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Risk factors for suspicion of developmental delays at 12 months of age

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Abstract

Objective: to investigate the risk factors and prevalence of suspected cases of developmental delay in a cohort of children born in Pelotas, Brazil, in 1993.

Methodology: the Denver II test was used to evaluate development at age 12 months in 1,363 children born in Pelotas, Brazil. The children who failed in two or more items of the test were suspected of having developmental disabilities. A set of independent variables was chosen taking into account the hierarchical relations between risk factors according to the conceptual framework (socioeconomic, reproductive and environmental, birth conditions, child care, nutrition and morbidity). Statistical analysis was carried out using Mantel-Haenszel's chi-square and the multivariate technique through conditional logistic regression, to control for possible confounders.

Results: at 12 months of age, 34% of 1,363 children failed in the screening test. After adjustment for confounders, failure was associated with lower family income (OR= 1.5), very low birth weight (OR= 4.0), gestational age of less than 37 weeks (OR= 1.6), more than three siblings (OR= 1.9), less than 3 months of breastfeeding (OR=1.6), or no breastfeeding (OR= 1.9). The risk for failing the Denver II test was 10 times higher in children who presented a weight/age index lower than or equal to -2 z score of the reference population at the 6th month of life.

Conclusions: our results support the notion that developmental disabilities have multiple etiologies and the concept of cumulative hazard effect. In this population those who are economically disadvantaged accumulate risk factors (social, economic, and environmental) that determine increased risk for developemental deficit.

J Pediatr (Rio J) 2000; 76(6): 421-8: child development, risk factors, Denver II Test, hierarchical model.

Introduction

Children who live in developing countries are exposed to numerous hazards, including the high prevalence of several diseases, being born from unfavorable and/or incomplete pregnancies, and living in adverse socioeconomic conditions.[1,2] As a result, these children are at higher risk to present delays in their development and growth potential. Therefore, the impact of biologic, psychosocial (individual and familial), and environmental factors on the development of children has been the object of several studies in the past decades.[3-5]

Historically, studies about development have established the biological characteristics of children as the main determinant of intellectual delays. This may be true in the

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case of severely affected children,[6] but may not be true for the majority of children who present moderate or slight delays in their development.[1,7,8] The assessment of human development requires a different approach, one that enables a collective analysis of developmental variations, offering an "ecological" view.[5,9] Sameroff and Chandler[10] described the "transactional model" of development, which relates familial, environmental, and societal effects concerning human development. That model considers development as unique and particular, in such a way that the final outcome would be the balance between risk and protection factors. According to this model, biological problems may be modified by environmental factors, and certain situations of vulnerability may originate from social and environmental factors.[11]

Due to the importance and to the impact of developmental delays for childhood morbidity, it is essential that children at higher risk be identified early, in order to minimize possible negative consequences. There is plenty of evidence showing that early diagnosis and intervention result in fewer developmental problems in the future.[12-14] Therefore, the aim of the present study was to define determinants and to investigate the prevalence of positive screening tests for neuropsychomotor developmental delays at 12 months in children born in Pelotas, state of Rio Grande do Sul, in 1993.

Patients and methods

In 1993, 5,304 children born in hospitals in the city of Pelotas, and living in urban areas were studied. Their mothers were interviewed and the children were assessed during their 1st year of life; several aspects related to the child's health were investigated. The results of this assessment are described in a previous issue.[15]

In order to evaluate the suspicion of neuropsychomotor development delay in our cohort, 20% of these 5,304 childre were submitted to the Denver II Developmental Screening Test ,[16] adapted to Brazilian Portuguese. The 1,363 children who were evaluated at 12 months of life were randomly selected from the original database collected during the first phase of the study, during visits to maternity hospitals in Pelotas.[15]

The Denver II test was chosen because it is frequently used test by health professionals to test asymptomatic populations;[17] in addition, the application of this test does not require complex training and its administration takes only 20 minutes. The test, designed to be applied in children from birth until the age of 6, consists of 125 items, divided into four parts: a) social/personal - aspects of socialization inside and outside the home; b) fine motor functions - eye/hand coordination, manipulation of small objects; c) language - production of sounds, ability to recognize, understand, and use language; and d) gross motor functions - motor control, sitting, walking, jumping, and other movements. These items are recorded through direct observation of the child, or for some points the mother reports whether the child is capable of performing a given task. Developmental disability was suspected in children with two attention span items (not performing a specified task that is performed by 75 to 90% of the children in the age group) and/or two or more failures (not performing an item when 90% or more of the children in the age group do), regardless of the area in which this failure occurred. Developmental disability was also considered for children who had a combination of one attention item and one failure.[16] Interviewers were performed by medical and psychology students who were trained to apply the test following the methodology described in the training manual. They were not aware of the hypotheses under investigation. We performed a pilot study that allowed us to reproduce the conditions in which the study would be developed, and to evaluate the interviewers' training. In addition, during the study a random sample of 5% of the cases was reviewed, so as to assess the reliability of the data and the criteria used for scoring the items.

Since the sample included preterm babies, the age of this group was adjusted (by subtracting from the child's age the number of weeks necessary to complete 37 weeks of gestation). Thus, the evaluation was performed according to developmental age, avoiding an overestimation of the children with an altered Denver II score.

The outcome variable "suspected delay" was treated as a dichotomous variable (Denver II test, suspected delay or normal). For analysis of the data, we used the method of logistic regression, whose modeling obeyed a hierarchical model (Figure 1). This model allows quantification of the contribution of each hierarchical level, and prevents underestimation of the effects of distal risk determination.[18] First, the independent variables were analyzed separately with the outcome. Afterwards, they were entered in the model. Only variables that had a significant contribution ($P < 0.20$) remained in the model. The multivariate analysis was performed following the plan proposed in the theoretical model, according to hierarchical levels. We considered the first level as the level of overdetermination, and the inclusion of variables followed in increasing order in relation to the other levels. Independent variables in the same hierarchical level or in an immediately superior level were considered as the possible factors of confusion. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) 6.0.[19]

Results

In the studied population, 34% (N = 463) of the children were suspected of developmental delay at 12 months of age according to the Denver II screening test. There were important alterations in the four areas analyzed: the motor

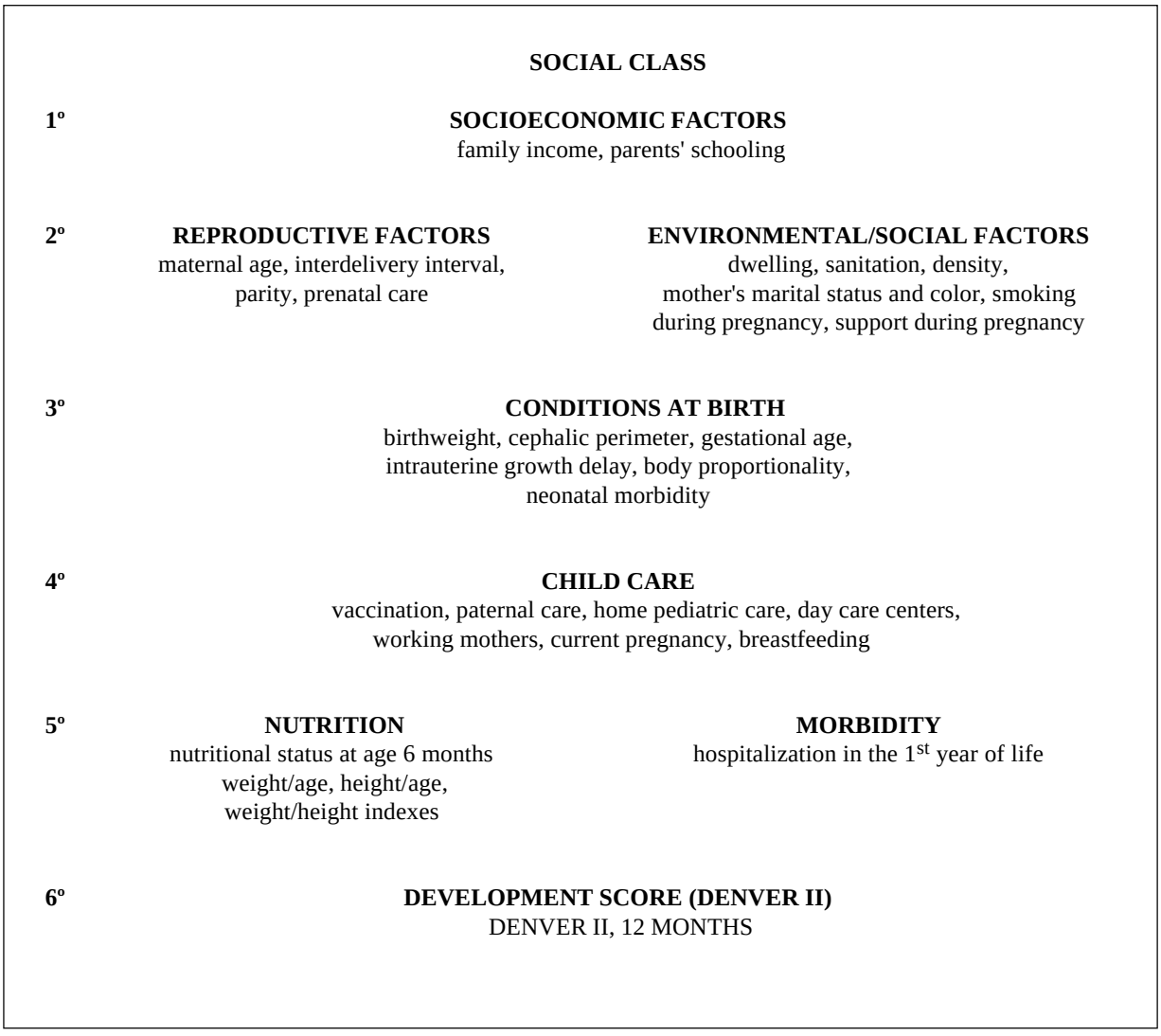

Figure 1 - Theoretical model for determination of risk for developmental delay at 12 months, according to the Denver II Test. Pelotas, 1993

development scale, for instance, was associated with the highest percentage of suspicion (15%), followed by the personal/social scale (5.5%) and by the motor function (1.6%) and language (less than 1%) scales.

The following results describe the findings of the Denver II screening test as one single result, without considering the separete areas. Due to the small degree of suspicion of delay associated with some of them, an adequate evaluation would not be possible if the results were divided into four areas.

In the bivariate analysis including the outcome and socioeconomic variables, the probability of being suspected of neuropsychomotor development delay was twice as high in children with lower income when compared to those with higher income. Regarding maternal schooling, the risk increases as maternal schooling decreases. The probability of giving birth to a child suspected of developmental delay was 2.2 times higher in illiterate mothers when compared to those with more schooling.

On the second hierarchical level, which included reproductive and socioenvironmental variables, maternal age did not show any statistically significant association with suspicion of delay at the 12th month of life. Despite this result, this variable was maintained in the multivariate model, due to its plausibility and importance, especially if teenage pregnancy is considered. The same was true for the variable "presence of husband/partner."

Concerning birth-related features, the following variables were selected: birthweight, gestational age, cephalic perimeter, length at birth, and morbidity, represented by the length of stay of the child at the intensive care unit or at the nursery during the neonatal period.

Considering that birthweight may be result from a shorter pregnancy, intrauterine delay, or from a combination of both factors, we chose to analyze some variables that would take these differences into consideration, relating birthweight, gestational age, and length at birth. The results are described on Table 1. Although without the same intensity of association, but still significant, the variable that resulted from the interaction between birthweight and gestational age was associated with higher risk for suspected developmental delay according to the Denver II test in preterm children presenting low weight. The variable resulting from the interaction between weight and length at birth presented a similar outcome: the children with low weight and proportional length were those who presented the highest risk, followed by those with low weight and disproportionate length.

In the group of care-related variables, the most important variable was duration of breastfeeding: no breastfeeding meant 2.5 times more risk for suspected delay; and the risk was almost twice as high in children who were breastfed until the 3rd month of life when compared to those who received breast milk for more than 6 months.

The variables on the last hierarchical level (that is, those that are potentially more related to the outcome, such as hospitalization, prevalence of malnutrition in terms of height/age and weight/age) were significantly associated with developmental delay (Table 2).

After the inclusion of all variables for stepwise logistic regression, the final model was defined through the set of variables that significantly helped to explain why children presented a Denver II screening test that suggested delay. The results of this model are presented in Table 3.

Children from lower income families showed a higher probability (50%) of presenting suspicion of developmental delay, even after adjustment for maternal schooling. This relation occurred in a linear fashion, maintaining the differences between income groups; thus, children belonging to an income group ranging from three to six minimum wages showed an increased probability (20%) of suspicion when compared to children in economically more privileged groups, although the difference was not significant.

After adjustment for the first hierarchical level, the variables referring to support during pregnancy and smoking were not significantly associated with delay, and had no independent effects regarding suspicion of delay. However, children with four or more siblings presented a higher probability (90%) of suspected delay.

The results for the association between birthweight, gestational age, and suspicion of delay confirmed the importance of these variables for the determination of suspected developmental delay according to the Denver II test. Even after adjustment for important variables on superior levels and on the same level, the probality of presenting problems was 4 times higher in children with lower birthweight; similarly, shorter gestation was associated with an increase of 60% in the probability of presenting problems, even after adjustment.

Duration of breastfeeding contributed significantly to explain suspected delay according to the Denver II test. The risk was 88% higher in children who were never breastfed in comparison to children who were breastfed for more than 6 months, even after adjustment for possible counfounding factors. On the other hand, the risk for suspected delay was 10 times higher in malnourished children, with a weight/age index higher than or equal to -2 standard deviations.

Table 1 - Suspicion of developmental delay at 12 months according to interactions between weight and length at birth and gestational age; Pelotas, 1993

Risk factors	Sample distribution % (n)	Suspect Denver II % (n)	P value*	Odds ratio (CI 95%)
Interaction weight/GA				
AB/term	87.0 (1.183)	31.2 (369)	<0.001	1.00
AB/preterm	3.3 (45)	45.7 (20)		0.93 (0.57-2.06)
LB/term	4.8 (66)	55.3 (36)		1.36 (0.90-2.06)
LB/preterm	4.9 (67)	59.0 (39)		1.58 (1.04-2.39)
Interaction weight/length				
AB proportional	62.5 (852)	19.3 (60)	<0.001	1.00
AB disproportional	62.5 (852)	34.3 (82)		2.19 (1.56-3.05)
LB disproportionall	2.4 (32)	36.0 (121)		2.35 (1.64-3.37)
LB proportional	6.8 (93)	55.0 (94)		5.10 (3.37-7.70)

* Chi-square for linear tendency AB: adequate birthweight LB: low birthweight

Table 2 - Suspicion of developmental delay at 12 months according to variables related to nutrition at the 6th month of life and to hospitalization in the 1st year of life; Pelotas, 1993

Risk factors	Distribution on the sample	Suspect Denver II	P value*	Odds ratio (CI 95%)
Hospitalization			<0.001	
no	81.6 (1.112)	31.8 (354)		1.00
yes	18.4 (250)	45.0 (112)		1.74 (1.31-2.30)
Height/age Z score at 6 months			<0.001	
>-1	80.8 (1.092)	30.8 (336)		1.00
-1/-1.9	14.6 (197)	43.6 (86)		1.73 (1.27-2.37)
≤ -2	4.6 (62)	64.0 (40)		4.00 (2.23-6.82)
Weight/age Z score at 6 months			<0.001	
>-1	89.4 (1.208)	31.2 (377)		1.00
-1/-1.9	8.6 (116)	53.1 (62)		2.5 (1.70-3.67)
≤ -2	2.0 (27)	91.6 (25)		23.7 (6.08-92.25)

* Test for linear tendency

Discussion

In Pelotas, in 1993, 34% of the children at 12 months of age presented a Denver II screening that suggested developmental delay. Despite its magnitude, this finding should be interpreted with care. The high proportion of children suspected of delay underscores a potential risk of delay, which must be confirmed by diagnostic tests.

The profile of child development in this cohort children was in agreement with previous studies, which point to the multifactorial character of the determination of delay; according to this multifactorial notion, the accumulation of risk factors determines a higher impact on child development.[9,20,21]

In this study, family income and parental schooling overdetermined other independent variables. Although in the bivariate analysis both variables presented a statistically significant association with suspicion of delay, this result was not maintained in the multivariate analysis carried out to control the effect of possible confouding factors. The effect of family income remained associated with suspicion of delay, even after adjustment for maternal schooling; thus, poorer children presented a 50% increase in the risk for presenting a Denver II screening test that suggested delay, as previously described.[22] Probably, more affluent children receive more stimulation and have more opportunities in their 1st year of life.

Among the variables of the second level of the model (reproductive and socioenvironmental), the only variable that remained significantly associated with the outcome in the final regression model was number of children. Since most of the variables on this hierarchical level presented a significant statistical association with the outcome in the bivariate analysis, it is possible that they were affected by family income, according to the proposed hierarchical model.

The chance for suspected delay was 90% higher in children with more than three siblings. Although there was a risk reduction after adjustment for confounding factors, the independent effect of this variable remained statistically associated with suspicion of delay, confirming that in families with a higher number of children, in general, children receive less stimulation to develop their potential. This situation is probably associated with decreased maternal disponibility to offer attention to the child.

It is well-known that birthweight is the most important isolated factor in the determination of childhood mortality. The results of this study show that there is a marked reduction in suspicion of delay with increase in birthweight. This possibility was 10 times higher in children who were born with less than 2,000g, when compared to heavier children. A similar effect, but with minor significance, was found for all the other indicators (gestational age, cephalic perimeter, and length), and for the interactions of these effects with the relations weight/age, weight/length, and gestational age. Although all these variables showed a statistically significant association in the bivariate analysis, only birthweight and gestational age had an independent effect in the final regression model. The risk for suspected

delay was 4 times higher in children who were born with less than 2,000g. Preterm babies, on the other hand, though with a decreased effect, presented a 60% increase in the chance for suspected neuropsychomotor developmental delay. This is coherent with previous findings, which emphasize the negative consequences of a preterm birth with very low weight for the future development and performance at school.[7,23]

It is important to stress that, in addition to the medical complications resulting from prematurity, the association with unfavorable social conditions and the sort of medical care received by these children determine the prognosis in relation to their development.[24] Besides that, it seems that other consequences of prematurity will appear later, when these children start school, which justifies an early intervention in this group.[25]

Table 3 - Odds ratio for suspicion of developmental delay at 12 months, adjusted for possible confounding variables; Pelotas, 1993

Independent variables	Non-adjusted odds ratio and 95% confidence interval	Adjusted odds ratio and 95% confidence interval*
Family income (a)	P<0.01	P<0.01
>6 MW	1.00	1.00
3.1-6 MW	1.28 (0.85-1.89)	1.20 (0.76-1.89)
1.1-3 MW	1.60 (1.12-2.28)	1.46 (0.97-2.21)
<1 MW	2.08 (1.35-3.01)	1.53 (0.93-2.49)
Support during pregnancy (b)	P<0.1	P<0.09
yes	1.00	1.00
no	1.70 (1.20-2.38)	1.38 (0.91-2.08)
Smoked during pregnancy (b)	P<0.5	P<0.3
no	1.00	1.00
yes	1.45 (1.14-1.83)	1.15 (0.86-1.52)
Parity (b)	P<0.001	P<0.001
up to 3 children	1.00	1.00
≤ 4 children	2.44 (1.60-3.75)	1.88 (1.25-2.84)
Birthweight (kg) (c)	P<0.01	P<0.006
≤ 3.5	1.00	1.00
3.00-3.49	1.53 (1.12-2.08)	1.43 (1.00-2.06)
2.50-2.99	2.40 (1.05-2.50)	1.86 (1.23-2.81)
2.00-2.49	3.70 (2.34-5.84)	1.97 (1.23-3.16)
<2.00	10.59 (4.16-27.0)	4.04 (1.84-8.85)
Gestational age (weeks) (c)	P<0.001	P<0.007
38-42	1.00	1.00
37	1.87 (1.41-2.49)	1.49 (0.90-2.46)
<37	2.85 (1.92-4.23)	1.60 (1.13-2.26)
Breastfeeding duration (c)	P<0.007	P<0.005
>6 months	1.00	1.00
3.1-6 months	1.60 (1.11-2.31)	1.58 (1.07-2.31)
up to 3 months	1.67 (1.20-2.30)	1.55 (1.09-2.20)
never sucked	2.15 (1.47-3.16)	1.88 (1.22-2.88)
Z score (weight/age) at 6 months (d)	P<0.001	P<0.007
≤ 1	1.00	1.00
-1/-1.9	2.5 (1.70-3.67)	1.65 (1.07-2.54)
≤ -2	23.7 (6.08-92.25)	10.16 (2.52-40.91)

* Test for linear tendency.
(a) Adjusted for maternal education.
(b) Adjusted for family income and maternal education + all other variables in level (b).
(c) Adjusted for variables of level (a) + variables of level (b) + all other variables in level (c).
(d) Adjusted for variables of level (a) + variables of level (b) + variables of level (c) + all other variables in level (d).
MW: minimum wage.

The fact that the other variables on the same hierarchical level are not statistically significant in the final regression model may be explained by a colinearity among them; that may be the case, for instance, with the variable use of neonatal ICU. Premature children with lower weight used the ICU more often. Thus, different variables could represent the same event.

Regarding the next hierarchical level, only breastfeeding showed an independent effect in relation to the developmental status at the 12th month of life. Children who were never breastfed had an increase of 88% in the chance for suspected delay when compared to those who were breastfed for more than 6 months. Similar results have been reported in the literature, although those studies used different methodologies.[26-28] One of the important results of the present study is the verification of a dose-response effect concerning the breastfeeding period: the longer the duration of breastfeeding, the lower the risk for suspected delay according to the Denver II screening test. In addition to the proved nutritional, psychological, and infections-protective advantages of breast milk,[29,30] there is evidence that breastfed children have a better cognitive performance, which is an additional reason to stimulate breastfeeding.[27]

Concerning nutritional status, the height/age and weight/age indices at 6 months were strongly associated with the outcome in the bivariate analysis. When included in the final regression model and adjusted for the other variables, the independent effect of the height/age index disappeared; the weight/age index, however, was still significant, although there was a reduction in its magnitude. After adjustment, the chance for suspected delay was still 10 times higher in children with ³2 standard deviations in the weight/age index when compared to children with a better nutritional status. This result is in agreement with a previous study employing a similar methodology.[29] The finding that malnourished children had a higher chance of presenting suspicion of delay at the 12th month of life confirms that nutrition is an important indicator of morbidity.[30]

The results of this study showed some differences regarding what was previously published in relation to the prevalence of suspected delay and to the magnitude of the effect that some variables presented.[17] A possible explanation for this may be related to the measurement used in this study, the dds ratio (OR), whose interpretation in cross-sectional studies is sometimes difficult. The discrepancy between the OR and the prevalence ratio (PR) depends on disease prevalence and exposure, with the former being qualitatively more important, although when the medium length of the disease is equal in individuals who were exposed and who were not exposed, OR better estimates the density of incidence than PR.[31]

In addition to possible analytical limitations, the difference in prevalence may be explained by the diagnostic difficulty in the first years of life. Even in developed countries, there is a dearth of consistent data regarding the prevalence of developmental delay in children who are less than 3 years old.[17] One possible explanation is offered by the notion of prevalence point[32] or age-specific manifestation, according to which age-specific manifestations may change from a developmental period to the next, even if the individuals remain at risk.[33]

Although without methodological uniformity, there is a certain convergence of results among the numerous studies about risk factors affecting child development. This reinforces the idea that the risk factors found in this study are associated with future morbidity, justifying early and adequate follow-up of children exposed to such hazards.[34]

The early identification of developmental problems is a rather difficult task for the professional who works with primary care. Due to the great malleability of the child neuropsychomotor development, it is necessary that the evaluation be repeated, mainly during the first years of life, when development is more dynamic and the impact of delays is more important[12] although it may be more difficult to implement early interventions in developing countries, there are several alternatives to promote low-cost, community-based actions involving children at risk for developmental delay, such as stimulating the mother to interact with the child, developing training programs for caretakers in day care centers and schools and for teachers in primary schools, and involving the media.[35]

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