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ANEMIA AND ASSOCIATED FACTORS AMONG SCHOOL-AGE CHILDREN IN CAPE VERDE, WEST AFRICA

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ABSTRACT

Anemia is a problem affecting a large group of school children in sub-Saharan Africa, contributing to morbidity in this region. In Cape Verde the magnitude of anemia in school-age children is unknown. The study aimed to assess the prevalence of anemia and associated factors among children in Cape Verde. The data are from a probabilistic sample of 1106 children between five and nine years of age included in the National Survey on the Prevalence of Anemia and Associated Factors among Children aged less than ten years which was organized by the Government of Cape Verde in 2009. Anemia was assessed by measuring blood hemoglobin (Hb) concentration using a portable hemoglobinometer. Children with Hb lower than 11.5 g/dL were considered anemic. Information on the families' socioeconomic conditions and the children's health variables were obtained through interviews with parents or guardians. Weight status and height deficits were defined by sex and age specific body mass index (BMI = weight/height^2) and height for age cutoffs, respectively. Associations between anemia and socio-environmental, anthropometric and children´s health variables were investigated by means of logistic regression, using hierarchical multivariate analysis. Odds ratios (OR) and the respective 95% confidence intervals (95% CI) were estimated. The prevalence of anemia was 23.8% (95% CI: 20.2% - 27.8%); 8.8% of children presented height-for-age deficit, 9.8% had thinness and 5.3% were obese. The factors associated with anemia were unfavorable socio-environmental conditions (OR = 1.92; 95% CI: 1.10-3.36) and age five to six, compared with seven to nine years (OR = 1.55; 95% CI: 1.13-2.13). Anemia among school-age children is a moderate public health problem in Cape Verde that mainly affects those between five and six years of age, belonging to families with low socio-environmental condition. Prevention and control programs for this disease should be implemented in conjunction with actions to improve the conditions of Cape Verdean families.

Key words: Anemia, socio-environmental conditions, school children

INTRODUCTION

Anemia is a worldwide public health problem that affects both developed and developing countries [1]. Africa and Southeast Asia are the regions that present highest prevalence of this disease. The groups most affected are pregnant women, children under the age of five years and, to a lesser extent, school-age children. The World Health Organization has estimated that 25% of school-age children are affected by anemia [2].

In Cape Verde, the prevalence of anemia in children under five years old is near 50% [3]. However, there are no data on the magnitude of this problem among school-age children, above five years. Moreover, studies conducted in other African countries have shown that high prevalence of anemia also exists at school-age. In Senegal the prevalence of anemia in children less 10 years was 30.7% [4]. In Nigeria, this proportion was 82.6% among children aged 7 to 12 years [5]. Other studies conducted in eight countries of Africa and Asia, observed that the highest prevalence in children 7 to 11 years, was found in Mali (58%), Tanzania (57%), Mozambique (54%) and Ghana (41%) [6].

Anemia is commonly associated with nutritional deficiencies, especially iron deficiency, in association with deficiencies of folate, vitamin B12 and vitamin A. Other causal factors include parasitic diseases, malaria, poor sanitary and health conditions and poor socioeconomic condition [7,8]. Ultimately, socioeconomic conditions are the main determinants of all the other factors.

Tackling iron deficiency anemia is a priority measure among healthcare policies because of its association with impaired physical and intellectual development among children and with diminished response from the immunological system, with major social and economic implications [7,9,10].

In 2002, a program of ferrous sulfate distribution to children was implanted in Cape Verdean schools. However, so far, lack of information on the prevalence of anemia and the associated factors within this age group have made it impossible to assess the impact of this program. It should also be noted that this program did not take into account children aged five to six years, given that public access to preschool education is not obligatory in Cape Verde.

Programs aiming towards prevention and treatment of anemia, by means of supplementation through medications and fortification of foods, may be ineffective if the contributions of other factors that could act towards causing the disease are not taken into account [11,12]. The objective of this study was to ascertain the magnitude of the anemia in school-age children and identify the factors associated with this, in order to define and reformulate anemia prevention and control strategies towards this age group.

MATERIALS AND METHODS

Study population

This study resulted from the National Survey on the Prevalence of Anemia and Associated Factors among Children aged less than ten years (IPAC 2009), which was conducted in Cape Verde between May and August 2009, by the Ministry of the Environment, Rural Development and Marine Resources.

The IPAC was a cross-sectional household-based study, with a probabilistic sample comprising 2,383 children between six months and nine years old. A total of 284 children were excluded from the analysis because of lack of data relating to date of birth, weight, height and hemoglobin concentration. Thus, the final sample comprised 2,099 children that represented 88% of the eligible children between six months and nine years old. In the present study, we analyzed the data from a sub-sample of 1,106 children aged five to nine years who were part of the national survey IPAC. The data from 993 children aged 6–59 months were analyzed in other article. The sample size (1,106 children aged five to nine years) made it possible to estimate the prevalence of anemia as around 25%, with an error of approximately 3.6% and sample design effect (by clustering) of 2.0 [13].

The sampling design was a clustering process in two stages of selection, based on the methods of the Questionnaire on Wellbeing Indicators (QUIBB survey) [14]. The first stage of the sampling was related to the study domains, corresponding to the nine inhabited islands of Cape Verde, among which one of them (island of Santiago) was divided into three domains (Northern Santiago, Urban Beach and Remainder of Santiago), thus resulting in 11 domains. The second stage corresponded to the locations of the homes, which were stratified as urban or rural area.

Measurements

Diagnosis of anemia

The data were gathered by a trained team. The presence of anemia was assessed through measuring hemoglobin (Hb) levels in the blood, using a portable hemoglobin meter (Hemocue, Angelholm, Sweden), in order to make direct readings on blood samples obtained via finger prick using a disposable lancet. Nursing technicians who had been properly trained collected the blood samples. The finger prick site was cleaned using antiseptic and dried, before withdrawing the blood. HemoCue is a device that has already been validated [15], and it has been recommended for use in population-based studies because of its practicality, low invasiveness and because of the possibility of obtaining immediate results. Children with hemoglobin concentrations less than 11.5 g/dL were considered to be anemic, in accordance with the WHO classification [7].

Anthropometry

An electronic platform scale (Seca), with capacity of 150 kg and variation of 50 g was used to measure the weight. The children were weighed wearing minimal clothing and without shoes. Height was measured using a portable anthropometer for children, made of wood and specifically produced and adapted for this study. The children were

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standing upright. Two measurements of height were made by the same evaluator, allowing a maximum variation of 0.5 cm between them and taking the average. It was used Z score < -2 for the indices height for age (H/A) and body mass index for age (BMI/A) to indicate height and weight deficits, respectively, and Z score ≥ 2 for BMI/A was taken to indicate overweight or obesity, according to WHO Growth Reference [16].

Socioeconomic, demographic and child morbidity characteristics

The children's parents or caregivers were interviewed using a questionnaire to obtain information relating to the child (sex, age, recent episodes of diarrhea, vaccination and use of iron supplementation), the parents' schooling level and household conditions.

Statistical analysis

The statistical analyses were carried out taking into account the effect of the sampling design per cluster in two selection stages (domain and local of residence: urban or rural) and sampling expansion corrected by the relative weight using the complex sample procedure of the Statistical Package for the Social Sciences, version 19.0 for Windows (SPSS Inc., Chicago, IL, USA). First bivariate analysis was done, in order to investigate associations between anemia and possible risk factors, using logistic regression with estimation of odds ratios (OR) and 95% confidence intervals (95% CI). Following this, hierarchical multivariate analysis was performed, using a conceptual model adapted from Silva *et al*. [17] as shown in Figure 1.

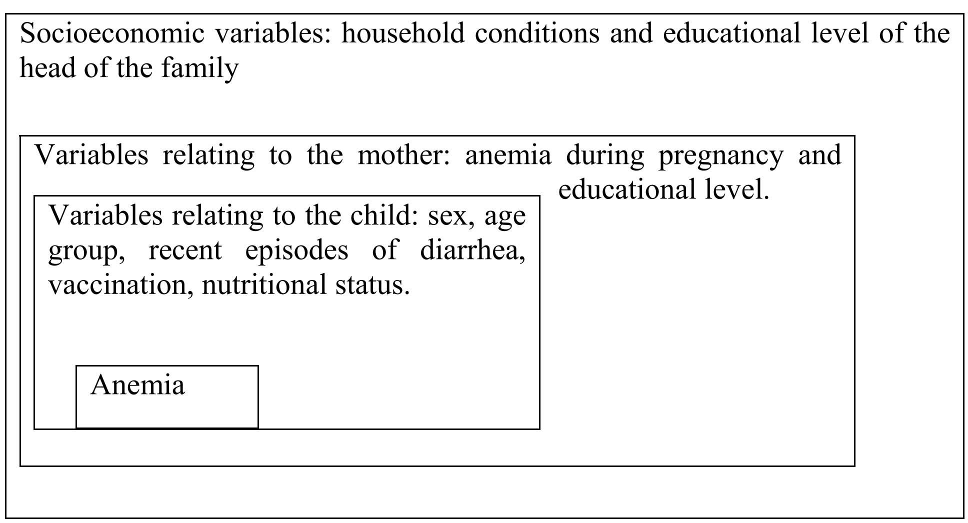

Figure 1: Conceptual hierarchical model adapted from Silva et al.[17]

The socioeconomic and environmental conditions as variables were introduced in the first dimension of the model. They were the schooling level of the family's head and the household conditions. The latter variable was constructed based on the following information for the all households: accommodation ownership, type of accommodation, predominant material used for roofing and flooring, presence of kitchen and bathroom, electrical service, garbage disposal, wastewater disposal, origin of drinking water,

water treatment and energy source for food preparation and presence of domestic goods (refrigerator, stove, television, car, radio and telephone), in accordance with an index adapted from Issler and Giugliani [18]. For each household, conditions assessed included assigning a numeric value, such that the most favorable condition received the highest numeric value (five) and the least favorable received value zero. So, a score was established based on the sum of the values, which could range from zero to 39 points. The families were grouped into tertiles of household conditions according to the score obtained: first tertile (14-26 points the worst household condition level), second tertile (27-31 points) and third tertile, the best household condition level (32 to 39 points).

In the second dimension of the hierarchical analysis, variables introduced related to the mother: anemia during the pregnancy (yes or no) and the mother's schooling level (up to end of elementary school, or high school or more). In the third and highest dimension we introduced the variables relating to the child: sex, age group (five to six years; or seven to nine years), recent episodes of diarrhea (yes or no), complete vaccination (yes or no) and anthropometric profile. Variables that presented a significance level of $p < 0.20$ were kept in the analysis from one stage to the next, and those that presented $p < 0.05$ were retained in the final model.

Ethics approval

This study was approved by the National Ethics Committee for Health-related Research of Cape Verde, in April 2009. The children's parents or caregivers were given information regarding the importance of conducting the study and on the methodological procedures and signed a free and informed consent statement, in accordance with the ethical principles recommended by the country. Children who were found to present with anemia were referred to the nearest healthcare service.

The authors declare no conliflit of interest in the preparation of the manuscript.

RESULTS

This study evaluated 1,106 children aged five to nine years, of whom 50.6% were boys and 49.4% were girls. Sixty per cent of the children aged seven to nine years, 53.7% had received complete vaccination, 15.9% were using iron supplementation 7.1% presented a recent episode of diarrhea, 8.8% presented a height-for-age deficit, 9.8% had thinness and 5.3% were obese (according to BMI-for-age) and 69.2% of their mothers had attained a schooling level less than or equal to the integrated elementary education level (Table 1).

The prevalence of anemia in total sample was 23.8% (95% CI: 20.2-27.8). It was 24.3% (95%CI: 20.3-28.8) in boys and 23.2% (95%CI: 18.0-29.4) in girls child. Based on the bivariate analysis, it was seen that a greater proportion of the children aged five to six years were anemic (OR = 1.68; 95% CI: 1.24-2.28), compared with the children aged seven to nine years. Other variables related with children (recent episodes of diarrhea, complete vaccination, use of iron supplements, BMI/A and H/A) were not associated with anemia (Table 2). Children that were in the first tertile of household conditions presented higher chance to have anemia than those that were in the third tertile (OR = 1.91; 95% CI: 1.11-2.65). The others socioeconomic and maternal variables were not associated with anemia (Table 3).

In the first stage of the multivariate analysis, according to the hierarchical theoretical model that had been defined a priori, only the household conditions variable was significantly associated with anemia; for example the children that lived in the worst household conditions level (first tertile according to the score obtained for household conditions) were more likely to have anemia than those that lived in better household condition. In the second level of the hierarchical model, in addition to the household conditions variable that remained from the first level, the variables relating to the mother were introduced for analysis and none of them presented association with anemia. However, for household conditions the association remained significant. In the last level of the model, the variables relating to the child were introduced, and only the age group was kept in the model. So, the final model remained the variables age group and household conditions, such that children aged five to six years and with worse household conditions presented a higher chance of having anemia (Table 4).

Table 5 shows the expected prevalence of anemia in the categories of variables that remained significant in the final model, such as the child's age group and socio-environmental conditions, such that, for those aged five to six years living under the worst socio-environmental conditions (first tertile according to the score obtained for household conditions), the prevalence of anemia could reach around 39%.

DISCUSSION

This is the first study showing the prevalence of anemia among school-age children from Cape Verde. Since anemia affected 23.8% of these children, it can be considered a moderate public health problem [7]. Comparing these results with those relating to other sub-Saharan African countries, it can be seen that they are equal to those found in Kenya (24%) [19]. Higher prevalences were reported in Mozambique and Mali, where more than half of the children aged 7 to 11 years were anemic [6]. In another study conducted among school-age children in a region of Tanzania, the prevalence of anemia was found to be 79.6% [20]. On the other hand, a lower prevalence than in the present study was found among school children of the North-West Province, South Africa (6.8%) [21].

Although the prevalences found in the present study are lower than those found in most other reports from Africa, it is nonetheless worrying since, within the regional context, Cape Verde presents better socioeconomic conditions and better nutritional health indices [22]. These results may also have been influenced by the actions of a prophylaxis distribution program aimed towards this specific age group that is in progress in the country. Furthermore, the results may have been also influenced by measures that have been taken towards ensuring that the diet served in schools includes some foods enriched with iron and other micronutrients, thereby providing the conditions for lower prevalence of anemia. Nevertheless, according to the reports from the mothers or caregivers, only 15.9% of the children were receiving iron supplementation. This is still a low proportion and raises questions about the efficacy of the coverage of the iron supplementation program in schools, or even in relation to the mothers' real level of knowledge regarding this supplementation, considering that the supplements are given to the children by their teachers at school.

Among all variables investigated, only household conditions and the child's age were associated with anemia in the final model. The results showed that worse household conditions of families were strongly associated with anemia among their children, such that these children had a greater chance of presenting anemia than did children whose families were living under better conditions. This finding confirms that anemia, as an important nutritional problem, is closely associated with families' living conditions. A similar result was observed in a study conducted in Tanzania [23], in Ethiopia [24] and in another study conducted in Northeast Brazil [25]. In the present study, it was not possible to evaluate per capita income, which is considered an important socioeconomic indicator. However, we assessed socioeconomic conditions based on indicators of housing conditions and possession of goods which have been used to estimate associations between health problems and living conditions in accordance with other studies [26,27]. Unfavorable living and sanitary conditions can expose children to parasitic infections and, consequently, diarrhea and loss of iron in the feces. Although in this study no association was observed between episodes of diarrhea and anemia, such association was verified in children under 5 years from Cape Verde evaluated in IPAC 2009 [28].

The child age groups were significantly associated with anemia. Children aged five to six years had a greater chance of developing anemia than did children aged seven to nine years. This diminishing prevalence of anemia with age is in line with the findings from a study conducted in eight African and Asian countries that also showed this trend among school children [6]. This finding may be explained by the increase in iron reserves that the child acquires over the years and by the decrease in the body's demand for iron, due to the lowering of the growth rate [29]. It should also be emphasized that in Cape Verde, children aged five to six years are generally not within the integrated elementary education system, given that according to the Guideline Law for Education, the age at which compulsory schooling starts is seven years. Thus, until this age, children are not benefited by the ferrous sulfate supplementation program that is implemented in schools, or by the school meals program, which might represent nutritional protection for children living under poor socioeconomic conditions.

Some studies have shown a distinct gender difference in the prevalence of anemia in schoolchildren, with levels much higher in males than females [6,30]. The present findings do not support this hypothesis.

Height-for-age deficits are considered to be an important determining factor for anemia in several countries in this region. In studies conducted with children less than 10 years in Senegal [4] and with preschool-age children in sub-Saharan [31], a positive association was found between anemia and height-for-age deficit. In the present study, height- for-age deficit was not shown to be associated with anemia, and this may be explained by the lower prevalence observed of these deficits (8.8%) when it was compared with what was found in Senegal (38.6%) [4]. Assefa *et al.* [24] also found no association between anemia and height-for-age deficit in children **aged 6–14 years** from Ethiopia where height-for-age deficit prevalence was 9.4%. In this study, BMI/A was evaluated as an indicator of both overweight (BMI/A equal to or above 2 Z score) and thinness (BMI/A below -2 Z score). However, no association was observed between anemia and BMI categories different from what was observed in Ethiopia where the prevalence of anemia was significantly higher in children whose BMI/A was below -2 Z score [24] but similar to what has been observed in studies conducted in Brazil [32, 33].

Although the assessment of dietary intake of the children could be a key point to check iron intake and its association with anemia, it was not possible to analyze information on the children's food intake, and this constitutes a limitation of this study. Another limitation was the difficulty in characterizing the losses among the eligible children caused by lack of information on their dates of birth. Thus, it was not possible to know whether these losses were concentrated more among the children under the age of five years, or over the age of five years, considering the IPAC survey overall, which covered the age range from six months to nine years.

It can be concluded that anemia is an important problem for school-age children in Cape Verde, and particularly for those under the age of seven years whose families live under worst household conditions.

Thus, actions to improve housing and sanitation of the population should be considered. With regard to the special feature of ferrous sulfate distribution in schools in Cape Verde, it is recommended that cost-benefit analysis should be conducted on this measure, as well as monitoring and assessment with the aim of better application of resources, in seeking to achieve better results or greater effectiveness.

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Table 1: Distribution of children, according to the socio-demographic, maternal and child health variables; Children 5-9 years, Cape Verde – 2009

Variables	N	%
Sex (N=1106)		
Male	565	50.6
Female	541	49.4
Age group (N=1106)		
5 - < 7 years	447	39.5
≥ 7 years	659	60.5
Mother's educational level (N=1103)		
Up to end of basic integrated education	773	69.2
Secondary or more	330	30.8
Use of iron supplements (N=1106)		
Yes	141	15.9
No	888	76.8
No Information	77	7.3
Recent episodes of diarrhea (N=1054)		
Yes	79	7.1
No	975	92.9
Complete vaccination (N=1106)		
Yes	593	53.7
No	513	46.3
H/A[a] (N=1106)		
<-2 Z score	99	8.8
≥ 2 Z score	1007	91.2
BMI/A[b] (N= 1106)		
< -2 Z score	108	9.8
≥-2 - <2 Z score	944	84.9
≥ 2 Z score	54	5.3

[a] H/A – height-for- age; [b] BMI/A: body mass index- for- age

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Table 2: Association of anemia (odds ratio and 95% confidence interval) with maternal and socioeconomic variables; Children aged 5 - 9 years, Cape Verde – 2009

Socioeconomic variables	Prevalence of anemia			
	%	**OR[a]**	**95%CI[b]**	**pvalue**
Household conditions				0.06
1st tertile	30.3	1.91	(1.11-2.65)	
2nd tertile	19.9	1.09	(0.65-1.82)	
3rd tertile	18.5	1.0		
No information	24.4	1.14	(0.87-2.30)	
Educational level of head of family				
Up to end of basic integrated education	24.9	1.29	(0.91-1.82)	0.14
Secondary or more	20.4	1.0		
Maternal variables				
Anemia during pregnancy				0.77
Yes	24.2	1.05	(0.67-1.65)	
No	23.2	1.0		
No Information	27.3	1.23	(0.68-2.22)	
Educational level of mother				
Up to end of basic integrated education	24.3	1.10	(0.77-1.59)	0.57
Secondary or more	22.5	1.0		

[a]OR: odds ratio; [b]**CI**: confidence interval

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Table 3: Association of anemia (odds ratio and 95% confidence interval) with variables related to children. Children aged 5-9 years, Cape Verde - 2009

Variables	Prevalence of anemia			
	%	OR[a]	95% CI[b]	p-value
Sex				
Male	24.3	1.06	(0.73-1.53)	0.75
Female	23.2	1.0		
Age group				
5 - < 7 years	29.6	1.68	(1.24-2.28)	0.001
≥ 7 years	20.0	1.0		
Recent episodes of diarrhea				
Yes	18.6	0.71	(0.37-1.38)	0.31
No	24.2	1.0		
Complete vaccination				
Yes	26.1	1.31	(0.90-1.92)	0.15
No	21.1	1.0		
Use of iron supplements				0.81
Yes	3.8	1.0		
No	18.0	0.96	(0.58-1.60)	
No Information	2.0	1.16	(0.55-2.46)	
BMI/A[c]				0.14
<-2 Z score	23.8	1.22	(0.66-2.25)	
≥-2 -<2 Z score	24.5	1.0		
≥ 2 Z score	13.2	0.33	(0.10-1.08)	
H/A[d]				
<-2 Z score	23.6	0.98	(0.51-1.91)	0.9
≥ 2 Z score	23.8	1.0		

[a] OR: odds ratio; [b] **CI**: confidence interval; [c] BMI/A: body mass index- for- age; [d]H/A: height-for- age

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Table 4: Logistic regression for association of anemia with risk factors, children aged 5 – 9 years, Cape Verde – 2009

Variables	1st stage		2nd stage		3rd stage	
	OR[c] 95%CI[d]	p value	OR [c] 95%CI[d]	pvalue	OR[c] 95%CI[d]	p value
Household conditions		0.11		0.06		0.06
1st tertile	1.87 (1.06-3.31)		1.92 (1.11-3.32)		1.90 (1.09-3.31)	
2nd tertile	1.11 (0.65-1.88)		1.10 (0.65-1.85)		1.07 (0.64-1.80)	
3rd tertile	1.0		1.0		1.0	
No information	1.39 (0.84-2.28)		1.44 (0.87-2.37)		1.38 (0.85-2.25)	
Educational level of		0.35				
Up to end of basic	1.18 (0.82-1.71)		_____		_____	
Secondary or more	1.0		_____		_____	
Mother's educational						
Up to end of basic	_____		1.04 (0.72-1.51)	0.82	_____	
Secondary or more	_____		1.0			
Anemia during						
Yes	_____		1.06 (0.67-1.67)	0.87	_____	
No	_____		1.0			
No Information			1.16(0.63-2.15)			
Sex						
Male	_____		_____		1.04 (0.69-1.55)	0.84
Female	_____		_____		1.0	
Age group						
5 to < 7 years	_____		_____		1.56 (1.14-2.13)	<0.005
≥ 7 years	_____		_____		1.0	
Recent episodes of						
Yes	_____		_____		0,71 (0,36-1,39)	0,32
No	_____		_____		1,0	
Complete vaccination						
No	_____		_____		0,89 (0,60-1,34)	0,60
Yes	_____		_____			
Use of iron supplements						0,75
Yes	_____		_____		1,0	
No	_____		_____		0,93 (0,53-1,63)	
No Information	_____		_____		1,15 (0,51-2,62)	
BMI/A[a]						0,21
< -2 Z score	_____		_____		2,24 (0,90-5,56)	
≥-2 - < 2 Z score	_____		_____		1,0	
≥ 2 z-score	_____		_____		2,09(0,73-6,00)	
H/A[b]						
< -2 Z score	_____		_____		1,02 (0,51-2,04)	0,95
≥ 2 Z score	_____		_____		1,0	

[a]BMI/A: body mass index- for- age; [b]H/A: height-for- age **[c]OR: odds ratio [d]CI: confidence interval**

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Table 5: Expected prevalence of anemia according to the categories of the variables that remained in the final model, Children aged 5 – 9 years, Cape Verde, 2009

Variables	Household conditions			
	1st tertile	2nd tertile	3rd tertile	No information
5 to < 7 years	38.5%	26.3%	24.8%	31.9%
≥ 7 years	28.4%	18.5%	17.3%	22.9%

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