Acta Scientific Neurology (ISSN: 2582-1121)

Volume 3 Issue 9 September 2020

Research Article

Preterm Births and Cognitive Development

Frolli A[1], Ricci MC[1], Valenzano L[1], Cavallaro A[1], Pastorino GMG[2] and Operto FF[2]*

[1]*Disability Research Centre of University of International Studies in Rome, Rome, Italy*

[2]*Child and Adolescent Neuropsychiatry Unit, Department of Medicine, Surgery and Dentistry, University of Salerno, Salerno, Italy*

***Corresponding Author:** Operto FF, Child and Adolescent Neuropsychiatry Unit, Department of Medicine, Surgery and Dentistry, University of Salerno, Salerno, Italy.

Received: June 13, 2020

Published: August 10, 2020

Abstract

The birth of a premature baby is a decisive factor in determining long-term consequences on cognitive development. Considering the Wechsler Intelligence Scale for Children (WISC) as a reference, there are several evidences resulting from numerous studies that show a variation in the cognitive profile: preterm-born children have been shown to have an increased risk of cognitive impairment and have consistently shown lower results than control groups on standardized tests of general intellectual functioning. In our study we expand the sample age and evaluate the cognitive profile of adolescents and understand if cognitive abilities had specific effects, comparing a group of adolescents born preterm (group 1) with a group of adolescents born on term (group 2). Broadening the study population age, we may conclude that the impairment of WM's abilities persists during the course of development, and therefore subjects with a preterm birth history continue to present difficulties in global cognitive functioning, also impacting lifestyle.

Keywords: Preterm Infants; Cognitive Development; Specific Learning Disorders; Working Memory

Introduction

Prematurity defines a condition characterized by a delivery that occurs before the 37th week of gestation. The birth of a premature baby is a decisive factor mortality and possible long-term consequences on cognitive development [1,2]. One third of children who are born prematurely have higher rates of cerebral palsy, sensory deficits, learning difficulties and respiratory diseases than full-term children. The events leading to preterm birth are not yet completely clear, although the etiology is believed to be multifactorial. Causal factors related to preterm birth include medical conditions of the mother or fetus, genetic influences, environmental exposure, infertility treatments, behavioral and socioeconomic factors, and iatrogenic prematurity. The gestational age is divided into periods: on Term, born between 42 and 37 weeks of gestation, Late Preterm, born between 37 and 32 weeks of gestation, Very Preterm, born between 32 and 28 weeks of gestation, extremely Preterm, born before the 28th week of gestation [1]. The consequences that are determined by a preterm birth are due to the abrupt interruption of all those maturation processes that occur during intrauterine development, and therefore must be completed extrauterine, not equally adequate and protected. The most stressed structures are the nervous ones, which are the last to complete their development both from a morphological-structural and vascular point of view. All these aspects put the child and its development at risk [3,4]. The most frequent and important dysfunctions that occur in premature children are Infantile Cerebral Palsy, Intellectual Disability, neurosensory pathologies (mainly sight and hearing), and dysfunctions that can be defined as "minor" such as learning difficulties, language disorders, perceptual problems, emotional regulation disorders, attention disorders [5]. Many studies associate premature birth (especially if before the 28th week of gestation) to the lack of development of sensory-motor areas, up to have a significant impact on cognitive functions, with repercussions such as intellectual disability [6]: it can be inferred that the cognitive development of premature infants differs significantly, both quantitatively and qualitatively, from that of peers born at term [7,8], with repercussions throughout the life span [9]. Towards the beginning of school age, the onset of some difficulties affecting cognitive

processes such as attention, executive functions, working memory, visual-motor and visual-perceptive abilities [10] compromise behavioral functioning and school efficacy [9]. Some difficulties in perceptual, motor, communicative, information processing basic skills can occur from the first years of life and have repercussions on the development of complex abilities. In this direction, in deepening the problems associated with the cognitive level, attention is given to neuropsychiatric diseases such as ADHD [11] and Autism [12], but especially to Specific Learning Disorders [13]. It has been shown that the so-called Very Low Birth Weight (VLBW - subjects born prematurely at 6 months) present greater difficulties of emotional regulation in comparison to a group of peers born at term (Wolf., *et al*. 2002). Regarding learning disorders, however, oral and writing skills appear particularly sensitive to premature birth, so as to make this variable a real risk factor for a typical development. Lexicon, pragmatics, phonological awareness [14] are domains conditioned until adolescence [6]. Learning difficulties, especially for VLBW [8], involve language at all levels, from spoken production (syllables and phonemes) to writing (graphemes) to reading and understanding [15]; for this very reason a heterogeneity of profiles and produced alterations emerges, which also appear in the light of environmental and relational factors [16]. Considering the Wechsler Intelligence Scale for Children (WISC) as a reference, there are several evidences resulting from numerous studies that show a variation in the cognitive profile: preterm-born children have been shown to have an increased risk of cognitive impairment and have consistently shown lower results than control groups on standardized tests of general intellectual functioning [17-19]. In this study we analyse the cognitive profiles and the percentages of specific learning disorders in a group of children born preterm reevaluated in the age range between 13 and 14 years.

Materials and Methods

Participants

In this study we observed 70 preterm-born adolescents, specifically those born between the 26th and the 30th week of gestation. All adolescents who had developed infantile cerebral palsy, neurological deficits and encoded motor disorders in the early years of life, or that reported ischemic abnormalities to encephalon MRI, were excluded from the study participants. We have therefore analysed the cognitive profiles of 70 adolescents (group 1) and compared them with those of 70 adolescents born on term (group 2 - control) of the same age (between 13 and 14 years). The data were collected at the Neurodevelopment Disorder Clinic of FINDS in collaboration with the TIN (Neonatal Intensive Care Unit) of the Civil Hospital of Caserta and the Child Neuropsychiatry of the University of Salerno. The two groups were also given specific batteries for the detection of Specific Learning Disorders; the results suggested a greater vulnerability and predisposition to develop in group 1 SLD (Table 1).

Group 1		Group 2	
M_{age}13.2	M/F 43/27	M_{age}13.4	M/F 55/15

Table 1: Study Group subdivision.

Procedures and tools

The neuropsychological evaluation was performed using standardized tests such as: WISC-IV (Wechsler Intelligence Scale for Children) [20] to evaluate the Global Cognitive functioning and the Basic Neuropsychological Profile, Reading and writing tests MT 16-19 [21] and AC-MT 11-14 calculation tests [22] to evaluate the learning capabilities.

WISC-IV: Clinical test to individually assess cognitive abilities of children aged between 6 years and 16 years of age. It computes the Intellectual Quotient (IQ) which represents the child's overall cognitive capacity. The IQ is comprises 4 indexes: Verbal comprehension index (VCI), visuo-perceptive reasoning index (PRI), working memory index (WMI) and processing speed index (PSI).

MT 16-19 test: Standardized tool for the evaluation of reading and writing skills and diagnosis of dyslexia and/or dysorthography in adolescence. It consists of 9 tests divided by skills areas (reading, writing and understanding).

AC-MT 11-14 test: Standardized test to evaluate calculation and problem-solving skills. It differentially evaluates a variety of aspects in the mathematical development such as skills in written and verbal expression of mathematical calculation, ability to understand and generate numbers, arithmetic reasoning skills, the ability of fast calculation and problem solving capabilities.

Results and Discussion

Data analysis was performed using the statistical survey software SPSS 26.0 (2019). Significance cutoff was set at 5% level ($\alpha < 0.05$). The comparison of group averages was carried out by means of a variance analysis test (Analysis of Variance - ANOVA), a parametric test that allows to compare two or more data groups by comparing the internal variability of these groups with the variability between the groups. In this study we performed an ANOVA to compare the weighted index scores (VCI, PRI, WMI, PSI, IQ) emerged from WISC-IV between group 1 (preterm born adolescents) and

group 2 (control group) and identify any significant differences between the two groups. Specifically, we compared the group 1 and group 2 weighted scores to the VCI, IRP and IVE indices, and no significant results were found. These data indicate that between preterm-born adolescents and term-born adolescents there are no significant differences in the development of verbal comprehension, visual-perceptual reasoning, and processing speed cognitive skills. Instead, significant results emerged from comparisons to the IML indices [F (1,139) = 86,70; p < 0.05] and IQ [F (1,139) = 9,99; p < 0.05]. Data indicate that between preterm-born adolescents and term-born adolescents there are significant differences about the development of working memory capacity, which have a significant impact on overall cognitive functioning (IQ) (Table 2 and figure 1). Furthermore, the case studies test analysis, test aimed to assess reading and calculation skills, showed the following percentages for the diagnosis of dyslexia and dyscalculia: 4,2% (3 subjects) with diagnosis of dyslexia and 11,4% (8 subjects) with diagnosis of dyscalculia. Of these, 17.1% (12 subjects) was diagnosed with both dyscalculia and dyslexia (Figure 2). As for the control group the following percentages were found: 4.28% with diagnosis of dyslexia and 1.4% with diagnosis of dyscalculia.

Subgroup (N = 70)					**Total Sample (N = 140)**			
VCI					**PRI**			
	Means	**SD**	**F**	**P**	**Means**	**SD**	**F**	**P**
Gr1	105,31	14,03			103,94	11,24		
Gr2	103,14	13,45	.873	.352	107,04	9,8	3,023	.084
	WMI							
	Means	SD	F	P				
Gr1	83,03	8,13						
Gr2	100,34	13,25	86,706	.000*				
	PSI				IQ			
	Means	SD	F	P	Means	SD	F	P
Gr1	96,34	13,31			97,94	10,42		
Gr2	99,73	11,51	2,58	.110	103,97	11,44	10,61	.000*
*p < 0.05								

Table 2: Comparison of IML and IQ indices.

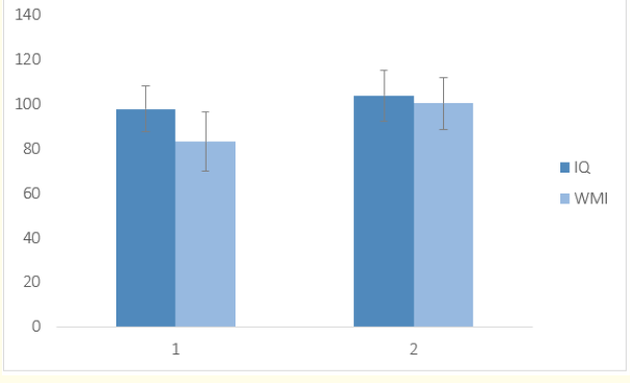

Figure 1: Comparison of IML and IQ indices.

Figure 2: Percentages of specific learning disorders in the group study.

Conclusion

A systematic analysis of studies carried out from 2006 to 2013, concerning the cognitive and neuropsychological development of preterm births from the first year of life to school age, has pointed at several results indicating that both preschool and school age preterm births reach a lower average cognitive level and have learning difficulties when compared to children born on term, results were confirmed by the meta-analysis by Kerr-Wilson*., et al* [23]. Already at the age of 2 years they have a lower cognitive development, even if the average scores do not fall into ranges that indicate a delay in development. Even in the following years (from 3 to 7 years) there remain differences in general cognitive skills and in some specific skills, such as those of the learning prerequisites, especially in tests of visual-constructive ability at 5 years and in reading tests at 7 years [24]. Other studies have also supported the finding that similar samples between 8 - 11 years get lower scores than on term births for both cognitive and attention level, memory tests and reading skills [25]. In our study we expand the sample age and evaluate the cognitive profile of adolescents and understand if cognitive abilities had specific effects, comparing a group of adolescents born preterm (group 1) with a group of adolescents born on term (group 2). Our analysis shows significant differences between the two groups, in particular we highlighted in group 1 specific difficulties to the tasks of working memory, made evident by the significance in comparison of scores to the WMI index. These difficulties also had a significant impact on global cognitive functioning, made evident by the significance of comparing scores to the IQ index.

These data are consistent with what has emerged in the literature about the difficulties of children born preterm regarding cognitive abilities, especially WM and IQ [10,23]. Many studies have also shown that severe prematurity is associated with deficits of general intellectual abilities, and deficits of attention, working memory and inhibitory control [18,19]. Broadening the study population age, we may conclude that the impairment of WM's abilities persists during the course of development, and therefore subjects with a preterm birth history continue to present difficulties in global cognitive functioning, also impacting lifestyle.

Furthermore, our analysis strongly demonstrates the presence of Specific Learning Disorders in the tested sample population, specifically in 4,2% (3 subjects) a diagnosis of dyslexia was detected whereas in the 11,4% (8 subjects) was diagnosed with dyscalculia. We also found that, of these, the 17.1% (12 subjects) was diagnosed with both dyscalculia and dyslexia. These data are consistent with what emerged in previous studies about the presence of SLD in children with a history of preterm birth (Molinaro, 2017) but in our sample, subjects specifically diagnosed with dyslexia and dyscalculia emerged specifically. Differently, as regards the control group, we detected in 4.28% the diagnosis of dyslexia and in 1.4% the diagnosis of dyscalculia.

Future studies direction could include an extension of the sample population and a longer-term follow-up in order to highlight whether these difficulties persist in the course of development, also providing further diagnostic analysis for the evaluation of behavioral aspects of individuals with a preterm birth history to define their lifestyle [26,27].

Conflict of Interest

The authors declare that they have no conflict of interest.

Bibliography

1. Beck S., *et al*. "The worldwide incidence of preterm birth: a systematic review of maternal mortality and morbidity". *Bulletin Word Health Organization* 88 (2010): 31-38.
2. March of Dimes, PMNCH, Save The Children, WHO. Born too soon: The Global action report on preterm birth, C.P. Howson, M.V. Kinney, J.E. Lawn (eds.), Geneva, World Health Organization (2012).
3. Bhutta A., *et al*. "Cognitive and Behavioral Outcomes of school-aged children who were born preterm". *Journal of American Medical Association* 288 (2002): 728-737.
4. Aylward GP. "Neurodevelopmental outcomes of infants born prematurely". *Journal of Developmental and Behavioral Pediatrics* 26 (2009): 427-440.
5. Molinaro A., *et al*. "La percezione della qualità delle cure erogate nei servizi di riabilitazione italiani per bambini con paralisi cerebrale: risultati di uno studio osservazionale multicentrico". *Giornale di neuropsichiatria dell'età evolutiva* (2017).
6. Ferrari F. Il neonato pretermine. Disordini dello sviluppo e interventi precoci, Franco Angeli, Milano (2017).
7. Stjernqvist K and Svenningsen NW. "Premature infants are followed up to the age of 5 years". *Lakartidningen* 93.6 (1996): 483-484.
8. Sansavini A., *et al*. "Fattori di rischio associati alla nascita pretermine e prime competenze linguistiche rilevate con il MacArthur". *Psicologia Clinica dello Sviluppo* 8 (2004): 47-67.
9. Aarnoudse-Moens CS., *et al*. "Metaanalysis of neurobehavioral outcomes in very preterm and/or very low birth weight children". *Pediatrics* 124.2 (2009): 717-728.
10. Sansavini A., *et al*. "Does preterm birth in increase a child's risk for language impairment?" *Early Human Development* 86 (2010): 765-772.

11. van Baar AL., *et al*. "Functioning at school age of moderately preterm children born at 32 to 36 weeks' gestational age". *Pediatrics* 124.1 (2009): 251-257.

12. Limperopoulos C., *et al*. "Positive screening for autism in ex-preterm infants: Prevalence and risk factors". *Pediatrics* 121.4 (2008): 758-765.

13. Grunau RE., *et al*. "Pattern of learning disabilities in children with extremely low birth weight and broadly average intelligence". *Archives of Pediatrics and Adolescent Medicine* 156.6 (2002): 615-620.

14. Guarini A., *et al*. "Reconsidering the impact of preterm birth on language outcome". *Early Human Development* 85 (2009) 693-645.

15. Gombert JE and Gombert JÉ. "Metalinguistic development". University of Chicago Press (1992).

16. Collin MF., *et al*. "Emerging developmental sequelae in the 'normal' extremely low birth weight infant". *Pediatrics* 88.1 (1991): 115-120.

17. Grunau RE., *et al*. "Neonatal pain, parenting stress and interaction, in relation to cognitive and motor development at 8 and 18 months in preterm infants". *Pain* 143 (2009): 138-146.

18. Negri R. Il neonato in terapia intensiva. Un modello neuropsicoanalitico di prevenzione, Milano: Raffello Cortina Editore (2012).

19. Nyman A., *et al*. "Factors affecting the cognitive profile of 11-year-old children born very preterm". *Pediatric Research* 82.2 (2017): 324-332.

20. Orsini A., *et al*. WISC-IV: Contributo alla taratura Italiana (WISC-IV Italian ed.). Florence, Italy: Giunti O. S (2012).

21. Cornoldi C and Candela M. "Prove di lettura e scrittura MT 16-19 Batteria per la verifica degli apprendimenti e la diagnosi di dislessia e disortografia". Erickson, Trento (2015).

22. Cornoldi C and Cazzola C. "Test di valutazione delle abilità di calcolo e problem solving dagli 11 ai 14 anni". Edizioni Erickson: Gardolo-Trento (2003).

23. Kerr-Wilson CO., *et al*. "Meta-analysis of the association between preterm delivery and intelligence". *Journal of Public Health* 34.2 (2012): 209-216.

24. Odd DE., *et al*. "Long-term cognitive outcomes of infants born moderately and late preterm". *Developmental Medicine and Child Neurology* 54.8 (2012): 704-709.

25. Anderson PJ. "Neuropsychological outcomes of children born very preterm". *In Seminars in Fetal and Neonatal Medicine* 19.2 (2014): 90-96.

26. Achenbach TM and Rescorla LA. "Manual for the ASEBA school-age forms and profiles". Burlington: Research Centre for Children, Youth and Families, University of Vermont (2001).

27. IBM (2019) to Acquire SPSS Inc. to Provide Clients Predictive Analytics Capabilities, in ibm.com, 28 luglio 2009 (2019).