

Child psychomotor development and its relationship with socio-demographic and family stimulation factors in children from Bariloche, Argentina

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ABSTRACT

Introduction. This study analyzed the association between psychomotor development and socio-demographic and family stimulation factors in 3-year-old children from San Carlos de Bariloche. **Population and Methods.** A total of 152 apparently healthy children aged 35-37 months old who attended municipal and private kindergartens were evaluated. Children's performance in personal-social, fine motor, language and gross motor skills development using the National Screening Test was analyzed. The relationship between environmental factors and the achievement of developmental milestones was studied using a multivariate logistic regression model.

Results. Twenty seven percent of children did not pass the test. The most common outcome measures associated with altered developmental milestones were no reading, low birth weight, and the parents' lower education level. The association with reading was always positive; and this also occurred in relation to the parents' education level. A low birth weight had a negative association with the possibility of passing four milestones, three of which were gross motor skills. Children who attended municipal kindergartens had a low performance in three language milestones, one personal-social milestone and one fine motor milestone when compared to national profiles.

Conclusions. The percentage of children who did not pass the test was 27%. The most common outcome measures associated with altered developmental milestones were lack of reading to the child, low birth weight, and the parents' lower education level.

Key words: child development, psychomotor performance, family stimulation.

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INTRODUCTION

An adequate mental and physical health status during pre-school age is critical for children to start school ready to learn,^{1,2} especially considering that the health and the academic performance of children have a major effect on their future achievements.³

Genetic factors, nutrition, health, environment where children grow, and opportunities offered by their families are all determinants of child development.^{4,5} A family environment that promotes learning favors a comprehensive development.⁶⁻⁹ Regardless of the skills that a child could have to achieve high competence levels, a poor environment can negatively affect the materialization of such skills.⁴

In many cases, detecting developmental delays and investigating their causes allow to implement treatments and support measures that could favor the child's development.¹⁰⁻¹² Several studies show evidence on the benefits of an early intervention in relation to the patient's progress in the short- and medium-term.¹³⁻¹⁵ As children grow, the influence of their environment also increases, and the differences in psychomotor development among children with different stimulation levels become deeper.

The objective of this study was to analyze the relationship between psychomotor development and socio-demographic and family stimulation factors in a population of 3-year-old children who attend different kindergartens in the city of Bariloche.

This study is part of a large project that plans to assess the psychomotor development of the same children at 5 years old, which will enable to perform a comparative analysis to check if environmental factors have greater influence over time. This is the first study of this kind in the region.

POPULATION AND METHODS

This study was conducted on a sample of apparently healthy children aged 3 years \pm 1 month old who attend initial education facilities in the city of Bariloche. All eight municipal kindergartens (MKs) and five private kindergartens (PKs) participated. Children attending MKs usually come from low-income families. Since the study objective was to analyze the association between development and socio-demographic factors, the selected PKs were among the seven facilities that serve the highest-income families. Participants were selected on a monthly basis. Based on the lists provided by each type of institution, children with the age in the range of interest at least 15 days of each month were identified. Out of them, 5 children were randomly selected to be interviewed, with a total of 10 children each month. If any of them was unable to attend the interview, another child was randomly selected. Parents were invited to participate, information was provided on the project and they were asked to give their consent.

The interview entailed recording information on socio-demographic aspects and family stimulation characteristics, and assessing the child's performance of developmental milestones. The interviews were conducted by the pediatricians who co-wrote this article, between June 2010 and May 2012, with interruptions only during summer vacations. Interviews were conducted at the kindergarten in the presence of the child and one of his/her parents.

For the assessment of development,²⁵ fine and gross motor skills, personal-social, and language milestones were applied using the National Screening Test (Prueba Nacional de Pesquisa, PRUNAPE by its acronym in Spanish) for children aged 35-37 months old.¹⁶ Milestone assessments were implemented by trained personnel and in accordance with the instructions of the PRUNAPE Technical Brochure.¹⁶ Categories included in the developmental milestones were yes: if the child passed, and no: if the child did not pass the milestone or refused to perform.

If the child did not pass the PRUNAPE, he/she was referred to his/her pediatrician with indications on the need to be assessed for possible developmental disorders and emphasizing the significance of follow-up. The principals of the kindergartens were reported on the development areas where children showed most difficulties.

The statistical analysis included, first of all, a calculation of the confidence intervals (CI)

of the percentage of children who passed each developmental milestone in relation to the total number of children and the groups attending MKs and PKs separately. Using the χ^2 test, the percentage of children who passed each test was compared based on whether they attended a MK or a PK.

The relationship between biological, socio-demographic, and family stimulation risk factors and the achievement of developmental milestones was studied using a multivariate logistic regression model. Biological and socio-demographic outcome measures included: sex, preterm birth, low birth weight (category 1: \leq 2500 g; 2: $>$ 2500 g), adolescent pregnancy (if the mother had the child before turning 19 years old), maximum education level attained by the parents (category 1: no education or primary education; 2: secondary, tertiary, or university education), parents employment modality (category 1: permanent; 2: temporary or day laborer, 3: no employment), and type of institution where the child attended (category 1: municipal; 2: private). An index was prepared combining the data on whether the family received a child benefit (yes/no) and whether they had health coverage through a social insurance program or a managed care organization (yes/no), with category 1: two "yes" answers; 2: one "yes"; 3: two "no" answers.

Family stimulation was evaluated using a survey based on the HOME inventory,¹⁷ leaving out the direct observation of the child in his/her home. The following aspects related with the child's comprehensive development were assessed.^{7,18,19-21} Learning stimulation materials: questions were asked about whether the child had three or more children's books, a ball, a tricycle or bicycle, color pencils, puzzles, building blocks, dolls or action figures, and toy cars. Category 1: less than 6 of these elements; 2: 6 or more of these elements. Academic stimulation: whether the child was taught animal names, colors, how to count, and the names of letters, and whether he/she listened to children's music. Category 1: less than 4 of these activities; 2: 4 or more of these activities. Modeling and stimulation of social maturity, which comprise the following aspects: whether the child is requested to respect meal times, go to bed before 9 PM, wash his/her teeth at least once a day, and wash his/her hands before meals and after using the bathroom. Category 1: less than 3 of these activities; 2: 3 or more of these activities. Varied experiences: whether the child went out at least once in the

previous week, visited or was visited by family or friends in the previous month, watches less than one hour of television a day, went on vacations at least once in the previous year. Category 1: less than 3 of these activities; 2: 3 or more of these activities. Reading: whether stories are read to the child. Category 1: no reading in the previous week; 2: reading at least once in the previous week.

The adequate model for each milestone was selected based on the forward stepwise selection method using the Akaike Information Criterion.²²

Statistical analysis were done using the R statistical package, version 2.15.1.23.

RESULTS

A total of 152 children were interviewed, 53% from municipal kindergartens and 47% from private kindergartens. Of them, 7% of the families from MKs and 16% of the families from PKs refused to participate. Socio-demographic characteristics of the families are described in *Table 1*.

Families of low socio-economic and education levels were more predominant in municipal institutions.

In relation to child development, *Table 2* shows the 95% CIs for the percentage of children who passed each milestone, for all children, and for the MK and PK groups; the p value of the comparison between the percentage of children attending MKs and PKs who passed the tests; and the percentile values and the age at which the child is expected to achieve the milestone at a national level.²⁴

Most differences between children from MKs and PKs were found in the language milestone group; six out of eight had significant differences: "saying phrases (noun, verb)", "humming in front of others", "saying full phrases", "making opposite analogies", "understanding prepositions", and "complying with two consecutive indications". In all cases, the CIs of the PKs tended more to the right than those of MKs. Tests referring to "saying full name", "making opposite analogies", and "complying with two consecutive indications" were passed by a lower percentage of children from MKs when compared to the milestone at a national level. The milestone "making opposite analogies" was the only one attained by a lower percentage of children from PKs than that recorded at a national level.

TABLE 1. Social characteristics of studied families

	Type of kindergarten		p
	Municipal	Private	
Maximum education level attained by the father			<0.001
No education or primary education	64.5	8.5	
Secondary education	30.3	31	
Tertiary or university education	5.3	60.6	
Maximum education level attained by the mother			<0.0001
No education or primary education	57.5	7	
Secondary education	36.2	21.1	
Tertiary or university education	6.2	71.8	
Father's employment modality			0.0002
Permanent	64.9	93	
Temporary or day laborer	29.9	7	
Unemployed	5.2	0	
Mother's employment modality			0.0015
Permanent	49.4	77.5	
Temporary or day laborer	13.9	8.5	
Unemployed	36.7	14.1	

Percent distribution of the social characteristics of the studied families by type of kindergarten and p value of the comparison.

A significant difference was found between MKs and PKs in terms of the gross motor skill milestones “jumping on both feet” and “making wide jumps.” The percentage of children who passed the test for “jumping on both feet” (95% CI: 68-87) was lower than the one recorded at a national level, with a 90% percentile at 34 months old.

The percentage of children who failed the PRUNAPE was 27% (95% CI: 20-35); and the difference between MKs (31%) and PKs (24%) was not significant.

Results of the assessment of the association between psychomotor development and

biological, socio-demographic, and family stimulation factors are shown in *Table 3*. No significant association was found between the following outcome measures and developmental milestones: adolescent pregnancy, employment modality of the father and mother, child benefit and health coverage index, academic stimulation, and modeling and stimulation of social maturity. Children whose mothers had completed secondary, tertiary or university education had 3.7 more chances of passing the “matching colors” milestone than those whose mothers had only attained a primary education level.

Outcome measures most commonly associated

TABLE 2. Psychomotor development and type of kindergarten

Milestones	Total	Type of kindergarten		p	PRUNAPE percentile
		Municipal	Private		
Personal-social skills					
Responding to the observer’s call	87.96	84.97	84.98	1	90 = 28 m
Sphincter control during the day	90.98	89.99	85.98	0.6052	90 = 33 m
Removing clothes or shoes	86.96	79.95	88.99	0.1888	90 = 34 m
Putting on clothes or shoes	92.99	93.100	86.98	0.3096	90 = 36 m
Putting puzzles together	78.90	70.88	81.96	0.1326	75 = 33 m
Matching colors	37.54	25.48	43.68	0.0246*	50 = 35 m
Fine motor skills					
Scribbling	94.100	91.100	93.100	1	90 = 19 m
Dumping a raisin into a bottle	94.100	91.100	93.100	1	90 = 19 m
Building a 4 cube tower	92.99	91.100	88.99	0.9046	90 = 24 m
Building an 8 cube tower	78.90	74.91	76.93	0.858	75 = 31 m
Building a bridge	55.71	47.69	57.80	0.2072	50 = 31 m
Correcting tower	60.76	50.72	64.85	0.0759	50 = 27 m
Language skills					
Naming two figures	88.97	84.97	86.98	0.8605	90 = 29 m
Saying phrases (noun and verb)	90.98	81.96	95.100	0.0167*	90 = 29 m
Humming in front of others	87.96	77.93	93.100	0.0117*	90 = 34 m
Saying full phrases	78.90	65.85	86.98	0.0037**	75 = 32 m
Saying full name	53.69	47.69	52.75	0.5857	75 = 34 m
Making opposite analogies	10.23	2.16	15.37	0.0104*	50 = 35 m
Understanding prepositions	46.64	28.52	59.82	<0.0001***	50 = 32 m
Complying with two consecutive indications	39.56	24.48	46.71	0.011*	50 = 32 m
Gross motor skills					
Kicking a ball	87.96	81.96	88.99	0.2941	90 = 21 m
Throwing a ball	87.96	80.95	90.100	0.0936	90 = 29 m
Jumping on both feet	79.91	68.87	84.98	0.0252*	90 = 34 m
Standing on one foot for 5 seconds	35.52	35.58	28.52	0.4466	50 = 28 m
Making wide jumps	48.65	55.77	34.58	0.0147*	50 = 30 m

*p < 0.05, **p < 0.01, ***p < 0.001. 95% confidence intervals of passing result percentages per milestone: total and by type of institution. p value of the comparison between the percentage of children who passed the milestones in each type of institution. Percentile and age in months (m) at which a child is expected to perform each milestone at a national level.

with developmental milestones were reading, low birth weight, and the parent's education level. In all cases, reading and a higher education level of parents favored the likelihood of achieving the milestones. Of the interviewed children, 36% were never read stories, 58% of them from MKs and 13% from PKs, $p < 0.0001$. It is worth mentioning that reading, the mother's education level and the father's education level were factors never significantly associated together with a milestone.

The number of hours spent watching television was included in the analysis using the varied experiences outcome measure; 58% of interviewed children watched more than one hour of television a day, and 31% did so alone.

A low birth weight was associated with a reduction in the possibility of passing three gross motor skill milestones. The fine motor skill milestones were only related to the education level of the parents.

DISCUSSION

In this study, we assessed the psychomotor development of 3-year-old children attending municipal or private kindergartens in the city of Bariloche. This is the first study of this kind in the region.

The national developmental profile was obtained based on a sample biased towards a higher education level of the mother in comparison with national values;²⁵ therefore, it can be considered a desirable goal for all Argentine children. Comparing our results with national ones, the percentage of children who failed the PRUNAPE was similar.²⁶ However, children from municipal institutions had a low performance in three language milestones, one personal-social milestone, and one fine motor skill milestone when compared to national profiles. PK children showed a low performance only in relation to "making opposite analogies". The

TABLE 3. Association between biological, socio-demographic and family stimulation factors and the capability to pass developmental milestones

Milestones	Learning material	Varied experiences	Reading	Type of institution	Education of the mother	Education of the father	Gender	Preterm	Low birth weight
Responding to the observer's call	NS	NS	4.9* y/n	NS	NS	NS	NS	NS	NS
Removing clothes or shoes	NS	NS	6.7* y/n	NS	NS	NS	NS	7.2** y/n	NS
Putting puzzles together	NS	NS	NS	NS	NS	6.8** 2/1	NS	NS	6.3* 2/1
Matching colors	NS	NS	NS	NS	3.7** 2/1	NS	2.9** f/m	NS	NS
Building a bridge	NS	NS	NS	NS	3.4** 2/1	NS	NS	NS	NS
Correcting tower	NS	NS	NS	NS	NS	3.2** 2/1	NS	NS	NS
Humming in front of others	NS	NS	NS	9.4* 2/1	NS	NS	NS	NS	NS
Saying full phrases	NS	3.9* 2/1	3.2* y/n	NS	NS	NS	4.5** f/m	NS	NS
Saying full name	NS	NS	NS	NS	NS	NS	NS	3.1* y/n	NS
Understanding prepositions	NS	NS	NS	4.4*** 2/1	NS	NS	NS	NS	NS
Complying with two consecutive indications	4.9*** 2/1	NS	NS	NS	NS	NS	NS	NS	NS
Kicking a ball	NS	NS	8.6* y/n	NS	NS	NS	NS	NS	8.8** 2/1
Throwing a ball	NS	NS	6.8* y/n	NS	NS	NS	NS	NS	NS
Jumping on both feet	NS	NS	7.8*** y/n	NS	NS	NS	NS	NS	4.1* 2/1
Standing on one foot for 5 seconds	NS	NS	NS	NS	NS	NS	2* f/m	NS	NS
Making wide jumps	5.9*** 2/1	NS	NS	NS	NS	NS	NS	NS	6.1* 2/1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The table shows the significant odds ratios of the multiple logistic regression model. The milestones for which it was not possible to make an adequate adjustment of the logistic regression model or had no significant association with the assessed factors were not included. y: yes, n: no, f: female, m: male; categories 1 and 2 of each outcome measure are detailed in the text.

NS: not significant.

development of language is related to the child's cognitive skills and influences his/her academic performance.²⁷

Almost 60% of all interviewed children watch television for more than one hour a day, and 31% always do so alone. Several studies have demonstrated that watching television has negative effects on the children's health because the time spent in front of the TV is taken away from play time, from interaction with their parents and from reading, and because of the contents of TV shows.^{28,29} Silinger, et al.³⁰ have highlighted the importance of accompanying children while they are in front of the television so as to establish a relationship and help them develop an active and critical attitude towards what they are watching.

Reading is one of the more effective instruments to help children develop their language and, in turn, is related to the development of thinking.³¹ Reading to a child from an early age also improves the development of reading and writing skills.

This study has several sources of bias. Two private schools in Bariloche refused to take part. Some of the parents invited to participate declined, and others were not able to arrange a date for the interview with the pediatricians.

Several studies found a relationship between biological and environmental outcome measures and mental and physical development.^{7,9,32} A better performance was found in relation to six milestones among the children to whom stories were read. In other cases, parents education level was associated with a better achievement of developmental milestones in their children. However, no significant association was found between socio-economic indicators and developmental milestones. Recart, et al.^{19,20} detected that the presence of books and reading material in the house offers a significant positive association with the development of cognitive functions at a pre-school age and with school performance at 8-9 years old. These authors consider that the presence of books in the house demonstrates that parents are interested in reading. They also found that the mother's education level influences children's academic performance.

In this sense, the implementation of actions aimed at promoting interest in reading from an early age is essential. Argentina offers several reading promotion programs (*Invitemos a leer*, *FUNDASAP*; *Leer es contagioso*, Ministry of Social

Welfare; *Leer es fundamental*, *Fundación Leer*).

Policies that promote continuing education among youth and adults are also very important given that the parents' level of education was found to be one of the outcome measures related to child development.

Female children showed a better performance in three milestones than boys, which is consistent with other authors' findings.^{24,27}

Several studies show evidence on the efficacy of child development intervention programs and their subsequent impact on academic performance, especially among low socio-economic level populations.^{11,13,15} The greatest benefit is obtained through programs that are started early and maintained in the long term.^{11,13,33-35}

This study underscores the importance of family stimulation in child development.

The low performance in some of the tests of children attending municipal institutions should be a warning sign regarding the significance of including psychosocial development in child health assessments and the implementation of early stimulation programs. These actions will enable an early management of potential developmental disorders.

In order to ensure equal opportunities for all children, adequate resources that will improve their learning environment are necessary because a better environment during early childhood can contribute to an improved psychosocial development and will have an impact on school performance and the prevention of academic failure.

CONCLUSIONS

The percentage of children who did not pass the PRUNAPE was 27%. In relation to six out of eight milestones, the percentage of children attending MKs who passed each milestone was significantly lower than that of children attending PKs, and in relation to three milestones, their performance was below that recorded at a national level. The most common outcome measures associated with altered developmental milestones were no reading, low birth weight, and the parents' lower education level.

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