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RESEARCH

Perception of quality of life in school-age children born before 32 weeks of gestational age

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Abstract

Preterm infants with bronchopulmonary dysplasia (BPD) are at increased risk of disruptions in their quality of life (QoL) at school age, often associated with respiratory morbidity and the need for ongoing hospital care. The objective of this study is to assess the impact of BPD on the perceived quality of life in preterm infants at school age. We conducted a prospective observational study of infants born at less than 32 weeks gestation who were admitted to our neonatal unit between January 2012 and December 2014. These children were followed up, and at ages 8 to 10 years, their quality of life was assessed using the Pediatric Quality of Life (PedsQL) questionnaire, with higher scores indicating poorer quality of life. The study included 102 patients with a mean gestational age of 29.42 weeks (SD 1.87) and a mean birth weight of 1221.36 g (SD 347.25), with an average age of 8.59 years (SD 0.90) at the time of the survey. Patients with BPD 2–3 exhibited a significantly poorer perception of "total quality of life" ($p=0.03$) and in the "social activities" domain ($p=0.02$) compared to those without BPD or with BPD 1, even after adjusting for gestational age in a multivariate model. No significant differences were observed for the "health and activities" domain ($p=0.31$), "emotional state" domain ($p=0.58$), or "school activities" domain ($p=0.33$). Patients who experienced asthma symptoms during follow-up had a poorer perception of total quality of life than those who did not (20.53 (SD 6.19) vs. 11.89 (SD 1.44), $p<0.01$). No significant differences were found between patients without a diagnosis of BPD and those with grade 1 BPD. Similarly, no significant differences were observed when comparing patients of less than 28 weeks gestational age and more than 28 weeks of gestational age.

Conclusion: In our population of preterm school-aged children with grades 2–3 BPD, worse perceived quality of life was reported compared to those with no BPD or grade 1 BPD. Preterm children who developed asthma symptoms during the follow-up period also reported lower perceived quality of life. No differences in QoL were observed between patients with no BPD and those with grade 1 BPD, or between those born before and after 28 weeks of gestation. These findings highlight the importance of assessing the QoL in preterm patients with BPD, particularly those with grade 2-3 BPD or asthma symptoms, as early assessment can help identify patients who may benefit from targeted interventions to improve quality of life and long-term outcomes.

What is Known:

- *Survival rates of extremely preterm infants have increased significantly in recent years, but respiratory morbidity, particularly bronchopulmonary dysplasia, remains a common problem. The impact of BPD on the quality of life of preterm infants, particularly at school age, is still debated. BPD is associated with an increased risk of asthma and abnormal lung function, but its effect on QoL is not fully understood.*

What is New:

- *Preterm infants with grade 2-3 BPD have a significantly worse perception of QoL at school age, especially in the domain of "social activities". This finding emphasises the need for long-term follow-up and possible interventions to improve QoL, especially in terms of social integration. Asthma symptoms during childhood also contribute to poorer QoL perceptions, highlighting the importance of early diagnosis and effective treatment.*

Keywords Bronchopulmonary dysplasia · Prematurity · Quality of life

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Introduction

While survival rates of extremely preterm infants have significantly increased in recent years, respiratory morbidity remains prevalent among the most immature neonates [1–3].

Bronchopulmonary dysplasia (BPD) is the most common respiratory consequence of prematurity. Its prevalence rises with decreasing gestational age, with up to 50% of infants born before 28 weeks gestation with grades 2–3 BPD [4]. These patients exhibit a heightened risk of asthma and impaired pulmonary function tests [5–7]. However, the impact of this condition on their quality of life (QoL) remains elusive and subject to debate.

BPD infants have an increased risk of hospital readmission after discharge compared to the general population, particularly in the first 2 years of life. In addition, their ongoing management requires multidisciplinary follow-up, resulting in frequent hospital visits [8, 9].

The increased frequency of hospital admissions, emergency department visits, outpatient follow-up appointments, and missed school days can have a significant impact on the quality of life of both caregivers and patients [10]. Some authors suggest that these circumstances may contribute to a decline in the physical and psychological well-being of those affected by BPD, potentially impacting not only their school years but also extending into adulthood [11, 12]. However, other authors have found no significant differences in the quality of life of young people with BPD compared with healthy volunteer controls [13, 14].

Furthermore, with advances in perinatal and neonatal care over the last decades, the pathophysiology and progression of BPD have evolved, leading to uncertainties regarding the impact on the quality of life of individuals affected by the so-called "new bronchopulmonary dysplasia" [3, 8, 15].

While some studies suggest a potential improvement in quality of life (QoL) over time, the variability in findings highlights the need for further research to provide a robust basis for guiding interventions and improving QoL in this vulnerable population. Therefore, the aim of this study was to assess the impact of a diagnosis of BPD on perceptions of QoL at school age in our cohort of preterm infants.

Material and methods

Study design and subjects

We conducted a single-center, prospective, observational study including all infants born at less than 32 weeks gestational age and admitted to our neonatal unit between January 2012 and December 2014. Perinatal and postnatal data were prospectively collected from medical records. Patients who agreed to participate were then followed up for ongoing assessment.

Exclusion criteria included patients who died during the neonatal period or before the start of the study,, patients who were lost to follow-up or could not be contacted, and patients whose family members refused to provide informed consent.

The following prenatal data were collected: gestational age, defined in weeks and days since the last menstrual period, or if this was not known, it was estimated from the first-trimester ultrasound; birth weight, in g; sex; presence of chorioamnionitis; intrauterine growth restriction (IUGR); and prenatal corticosteroid administration.

As postnatal variables, the need for delivery room ventilation, surfactant administration, use of invasive mechanical ventilation (IMV) and high-frequency oscillatory ventilation (HFOV), presence and grade of BPD (defined according to the NIH consensus definition [15]; supplemental oxygen required for at least 28 days, defined as grade 1 [breathing room air at 36 weeks PMA or discharge], grade 2 (need for $<30\%$ oxygen at 36 weeks PMA or discharge), or grade 3 (need for $\geq 30\%$ oxygen and/or positive pressure at 36 weeks PMA or discharge), periventricular leukomalacia/stage 3 intraventricular hemorrhage or in association with intraparenchymal hemorrhage (PVLM/IVH) according to the modified Papile's classification [16], necrotizing enterocolitis (NEC), late-onset sepsis (LOS), and patent ductus arteriosus (PDA) were collected.

During the children's follow-up, we recorded the perceived quality of life of the participants at the age of 8 to 10 years.. In addition, respiratory symptoms were monitored throughout the follow-up period, including episodes of wheezing and asthma symptoms (such as nocturnal cough unrelated to infection, dyspnea during physical activity, and recurrent bronchospasm).

Quality of life analysis

During the children's follow-up, the Pediatric Quality of Life Questionnaire (PedsQL) was used to assess the participants' perceived quality of life. This questionnaire was developed by the Children's Hospital and Health Center in San Diego, California. It was designed to assess health-related quality of life (HRQoL) in children and adolescents aged 2 to 18 years. In this study, the scale for children aged 8–12 years was used to assess their perceived quality of life [17].

The PedsQL 4.0 questionnaire consists of 23 items covering four domains: (1) "health and activities" (8 items), (2) "emotional state" (5 items), (3) "social activities" (5 items), and (4) "school activities" (5 items). These scales have been carefully developed through focus groups and cognitive

interviews [18]. The items are scored on a scale from 0 to 4, where 0 indicates never and 4 almost always, with a higher number indicating a poorer perceived quality of life.

In order to summarize the results of this study, the items were grouped according to domains ("health and activities," "emotional state," "social activities," and "school activities") and simplified by adding them to a "total quality of life."

Statistical analysis

Descriptive analysis was performed using absolute frequencies and percentages for the analysis of qualitative variables and means with standard deviation or medians with interquartile range for quantitative variables, depending on the symmetry of the distributions.

Proportions were compared using Pearson's $\chi 2$ test and Fisher's exact test, where appropriate, and quantitative variables were compared using Student's *t*-test for normal distributions and Mann–Whitney *U* test for non-normal distributions. Multivariate analysis was performed using logistic regression or multiple linear regression, as appropriate. Statistical significance was set at $p < 0.05$. The Statistical Package for the Social Sciences (SPSS, version 25) was used.

Results

A total of 102 patients were included in the study (Fig. 1), 60 (58%) were male. Of the participants, 42.3% (44 patients) were diagnosed with BPD (all grades 1, 2, and 3), with 17 (16.6%) patients classified as BPD 2–3. The mean gestational age of the total sample was 29.42 weeks (SD 1.87), with a minimum gestational age of 23.9 weeks and a maximum of 31.9 weeks. Those in the no BPD/1 group had a mean gestational age of 29.61 weeks (SD 1.80), while those in the BPD 2–3 group had a mean gestational age of 28.48 weeks (SD 2.00) ($p = 0.02$). Baseline characteristics of the total sample and subgroups based on BPD diagnosis are shown in Table 1.

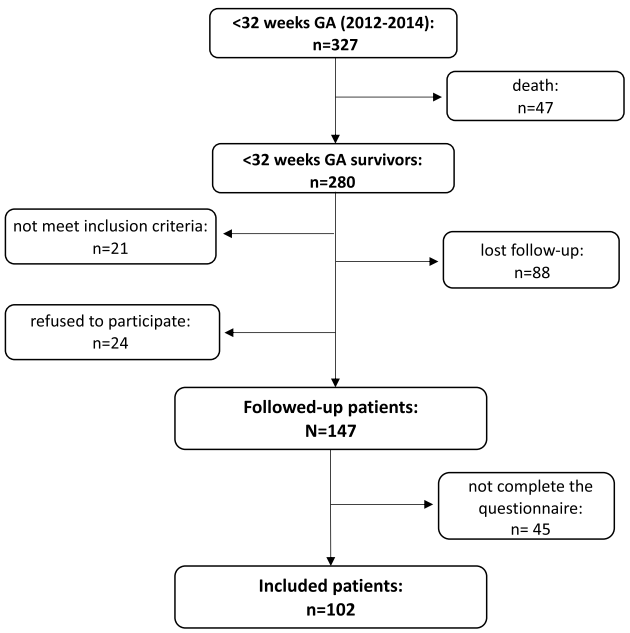

Fig. 1 Flow chart—recruitment of preterm infants for follow-up

At the time of the questionnaire, the mean age of the patients was 8.59 years (SD 0.90). No significant differences were observed between patients without and with BPD (all grades 1, 2, and 3) in the total perception of quality of life ($p = 0.53$) or across the four domains: "health and activities" ($p = 0.52$), "emotional state" ($p = 0.34$), "social activities" ($p = 0.11$), and "school activities" ($p = 0.91$) (Table 3).

However, patients with BPD 2–3 exhibited a significantly poorer perception of "total quality of life" ($p = 0.03$) and in the "social activities" domain ($p = 0.02$) compared to those without BPD or with BPD 1, with no differences noted in "health and activities" domain ($p = 0.31$), "emotional state" domain ($p = 0.58$), or "school activities" domain ($p = 0.33$) (Fig. 2, Table 2). This effect persisted after adjusting for gestational age in the multivariate model (Table 2).

No statistically significant differences were found between patients without a diagnosis of BPD and those with grade 1 BPD (Table 3). Similarly, there were no statistically significant differences in quality of life between those of less or more than 28 weeks of gestational age (Table 4).

Of the patients who completed the PedsQL questionnaire, information on respiratory symptoms was available for 81 individuals: 68 from the no BPD/1 group and 13 from the grade 2–3 BPD group. Of the 13 patients in the grade 2–3 BPD group, 10 (77%) experienced wheezing episodes, compared with 32 (47%) in the no BPD/1 group, $p = 0.04$. Seven patients in the no BPD/1 group had asthma symptoms throughout their follow-up (10%), compared to 4 patients in the grade 2-3 BPD group (31%), p 0.04. Patients who experienced asthma symptoms during follow-up had a poorer perception of total quality of life (as indicated by higher scores) than those who did not (20.53 (SD 6.19) vs. 11.89 (SD 1.44), $p < 0.01$). However, no significantly higher quality of life scores were observed between those with isolated wheezing and those without (22.00 (SD 16.76) vs. 16.00 (SD 10.91), $p = 0.07$).

Further analysis of factors potentially influencing quality of life at school age revealed a poorer perception of quality of life) with increased hours of mechanical ventilation, adjusted for the degree of BPD. The presence of asthma symptoms during childhood was also associated with a higher risk of poorer QoL perception, even after adjusting for BPD grade. However, no significant associations were observed between other perinatal factors such

Table 1 Characteristics of the sample

	No BPD/1 ($n=85$)	BPD 2–3 ($n=17$)	Total ($n=102$)	p
Gestational age (weeks)	29.61 (1.80)	28.48 (2.00)	29.42 (1.87)	0.02
Birth Weight (g)	1276.20 (335.09)	947.18 (275.37)	1221.36 (347.25)	< 0.01
Small for gestational age	10 (12%)	4 (24%)	14 (14%)	0.19
Male sex	51 (60%)	9 (53%)	60 (59%)	0.59
Antenatal corticosteroids	66 (78%)	11 (65%)	77 (75%)	0.25
Chorioamnionitis	18 (21%)	4 (24%)	22 (22%)	0.83
NIPPV/IPPV at delivery room	45 (53%)	16 (95%)	42 (60%)	< 0.01
Surfactant administration	37 (44%)	13 (76%)	50 (49%)	0.01
Postnatal corticosteroids	0 (0%)	1 (6%)	1 (1%)	0.03
Invasive mechanical ventilation	34 (40%)	15 (89%)	49 (48%)	< 0.01
High-frequency oscillatory ventilation	10 (12%)	7 (42%)	17 (17%)	< 0.01
Hours of invasive mechanical ventilation	45.75 (128.22)	299.15 (347.15)	87.98 (204.37)	< 0.01
NEC	2 (1%)	1 (6%)	3 (3%)	0.43
PVLM/IVH	3 (4%)	6 (35%)	9 (9%)	< 0.01
PDA Patent ductus arteriosus	16 (19%)	8 (47%)	24 (24%)	0.01
LOS Late-onset sepsis	43 (51%)	14 (82%)	57 (56%)	0.02

Data are expressed as mean (standard deviation) and n (%); comparison of means (student's t-test); comparison of proportions (chi-squared test)

Abbreviations: BPD: Bronchopulmonary dysplasia; NIPPV, noninvasive positive pressure ventilation IPPV, invasive positive pressure ventilation; NEC, necrotizing enterocolitis (> Grade 2 Bell); PVLM/IVH, periventricular leukomalacia/stage 3 intraventricular hemorrhage or in association with intraparenchymal hemorrhage

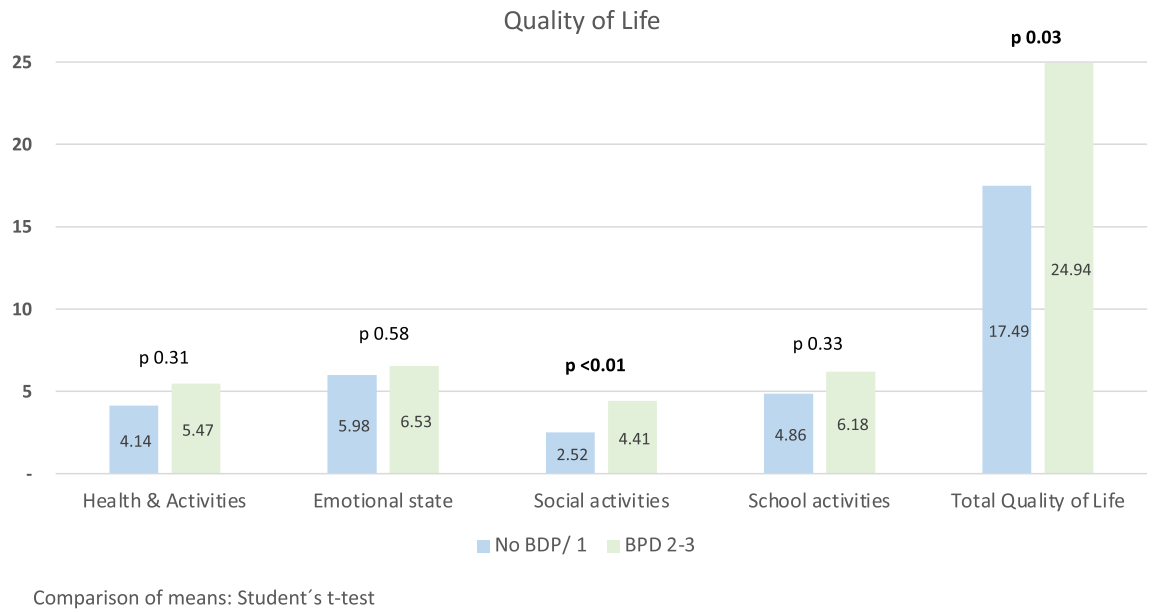

Fig. 2 Quality of life according to the different ITEMS

as gestational age, low birth weight, necrotizing enterocolitis, patent ductus arteriosus, periventricular leukomalacia, stage 3 or higher intraventricular hemorrhage, late-onset sepsis, and quality of life perception at school age, adjusted for the degree of BPD (Table 5).

Discussion

This study highlights the importance of assessing the quality of life in preterm patients with BPD, particularly those

Table 2 Comparison of quality of life between patients with no BPD/1 and patients with grades 2–3 BPD

	No BPD/1 ($n=85$)	BPD 2–3 ($n=17$)	p	B	Standard error	p
Health and activities	4.14 (4.75)	5.47 (5.88)	0.31	1.37	1.36	0.32
Emotional state	5.98 (3.86)	6.53 (3.22)	0.58	0.97	1.01	0.34
Social activities	2.52 (2.85)	4.41 (3.41)	<0 .01	1.74	0.80	0.03
School activities	4.86 (3.87)	6.18 (5.15)	0.33	1.34	1.12	0.23
Total quality of life	17.49 (12.31)	24.94 (17.85)	0.03	7.98	3.65	0.03

Variables are described as mean (standard deviation); comparison of means with Student's *t-test*; multiple linear regression (adjusted for gestational age)

Table 3 Comparison of quality of life between patients without BPD and patients with grade 1 BPD

	No BPD (58)	BPD 1 (27)	p	No DBP ($n=58$)	DBP 1–2–3 ($n=44$)	p
Health and activities	4.09 (5.11)	4.26 (3.96)	0.87	4.09 (5.11)	4.73 (4.76)	0.52
Emotional state	6.38 (3.77)	5.11 (3.99)	0.16	6.38 (3.77)	5.66 (3.74)	0.34
Social activities	2.41 (2.59)	2.74 (3.38)	0.62	2.42 (2.59)	3.39 (3.45)	0.11
School activities	5.12 (4.11)	4.30 (3.28)	0.36	5.12 (4.11)	5.02 (4.15)	0.91
Total quality of life	18.00 (12.79)	16.41 (11.36)	0.58	18.00 (12.79)	19.70 (14.64)	0.53

Variables are described as mean (standard deviation); comparison of means with Student's t-test

Table 4 Comparison of quality of life between patients with less and more than 28 weeks of gestational age

	<28 weeks ($n=20$)	>28 weeks ($n=82$)	p
Health and activities	4.25 (5.18)	4.39 (4.92)	0.91
Emotional state	4.60 (3.62)	6.43 (3.72)	0.05
Social activities	3.05 (3.2)	2.78 (2.99)	0.72
School activities	5.10 (4.62)	5.07 (4.01)	0.98
Total quality of life	17.00 (14.94)	19.16 (13.29)	0.53

Variables are described as mean (standard deviation); comparison of means with Student's *t-test*

with grades 2–3, as they have a worse perception of quality of life at school age.

Despite recent advancements in the survival rates of extremely preterm infants, the prevalence of respiratory sequelae, particularly BPD, remains high [1, 2]. Prior research indicates that patients diagnosed with BPD are at an increased risk of asthma and pulmonary function abnormalities compared to those without BPD [5, 19–22]. However, there is no established consensus on the impact of this condition on quality of life.

The present study used the Pediatric Quality of Life Questionnaire (PedsQL) to evaluate the QoL of preterm infants during school age, focusing on four domains: "health and activities," "emotional state," "social activities," and "school activities." Patients with BPD 2–3 exhibited a significantly poorer perception of the "total quality of life" ($p=0.03$) and in the "social activities" domain ($p=0.02$) compared to those without BPD or with BPD 1, even after adjusting for gestational age in a multivariate model. In our sample of patients with BPD, the scores were higher (indicating poorer quality of life) than those reported in the study by W. Varni et al. [17], where the questionnaire was completed by healthy children.

Lee et al. [12] conducted a systematic review in 2023 to analyze the impact of BPD on quality of life from three perspectives: caregivers' quality of life, caregivers' perception of patients' quality of life, and BPD patients' self-reported quality of life. The results highlighted difficulties experienced by patients and carers, including sleep problems and acute care needs, which negatively affected quality of life, particularly in the immediate post-discharge period. In this study, patients with BPD demonstrated physical QoL similar to preterm infants without BPD in late childhood and early adulthood [12]. Additionally, Sudhir Sriram et al. [24] and Wook Kim, S. et al. [23] reported that patients without BPD had better perceived QoL than those with BPD.

In our study population significant differences were found in the "social activities" domain, potentially related to findings described by Della Longa L. et al. [25], who noted that preterm infants have difficulties recognizing facial emotions, which may impact their social skills. In light of these findings, it may be worth considering referring patients with BPD to psychological services to enhance their social skills, as research suggests that simple interventions can result in clinical improvement [26].

However, other authors have not found differences in quality of life in patients with BPD. Beaudoin et al. [27] found similar health-related quality of life and respiratory symptoms when comparing patients with a history of prematurity and bronchopulmonary dysplasia with healthy term controls, despite the fact that the former required greater use

Table 5 Multiple linear regression: perinatal and postnatal factors influencing "total quality of life" adjusted for bronchopulmonary dysplasia

	F	R^2	*B*	Standard error	*p*
Gestational age	2.40	0.046	0.47	0.73	0.52
Birth weight	2.34	0.045	0.002	0.01	0.58
Small for gestational age	2.23	0.043	1.20	3.89	0.76
Chorioamnionitis	2.20	0.043	−0.62	3.23	0.85
NIPPV/IPPV at delivery room	2.18	0.042	0.17	2.85	0.95
Surfactant administration	2.66	0.051	2.61	2.73	0.34
Postnatal corticosteroids	2.26	0.044	−5.25	13.82	0.70
Hours of invasive mechanical ventilation	4.37	0.081	0.015	0.01	**0.04**
High-frequency oscillatory ventilation	2.27	0.044	1.51	3.73	0.69
NEC*	2.41	0.046	−5.16	7.87	0.51
PVLM/IVH*	2.39	0.046	−3.27	5.14	0.53
Patent ductus arteriosus	2.20	0.043	−0.61	3.23	0.85
LOS*Late-onset sepsis	2.20	0.043	0.53	3.67	0.85
Wheezing episodes	3.45	0.081	4.92	3.20	0.13
Asthma symptoms	8.60	0.181	15.24	4.41	**0.01**

Abbreviations: NIPPV, noninvasive positive pressure ventilation IPPV, invasive positive pressure ventilation; NEC, necrotizing enterocolitis (> Grade 2 Bell); PVLM/IVH, periventricular leukomalacia/stage 3 intraventricular hemorrhage or in association with intraparenchymal hemorrhage

Multiple linear regression (adjusted for bronchopulmonary dysplasia)

of health services and prescription drugs. Other authors also report no significant differences in quality of life between patients with BPD and healthy controls [14] and even find lower rates of depression, fatigue, and pain in the BPD group [13].

In our study, we observed no significant differences in QoL between patients without BPD and those with grade 1 BPD, nor between those born before and after 28 weeks gestation. This suggests that the presence of grades 2–3 BPD has a more substantial impact on perceived QoL than gestational age. The association between prematurity and altered QoL remains contentious, with some studies indicating a diminished perception of QoL in preterm infants compared to term infants [28, 29], while others show no such correlation [30–32]. Our findings align with previous research by Wook Kim, S. et al. [23], who noted worse QoL perceptions in infants born before 26 weeks of gestational age but found that this effect disappeared when adjusted for BPD and other comorbidities. Zwiker et al. [33] found a decreasing effect of prematurity/very low birth weight on health-related quality of life over time, but the heterogeneous nature of the studies limits definitive conclusions.

Additionally, among other perinatal factors considered, only the duration of invasive mechanical ventilation increased the risk of poorer QoL (adjusted for BPD). In line with our sample, other studies using the PedsQL scale have also found no association between low birth weight for gestational age and quality of life [34]. As for other perinatal factors, there is currently no clear evidence that they are associated with changes in perceived quality of life.

During follow-up, asthma symptoms were shown to increase the risk of poorer quality of life perception, even after adjustment for gestational age in a multivariate model. This finding is consistent with reports by other authors who also describe an increased risk of poorer quality of life perception in children with both diagnosed and undiagnosed asthma, particularly due to limitations in social activities, similar to what we observed in our patient sample. Furthermore, Čibirkaitė et al. [35–37] note that as children with bronchial asthma grow older, the impact of the disease on their overall well-being decreases. This underlines the importance of early diagnosis and effective treatment to improve the quality of life of these patients.

There are several limitations that need to be acknowledged in our study. Firstly, we were unable to include a control group of healthy term infants, which poses a challenge to adequately assess the effect of prematurity on quality of life in comparison with this group. Although we have attempted to mitigate this gap by analyzing the relationship between gestational age and quality of life, the lack of a direct comparison remains a limitation. In addition, as a single-center study, the generalizability of our findings to wider populations may be limited. Furthermore, the inability to include all preterm infants born during the study due to the extended follow-up period and loss of follow-up of several patients introduces a potential bias; it is plausible that healthier infants were more likely to remain in the study, thereby influencing the results.

This study highlights the importance of assessing the quality of life in preterm patients with BPD, particularly

in those with grades 2–3 BPD and asthma symptoms. The findings suggest that the presence of BPD 2–3, significantly impacts their perception of quality of life, particularly in aspects related to "social activities." These results underscore the necessity for long-term follow-up, not only for the detection and treatment of medical issues but also for intervention in areas affecting quality of life. Moreover, given the lack of consensus in the literature and the variability of results, further research is essentialto guide specific interventions aimed at improving the well-being of this vulnerable population throughout their development.

Conclusion

In our population of preterm school-aged children with grades 2–3 BPD, worse perceived quality of life was reported compared to those with no BPD or grade 1 BPD, regardless of gestational age. Preterm children who developed asthma symptoms during the follow-up period also reported lower perceived quality of life. No differences in QoL were observed between patients with no BPD and those with grade 1 BPD, or between those born before and after 28 weeks of gestation. These findings highlight the importance of assessing QoL in preterm patients with BPD, particularly those with grade 2-3 BPD or asthma symptoms, as early assessment can help identify patients who may benefit from targeted interventions to improve quality of life and long-term outcomes.

Authors' contributions A.M.-H.: conceptualization, data curation, investigation, software, validation, writing original draft, and writing review and editing. A.M.-C.: data curation and writing review and editing. C.R.-N.: data curation and writing review and editing. S.B.-A.: writing—review and editing. JL.R.-C.: writing—review and editing. N.G.-P.: writing—review and editing. M.S.-L.: conceptualization and writing—review and editing.

Data availability No datasets were generated or analysed during the current study.

Declarations

Ethics approval This study was approved by the Ethics Committee of the Gregorio Marañon Hospital (ref. FXPULMPREM) and conducted in accordance with the Declaration of Helsinki.

Competing interests The authors declare no competing interests.

References

1. Saigal S, Doyle LW (2008) An overview of mortality and sequelae of preterm birth from infancy to adulthood. Lancet Lond Engl 371(9608):261–269
2. Field DJ, Dorling JS, Manktelow BN, Draper ES (2008) Survival of extremely premature babies in a geographically defined population: prospective cohort study of 1994–9 compared with 2000–5. BMJ 336(7655):1221–1223
3. Raju TNK, Pemberton VL, Saigal S, Blaisdell CJ, Moxey-Mims M, Buist S et al (2017) Long-term healthcare outcomes of preterm birth: an executive summary of a conference sponsored by the national institutes of health. J Pediatr 181:309-318.e1
4. Stoll BJ, Hansen NI, Bell EF, Walsh MC, Carlo WA, Shankaran S et al (2015) Trends in care practices, morbidity, and mortality of extremely preterm neonates, 1993–2012. JAMA 314(10):1039–1051
5. Kotecha SJ, Edwards MO, Watkins WJ, Henderson AJ, Paranjothy S, Dunstan FD et al (2013) Effect of preterm birth on later FEV1: a systematic review and meta-analysis. Thorax 68(8):760–766
6. Fawke J, Lum S, Kirkby J, Hennessy E, Marlow N, Rowell V et al (2010) Lung function and respiratory symptoms at 11 years in children born extremely preterm: the EPICure study. Am J Respir Crit Care Med 182(2):237–245
7. Vollsæter M, Røksund OD, Eide GE, Markestad T, Halvorsen T (2013) Lung function after preterm birth: development from mid-childhood to adulthood. Thorax 68(8):767–776
8. Haggie S, Robinson P, Selvadurai H, Fitzgerald DA (2020) Bronchopulmonary dysplasia: A review of the pulmonary sequelae in the post-surfactant era. J Paediatr Child Health 56(5):680–689
9. You JY, Shu C, Gong CH, Liu S, Fu Z (2017) Readmission of children with bronchopulmonary dysplasia in the first 2 years of life: a clinical analysis of 121 cases. Zhongguo Dang Dai Er Ke Za Zhi Chin J Contemp Pediatr 19(10):1056–1060
10. McGrath-Morrow SA, Ryan T, Riekert K, Lefton-Greif MA, Eakin M, Collaco JM (2013) The impact of bronchopulmonary dysplasia on caregiver health related quality of life during the first 2 years of life. Pediatr Pulmonol 48(6):579–586
11. Homan TD, Nayak RP (2021) Short- and long-term complications of bronchopulmonary dysplasia. Respir Care 66(10):1618–1629
12. Lee DMX, Tan AKS, Ng YPM, Amin Z (2023) Quality of life of patients and caregivers affected by bronchopulmonary dysplasia: a systematic review. Qual Life Res Int J Qual Life Asp Treat Care Rehabil 32(7):1859–1869
13. Sierra G, Liu JP, Ith I, Gudur D, Cunningham D, Dahlberg SE et al (2023) Health-related qualities of life in school-aged children with bronchopulmonary dysplasia. J Pediatr 261:113548
14. Bozzetto S, Carraro S, Tomasi L, Berardi M, Zanconato S, Baraldi E (2016) Health-related quality of life in adolescent survivors of bronchopulmonary dysplasia. Respirol Carlton Vic 21(6):1113–1117
15. Jobe AH, Bancalari E (2001) Bronchopulmonary dysplasia. Am J Respir Crit Care Med 163(7):1723–1729
16. Papile LA, Burstein J, Burstein R, Koffler H (1978) Incidence and evolution of subependymal and intraventricular hemorrhage: a study of infants with birth weights less than 1,500 gm. J Pediatr 92(4):529–534
17. Varni JW, Burwinkle TM, Seid M, Skarr D (2003) The PedsQL 4.0 as a pediatric population health measure: feasibility, reliability, and validity. Ambul Pediatr Off J Ambul Pediatr Assoc. 3(6):329–41
18. Varni JW, Sherman SA, Burwinkle TM, Dickinson PE, Dixon P (2004) The PedsQL™ family impact module: preliminary reliability and validity. Health Qual Life Outcomes 2(1):55
19. Ronkainen E, Dunder T, Peltoniemi O, Kaukola T, Marttila R, Hallman M (2015) New BPD predicts lung function at school age: Follow-up study and meta-analysis. Pediatr Pulmonol 50(11):1090–1098
20. Vom Hove M, Prenzel F, Uhlig HH, Robel-Tillig E (2014) Pulmonary outcome in former preterm, very low birth weight children

with bronchopulmonary dysplasia: a case-control follow-up at school age. J Pediatr 164(1):40-45.e4
21. Gibbons JTD, Course CW, Evans EE, Kotecha S, Kotecha SJ, Simpson SJ (2023) Increasing airway obstruction through life following bronchopulmonary dysplasia: a meta-analysis. ERJ Open Res 9(3):00046–02023
22. Sun T, Yu HY, Yang M, Song YF, Fu JH (2023) Risk of asthma in preterm infants with bronchopulmonary dysplasia: a systematic review and meta-analysis. World J Pediatr WJP 19(6):549–556
23. Kim SW, Andronis L, Seppänen AV, Aubert AM, Barros H, Draper ES et al (2023) Health-related quality of life of children born very preterm: a multinational European cohort study. Qual Life Res 32(1):47–58
24. Sriram S, Schreiber MD, Msall ME, Kuban KCK, Joseph RM, O' Shea TM, et al. Cognitive development and quality of life associated with BPD in 10-year-olds born preterm. Pediatrics. 2018;141(6):e20172719
25. Della Longa L, Nosarti C, Farroni T (2022) Emotion recognition in preterm and full-term school-age children. Int J Environ Res Public Health 19(11):6507
26. Dell'Aversana V, Tofani M, Valente D (2023) Emotional regulation interventions on developmental course for preterm children: a systematic review of randomized control trials. Child Basel Switz 10(3):603
27. Beaudoin S, Tremblay GM, Croitoru D, Benedetti A, Landry JS (2013) Healthcare utilization and health-related quality of life of adult survivors of preterm birth complicated by bronchopulmonary dysplasia. Acta Paediatr Oslo Nor 1992 102(6):607–12
28. Theunissen NC, Veen S, Fekkes M, Koopman HM, Zwinderman KA, Brugman E et al (2001) Quality of life in preschool children born preterm. Dev Med Child Neurol 43(7):460–465
29. Girard-Bock C, Flahault A, Bernard É, Bourque CJ, Fallaha C, Cloutier A et al (2021) Health perception by young adults born very preterm. Acta Paediatr Oslo Nor 1992 110(11):3021–9
30. Baumgardt M, Bucher HU, Mieth RA, Fauchère JC () Health-related quality of life of former very preterm infants in adulthood. Acta Paediatr Oslo Nor 1992. febrero de 101(2):e59–63.
31. Cooke RWI (2004) Health, lifestyle, and quality of life for young adults born very preterm. Arch Dis Child 89(3):201–206
32. Donohue PK (2002) Health-related quality of life of preterm children and their caregivers. Ment Retard Dev Disabil Res Rev 8(4):293–297
33. Zwicker JG, Harris SR (2008) Quality of life of formerly preterm and very low birth weight infants from preschool age to adulthood: a systematic review. Pediatrics 121(2):e366-376
34. Palta M, Sadek-Badawi M (2008) PedsQL relates to function and behavior in very low and normal birth weight 2- and 3-year-olds from a regional cohort. Qual Life Res 17(5):691–700
35. van Gent R, van Essen LEM, Rovers MM, Kimpen JLL, van der Ent CK, de Meer G (2007) Quality of life in children with undiagnosed and diagnosed asthma. Eur J Pediatr 166(8):843–848
36. Čibirkaitė A, Bubnaitienė V, Hansted E, Gurskis V, Vaidelienė L (2024) Quality-of-life assessment in children with mild to moderate bronchial asthma. Med Kaunas Lith 60(5):771
37. Kim Y, Park HR (2018) Structural equation model of health-related quality of life in school age children with asthma. J Korean Acad Nurs 48(1):96–108

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