Developmental status at age 12 months according to birth weight and family income: a comparison of two Brazilian birth cohorts

Estado de desenvolvimento aos 12 meses de idade de acordo com peso ao nascer e renda familiar: uma comparação de duas coortes de nascimentos no Brasil

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Abstract

Two cohorts of children born in the city of Pelotas, Southern Brazil, in 1993 and 2004, were compared in terms of neuro-psychomotor development at the age of 12 months. Children were evaluated using the Denver II screening test. Analyses were performed using the Poisson regression technique. The prevalence of suspected developmental delay fell from 37,1% in 1993 to 21.4% in 2004 and was inversely proportional to family income and birth weight. Among children born weighing under 2,000 g, there was a fourfold reduction in the prevalence of developmental delay between 1993 and 2004. With regard to family income, the poorest group showed the greatest reduction between the two cohorts – a 30% reduction in risk. Our results confirm the influence of income and birth weight on child development. The decrease in the prevalence of developmental delay in the last decade reflects, among other factors, improvements in neonatal care, increased coverage of developmental monitoring in the first year of life, and longer breastfeeding duration. Despite this reduction, the prevalence of developmental delay is still high, reinforcing the need for early diagnosis and intervention.

Child Development; Low Birth Weight Infant; Cohort Studies

Introduction

A number of intervention studies carried out in developed countries [1,2] call attention to the importance of monitoring child development during both routine and disease-related medical visits, so as to be able to identify and treat as promptly as possible children at high risk of developmental delay [3]. Children from middle and low-income countries face an even greater challenge: in addition to being more susceptible to perinatal problems, these children are also subject to unfavorable household environments, in which stimulation and social support are inadequate [4]. This combination of events increases the risk of problems in cognitive, physical, and social development [5,6,7,8].

In spite of advancements in perinatal and child care in the last decade [9] and improvements in living conditions, prevalence of developmental delay is still high. This is especially true among high-risk children, including children with very low birth weight [10].

The goal of the present study is (i) to compare the prevalence of suspected developmental delay in two birth cohorts from Pelotas, Southern Brazil, carried out in 1993 and 2004; (ii) to trace its evolution among different birth weight and family income groups; and (iii) to test the association between birth weight/family income and developmental delay.

Methods

The 1993 and 2004 Pelotas birth cohort studies investigated all births that took place in the city's hospitals during these two years. A detailed description of the methodology of these studies has been published elsewhere [11]. Mothers responded to a questionnaire including items on reproductive, demographic, socioeconomic, and environmental variables, as described previously [11]. We also collected maternal and newborn anthropometric measures and calculated gestational age using both the date of the mother's last period and the Dubowitz et al. method [12]. For the 1993 study, a sub-sample including a random selection of 20% of all children plus all low birth weight babies (< 2,500g) was visited at home at age 12 months. Sample size was calculated assuming 5% alpha error and 80% power, and based on the prevalences of the exposure variables, the number of children studied is more than sufficient to maintain the desired power. All results were weighted so as to reproduce the proportion of low birth weight children in the general population. For the 2004 study, we attempted to locate all children as they reached the age of 12 months. Child development was assessed using the Denver II screening instrument [13], in a version adapted to the Brazilian population. This instrument consists of 125 items, divided into four sectors: *Personal-Social, Fine Motor Adaptive, Gross Motor, and Language*, and is designed for use on children from birth to age six months. The instrument allows for the detection of suspected developmental delay by assessing the failure to acquire certain developmental skills at a given chronological age. Methodological details have been described elsewhere [6].

As in all other follow-ups [11], a sample of 5-10% of cases was revisited by a supervisor for quality control purposes. Since this sub-sample included preterm babies, age was adjusted by subtracting the difference between gestational age at birth and the 37 weeks of normal pregnancy. Evaluation was therefore based on developmental age, thus preventing overestimation of the number of children with suspected developmental delay due to the presence of preterm babies.

Crude and adjusted analyses were carried out using Poisson regression with robust variance. This type of analysis was adopted because it provides direct estimates of prevalence ratios without leading – as is the case with logistic regression – to overestimations when dealing with cross sectional analyses of high-prevalence binary outcomes [14]. For statistical analysis, we used Stata software (Stata Corp., College Station, USA) to calculate the percentage of children with suspected developmental delay at age 12 months, stratified according to birth weight and family income in each of the follow-ups.

The study protocol was approved by the Medical Research Ethics Committee of the Federal University of Pelotas. In 1982 and 1993, verbal consent was obtained from all mothers participating in the study. In 2004, written consent was also requested.

Results

The 12-month follow-ups included 1,364 children in 1993 and 3,907 children in 2004, with follow-up rates of 93% and 94%, respectively. In 1993, the prevalence of suspected developmental delay was 37.1%. This proportion fell to 21.4% in 2004, a 42% reduction ($p < 0.001$).

Table 1 presents the prevalence of developmental delay according to family income and birth weight in the two cohorts. The prevalence of suspected delay decreases as family income and birth weight increase, showing a statistically significant linear trend. In 1993, poorer children showed a 60% higher frequency of suspected developmental delay than children from the highest income group. This proportion fell to 40% in 2004.

A comparison between 2004 and 1993 shows a 29% reduction in the prevalence of suspected developmental delay among children from richer families, whereas among the poor families prevalence fell 36% ($p < 0.05$). On the other hand, relative risk between the poorest and richest children fell slightly (from 1.6 to 1.4), indicating a relatively stable effect of family income on suspected delay across the 11 years that separate the two cohorts. The concentration index, another form of measuring inequality, evolved from -8.2 in 1993 to -9.3 in 2004 – indicating that there was in fact a slight increase in inequality when analyzing all five income groups.

Birth weight was inversely associated with suspected developmental delay in both cohorts (Table 1), but the magnitude of this association decreased in 2004. In the latter cohort, the risk of suspected delay was similar among children born weighing 2,500g or more, and increased by 50% and 130% among children weighing under 2,500 and 2,000g, respectively. The prevalence ratio for the 1993 cohort was as high as 4 for children weighing under 2,000g. As with family income, the greatest reduction in risk of delay was seen among more vulnerable groups.

We also explored confounding and interaction between birth weight and family income as determinants of suspected delay. There was a sig-

Table 1

Prevalence of suspected developmental delay (≥ 2 items in the Denver II test) at age 1 year, according to income and birth weight groups, and respective prevalence ratios. Pelotas, Southern Brazil, 1993 and 2004.

	1993 (n = 1,364)			2004 (n = 3,907)		
	% of sample	Suspected delay (%)	Prevalence ratio (95%CI)	% of sample	Suspected delay (%)	Prevalence ratio (95%CI)
Family income (as a multiple of the minimum wage)			p = 0.007 *			p < 0.001 *
≤ 1	18.6	41.1	1.6 (1.2; 2.1)	21.0	26.1	1.4 (1.1; 1.8)
1.1-3	44.7	35.8	1.4 (1.0; 1.8)	46.1	21.9	1.2 (1.0; 1.5)
3.1-6	22.3	30.5	1.3 (1.0; 1.7)	22.3	17.5	1.0 (0.8; 1.2)
> 6	14.4	25.5	1.0	10.6	18.1	1.0
Birth weight (g)			p < 0.001 **			p < 0.001 **
< 2,000	5.8	74.7	3.9 (2.4; 6.2)	4.1	43.8	2.3 (1.6; 3.4)
2,000-2,499	23.7	50.0	2.6 (1.6; 4.2)	6.8	27.8	1.5 (1.0; 2.1)
2,500-2,999	18.7	41.7	2.0 (1.2; 3.3)	24.5	21.8	1.2 (0.8; 1.6)
3,000-3,499	32.0	31.3	1.6 (1.0; 2.6)	38.6	20.4	1.1 (0.8; 1.5)
3,500-3,999	15.1	24.9	1.3 (0.8; 2.2)	21.3	18.6	1.0 (0.7; 1.4)
≥ 4,000	4.8	16.9	1.0	4.6	18.9	1.0
All	100.0	37.1	-	100.0	21.4	-

* p-value for difference between income groups;

** p-value for difference between birth weight groups.

nificant interaction between these two variables in 1993 (p = 0.02), but not in 2004 (p = 0,686). Figure 1 shows the effects of birth weight (adjusted as a continuous variable) for each family income group. In 1993, the effect of birth weight seems to be similar across all groups, except for that of lowest income. In this group the effect is smaller, with the prevalence of delay being lower for lower birth weights and higher for higher birth weights. In 2004 this interaction was not statistically significant, and showed a pattern entirely different from that seen in 1993, suggesting a decreasing effect of birth weight among higher-income groups. No confounder effects were detected between birth weight and family income.

Discussion

The opportunity to compare child development status between two birth cohorts in Brazil paves the way for a better understanding of developmental delay and its determinants. The present study confirms the protective effect of birth weight and socioeconomic conditions on child development at age 12 months, which is in agreement with results obtained in other settings [7,15,16,17].

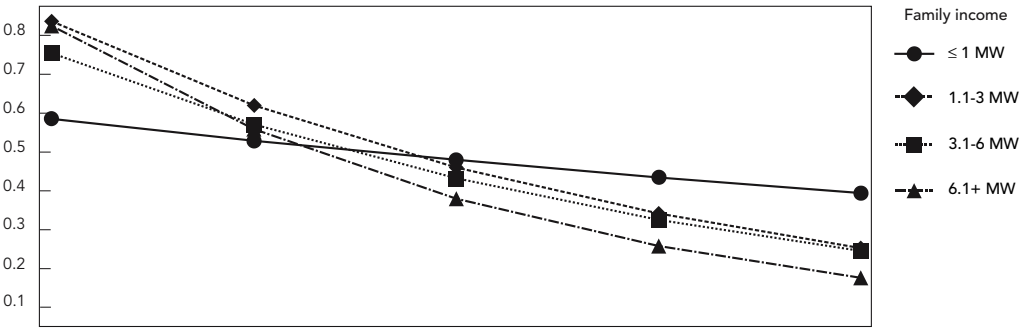
Even though suspected delay was more prevalent among children of poorer households, it was even more strongly associated with birth weight, which accounted for most of the observed variance. There was a strong interaction between these two variables in the 1993 cohort, which, surprisingly, showed a smaller effect of birth weight among children from the lowest income group. Although in theory higher-income families would be better able to offset, through stimulation, attention, and care, any disadvantages brought about by lower birth weight than poorer families, this was not the case in 1993. A similar pattern can be seen in the 2004 cohort, but this interaction was not statistically significant.

A possible explanation for our findings regarding 1993 is that the survival of low-birth weight children from poor families was also lower, so that only the fittest children were evaluated at 12 months. In 1993, the infant mortality rate for low birth weight children from families earning less than or the equivalent of the minimum wage was 621 per 1,000 live births, whereas in 2004, this rate was 464 per 1,000. The last decade witnessed significant improvements in the quality of neonatal care, with a reduction in mortality among very-low-birth weight children [9,18]. One

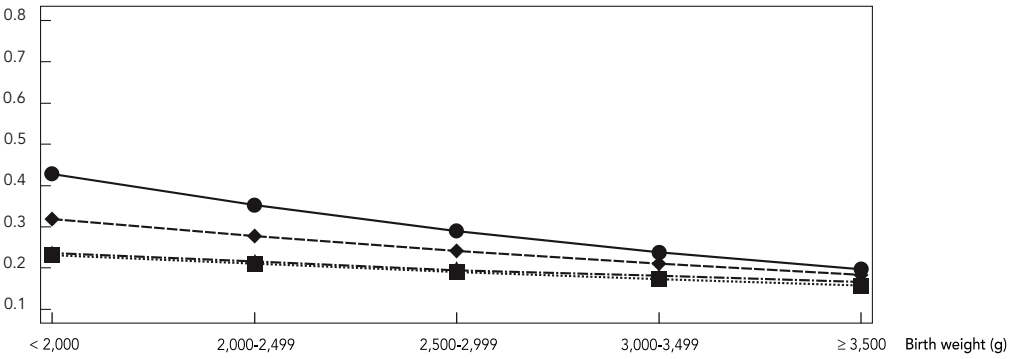
Figure 1

Prevalence of suspected developmental delay at age 12 months (Denver II) obtained using a regression model exploring the interaction between family income and birth weight for 1993 (p = 0.02) and 2004 (p = 0.686). Pelotas, Southern Brazil.

a) 1993 cohort



b) 2004 cohort



MW: minimum wages

of the major reasons behind such a reduction was the widespread use of pulmonary surfactant, which dramatically reduced mortality caused by respiratory difficulties [19]. With this reduction, the largest proportion of developmental delay became concentrated in an ever decreasing number of newborns who, given their very low birth weight, were those most likely to experience complications. An analysis of the percentage of delay among babies born weighing under 1,000g in 2004 shows that developmental delay in this group affects 66% of children, and this is consistent with the findings of other studies [9,20]. According to a study conducted by Hintz et al. [9] with children born between 1993 and 1999, there were no changes in the prevalence of delay in the highest risk group, despite the advancements in perinatal care over the previous decade. Stratified analysis showed that the effects of birth weight and income are independent from one another, confirming the importance of both factors in determining developmental delay.

Because of the multifactorial etiology of psychomotor development, other factors in addition to birth weight and family income may have contributed to the reduction in developmental delay and the differences found in the 2004 cohort. Variables such as maternal schooling, family size, and paternal occupation, which were not addressed in the present study, are also important predictors for the child's future development [6,21].

The increase in median breastfeeding duration seen in 2004 [22] may also have contributed to reducing developmental delay. The importance of breastfeeding is well established for issues extending beyond healthy child nutrition, such as improvement of the mother-child relationship, which may lead to improved development [16,22,23,24,25,26].

Other possibilities include the reduction in the number of children and the increase in birth spacing [27], which are known to influence development by allowing the mother to dedicate more time to her child.

In the last decade, traditional pediatric care has been improved by the introduction of development monitoring during healthcare visits. The Brazilian Ministry of Health has introduced, by means of the *caderneta de saúde* (healthcare notebook), concepts encouraging caretakers to stimulate children through play and communication [28]. In addition, the *Pastoral da Criança* and United Nations Children's Fund (UNICEF), through a program for promoting family competences, have encouraged monitoring child development during the first six years of life (UNICEF. Brasil Família Brasileira Fortalecida; 2004). Furthermore, there has been a substantial increase in training and information regarding this subject in pediatric education programs. All these factors may have contributed to the observed reduction.

Despite the reduction seen throughout the decade, the prevalence of developmental delay is still high, with one in every five children showing suspected delay in the first year of life. It is evident that the risk is higher among poor and low birth weight children, a trend which has not been reversed in the last decade. In developing countries, children are victimized by socioeconomic inequities that lead to an unequal distribution of goods and services. Furthermore, these children are subject to what Bobadilla & Possas [29] have called a "double burden of disease", where the child is exposed to both traditional and modern hazards. According to Victora et al. [30], advancements in healthcare are likely to reach the rich before they can reach the poor, thus promoting an increase in social inequity, which would eventually decline when the improvements reach the poor. However, in this case what we see is the stability of income-related differences, the ratio indicator showing a slight improvement, and the concentration index, a slight worsening of inequality. It is possible that rich families may have incorporated already in 1993 the psychomotor stimulation practices that were only adopted by poorer families during the last decade.

The results of the present analysis reinforce the need for monitoring child development during the first year of life, with the need for giving special attention to children with low birth weight and those from families with less favorable socioeconomic conditions.

Resumo

Foram comparadas duas coortes de crianças nascidas no município de Pelotas, Rio Grande do Sul, em 1993 e 2004, em relação ao desenvolvimento neuropsicomotor aos 12 meses de idade. As crianças foram avaliadas pelo teste de triagem de Denver II. As análises foram realizadas usando a técnica de regressão de Poisson. A prevalência de suspeita de atraso no desenvolvimento diminuiu de 37,1% em 1993 para 21,4% em 2004, e era inversamente proporcional à renda familiar e ao peso ao nascer. Entre crianças com peso ao nascer abaixo de 2000g, houve uma redução de quatro vezes no atraso no desenvolvimento, entre 1993 e 2004. Com relação à renda familiar, o grupo mais pobre mostrou a maior redução entre as duas coortes – uma redução de 30% no risco. Nossos resultados confirmam a influência de renda e peso ao nascer sobre o desenvolvimento infantil. A queda na prevalência de atraso no desenvolvimento na última década reflete, entre outros fatores, melhorias na assistência pré-natal, aumento de cobertura no monitoramento do desenvolvimento no primeiro ano de vida e maior duração do aleitamento materno. Apesar dessa redução, a prevalência de atraso no desenvolvimento permanece alta, reforçando a necessidade de diagnóstico precoce e intervenção.

Desenvolvimento Infantil; Recém-Nascido de Baixo Peso; Estudos de Coortes

Contributors

R. Halpern devised the research question and wrote the first draft of the article. A. J. D. Barros and A. Matijasevich conducted the analyses and contributed with the interpretation of the findings. I. S. Santos, C. G. Victora and F. C. Barros contributed to the interpretation of the findings and assisted with the editing of the article.

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