (37.50–81.87)	60.35 (37.50–87.50)	0.512
Pain	57.50 (45.00–88.12)	57.50 (35.00–77.50)	0.416
General health	57.50 (43.75–70.00)	55.00 (35.00–65.00)	0.116

M Median, *IQR* Interquartile Range, *BMI* Body Mass Index, *CSHQ-AF* 33-item Children's Sleep Habits Questionnaire-Abbreviated Form, *SF-36* 36-Item Short Form Survey

have a higher number of sleeping problems (Didden and Sigafoos 2001; Hemmingsson et al. 2009; Hill et al. 2009).

In this study, the total sleep duration was 10.2 h (611.58 ± 114.6 mins) for children with CP and 10 h (600.5 ± 58 mins) for children with TD. In particular, sleep durations in NBU and NNBU children with CP were 9.9 h (593.1 ± 140 mins) and 10.5 h (627.1 ± 87.4 mins), respectively. Studies report that children between 3 and 5 years of age should sleep 11–13 h a day (Coons and Guilleminault 1982; Parmelee and Stern 1972). Accordingly, both the children with CP and TD had sleep durations below the reference values for their age groups, causing sleeping problems.

Table 4 Comparisons of age, development, and CSHQ-AF parameters of CP children at different GMFCS levels

	GMFCS I ($n = 9$) M IQR (25–75)	GMFCS II ($n = 11$) M IQR (25–75)	GMFCS III ($n = 13$) M IQR (25–75)	GMFCS IV ($n = 14$) M IQR (25–75)	GMFCS V ($n = 10$) M IQR (25–75)	p
Age (months)	66.00 (41.00–72.00)	52.00 (35.00–58.00)	64.00 (53.00–68.00)	49.50 (36.00–63.25)	48.00 (39.75–68.25)	0.066
Height _Z	0.49 (−0.06–1.06)	−1.61 (−2.51-(−0.52))	0.26 (−1.29–1.87)	−1.71 (−2.29-(−0.27))	−2.29 (−3.27-(−1.19))	**0.002**$_{\beta}$
Weight_Z	0.25 (−0.12–0.77)	−0.10 (−0.47–1.19	−0.71 (−1.67–0.30)	−1.68 (−2.57-(−0.47))	−1.86 (−2.48-(−0.67))	**0.001**$_{\infty}$
BMI_Z	−0.05 (−0.85–0.64)	0.90 (0.05–3.00)	−1.47 (−2.87–0.58)	−0.99 (−2.37–0.59)	−0.12 (−1.72–1.78)	**0.037**
Birth week	32.00 (30.50–36.50)	33.30 (30.00–37.00)	33.00 (28.50–38.50)	30.50 (27.75–38.00)	35.00 (29.00–38.00)	0.805
Bedtime resistance	9.00 (6.00–13.00)	10.00 (8.75–12.00)	12.00 (6.50–15.00)	12.00 (10.00–13.50)	11.00 (9.00–12.00)	0.569
Sleep onset delay	1.00 (1.00–2.50)	1.00 (1.00–2.00)	2.00 (1.00–2.00)	1.50 (1.00–2.00)	1.00 (1.00–2.25)	0.894
Sleep duration	3.00 (3.00–4.50)	4.00 (3.00–5.00)	5.00 (3.00–7.00)	3.50 (3.00–4.25)	4.00 (3.00–5.50)	0.540
Sleep anxiety	7.00 (4.50–10.00)	7.00 (5.00–9.00)	9.00 (5.00–10.50)	8.50 (7.00–10.00)	8.00 (6.00–8.00)	0.469
Night wakings	5.00 (3.00–5.50)	5.00 (4.67–6.00)	5.00 (3.50–6.50)	4.00 (4.00–5.25)	5.00 (4.75–5.00)	0.569
Parasomnias	7.00 (7.00–10.50)	9.00 (8.00–9.00)	9.00 (7.00–10.50)	9.00 (7.00–10.25)	9.00 (8.00–10.25)	0.740
Sleep-disordered breathing	3.00 (3.00–3.50)	3.00 (3.00–4.00)	3.00 (3.00–4.00)	3.00 (3.00–3.50)	3.50 (3.00–4.00)	0.779
Daytime sleepiness	10.00 (8.50–11.50)	9.00 (8.00–11.00)	10.00 (8.00–12.50)	8.50 (7.00–10.25)	9.00 (7.75–10.25)	0.430
CSHQ-AF total score	45.00 (37.50–53.50)	47.00 (42.00–50.00)	52.00 (38.50–63.00)	46.00 (41.00–53.00)	46.50 (45.00–51.25)	0.857

M Median, *IQR* Interquartile Range, *GMFCS* Gross Motor Function Classification System

p_{β} = The difference obtained from the Kruskal-Wallis test results from the GMFCS 1/5 binary comparison

p_{∞} = The difference obtained from the Kruskal-Wallis test results from the GMFCS 1/4 and GMFCS 1/5 binary comparison

According to the verbal reports of the parents, using NB affected the sleep duration and comfort of the children. Indeed, the sleep duration of the NNBU group was found to be longer, but the difference between the groups (NBU/NNBU/TD) was not statistically significant. Newman et al. (2006) found a similar result, suggesting that using a night orthosis does not cause sleeping problems in children because the orthosis is removed or disused when they cause discomfort (Mol et al. 2012; Newman et al. 2006). Similarly, in our study, NBU was not associated with sleep parameters. However, to comment on the conclusion by Newman et al., the exact duration of using NB at nights (without being removed) needed to be recorded and analyzed. On the other hand, epilepsy and epilepsy drugs adversely affect sleeping habits (Galland et al. 2012; Pruitt and Tsai 2009). In this study, 10 NBU and 7 NNBU children with CP had epilepsy, and 11 NBU and 9 NNBU children with CP used epilepsy drugs. This difference between the groups may have caused the difference in their sleep duration. Poindexter and Bihm (1994) showed that sleeping problems in CP were not associated with a reduction in sleep time. Therefore, it is more important to examine different sleep parameters rather than sleep duration. The NBU children had lower birth weeks (Table 3). Greater prematurity also affects the sleeping habits of preschool children. Greater prematurity in NBU children reveals the relationship between increased tonus and prematurity (Spittle et al. 2014; Spittle and Orton 2014). Health issues resulting from increased tonus, such as spasms, movement difficulty in sleep, constipation, and ear infections, cause sleeping problems in children with CP (Dutt et al. 2015; Galland et al. 2012; Gringras 2017). All these problems may cause children with CP to present more night waking. However, these results suggest that CP and NBU may not affect sleep duration in children. Assuming that insufficient sleep independently affects development in a multidimensional way, the reduced sleep duration found in this study is negligible. Apart from sleep duration, sleeping problems in CP patients should be addressed in 7 aspects according to the classification of Galland et al. (2012). These are respiratory disorders, movement disorders (muscle spasms, difficulty in changing position), sleep-wake cycles (difficulties initiating and maintaining sleep due to visual impairment), epilepsy, abnormal sleep patterns, pain and discomfort (acute and chronic pain, use of orthopedic and postural equipment, gastro-esophageal reflux disease, sleep disturbances), and physiological factors including nervousness, negative behaviors, anxiety, low mood, excessive activity, and short attention span (Galland et al. 2012).

Many studies comparing the sleeping habits of children with CP and TD have reported that problems are more common in children with CP, in whom an increase in age is accompanied by secondary problems and pain (Didden and Sigafoos 2001; Newman et al. 2006; Wright et al. 2006).

A great number of studies have reported that children with CP suffer from sleeping problems. However, a similar result for children with TD suggests that this situation may stem from behavioral problems. Although sleeping problems can be seen in all ages of childhood, it is reported that in preschool period these problems may be caused by environmental and cultural factors as well as behavioral problems of the child (Horne 1992; Minde et al. 1993; Owens 2004; Richman et al. 1982). It is also reported that children who attend kindergarten have a reduced weekday sleep duration (Cairns and Harsh 2014). Behavioral sleeping problems are the most common sleeping problems in childhood, observed in 15–30% of children with TD aged 2–5 years (Gregory and O'Connor 2002; Lavigne et al. 1999; Petit et al. 2007). CP affects children's

behaviors and emotional state, and behavioral and emotional health issues are seen in 25–65% of children with CP (Goodman and Graham 1996; Graham and Rutter 1968; Parkes et al. 2008). As the present study included preschool-age children, sleeping problems could be seen in both groups.

One study investigating the relationship between CP-related changes in sleeping pattern and the musculoskeletal system found that motor function level, postural limitation, degree of spasticity, and accompanying physical and muscular problems are associated with sleep disturbance (Lélis et al. 2016). No statistically significant difference was found between the sleep habits of children with CP according to their GMFCS classification. A number of studies have reported chronic pain and pain-related sleeping problems in children with CP categorized by the GMFCS (Christensen et al. 2017; de Albuquerque Botura et al. 2017; Perina et al. 2017). It is well recognized that CP-specific problems lead to secondary problems over time, and consequently pain and pain-related sleeping disorders may increase with age (Didden and Sigafoos 2001; Newman et al. 2006; Wright et al. 2006). However, the study sample included 3–6-year-old children, an age group in which secondary disorders are not yet fully emerged. This could be the possible reason for the absence of pain and sleep problems related to these disorders. The present study has shown that children with a good developmental level have better development in terms of height, weight, and BMI, which is a result in line with the literature (Brooks et al. 2011; Jane and Peter 1999; Reid et al. 2012). On the other hand, studies have reported that children with spastic quadriplegia and dystonic/dyskinetic CP have more difficulties initiating and maintaining sleep. Examining the sleeping problems of children with CP in relation to body involvement could produce different results.

The second aim of the study was to investigate the association between children's sleep habits and health-related quality of life of their parents. The parents of children with CP need more emotional support, suffer more from sleep deprivation, and have higher impaired quality of life than parents of children with TD (Esdaile and Greenwood 2003; Glidden and Schoolcraft 2003; Hanson and Hanline 1990; Hastings 2003; Uğuz et al. 2004). Wright et al. (2006) compared the sleep disorders in parents of children with and without physical disabilities aged 1–16 years, and found that parents of children with physical disabilities had significantly greater concerns regarding general sleeping problems (Wright et al. 2006). This study also found a significant difference between all SF-36 sub-parameters of the parents of children with CP and TD. Having children with developmental disorders affects parents' physical, emotional, and social health. The children included in the present study were of preschool age, which coincides with the period in which most parents have not yet completed the acceptance process. This period is also a process in which nursery-kindergarten life starts, or cannot start due to children's limitations. This process may impair the health-related quality of life of parents. No significant difference was found between the life quality of parents of NBU and NNBU children with CP.

Limitations of the Study

The present study has some limitations that need to be addressed. First is the small sample size of the study, whereas a bigger sample size could demonstrate the difference between sleep parameters of children with CP and TD. The small

sample size is a limitation that hinders detecting potential effects of using night braces on sleep habits of children with CP and TD. Moreover, although parental reports are an important source for detecting sleeping problems, using more objective evaluations could lead to different results. It is recommended that future studies examine sleep parameters with a larger sample size and objective measurements, where children with CP are classified according to their muscle tone.

Since the study compared the sleeping habits and development parameters of children with CP, children with severe feeding difficulties and those with tube-feeding were excluded from the study. Malnutrition and feeding difficulties are more common in children in GMFCS IV-V levels, and these children present low developmental parameters (Jane and Peter 1999; Reid et al. 2012). Tube-feeding provides adequate food intake and improves children's physical development. Since the study examined sleep in relation to development parameters, non-orally fed (tube-fed) children were excluded. Feeding difficulties have adverse effects on parents' quality of life (Rogers 2004). In order to evaluate the quality of life of the parents, other factors that could impose a negative effect needed to be excluded. The second limitation of the present study is the fact that feeding difficulties, which also affect sleeping, could not be evaluated. If children with feeding difficulties were included, shorter sleep duration could be reported for children with CP.

Finally, recording the exact duration of continues use of night brace, i.e. without removing the brace at any point during night, could increase the accuracy of the findings and results.

Conclusions

Contrary to popular belief, the use of night braces neither causes major sleeping problems in children with CP nor impairs the quality of life and general health of their parents. Knowing this will relieve parents of children who need to use night braces, promoting more stable NB use.

Acknowledgements The authors wish to thank all the children and parents who participated in the study.

Author's Contributions All authors contributed to the study conception and design. Material preparation, data collection were performed by Meltem Yazıcı. Statistical analysis were performed by Mustafa Cem Türkmen. The first draft of the manuscript was written by Meltem Yazıcı and Türkmen commented on previous versions of the manuscript. Authors read and approved the final manuscript.

Funding Information This research did not receive any specific grant from funding agencies in the public, commercial, or non-profit sectors.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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