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# Factors associated with the decline in stunting among children and adolescents in Pernambuco, Northeastern Brazil

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## ABSTRACT

**OBJECTIVE:** To analyze the evolution of stunting among children and adolescents and identify their associated factors.

**METHODS:** This was a cross-sectional study using data from the state health and nutrition surveys that were conducted in Pernambuco (Northeastern Brazil) in 1997 and 2006. The sample was probabilistic (random and stratified) and was representative of urban and rural strata of the state. Questionnaires containing precoded questions relating to information on socioeconomic, demographic and anthropometric variables (of the mothers, children and adolescents) were used for data gathering. The population studied comprised 1853 children and 1484 adolescents between the ages of five and 19 years. Multiple regression analysis with hierarchical selection was used to evaluate associations between explanatory variables relating to stunting.

**RESULTS:** The prevalence of stunting presented a significant reduction of 43% (from 16.9% in 1997 to 9.6% in 2006). Socioeconomic variables and maternal height were associated with this decline. The reductions ranged from 39% to 60% among the strata analyzed. Analysis on determinants of stunting showed that in 2006, the following remained significant: per capita family income (< 0.25 minimum salary), possession of domestic goods ( $\leq$  three), greater number of people per household, lower schooling level and lower maternal height.

**CONCLUSIONS:** The reduction in stunting reflected improvements in social and economic conditions. However, it remains necessary to maintain and improve public policies, in order to increase the purchasing power of the poorest people and to achieve universal access to health and education services for the population.

**DESCRIPTORS:** Child. Adolescent. Body Height. Developmental Disabilities. Nutritional Status. Risk Factors. Socioeconomic Factors. Cross-Sectional Studies. Health Inequalities.

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## INTRODUCTION

Linear growth is one of the best health indicators for children and adolescents, besides reflecting previous living conditions. It can be used to obtain information on individuals' health status or nutritional wellbeing, or even, at an epidemiological level, to portray the quality of life of a population group, thereby allowing possible nutritional disorders and associated factors to be diagnosed.<sup>3,18</sup>

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Impaired linear growth, resulting in stunting during childhood and adolescence, can contribute towards low school performance, reduced physical capacity for work and transference of poverty to the next generations, especially in developing countries.<sup>4</sup> Moreover, recent studies have signaled that nutritional disorders during childhood are related to higher risk of obesity in adulthood, and higher occurrence of diseases and non-transmissible chronic injuries.<sup>8,19</sup>

In Brazil, the prevalence of stunting among children under five years of age was reduced by around 50% over one decade, from 13% in 1996 to 6% in 2008/9.<sup>a</sup> In the northeastern region, this decrease was so large (from 22.5% to 5.9%) that it suppressed all the disadvantage of this region in relation to the national mean.<sup>11,14</sup>

This evolution of nutritional status among the Brazilian child population results from many factors, such as: increments in maternal education; increased family income; improvements in basic sanitation; expansion of the coverage of and access to health services, including encouragement for breastfeeding and monitoring growth; early diagnosis of malnutrition; and inclusion in social programs.<sup>2,18</sup>

However, despite the important decline in stunting over the years and progress in the population's living conditions, discrepant prevalences within and between regions are still observed in Brazil.<sup>a</sup> Furthermore, most of the studies have been directed towards the child population under five years of age, which highlights the need for investigations directed towards children of school age and adolescents.<sup>12,13</sup>

In this light, the objective of the present study was to analyze the evolution of stunting among children and adolescents and identify their associated factors.

## METHODS

This study used secondary data from the second and third state health and nutrition surveys (PESN), conducted in 1997 and 2006. The surveys were representative of urban and rural strata, and had the aim of updating and expanding the diagnosis of the health, nutrition, dietary and socioeconomic conditions of the population of the state of Pernambuco, northeastern Brazil.<sup>b,c</sup>

The sample was probabilistic (random and stratified), and was representative of urban and rural strata of the

state. It was composed of children and adolescents aged from five to 19 years, of both sexes, totaling 1,853 individuals (male = 42.8% and female = 57.2%) in the second PESN, and 1,484 (male = 44.4% and female = 55.6%) in the third PESN.

The fieldwork was carried out by an interview and anthropometry team. Questionnaires containing precoded questions were used for data gathering, with daily checking to identify filling-out errors. Information on socioeconomic, demographic and anthropometric variables (of the mothers, children and adolescents) was gathered.

Anthropometry was performed by trained researchers in accordance with technical procedures recommended by the World Health Organization (WHO)<sup>23</sup> and the norms of the Growth and Development Follow-up Manual of the Ministry of Health.<sup>d</sup>

Regarding the anthropometric measurements in the second PESN, body weight was obtained using a Filizola® electronic digital scale ("Personal Line E-150" model); while in the third PESN, the "MEA-03200/Plenna" model of digital scale was used. Both of these had a maximum capacity of 150 kg and precision of up to 100 g. For gauging height, in the second and third PESN respectively, a 200-cm tape measure and a portable stadiometer (Alturaexata®, Ltda) were used, which both had precision of 1 mm throughout their lengths.

To ensure accuracy, measurements were made twice for each individual with the condition that the difference between values should not exceed 0.5 cm. In the event that this limit were to be passed, the evaluation would be repeated and the two measurements with closest values would be noted. Then, the mean of these measurements would be recorded.

Child and adolescent stunting was evaluated based on the WHO recommendations (2007),<sup>5</sup> taking low height/age to be < -2 Z-scores. For the maternal height evaluation, the WHO (2007) reference standard was also used, in which the cutoff points were those that are interpreted for 19-year-old females, in the final phase of the linear growth process. According to this reference point, low maternal height (< -2 Z-scores) is equal to < 150.1 cm.

The socioeconomic and demographic variables were analyzed in the following manner: per capita family

<sup>a</sup> Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares 2008-2009: despesas, rendimentos e condições de vida. Rio de Janeiro; 2010.

<sup>b</sup> Batista Filho M, Romani SAM, organizadores. Alimentação, nutrição e saúde no Estado de Pernambuco. Recife: Instituto Materno-Infantil de Pernambuco. 2002. (Série de Publicações Científicas do IMIP, 7).

<sup>c</sup> Secretaria do Estado de Pernambuco. Universidade Federal de Pernambuco. III pesquisa estadual de saúde e nutrição: saúde, nutrição, alimentação, condições socioeconômicas e atenção à saúde no estado de Pernambuco. Recife; 2010.

<sup>d</sup> Ministério da Saúde (BR), Secretaria de Políticas de Saúde, Departamento de Atenção Básica. Saúde da criança: acompanhamento do crescimento e desenvolvimento infantil. Brasília (DF); 2002. (Série Cadernos de Atenção Básica, 11. Série A. Normas e Manuais Técnicos).

income in minimum wages (MW – income obtained by the family in the month prior to the interview):  $< 0.25$  and  $\geq 0.25$ ; maternal schooling level, categorized according to number of complete years of schooling attended by the mother: no schooling,  $< 4$  years and  $\geq 4$  years; household location: metropolitan region of Recife (MRR), urban areas other than the MRR and rural areas; number of household residents, categorized as:  $< 5$  and  $\geq 6$  people; consumer goods (television, refrigerator, stove and radio), represented by four categories: possessing all of them, two or three items, one item or none of them; and age group, distributed as: 5 to 9 years of age, 10 to 14 years of age and 15 to 19 years of age.

The survey data was entered twice, validated and processed using the EpiInfo software, version 6.04. The anthropometric evaluation was interpreted using the AnthroPlus-2007 software,<sup>e</sup> and for the statistical analysis, the software used was EpiInfo version 6.04 and SPSS version 8.0.

The evolution of stunting evolution was investigated by comparing simple frequencies and their confidence intervals, from 1997 and 2006. To compare categorical variables, the chi-square test was used, with Yates' correction when necessary, and the p value for statistical significance was used.

The analysis of factors associated with stunting was limited to the data from the third PESN (2006), considering that in a previous study, Laurentino et al<sup>10</sup> conducted a similar investigation using data from the second PESN (1997).

Prevalence ratios (PR) for stunting were calculated for each exposure variable by means of Poisson regression, using a hierarchical model.<sup>16</sup> Variables presenting  $p < 0.20$  in bivariate analysis were selected for inclusion in the regression analysis.

A grouped modeling process was used, such that the first group comprised socioeconomic variables: *per capita* family income and maternal schooling level. The variables of household location, consumer goods and number of people in the household were introduced in the second group. The third group consisted of maternal height, and the fourth group contained the variables of sex and age. From the second block onwards, the analyses were adjusted according to the variables from the previous groups.

The research projects were approved by the Ethics Committee for Research on Human Beings of the Health Sciences Centre of the Universidade Federal de Pernambuco (second PESN, February 27, 1997) and the Ethics Committee of the “Professor Fernando Figueira” Institute of Comprehensive Medicine (third

PESN. November 9, 2005; procedural number 1321), in compliance with the regulatory norms for research involving human beings: Resolution 196/96, of the National Health Council. The adults responsible for the participating children and adolescents signed a free and informed consent statement.

## RESULTS

Between the years evaluated, the prevalence of stunting among children and adolescents in Pernambuco decreased from 16.9% (95%CI: 15.3; 18.7) in 1997 to 9.6% (95%CI: 8.1; 11.1) in 2006, i.e. a decrease of 43%. In relation to the variables associated with this decrease (Table 1), in the strata analyzed, there were significant reductions in stunting, ranging from 39% to 60%, except for the following categories: income  $\geq 0.25$  MW, living in the urban areas other than the MRR, possessing one or no consumer goods and adolescents aged between 15 and 19 years.

Table 1 also shows that having per capita family income  $< 0.25$  MW, maternal schooling level less than four years, living in the interior of the state (outside the MRR), having six or more individuals in the household and not possessing all the consumer goods investigated were among the conditions related to higher prevalence of stunting, in 1997 and in 2006.

Also according to Table 1, in 1997, stunting was associated with males, age between 10 and 14 years and low maternal height. However, in 2006, the differences between the sexes and age groups lost their statistical significance, such that only maternal height remained associated to stunting, among the biological variables.

Table 2 presents the prevalence ratios adjusted in multiple logistic regression analysis and shows that having per capita family income lower than 0.25 MW, not possessing all the domestic goods investigated, living in rural areas, living in households with  $\geq 6$  people, maternal schooling level lower than four years and low maternal height are still among the factors associated with stunting among the children and adolescents studied.

## DISCUSSION

The reduction of over 40% of stunting in Pernambuco, between 1997 and 2006, is close to the findings from surveys with national coverage, in which the prevalence halved over the same time period.<sup>13</sup> Despite this reduction, the percentages of children and adolescents with delayed growth (8.1% and 10.9%, respectively) are slightly higher than the national mean (6.8% and 9.8%,

<sup>e</sup> World Health Organization. Anthro for personal computers. Version 2. 2007: software for assessing growth and development of the world's children. Geneva; 2007 [cited 2009 Jul 21]. Available from: <http://www.who.int/childgrowth/software/en/>

**Table 1.** Temporal variations in stunting among children and adolescents, according to socioeconomic conditions, biological variables and maternal height. Pernambuco, Northeastern Brazil, 1997 and 2006.

Variable	Stunting/age (< -2 Z-scores)						Difference 1997/2006 %
	PESN 1997 (N = 1853)			PESN 2006 (N = 1484)			
	n = 314 <sup>a</sup>	%	95%CI	n = 142	%	95%CI	
<i>Per capita</i> family income			p < 0.0001			p < 0.0001	
< 0.25	282	21.0	18.8;23.2	111	12.0	10.0;14.2	- 42.8*
≥ 0.25	32	6.3	4.4;8.7	29	5.4	3.7;7.6	- 14.3
Maternal schooling level (years attended)			p < 0.0001			p < 0.0001	
Illiterate	113	26.0	22.1;30.3	56	14.4	11.1;18.1	- 44.6*
< 4	94	23.2	19.2;27.4	22	10.6	6.9;15.4	- 54.3*
≥ 4	60	9.8	7.6;12.3	24	4.3	2.8;6.2	- 56.1*
Location			p < 0.0001			p < 0.0001	
Metropolitan region	52	9.0	6.9;11.6	11	3.6	1.9;6.2	- 60.0**
Urban areas other than metropolitan region	66	11.7	9.3;14.6	27	8.9	6.0;12.5	- 24.0
Rural areas	196	27.4	24.2;30.7	104	11.9	9.8;14.1	- 56.5*
Number of individuals per household			p < 0.0001			p < 0.0001	
1 – 5	52	10.1	7.7;12.9	32	5.6	3.9;7.7	- 44.5**
≥ 6	260	19.7	17.6;21.9	110	12.0	10.0;14.3	- 39.1*
Possession of goods (refrigerator, TV, radio and stove)			p < 0.0001			p < 0.0001	
All	80	9.1	7.3;11.1	34	4.7	3.3;6.4	- 48.3*
Two or three	166	22.7	19.7;25.8	74	12.4	9.9;15.9	- 45.37*
One or none	66	29.7	24.0;36.0	34	21.1	15.3;27.9	- 29.0
Sex			p < 0.0001			p = 0.06	
Male	174	21.2	18.4;24.6	70	11.0	8.7;13.6	- 48.1*
Female	140	13.6	6.7;10.5	72	8.5	6.7;10.5	- 37.5*
Age (years)			p = 0.01			p = 0.16	
5 – 9	128	15.3	12.9;17.8	58	8.1	6.2;10.2	- 47.0*
10 – 14	118	20.7	17.5;24.2	43	10.9	8.1;14.3	- 47.3*
15 – 19	68	15.3	12.2;18.8	41	11.0	8.1;14.5	- 28.1
Maternal height			p < 0.0001			p < 0.0001	
Low height (< 150.1 cm)	131	36.6	31.7;41.7	44	20.7	15.6;26.5	- 43.4*
Normal (≥ 150.1 cm)	136	12.4	10.5;14.4	57	6.3	4.8;8.0	- 49.2*

PESN: state health and nutrition survey

<sup>a</sup> The values differ because of losses in some variables

\* p < 0.0001

\*\* p < 0.001

respectively)<sup>f</sup> and in both cases, the percentages are considerably higher than the threshold value (2.3%)<sup>19</sup> recommended by WHO.

Even though this decrease occurred prominently in all the strata investigated, it is clear that social inequalities that would no longer be expected with the scientific and technological advances that this country has achieved still remain. This assertion can be confirmed from 2006 data that showed that the proportion of individuals with malnutrition who were at a clear socioeconomic

disadvantage was three to four times higher than the proportion that was more favored economically. This has been observed not only in Brazil, but also generally in developing countries.<sup>13,16</sup>

Historically, social indicators have been crucial determinants of child malnutrition. Among these, improvement of families' purchasing power and progress in maternal schooling levels have direct repercussions on positive linear growth evolution.<sup>12,19</sup> According to Laurentino et al,<sup>10</sup> in Pernambuco, in 1997, the explanatory variables

<sup>f</sup> Instituto Brasileiro de Geografia e Estatística. Pesquisa de Orçamentos Familiares: antropometria e estado nutricional de crianças, adolescentes e adultos do Brasil. Rio de Janeiro; 2010.

**Table 2.** Unadjusted and adjusted prevalence ratios and respective 95% confidence intervals for the determinants of stunting (< -2 Z-scores) among children and adolescents. Pernambuco, Northeastern Brazil, 2006.

Variable	Crude PR	95%CI	Adjusted PR	95%CI	p
<b>MODULE 1</b>					
<i>Per capita family income</i>					
≥ 0.25 MW	1		1		
< 0.25 MW	2.21	1.47;3.34	1.94	1.15;3.25	0.01
<i>Maternal schooling (years attended)</i>					
≥ 4	1		1		
Illiterate	3.33	2.06;5.37	2.82	1.73;4.60	< 0.0001
< 4	2.46	1.38;4.39	2.14	1.20;3.84	0.01
<b>MODULE 2</b>					
<i>Location</i>					
Metropolitan region	1		1		
Urban areas other than metropolitan region	2.42	1.22;4.96	2.45	0.69;8.76	0.17
Rural areas	3.50	1.76;6.10	3.52	1.05;11.74	0.04
<i>Number of individuals per household</i>					
1-5	1		1		
≥ 6	1.78	1.39;2.28	1.37	0.99;1.90	0.05
<i>Possession of goods (refrigerator, TV, radio and stove)</i>					
All	1		1		
Two or three	2.64	1.76;3.96	1.85	1.11;3.09	0.02
One or none	4.50	2.79;7.24	2.67	1.44;4.92	0.002
<b>MODULE 3</b>					
<i>Maternal height</i>					
Normal	1		1		
Low height	3.30	2.22;4.89	2.74	1.82;4.13	< 0.0001
<b>MODULE 4</b>					
<i>Sex</i>					
Female	1		1		
Male	1.29	0.94;1.81	1.40	0.94;2.08	0.09
<i>Age (years)</i>					
5-9	1		1		
10-14	1.36	0.9;2.0	1.34	0.86;2.09	0.20
15-19	1.37	0.9;2.0	1.69	0.94;2.94	0.06

MW: minimum wage

Module 2: adjusted according to variables in module 1

Module 3: adjusted according to variables in modules 1 and 2.

Module 4: adjusted according to variables in modules 1, 2 and 3.

that presented independent effects in relation to stunting were: household location, drinking water treatment, sex, maternal schooling level and per capita family income. In the present study, income and maternal schooling level remained substantially associated with delayed linear growth in the state of Pernambuco.

Although stunting presented a declining trend among children and adolescents in Pernambuco, in the two income categories investigated, it was found in 2006 that the reduction was three times bigger among the individuals with per capita monthly income less

than one quarter of the MW, who were the ones most affected by the impairment in 1997 (42.8%). Although the two income categories did not greatly differentiate families' social condition, per capita income < 0.25 MW represented almost twice the chance of stunting. Over the same period (1996-2006), Monteiro et al<sup>14</sup> (2009) found at national level that the prevalence of stunting decreased by 57.3% (from 25.5% to 10.9%) among individuals with lower purchasing power and, on average, by 8% (from 6.7% to 6.2%) among those who were more favored economically.

These observations are possibly related to the reduction in extreme poverty observed over recent years in Brazil (1995-2008).<sup>g</sup> The improvement, even if only from a miserable condition (monthly income per person of up to one quarter of the MW) to a status of absolutely poor (monthly income per person of up to half the MW), reflects positively in individuals' health conditions, given that as income increases, families start to invest in food consumption and improving their living conditions. Nonetheless, although a significant reduction of 40.5% in the proportion living under miserable conditions in the northeastern region has been observed, 50.1% of the population in the state of Pernambuco still live in absolute poverty.

Income and food availability in homes are characteristic socioeconomic indicators of families included in the picture of so-called food and nutrition insecurity. Today, in Brazil, the highest percentages and most severe forms of this insecurity are in households that include individuals under the age of 18 in municipalities in the northern and northeastern regions, which are where the highest prevalence of stunting is found.<sup>6</sup>

The increase in family income that has occurred concomitantly with progress in maternal schooling levels accounts for almost half the decrease in child malnutrition in this country. Mothers' education levels are the variable with highest participation in the decrease.<sup>14</sup> According to the National Demography and Health Survey (PNDS),<sup>h</sup> in 2006 stunting was concentrated in the less educated strata, in this case among children and mothers with one to three years of education (13.6%) or who were illiterate (16.6%). These findings are in line with others in the state of Pernambuco, in which the stunting strength among children from mothers who were illiterate or had had less than four years of schooling was 2.8 and 2.1 times higher than among those from mothers with greater schooling.

The importance of maternal schooling in protecting child health comes from motherly care provided with greater propriety, due to greater knowledge and access to services. The higher the mother's education level is, the greater the chance will be that she breastfeeds her children at young ages, and thereafter provides a quality diet during their childhood.<sup>7</sup>

Concomitantly with the maternal schooling level, the variable of possession of domestic items defines the socioeconomic condition and appears as an important indicator of family purchasing power.<sup>i</sup>

Despite great advances in durable equipment possession for most of the population, such that a radio, television and refrigerator are present in approximately 90% of Brazilian households, inequalities of access to these goods are observed in many regions of the country.<sup>h</sup> In the present study, among the variables included in the second regression analysis group, possession of goods presented the strongest association with stunting. The strength of this association among the children and adolescents living in households that possessed one or none of the goods investigated, was three times higher than among those who possessed all the items. According to Guimarães et al<sup>7</sup> (1999), some domestic equipment differentiates family lifestyles and expands access to healthcare conditions, since they facilitate access to information or are important for food conservation and preparation.

Family unit composition also has a relationship to stunting. In Pernambuco, families with six or more individuals present stunting strength that was approximately 1.4 times that of families with five or less individuals. One plausible explanation for this is that large families generally only have one provider, or depend on the retirement income of the older members or depend on social benefits. This is often reflected in precarious housing conditions and the quantity and quality of access to food.

Even though stunting has reduced considerably in the MRR and in the rural interior of the state, this last stratum still contains the highest prevalence of this condition. With the modest decrease in malnutrition found in urban areas other than the MRR, the difference between these area and rural areas, which in 1997 was 15.7%, reduced to only 3.0% in 2006. In comparison with individuals living in the MRR, those living in rural areas and in urban areas other than the MRR presented 3.5 and 2.4 times greater stunting strength, thus portraying the historical gap in development between the MRR and the interior of the state of Pernambuco.<sup>10</sup>

The attention directed towards the interior deserves to be looked at further, considering that at national level, it has been found that there is no significant difference in malnutrition between urban and rural environments (6.9% and 7.5%, respectively). This is probably because of the participation of data from the southern and southeastern regions, which are more favored economically, independent of geographical stratum.<sup>h</sup>

With regard to biological variables, male children and adolescents and individuals aged between 15 and 19

<sup>g</sup> Instituto de Pesquisa Econômica Aplicada. Dimensão, evolução e projeção da pobreza por região e por estado no Brasil. Brasília (DF); 2010. (Comunicados do IPEA, 53).

<sup>h</sup> Ministério da Saúde (BR); Centro Brasileiro de Análise e Planejamento. Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher: PNDS 2006: dimensões do processo reprodutivo e da saúde da criança. Brasília (DF); 2009.

<sup>i</sup> Instituto de Pesquisa Econômica Aplicada. Dimensão, evolução e projeção da pobreza por região e por estado no Brasil. Brasília (DF); 2010. (Comunicados do IPEA, 53).

years presented stunting strength that was 1.4 and 1.7 times greater than among females and younger individuals. These results are similar to national data, in which stunting is more frequent among males (11.3%) than among females (8.3%), aged between ten and 19 years.<sup>h</sup> This may be because of the higher risk of inadequate living conditions, as shown by starting to work at an early age and abandonment of schooling. This is still seen among with young individuals, especially in rural areas in less developed regions of Brazil.<sup>j</sup> Both in the state of Pernambuco and in the rest of the country, the decrease in stunting has been greater among males and, as stunting has diminished, the difference in prevalence between the sexes has tended to disappear.<sup>f</sup>

Out of all the variables included in the multiple regression model, the one with the highest degree of association with stunting was maternal height (PR = 2.74). However, although the genetic pattern is a good child height predictor, it has been shown to be more effective among individuals with a satisfactory socioeconomic level, because under unfavorable social conditions, stunting may be the accumulated result of poverty between generations.<sup>1,17</sup> Childhood stunting among females gives rise to adult women of low height, with a higher risk of having children with low birth weight

who, in turn, will have higher risk of presenting delayed growth and development.<sup>4,9</sup>

Besides the variables studied, the positive effect of healthcare expansion needs to be taken into consideration. Although this was not within the scope of the present discussion, this expansion does have an association with reduction of stunting. This assertion can be verified from descriptions of the temporal decline of child malnutrition in northeastern Brazil during two successive periods (1986-1996-2006). The decrease in stunting over the last decade was twice the magnitude of the decline over the first time interval analyzed. This advance could be a reflection not only of improvements in maternal schooling level and family purchasing power, but also to healthcare, especially through the Family Health Strategy and access to better sanitation conditions.<sup>11</sup>

Therefore, it is essential to intensify health promotion actions and social, educational and income-generating investments such that these become the path towards preventing and combating these nutritional ailments, which are still significantly present, especially in the north and northeast of Brazil, thereby ensuring equity among families in urban and rural areas of these regions.

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<sup>j</sup> Ministério da Educação (BR); Universidade Estadual do Rio de Janeiro, Pró-Reitoria de Extensão. Políticas públicas nos territórios das juventudes. Rio de Janeiro; 2006. (Coleção Grandes Temas do Conexões de Saberes).

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