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Impact of the health and living conditions of migrant and non-migrant Senegalese adolescent girls on their nutritional status and growth

Denis Garnier[1,*], Kirsten B Simondon[1], Thierry Hoarau[2] and Eric Benefice[1]
[1]UR24 'Epidémiologie et Prévention', Institut de recherche pour le développement (IRD), BP 64501, 34394 Montpellier Cedex 5, France: [2]Laboratoire de Nutrition, Institut de recherche pour le développement (IRD), BP 1386, Dakar, Senegal

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Abstract

Objective: To describe the living conditions of Senegalese adolescent girls according to their migration status, and to define the main socio-economic and biological determinants of their nutritional and growth status.
Design: Health and living conditions, sexual maturation, and nutritional and growth status of adolescent girls were determined within the framework of a longitudinal study on growth.
Settings: The capital city of Senegal (Dakar) and a rural community (Niakhar), 120 km south-east of Dakar.
Subjects: Three hundred and thirty-one girls, 14.5–16.6 years of age, were recruited from the same villages. Thirty-six per cent of the sample remained in the villages to attend school and/or to help with household subsistence tasks (non-migrants). The remaining (64%) migrated to cities to work as maids (migrants) and lived in two different socio-economic environments: at the home of a guardian during the night and in the house of the employer during the daytime.
Results: Family rural environment and guardian and employer urban environments were socio-economically different ($P < 0.001$). Living conditions in urban areas were better than in rural areas and the employer's environment was socio-economically more favourable. Migrants had more advanced sexual maturation and higher body mass index (BMI), fat mass index (FMI) and mid-upper arm circumference than non-migrants. However, migrants were smaller than non-migrants. BMI, FMI and weight-for-age were related to socio-economic levels and duration of migration. Schooling was positively related to height and negatively related to BMI.
Conclusions: Migrants enjoyed better living conditions than non-migrants. This could be partly due to the better socio-economic environment of the employer. It was associated with earlier puberty and better nutritional status, but not with a better growth.

Keywords
Child labour
Living conditions
Malnutrition
Nutrition transition
Rural–urban migration
Schooling
Senegal
Socio-economic environment
Stunting
Body mass index

In developing countries, socio-economic factors are often the main determinants of nutritional status and growth from childhood[1–3] to adulthood[1,4] throughout adolescence[5]. An adolescent from a high socio-economic environment will usually be taller and heavier. In addition, height can be considered and used as an indicator of socio-economic environment and health[5].

Moreover, urbanisation is an important phenomenon in developing countries and the highest urban growth rates (more than 4% per annum) are currently being recorded in Africa[6]. Urban populations are, on an average, richer than rural populations and have better living conditions[7–9], since wealth and economic, sanitary and social infrastructures are concentrated in cities. However, the gap between poor and rich is much greater in urban areas[10]. These differences in wealth and living conditions, as well as differences in diet and food intake[11], between urban and rural environments are often related to differences in nutritional status. Urban populations tend to be taller and heavier during childhood[10,12], adulthood[4,13] and adolescence[9,14]. For instance, the prevalence of stunting or wasting in Senegalese pre-school children is lower in the urban environment than in the rural environment, and this difference increased between 1986 and 1993[15]. However, because of economic heterogeneity, differences between rich and poor are

*Corresponding author: Email dgarnier@mpl.ird.fr

more pronounced in urban environments than in rural environments. Malnutrition levels for the poor in an urban environment are close to those of the poor in a rural environment[10,16].

Finally, factors such as adoption[17], migration from developing to industrialised countries[18], and rural–urban migration[19–22] are important determinants of nutritional status and growth of adolescents from developing countries because of the improvement in socio-economic status and behavioural changes that they bring about.

It is compulsory for rural African households to diversify their activities in order to cope with chronic agricultural crises and to survive or improve their living conditions[23]. One of the most common sources of livelihood involves rural–urban migration for labour. In Senegal, many adolescent girls migrate to cities to work as maids[24].

In this context, it appears important to study the growth during adolescence taking into account different socio-economic factors. African adolescent girls, by performing multiple domestic productive tasks, play a significant role in the subsistence of households. Few studies have considered this topic even though the reproductive life of these adolescent girls depends in large part on their nutritional status. The present study aims to describe the living and health conditions of Senegalese girls in rural (non-migrants) and urban (migrants) areas and to estimate their sexual maturation, nutritional status and growth. We also report the impact of socio-economic and biological factors on their nutritional status and growth.

Methods

Environment

Rural area

The study was carried out in the Niakhar district, located in the *peanut basin* of Senegal (West Africa) 120 km south-east of the capital city, Dakar. The study area included 30 villages with a high population density (30 000 inhabitants[25] at 1 January 2001). Most of the inhabitants (96%) belonged to the *Sereer* ethnic group and 75% were Muslims. This population was very young: nearly 58% were under 20 years of age. The school attendance rate was low but higher for males. In the 15–24-year-old age bracket, only 20% of the women attended school compared with 41% of the men[25]. Over the past 30 years, infant and child mortality has decreased but remains high (213‰ in 1994–99)[25]. Fertility is high (synthetic index of fertility = 7.1 in 1994–96) despite some signs of demographic transition[25]. For the period 1984 to 1997, the maternal mortality index was high (516 deaths for 100 000 births) and the risk of maternal death for a young woman or adolescent girl was four times higher than for a 20–39-year-old woman[26]. The living conditions of this population during the study period were therefore precarious. The area has suffered from severe and persistent drought with limited and irregular rainfall since the 1970s. Most rain occurs from July to September and is a determining factor for crops, as the soil is rather infertile[27]. The main activities include subsistence agriculture: livestock breeding, food crops (millet, sorghum and beans) and cash crops (peanuts)[27].

Urban area

The agricultural crisis, high demographic density and the worsening of living conditions led the population to diversify its activities in order to survive[23]; young people in particular migrated periodically to cities during the dry season to find work. There, adolescent girls worked as maids[24]. A guardian, either an uncle or aunt, was responsible for the girl and cared for her while in town[24]. The salary of adolescent girls was equal to €11.6 per month (standard deviation (SD) €3.0), representing 16% of the average salary of a Senegalese worker. Urban studies were mainly carried out in Dakar (86.4% of migrants) and in three secondary towns (Mbour, Fatick and Joal). The population density in Dakar is very high (estimated at 2 million inhabitants[28]). Precariousness and poverty are widely scattered in the different districts of the urban area of Dakar[29]. Within the same district, shanty-towns and precarious housing areas coexist with more comfortable housing areas composed of permanent structures.

Subjects

All adolescent girls studied were born and raised, up until the beginning of puberty (10 years of age), in the rural community of Niakhar. They have been followed, since 1995, within the framework of a longitudinal study of growth during adolescence[30]. This study corresponded to the twice-yearly (biannual) round of this longitudinal survey. In April–June 1999, the average age was 15.5 (SD 0.5) years. Their anthropometric and nutritional status was measured during infancy[31] and at the beginning of puberty[22,32].

Survey planning

Non-migrants ($n = 119$, 36%) and migrants ($n = 213$, 64%) were surveyed from April to June 1999 in rural and urban areas. The aim of the study and the methods were individually explained to each girl and her parents. They were allowed to participate or not in the study. Oral consent was requested, since most of the population is illiterate. The study protocol was approved by a review board of the Senegalese Ministry of Research and the Institut de recherche pour le développement (IRD).

Anthropometry

Adolescent girls were weighed using an electronic scale accurate to 100 g (TEFAL®; Paris, France). Stature was measured with a Harpenden® anthropometer (Siber

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Hegner & Cie, Miribel, France) accurate to 1 mm. Mid-arm circumference was measured to the nearest 1 mm with a tape measure. Six subcutaneous skinfolds (triceps, biceps, subscapular, suprailiac, periumbilical and calf) were taken using a Holtain® calliper (Siber Hegner & Cie, Miribel, France) with 0.2 mm precision. The same person performed all measurements (except weight) twice at the recommended sites, following standard techniques[33]. The two measurements were averaged to reduce measurement variation. Body mass index (BMI, $kg\,m^{-2}$) (calculated as weight (in kg) divided by the square of height (in m)) was calculated. Anthropometric indices (height-for-age and weight-for-age) were calculated with the Epinut module of Epi Info software version 6.04[34] and expressed as *Z*-scores according to the National Center for Health Statistics (NCHS)/World Health Organization (WHO) international references[35]. Fat mass index (FMI) was defined as the logarithm of the sum of the six skinfolds.

Sexual maturation

Sexual maturation was based on two indicators: breast development stage according to the Tanner classification[36] and the occurrence of menarche. A global gradient of maturation, which combined these two indicators, was constructed in order to allow adjustments for sexual maturation in further analysis.

Living conditions

Different variables were collected either at home (rural area) or at the guardian's home and at the employer's home (urban area) in order to analyse the socio-economic environment (see Appendix A). It is important to distinguish between the function of guardian (person in charge of the adolescent girl) and the employer. The procedure of data reduction and construction of the living condition profile were made by multiple correspondence and hierarchical cluster analyses. This kind of analysis allows one to construct synthetic indices of socio-economic level which are weighted linear combinations of initial socio-economic variables[37,38].

The first factorial plane of the multiple correspondence analysis explains 34.5% of the total inertia (first axis: 21.5%, second axis: 13.0%). The characteristics (partial contribution, coordinates and raised cosine) of the main variables contributing most to the construction of the first and second axes are shown in Appendix B.

Morbidity and healthcare behaviour

An investigator questioned each adolescent girl. Morbidity was defined by the frequency of the types of disease that had occurred during the three months prior to the survey. Type of medication and means of payment described healthcare behaviour. Adolescent girls were questioned to determine whether they had worked during their period of ill health.

Statistical analysis

Duplicate data entry and quality control of variables were performed with Epi Info, version 6.04[34]. Statistical analysis was performed using NCSS 2000[39] and StatBox Pro 5.0[40] software. Morbidity, healthcare behaviour (qualitative variables) and anthropometric characteristics (quantitative variables), adjusted for sexual maturation, were compared according to migration status using the chi-square test and analysis of covariance (the hypothesis of equality of slopes was checked). The influence of socio-economic and biological variables on nutritional status and growth of adolescent girls was estimated using a backward general linear model (significance threshold, $P < 0.1$) after checking its reliability[41]. Dependent variables were height-for-age, weight-for-age, BMI and FMI. Independent socio-economic variables constituted the first two axes of the multiple correspondence analysis. The first axis corresponded to an economic component and the second axis corresponded to demographic and social stability components. Other socio-economic variables represented foods stored by the household in which the girl lived, the presence of father and mother, birth order, financial help, schooling, the number of persons helping the adolescent girl at work and the duration of migration. Independent biological variables were morbidity during the three months prior to the survey and malnutrition at the beginning of puberty. Variables were first selected by a univariate analysis procedure (significance threshold, $P \leq 0.2$). Two-way interactions were tested and retained according to their significance level and epidemiological meaning. No interaction was retained in final models. Age and global sexual maturation gradient were considered as adjustment variables of anthropometric indices.

Results

Living conditions

Rural–urban migrations for labour are represented by three types of socio-economic environment: family (rural), guardian (urban) and employer (urban). Migrants live in two urban settings: with the guardian (person responsible for them in town) or with the employer where they work (average hours at employer's house per day: 10 (range 3–15)). The pattern of their living conditions (socio-economic environment) is shown in Fig. 1 and details of the multiple correspondence analysis are found in Appendices A and B. The interpretation of variables constituting the first two factors is given in Fig. 2.

The first axis can be considered as a socio-economic index, contrasting a non-privileged environment (no electricity, outside access to running water, precarious housing, food store from cash and staple food crops) with a more favourable environment (access to electricity and running water, housing structure of good quality (building material, sanitary), environmental hygiene (rubbish collection) and varied food store) (Figs. 1 and 2).

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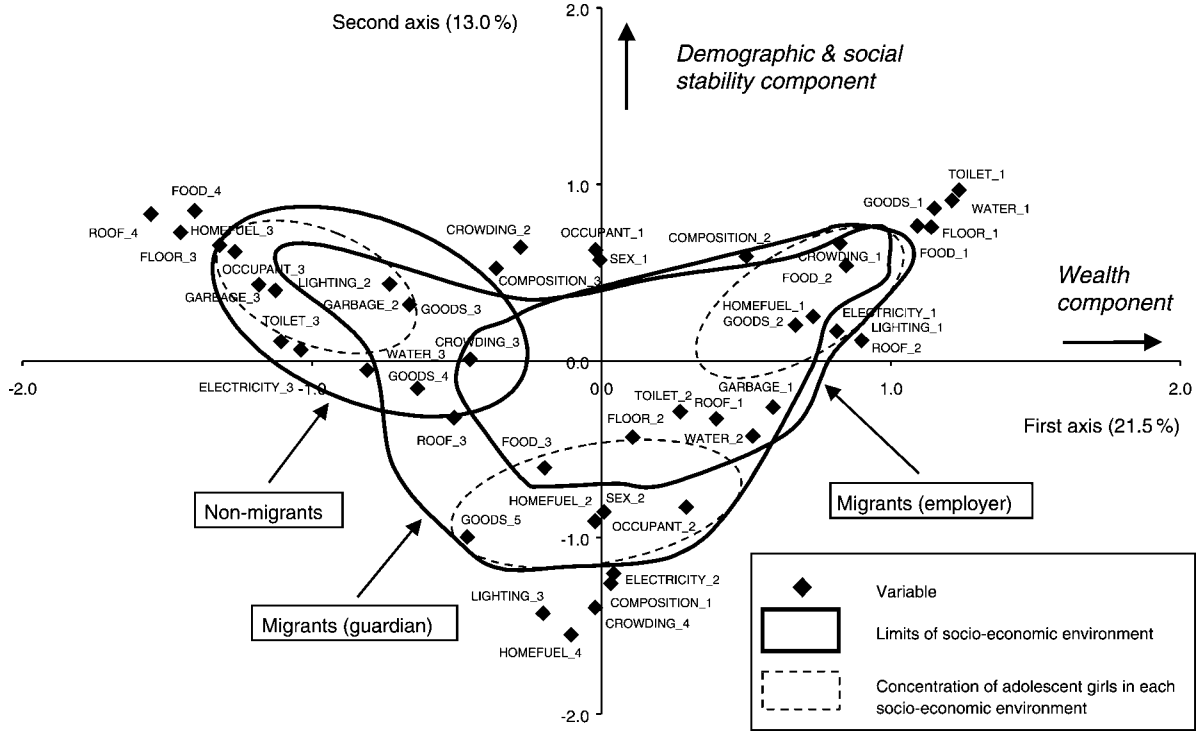

Fig. 1 Typology of living conditions (rural and urban area (guardian and employer)) by multiple correspondence analysis

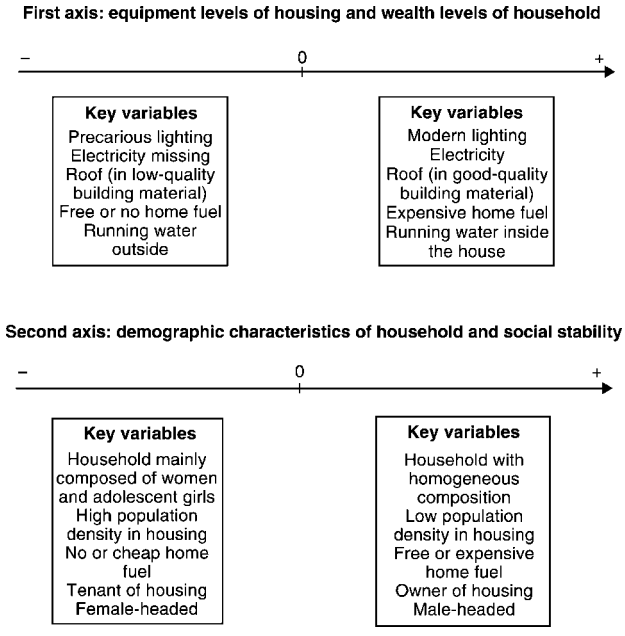

Fig. 2 Definition of the first two factorial axes from key variables

Variables characterising a precarious environment corresponding to shantytowns can be observed at the origin of the first axis (Fig. 1). The first axis can be considered as an urbanisation index opposing the rural area (left) and the urban area (underprivileged urban area, shantytowns (middle) and residential districts (right)).

The second axis, from bottom to top, represents adolescent girls living in an urban setting located in poorly integrated households (high density of dwellers, household with only women and girls, female-headed household, tenant, few goods and no food store) compared with adolescent girls living in villages or in residential area of cities (low density, male-headed household, home-owner, goods and food store) (Figs. 1 and 2). The second axis can be considered as a demographic (demographic characteristics of household) and socio-economic axis (ownership of food store and goods, type of occupation of dwelling) (Fig. 2). It is an index of stability and social integration of the household.

The three socio-economic environments had some points in common. However, there was no intersecting according to the concentration of adolescent girls (Fig. 1). The three environments are represented by the coordinates of the first axis (Fig. 3). Non-migrants were less scattered in the rural environment than migrants (axis one (-1.32 to -0.26)), indicating that it was the most homogeneous environment socio-economically. Conversely, the urban environment of the guardian was much more heterogeneous (-1.12 to 1.00). The employer's environment (-0.50 to 1.07) was situated between the two poles (Fig. 3). These three profiles were statistically different. Medians of coordinates of these three environments were also different (*post-hoc* test: Kruskal–Wallis multiple comparison test, $\chi^2 = 356.54$, $P < 0.0001$, $z > 2.39$). The rural environment appeared to be the most restrictive and the environment of the guardian was more favourable despite the fact that 24% of migrants lived in precarious conditions corresponding to true poverty

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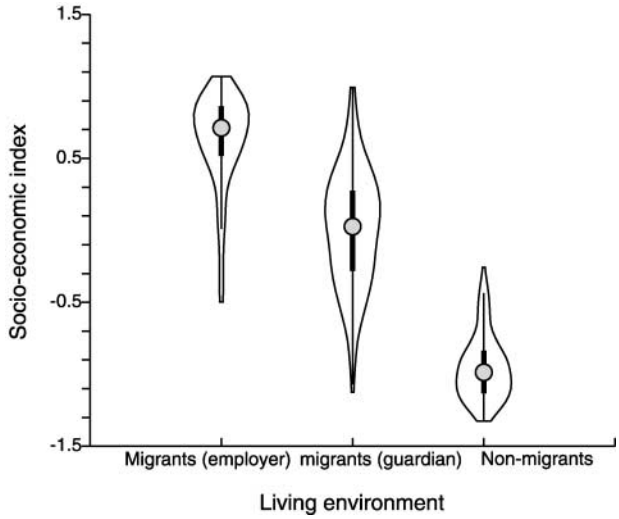

Fig. 3 Differences in socio-economic index according to living environment (violin plot)

pockets (shantytowns). The employer's environment was the best of the three, corresponding to a socially favoured household.

Morbidity and healthcare behaviour

More than half (61.5%) of the adolescent girls were ill during the three months preceding the survey. There was no significant difference in the prevalence of morbidity and type of disease between migrants and non-migrants (Table 1). Healthcare behaviour and means of payment were different. Migrants often relied on self-medication, whereas non-migrants often turned to folk medicine. Both groups used health services (community clinic or hospitals), and the absence of health care was slightly higher for non-migrants. Migrants more often tended to pay for health services themselves, whereas, in the case of non-migrants, close relatives paid for health services. Non-migrants very often had recourse to folk self-medication (Table 1).

Anthropometry and sexual maturation

As a whole, these Senegalese adolescent girls displayed a delay in weight and height compared with the NCHS/WHO population[35]. About 11.1% of adolescent girls had a BMI lower than the 5th percentile of North American girls[43]. A few girls (5.1%) were pre-pubescent and 36.5% had undergone menstruation (median age of the sample: 15.5 years). Adolescents living in a more favourable socio-economic environment were more advanced in puberty than were those living in a less favourable environment (difference in breast development stages: $\chi^2 = 20.78$, $P = 0.008$; difference in menarche occurrence: $\chi^2 = 11.02$, $P = 0.004$). Migrants were more advanced in puberty than non-migrants (Table 2). The difference in age between these two

Table 1 Morbidity and healthcare behaviour

Variable	Migrants, *n* (%)	Non-migrants, *n* (%)	χ^2 (*P*-value)
Disease within the last three months			
Yes	134 (58.8)	70 (62.9)	0.538 (0.463)
No	79 (41.2)	49 (37.1)	
Total	213	199	
Kind of disease*†			
Fever, malaria	6 (4.9)	6 (7.3)	1.466 (0.833)
Intestinal and gastric infections (diarrhoea, abdominal pain, etc.)	29 (23.6)	15 (18.3)	
Breathing and pulmonary infections (chest pain, cough, cold)	17 (13.8)	10 (12.2)	
Headaches	61 (49.6)	43 (52.4)	
Articular pains (aches, body pain, neck pain, rib pain, etc.)	10 (8.1)	8 (9.8)	
Total	123	82	
Kind of health care			
Community clinic, health case, hospital	36 (26.9)	20 (28.6)	8.77 (0.032)
Folk medicine	20 (14.9)	18 (25.7)	
Self-medication	45 (33.6)	11 (15.7)	
Nothing	33 (24.6)	21 (30.0)	
Total	134	70	
Payment of health care*			
Adolescent girl	14 (14.6)	1 (2.2)	31.77 (<0.0001)
Third party (immediate family)	25 (26.0)	31 (67.4)	
Third party (distant family)	26 (27.1)	4 (8.7)	
Third party (no link)	20 (20.8)	1 (2.2)	
Free – without payment	11 (11.5)	9 (19.6)	
Total	96	46	
Work during disease			
Yes	60 (44.8)	34 (48.6)	0.267 (0.606)
No	74 (55.2)	36 (51.4)	
Total	134	70	

* χ^2 tests for kind of disease and payment of health care were carried out with one cell of expected frequencies less than five but higher than one (10% of cells)[42].
† Only the most important diseases have been mentioned in the analysis. An adolescent girl could have several kinds of disease within the three-month period.

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Table 2 Sexual maturation and anthropometry characteristics according to migration status

Variable	Migrants ($n = 214$)	Non-migrants ($n = 119$)	Test (P-value)
Sexual maturation (Tanner's stage and menarche)*			
B1	8 (3.7)	9 (7.6)	9.74† (0.045)
B2	9 (4.2)	10 (8.4)	
B3	33 (15.4)	20 (16.8)	
B4	65 (30.4)	43 (36.1)	
B5	99 (46.3)	37 (31.1)	
Menarcheal girl	88 (41.3)	33 (27.7)	6.08† (0.014)
Non-menarcheal girl	125 (58.7)	86 (72.3)	
Anthropometry‡			
Age (years)	15.5 ± 0.0	15.5 ± 0.1	0.62§ (NS)
Weight (kg)¶	46.8 ± 0.4	46.4 ± 0.6	0.32 (NS)
Height (cm)¶	155.3 ± 0.4	158.2 ± 0.6	15.77 (<0.0001)
Mid-upper arm circumference (cm)¶	24.1 ± 0.2	23.2 ± 0.2	14.29 (<0.001)
Fat mass index (mm)¶	4.18 ± 0.02	3.93 ± 0.03	56.39 (<0.0001)
Weight-for-age (Z-score)¶	−1.02 ± 0.05	−1.07 ± 0.07	0.32 (NS)
Height-for-age (Z-score)¶	−1.01 ± 0.06	−0.59 ± 0.08	15.72 (<0.0001)
Body mass index (kg m^{-2})¶	19.3 ± 0.1	18.4 ± 0.2	12.48 (<0.001)

NS – not significant.
* Values given as n (%).
† χ^2 value.
‡ Values given as mean ± standard error of the mean.
§ Kruskal-Wallis one-way analysis of variance on ranks.
¶ Comparison after adjusting for differences in puberty by covariance analysis.

groups was not significant. After adjusting for sexual maturation (i.e. taking into account the maturation effect on nutritional status and growth), migrants had a higher mid-arm circumference, BMI and FMI than non-migrants. There was no significant difference in weight (Table 2). Non-migrants were taller for the same level of sexual maturation (difference in height (+2.8 cm) and height-for-age Z-score (+0.42)) than migrants. Without adjusting for sexual maturation, migrants were significantly heavier (+2.2 kg; $P = 0.016$) and smaller (−1.6 cm; $P = 0.048$) than non-migrants.

Socio-economic and biological determinants of nutritional status and growth

The height-for-age value was lower when the adolescent girl did not or no longer attend school and when she had suffered from malnutrition at the beginning of puberty (Table 3). The weight-for-age value was lower when the socio-economic index was poor and when malnutrition existed at the beginning of puberty. The BMI was higher when the girl did not suffer from malnutrition at the beginning of puberty and when she was not schooled and lived in a healthy environment (Table 3). Stature and weight retardation determinants explained BMI index. The FMI value was higher when the adolescent lived in a favourable socio-economic environment and when she had migrated to the city several times (Table 3).

Discussion

This study provides precise information on the socio-economic environment, nutritional status and growth of Senegalese adolescent girls according to their migration status. As a rule, living conditions are better in an urban than in a rural environment. On the whole, these adolescent girls showed delayed puberty[44] and moderate malnutrition characterised by stunting and underweight compared with international references[35]. Migrants tended to be fatter and more corpulent but smaller than non-migrants. As far as we are aware, this is the first systematic study on the impact of migration for labour on the growth and nutritional status of African adolescent girls.

Differences in living conditions

Our study shows that, in an urban area, migration leads to an improvement in living conditions. Migrants spend, on an average, 10 hours per day at the employer's home and they take advantage of this environment, which has a favourable effect upon their nutritional status. When they are not working, a quarter of migrants live in shantytowns, where the living conditions are more precarious than at the employer's home, similar to the situation in rural areas. Other adolescents live in permanent structures in popular districts. Despite the precarious living conditions of migrants[45], the urban environment appears to be more favourable for girls than the rural environment. It offers better food availability and diversity[15] (mainly from the employer), more infrastructures, a higher concentration of health resources[11] and more frequent transport services[8,9]. On average, urban households have more goods. However, the urban context is much more heterogeneous in terms of living conditions than the rural environment[10]. The poorest urban populations have less access to health services[11] and the living conditions are precarious in shantytowns.

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Table 3 Socio-economic and biological determinants of nutritional status and growth of adolescent girls ($n = 304$) estimated by the general linear model

Height-for-age (*Z*-score)			Weight-for-age (*Z*-score)			Body mass index (kg m^{-2})			Fat mass index (mm)		
Variables											
Malnutrition at the beginning of puberty			Malnutrition at the beginning of puberty			School attendance			Socio-economic index		
Malnutrition*	−1.97†	0.10‡	Malnutrition	−1.85	0.08	Never schooling	18.6	0.2	Poor	3.95	0.03
Without malnutrition	−0.65	0.07	Without malnutrition	−1.07	0.06	No more schooling	18.5	0.3	Medium	4.14	0.03
						Presently schooling	17.6	0.3	Good	4.15	0.03
	$F = 162.76$	$P < 0.0001$		$F = 73.46$	$P < 0.0001$		$F = 4.78$	$P = 0.009$		$F = 11.73$	$P < 0.0001$
School attendance			Socio-economic index			Malnutrition at the beginning of puberty			Migration class		
Never schooling	−1.47	0.07	Poor	−1.58	0.07	Malnutrition	17.9	0.3	No migration	4.02	0.05
No more schooling	−1.37	0.11	Medium	−1.43	0.08	Without malnutrition	18.5	0.2	Short duration	4.03	0.03
Presently schooling	−1.08	0.10	Good	−1.36	0.08				Medium duration	4.12	0.03
									Long duration	4.14	0.03
	$F = 6.91$	$P = 0.001$		$F = 2.78$	$P = 0.063$		$F = 5.45$	$P = 0.020$		$F = 2.46$	$P = 0.063$
						Socio-economic index					
						Poor	17.7	0.2			
						Medium	18.4	0.2			
						Good	18.5	0.3			
							$F = 2.87$	$P = 0.058$			
Adjustment variables											
Sexual maturation	$F = 23.42$	$P < 0.0001$	Sexual maturation	$F = 68.67$	$P < 0.0001$	Sexual maturation	$F = 43.90$	$P < 0.0001$	Sexual maturation	$F = 60.36$	$P < 0.0001$
Age	$F = 10.15$	$P = 0.002$	Age	$F = 0.017$	$P = 0.895$	Age	$F = 2.56$	$P = 0.111$	Age	$F = 0.01$	$P = 0.923$
Model			*Model*			*Model*			*Model*		
$F = 47.72$	$P < 0.0001$		$F = 57.75$	$P < 0.0001$		$F = 20.81$	$P < 0.0001$		$F = 24.55$	$P < 0.0001$	
$R^2 = 0.492$	Adjusted $R^2 = 0.481$		$R^2 = 0.492$	Adjusted $R^2 = 0.482$		R^2=0.362	Adjusted $R^2 = 0.344$		$R^2 = 0.370$	Adjusted $R^2 = 0.355$	

* Adolescent girls having height or weight for age index lower than −2 *Z*-scores at the beginning of puberty.
† Adjusted means.
‡ Standard error of the mean.

In Senegal, the food habits of rural and urban populations are different[19]. The rural population relies mainly on staple foods such as millet and sorghum served with a small portion of dry fish and sauces. Energy sources come essentially from plants and cereals[46]. In contrast, the urban population relies on imported cereals (rice), oil-based sauces, fresh fish and meat[29]. Migrants eat at the employer's home during the day[19,20] and leave in the evening with leftovers[24]. They benefit from a more varied diet than in a rural environment. They may go from a traditional rural diet to a rich urban diet which is sometimes unbalanced (street food)[47]. This shift from a diet rich in carbohydrates and fibre to a fat-based diet is likely at least partly to explain the improvement in the nutritional status of migrants.

Differences in healthcare behaviour

The morbidity rate is high but the indicator used is not selective. Non-migrant adolescent girls generally rely upon traditional medicine. Migrants from rural areas have the opportunity of changing their habits[48], and generally prefer to turn to modern medicine. Their employer may advise them and sometimes pay for them. Nevertheless, self-medication remains very high, since their limited financial means and access to health care tend to direct them to informal medication shops. In terms of public health, there is a real risk of drug intoxication. There is no difference in the morbidity rate between migrant and non-migrant girls, and morbidity during the last three months does not have an influence upon nutritional status and growth.

Living conditions, migration and nutrition

The sexual maturation of adolescent girls varies according to socio-economic status[5] and environment (urban vs. rural)[5,49]. It is evident that migrants are more advanced in puberty than non-migrants. A difference in weight (2–4.9 kg) between *Sereer* migrant and non-migrant adolescent girls has been pointed out in other studies. In all other published studies from Niakhar[19–22], BMI and skinfolds (triceps and subscapular) of migrants have always been higher than those of non-migrants. Other studies have confirmed greater corpulence and fat for migrants to urban areas[50–52]. Rural–urban migrations bring out an increase in fat at adulthood[50,52]. This is in agreement with the fact that fat is widely dependent on environmental and economic factors[5]. Better nutritional status might be due to the improvement in living conditions related to urban migration (weight-for-age, BMI and FMI) and to the duration of migration (FMI). These represent short-term changes in relation to an improvement in living conditions[4,53].

The subjects studied had grown up in the same rural area during their first 10 years of life, and had undergone the same environmental constraints and infectious burden[31]. At early adolescence some of them began migration for labour. No difference was observed in nutritional status during infancy[20,22] or at the beginning of puberty[54] between migrants and non-migrants prior to migration. Anthropometric selection to migrate did not appear to exist, i.e. a better nutritional status did not exist prior to migration, as other studies have shown[55].

Migrants are smaller than non-migrants with or without adjustment for sexual maturation. Short-term improvements in socio-economic environment do not seem to have an effect on stature. However, heavy physical activity, short duration of sleep and of rest could have a negative effect on growth. Height of adolescents gives an indication as to their nutritional past (from *in utero* to puberty). Adolescent girls previously suffering from malnutrition are smaller than the others[30]. Girls attending school are taller than girls not attending school (who are mainly migrants) when there was no difference in height at the beginning of puberty (data not shown). School attendance has an independent effect on height which can be partly explained by less physical activity and more rest for girls attending school[21]. Less physical activity can be beneficial for them and improve their energy balance. These girls will be mothers soon and it has been shown in several studies that non-schooling mothers give birth to small children[1,2]. Small stature and no schooling of migrants may have a negative impact on the nutrition of their future children.

It is tempting to compare the status of these adolescents with that in reports describing the world-wide nutrition transition process. The kind of rural–urban migration observed here does not bring about a situation similar to that of nutrition transition[56,57], when food intakes become quantitatively and qualitatively richer and physical activity less important. In our study, migrants had better living conditions and richer foods[47], but heavier physical activity[21]. The prevalence of overweight and obesity in our population was very low (3.3% in 1999), and was observed only in adolescent girls having migrated several times. Nutrition transition is considered to be an irreversible phenomenon, whereas the situation described here is not definitive. Most of these adolescent girls will go back to their villages to get married and will remain there to live.

In conclusion, improvement in living conditions can be observed during rural–urban migration for labour. The nutritional consequences of this migratory phenomenon appear to be divergent. Higher BMI and fat mass are associated with better living conditions. However, no effect on stature was observed. A heavier workload and a shorter duration of sleep and rest may explain the persistence of a short stature in migrant girls.

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References

1 Delpeuch F, Traissac P, Martin-Prével Y, Massamba JP, Maire B. Economic crisis and malnutrition: socioeconomic determinants of anthropometric status of preschool children and their mothers in an African urban area. *Public Health Nutrition* 2000; **3**: 39–47.
2 Islam MA, Rahman MM, Mahalanabis D. Maternal and socioeconomic factors and the risk of severe malnutrition in a child: a case–control study. *European Journal of Clinical Nutrition* 1994; **48**: 416–24.
3 Martin-Prével Y, Delpeuch F, Traissac P, Massamba JP, Adoua-Oyila G, Coudert K, *et al*. Deterioration in the nutritional status of young children and their mothers in Brazzaville, Congo, following the 1994 devaluation of the CFA franc. *Bulletin of the World Health Organization* 2000; **78**: 108–18.
4 Nube M, Asenso-Okyere WK, van den Boom GJ. Body mass index as indicator of standard of living in developing countries. *European Journal of Clinical Nutrition* 1998; **52**: 136–44.
5 Eveleth PB, Tanner JM. *Worldwide Variation in Human Growth*. Cambridge: Cambridge University Press, 1990.
6 United Nations Population Fund (UNFPA). *Footprints and Milestones: Population and Environmental Change – The State of the World Population 2001*. New York: UNFPA, 2001.
7 Durkin MS, Islam S, Hasan ZM, Zaman SS. Measures of socioeconomic status for child health research: comparative results from Bangladesh and Pakistan. *Social Science and Medicine* 1994; **38**: 1289–97.
8 McDade TW, Adair LS. Defining the 'urban' in urbanization and health: a factor analysis approach. *Social Science and Medicine* 2001; **53**: 55–70.
9 Adair LS, Vanderslice J, Zohoori N. Urban–rural differences in growth and diarrhoeal morbidity of Filipino infants. In: Schell LM, Smith MT, Bilsborough A, eds. *Urban Ecology and Health in the Third World (Society for the Study of Human Biology, Symposium 32)*. Cambridge: Cambridge University Press, 1993; 75–98.
10 Haddad L, Ruel MT, Garrett JL. Are urban poverty and undernutrition growing? Some newly assembled evidence. *World Development* 1999; **27**: 1891–904.
11 Popkin BM, Bisgrove EZ. Urbanization and nutrition in low-income countries. *Food and Nutrition Bulletin* 1988; **10**: 3–23.
12 United Nations Children's Fund (UNICEF), ed. Rural/urban nutrition gaps identified. In: *The Progress of Nations 1999*. New York: UNICEF, 1999; 13.
13 Delpeuch F, Cornu A, Massamba JP, Traissac P, Maire B. Is body mass index sensitively related to socio-economic status and to economic adjustment? A case study from the Congo. *European Journal of Clinical Nutrition* 1994; **48**(Suppl. 3): S141–7.
14 Panter-Brick C, Todd A, Baker R. Growth status of homeless Nepali boys: do they differ from rural and urban controls? *Social Science and Medicine* 1996; **43**: 441–51.
15 Martin-Prével Y, Maire B, Delpeuch F. Nutrition, urbanization and poverty in subSaharan Africa [in French]. *Medecine Tropicale* 2000; **60**: 179–91.
16 Menon P, Ruel MT, Morris SS. Socio-economic differentials in child stunting are consistently larger in urban than in rural areas. *Food and Nutrition Bulletin* 2000; **21**: 282–9.
17 Proos LA, Hofvander Y, Tuvemo T. Menarcheal age and growth pattern of Indian girls adopted in Sweden. II. Catch-up growth and final height. *Indian Journal of Pediatrics* 1991; **58**: 105–14.
18 Bogin B, Loucky J. Plasticity, political economy, and physical growth status of Guatemala Maya children living in the United States. *American Journal of Physical Anthropology* 1997; **102**: 17–32.
19 Benyoussef A, Cutler JL, Baylet R, Collomb H, Diop S, Lacombe B, *et al*. Health, migration and urbanization: a collaborative study in Senegal [in French]. *Bulletin of the World Health Organization* 1973; **49**: 517–37.
20 Bénéfice E, Cames C, Simondon KB. Growth and maturation of Sereer adolescent girls (Senegal) in relation to seasonal migration for labor. *American Journal of Human Biology* 1999; **11**: 539–50.
21 Garnier D, Bénéfice E. Habitual physical activity of Senegalese adolescent girls under different working conditions, as assessed by a questionnaire and movement registration. *Annals of Human Biology* 2001; **28**: 79–97.
22 Simondon KB, Simon I, Simondon F. Nutritional status and age at menarche of Senegalese adolescents. *Annals of Human Biology* 1997; **24**: 521–32.
23 Ellis F. Household strategies and rural livelihood diversification. *Journal of Development Studies* 1998; **35**: 1–38.
24 Delaunay V. Le travail des fillettes en Afrique subsaharienne. Conditions de vie et de travail des jeunes migrantes Sereer à Dakar. In: Schlemmer B, ed. *Colloque International – L'enfant exploité – mise au travail et prolétarisation*. Bondy, France: ORSTOM, 1994; 3–10.
25 Delaunay V, Etard JF, Marra A, Préziosi MP, Simondon F. Decline of infant and child mortality rates in rural Senegal over a 37-year period (1963–1999). *International Journal of Epidemiology* 2001; **30**: 1286–93.
26 Kodio B. *Niveaux, causes et facteurs de risque de la mortalité maternelle en milieu rural au Sénégal 1984–1998*. PhD dissertation, Victor Segalen Bordeaux II, Bordeaux, 2001.
27 Garin P, Guigou B, Lericollais A. Les pratiques paysannes dans le Sine. In: Lericollais A, ed. *Paysans sereer. Dynamiques agraires et mobilités au Sénégal*. Paris: Institut de Recherche pour le Développement, 1999; 210–98.
28 Food and Agriculture Organization. *Sénégal: Présentation générale*, 2001. Available at http://www.fao.org/giews/french/basedocs/sen/sengen1f.stm.
29 Salem G. *La santé dans la ville. Géographie d'un petit espace dense: Pikine (Sénégal)*. Paris: Karthala–ORSTOM, 1998.
30 Bénéfice E, Garnier D, Simondon KB, Malina RM. Relationship between stunting in infancy and growth and fat distribution during adolescence in Senegalese girls. *European Journal of Clinical Nutrition* 2001; **55**: 50–8.
31 Garenne M, Maire B, Fontaine O, Dieng K, Briend A. *Risques de décès associés à différents états nutritionnels chez l'enfant d'âge préscolaire: Etude réalisée à Niakhar (Sénégal), 1983–1986*. Paris: Centre Français sur la Population et le Développement, 2000.
32 Simondon KB, Simondon F, Simon I, Diallo A, Benefice E, Traissac P, *et al*. Preschool stunting, age at menarche and adolescent height: a longitudinal study in rural Senegal. *European Journal of Clinical Nutrition* 1998; **52**: 412–8.
33 Lohman TG, Roche AF, Martorell R. *Anthropometric Standardization Reference Manual*. Champaign, IL: Human Kinetics Books, 1988.
34 Dean AG, Dean JA, Coulombier D, Brendel KA, Smith DC, Burton AH, *et al*. *Epi Info, Version 6: A Word-Processing, Database, and Statistics Program for Public Health on Microcomputers*. Atlanta, GA: Centers for Disease Control and Prevention, 1995.

35 World Health Organization (WHO). Use and interpretation of anthropometric indicators of nutritional status. WHO Working Group. *Bulletin of the World Health Organization* 1986; **64**: 929–41.
36 Tanner JM. *Growth at Adolescence*, 2nd ed. Oxford: Blackwell Scientific, 1962.
37 Traissac P, Delpeuch D, Maire B, Martin-Prével Y, Cornu A, Tresche S. Building a summary index of the household's economic level in nutritional surveys. Application examples in the Congo [in French]. *Revue d'Épidémiologie et de Santé Publique* 1997; **45**(Suppl. 1): S114–5.
38 Cortinovis I, Vella V, Ndiku J. Construction of a socio-economic index to facilitate analysis of health data in developing countries. *Social Science and Medicine* 1993; **36**: 1087–97.
39 Hintze JL. *NCSS Statistical System for Windows, Version 2000*. Kaysville, UT: Number Cruncher Statistical Systems, 1999.
40 GrimmerSoft. *StatBox Pro, Version 5.0*. Paris: GRIMMER Logiciels, 2000.
41 Searle SR. General linear model. In: Kotz S, Norman LJ, Campbell BR, eds. *Encyclopedia of Statistical Sciences*. New York: John Wiley & Sons Ltd, 1983; 357–72.
42 Armitage P. Comparison of several groups. In: Armitage P, ed. *Statistical Methods in Medical Research*. Oxford: Blackwell Scientific Publications, 1994; 212.
43 Must A, Dallal GE, Dietz WH. Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht^2) – a correction. *American Journal of Clinical Nutrition* 1991; **54**: 773.
44 World Health Organization (WHO). *Physical Status: The Use and Interpretation of Anthropometry*. WHO Technical Report Series No. 854. Geneva: WHO, 1995.
45 Brockerhoff M. Child survival in big cities: the disadvantages of migrants. *Social Science and Medicine* 1995; **40**: 1371–83.
46 Bénéfice E, Garnier D, Ndiaye G. High levels of habitual physical activity in West African adolescent girls and relationship to maturation, growth and nutritional status: results from a three-year prospective study. *American Journal of Human Biology* 2001; **13**: 808–20.
47 Garnier D, Bénéfice E. Etat nutritionnel d'adolescentes sénégalaises selon leurs conditions de travail. *Revue d'Épidémiologie et de Santé Publique* 2000; **48**: 3S151.
48 Uyanga J. Rural–urban migration and sickness/health care behaviour: a study of Eastern Nigeria. *Social Science and Medicine* 1983; **17**: 579–83.
49 Pasquet P, Biyong AM, Rikong-Adie H, Befidi-Mengue R, Garba MT, Froment A. Age at menarche and urbanization in Cameroon: current status and secular trends. *Annals of Human Biology* 1999; **26**: 89–97.
50 Torun B, Stein AD, Schroeder D, Grajeda R, Conlisk A, Rodriguez M, *et al*. Rural-to-urban migration and cardiovascular disease risk factors in young Guatemalan adults. *International Journal of Epidemiology* 2002; **31**: 218–26.
51 Schroeder DG, Martorell R, Flores R. Infant and child growth and fatness and fat distribution in Guatemalan adults. *American Journal of Epidemiology* 1999; **149**: 177–85.
52 He J, Klag MJ, Wu Z, Qian MC, Chen JY, Mo PS, *et al*. Effect of migration and related environmental changes on serum lipid levels in southwestern Chinese men. *American Journal of Epidemiology* 1996; **144**: 839–48.
53 Cameron N, Kgamphe JS, Leschner KF, Farrant PJ. Urban–rural differences in the growth of South African black children. *Annals of Human Biology* 1992; **19**: 23–33.
54 Garnier D, Ndiaye G, Bénéfice E. Growth, nutritional status and regional fat distribution in relation to seasonal urban migration for labour among Senegalese adolescent girls. *Annals of Nutrition and Metabolism* 2001; **45**(Suppl. 1): 485.
55 Malina RM, Buschang PH, Aronson WL, Selby HA. Childhood growth status of eventual migrants and sedentes in a rural zapotec community in the Valley of Oaxaca, Mexico. *Human Biology* 1982; **54**: 709–16.
56 Popkin BM. The nutrition transition in low-income countries: an emerging crisis. *Nutrition Reviews* 1994; **52**: 285–98.
57 Popkin BM. Nutrition in transition: the changing global nutrition challenge. *Asia Pacific Journal of Clinical Nutrition* 2001; **10**: S13–8.

Appendix A – Variables describing living conditions: mode, frequency and missing values

Variable	Mode	Mode name	Frequency, *n* (%)
Ownership			
1. Goods ownership (quantity and quality (market value))*	Higher	GOODS_1	106 (20.0)
	High	GOODS_2	106 (20.0)
	Medium	GOODS_3	106 (20.0)
	Low	GOODS_4	83 (15.7)
	Lower	GOODS_5	128 (24.1)
	Missing value		1 (0.2)
2. Animal ownership	Animals	ANIMALS_1	142 (26.8)
	No animals	ANIMALS_2	387 (73.0)
	Missing value		1 (0.2)
Housing			
3. Home fuel	Expensive	HOMEFUEL_1	268 (50.6)
	Cheap	HOMEFUEL_2	68 (12.8)
	Free	HOMEFUEL_3	134 (25.3)
	No	HOMEFUEL_4	57 (10.7)
	Missing value		3 (0.6)
4. Lighting	Modern	LIGHTING_1	278 (52.5)
	Cheap	LIGHTING_2	173 (32.6)
	Precarious	LIGHTING_3	78 (14.7)
	Missing value		1 (0.2)
5. Electric power equipment and running electricity	Electricity and equipment existing	ELECTRICITY_1	278 (52.5)
	Electricity missing and equipment existing	ELECTRICITY_2	48 (9.0)
	Electricity and equipment missing	ELECTRICITY_3	203 (38.3)
	Missing value		1 (0.2)
6. Wastewater disposal	Modern	WASTEWATER_1	155 (29.2)
	Poor quality	WASTEWATER_2	92 (17.4)
	No	WASTEWATER_3	282 (53.2)
	Missing value		1 (0.2)
7. Refuse collection	Refuse collection service existing	REFUSE_1	336 (63.4)
	Done by household	REFUSE_2	85 (16.0)
	No collection	REFUSE_3	108 (20.4)
	Missing value		1 (0.2)
8. Building material (for walls)	Good	WALL_1	392 (74.0)
	Rather good	WALL_2	86 (16.2)
	Poor	WALL_3	51 (9.6)
	Missing value		1 (0.2)
9. Building material (for floors)	Good	FLOOR_1	101 (19.1)
	Rather good	FLOOR_2	332 (62.6)
	Poor	FLOOR_3	96 (18.1)
	Missing value		1 (0.2)
10. Building material (for roofs)	Good	ROOF_1	102 (19.2)
	Rather good	ROOF_2	193 (36.4)
	Poor	ROOF_3	159 (30.0)
	Very poor or no roof	ROOF_4	75 (14.2)
	Missing value		1 (0.2)
11. Toilet	Inside the house	TOILET_1	71 (13.4)
	Inside the concession	TOILET_2	311 (58.7)
	Outside	TOILET_3	147 (27.7)
	Missing value		1 (0.2)
12. Kind of housing	Permanent structure (same level)	HOUSING_1	296 (55.9)
	Several stories	HOUSING_2	111 (20.9)
	Bad quality	HOUSING_3	122 (23.0)
	Missing value		1 (0.2)
Household			
13. Population density in housing (persons per room)	0–1.25	CROWDING_1	134 (25.3)
	1.26–2.00	CROWDING_2	135 (25.5)
	2.01–5.00	CROWDING_3	139 (26.2)
	≥5.00	CROWDING_4	120 (22.6)
	Missing value		2 (0.4)
14. Matrimonial status of head of household	Lives alone	MATRIMONIAL_1	81 (15.3)
	Monogamous	MATRIMONIAL_2	274 (51.7)
	Polygamous	MATRIMONIAL_3	172 (32.4)
	Missing value		3 (0.6)
15. Status of occupant	Owner	OCCUPANT_1	251 (47.4)
	Tenant	OCCUPANT_2	223 (42.1)
	Free	OCCUPANT_3	49 (9.2)
	Missing value		1 (0.2)
	Don't know		6 (1.1)

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Appendix A. *Continued*

Variable	Mode	Mode name	Frequency, *n* (%)
16. Schooling of household head	Schooling	SCHOOLING_1	257 (48.5)
	No schooling	SCHOOLING_2	250 (47.2)
	Don't know		22 (4.1)
	Missing value		1 (0.2)
17. Sex of household head	Male-headed	SEX_1	318 (60.0)
	Female-headed	SEX_2	211 (39.8)
	Missing value		1 (0.2)
18. Household size	1–5	SIZE_1	106 (20.0)
	6–7	SIZE_2	117 (22.1)
	8–9	SIZE_3	100 (18.9)
	10–13	SIZE_4	109 (20.5)
	≥14	SIZE_5	97 (18.3)
	Missing value		1 (0.2)
19. Household composition†	Household mainly composed of women and adolescent girls	COMPOSITION_1	157 (29.6)
	Medium-sized household with a majority of adults	COMPOSITION_2	162 (30.6)
	Large household with a majority of young people (0–17 years old)	COMPOSITION_3	210 (39.6)
	Missing value		1 (0.2)
Food and water			
20. Running water	Inside the house	WATER_1	96 (18.1)
	Inside the concession	WATER_2	184 (34.7)
	Outside	WATER_3	249 (47.0)
	Missing value		1 (0.2)
21. Food store‡	Numerous and varied food store	FOOD_1	68 (12.8)
	Food store existing	FOOD_2	105 (19.8)
	No or hardly any food store	FOOD_3	284 (53.6)
	Food store from cash and staple food crops	FOOD_4	71 (13.4)
	Missing value		2 (0.4)
22. Drinking water storage	Storage	STORAGE_1	368 (69.4)
	No storage	STORAGE_2	161 (30.4)
	Missing value		1 (0.2)
Overall size			***530 (100)***

* Various categories of material goods were listed: electrical household appliances, means of transport, furniture, hi-fi, miscellaneous. A synthetic index of material goods ownership was calculated using the average market value of each type of goods (*MV*) and the existence or absence of each type of goods in the household (*EM*, $EM = 1$ when the goods are present and $EM = 0$ when the goods are absent):

$$Index_{goods} = \sum_{1}^{19} (MV_i \times EM_i).$$

† The 'household composition' variable was constructed using a three-step procedure: (1) correspondence analysis was performed on an occurrence table composed of eight variables characterising the number of persons in each sex and age bracket; (2) hierarchical cluster analysis was performed with the first two axes of this correspondence analysis; and (3) truncation of the dendrogram led to a partition into three classes.

‡ The 'food store' variable was also constructed using a three-step procedure. However, correspondence analysis was replaced by multiple correspondence analysis carried out on a table of 17 binary variables characterising the presence or absence of foods or food groups. The dendrogram of the hierarchical cluster analysis was truncated into four classes.

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Appendix B – Characteristics (partial contributions, coordinates and raised cosine) of the first five variables contributing to inertia of each axis (the first and the second axes)

			Contribution (%)		Coordinates		Raised cosine	
Variable	Theme	Mode	Axis 1	Axis 2	Axis 1	Axis 2	Axis 1	Axis 2
The first five variables contributing to the first axis								
Lighting	Housing	Modern	3.246	0.229	0.813	0.168	0.680	0.029
		Cheap	4.157	0.870	−1.126	0.400	0.649	0.082
		Precarious	0.060	5.057	−0.201	−1.429	0.007	0.373
		Total	*7.463*	*6.156*				
Electric power equipment and running electricity	Housing	Electricity and equipment existing	3.246	0.229	0.813	0.168	0.680	0.029
		Electricity missing and equipment existing	0.002	2.143	0.043	−1.204	0.000	0.147
		Electricity and equipment missing	4.185	0.027	−1.038	0.065	0.721	0.003
		Total	*7.433*	*2.399*				
Building material (for roofs)	Housing	Good	0.297	0.334	0.397	−0.327	0.038	0.026
		Rather good	2.713	0.075	0.899	0.116	0.429	0.007
		Poor	0.779	0.518	−0.509	−0.322	0.117	0.047
		Very poor or no roof	3.478	1.645	−1.556	0.832	0.422	0.120
		Total	*7.267*	*2.572*				
Home fuel	Housing	Expensive	2.561	0.499	0.732	0.251	0.522	0.061
		Cheap	0.001	1.724	−0.022	−0.908	0.000	0.124
		Free	4.423	1.797	−1.319	0.653	0.619	0.152
		No	0.012	4.403	−0.104	−1.550	0.001	0.310
		Total	*6.997*	*8.423*				
Running water	Food and water	Inside the house	2.593	2.411	1.212	0.908	0.327	0.184
		Inside the concession	0.878	0.958	0.524	−0.425	0.135	0.089
		Outside	3.089	0.021	−0.809	−0.051	0.622	0.002
		Total	*6.560*	*3.390*				
Total contribution			**35.72**					
The first five variables contributing to the second axis								
Household composition	Household	Household mainly composed of women and adolescent girls	0.003	7.751	0.032	−1.260	0.000	0.695
		Medium-sized household with a majority of adults	0.682	1.583	0.501	0.593	0.098	0.137
		Large household with a majority of young people (0–17 years old)	0.529	1.825	−0.363	0.524	0.093	0.194
		Total	*1.214*	*11.159*				
Population density in housing (persons per room)	Household	0–1.25	1.584	1.704	0.825	0.665	0.215	0.140
		1.26–2.00	0.193	1.710	−0.279	0.645	0.027	0.143
		2.01–5.00	0.535	0.000	−0.454	0.009	0.076	0.000
		≥5.00	0.001	7.343	−0.022	−1.397	0.000	0.598
		Total	*2.313*	*10.757*				
Home fuel	Housing	Expensive	2.561	0.499	0.732	0.251	0.522	0.061
		Cheap	0.001	1.724	−0.022	−0.908	0.000	0.124
		Free	4.423	1.797	−1.319	0.653	0.619	0.152
		No	0.012	4.403	−0.104	−1.550	0.001	0.310
		Total	*6.997*	*8.423*				
Status of occupant	Household	Owner	0.002	3.020	−0.020	0.628	0.000	0.360
		Tenant	0.359	4.735	0.293	−0.828	0.065	0.519
		Free	1.431	0.565	−1.266	0.618	0.163	0.039
		Total	*1.792*	*8.320*				
Sex of household head	Household	Male-headed	0.000	3.147	−0.006	0.572	0.000	0.490
		Female-headed	0.000	4.705	0.009	−0.856	0.000	0.490
		Total	*0.000*	*7.852*				
Total contribution				**46.51**				

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