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Is body mass index sensitively related to socio-economic status and to economic adjustment? A case study from the Congo

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Several nutritional surveys based on representative samples from various urban and rural situations show that the Congo presents a situation of nutritional transition. There is a large prevalence of low body mass index (BMI) in adults from rural zones and this increases with age. There is, however, a large prevalence of high BMI in urban populations despite the persistence of some degree of chronic energy deficiency (CED), particularly at younger ages. Correspondence analysis and logistic regression were used to construct a socio-economic index and measure adjusted risk factors for CED. In rural areas, the major risk factors were old age, sex (women) and the absence of schooling; low economic status, a commonly shared factor, did not differentiate between households for CED. In Brazzaville, CED was linked to a young age (<30 years) and, clearly, to poverty. The change in the prevalence of CED in mothers from the capital city during a period of economic adjustment showed an increased incidence in young mothers, and also showed that the disparity between low and high economic levels regarding CED had grown. Finally, there was a high level of correspondence between the mean values for the weight-for-height of children and the BMI categories of the mothers. There is a parallel evolution during the period of economic adjustment between the increase of wasting in infants and the increase of CED in mothers. Therefore BMI appears to be a potential core indicator for use in nutritional surveillance in the Congo.

Introduction

The Congo is a central African country of 342 000 km^2 located across the equator, with a rather uniformly warm, wet climate and a population of about 2 million. The country has reached a high level of urbanization, with >50% living in the four main cities while the average density of the rural regions is low (5.6 inhabitants/km^2).

Several nutritional surveys have been conducted in the Congo since 1986, in both rural and urban settings, as part of nutritional programmes (Simondon *et al.*, 1989; Cornu *et al.*, 1990, 1991; DGRST-ORSTOM-UNICEF, 1992). These surveys were primarily designed to establish baseline data on nutritional status and to identify risk factors for malnutrition; they gave us an opportunity to analyse the relationships between indicators of nutritional status and various socio-economic characteristics on the basis of representative data sets.

The country offers an example of the transitional situation which can be seen in several African countries with a high degree of urbanization; chronic energy deficiency (CED), largely prevalent in rural areas, remains important in cities, where obesity also appears to be

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becoming a public health concern (Maire *et al.*, 1992).

After a period of relative economic expansion up to the beginning of the 1980s, a crisis occurred in 1983 leading to a 40% decrease of the Gross National Product within a few years. A programme of economic adjustment was established in 1986; recruitment of civil servants stopped and unemployment rose from 20% to 30%. One survey was therefore specifically designed in 1991 to evaluate in Brazzaville, the capital city, the impact of this economic adjustment, based on the same sample frame as that used in 1986.

The objective of this paper is to document for both urban and rural settings the prevalence of low values of body mass index (BMI) which have recently been proposed (James, Ferro-Luzzi & Waterlow, 1988; Ferro-Luzzi *et al.*, 1992) as indicators of adult CED and to examine the relationship of BMI with household socio-economic status and its sensitivity to economic adjustment in the specific situation in Brazzaville.

Methods

Two cross-sectional surveys concern an urban section of the eastern part of the capital city, Brazzaville, representative of the various urban housing and socio-economic conditions. One survey was conducted in 1986 and the second 5 years later, on the same sample basis; they have been described more extensively elsewhere (Simondon *et al.*, 1989; DGRST-ORSTOM-UNICEF, 1992). The other two surveys deal with rural zones in 1987 and 1992; the first one is representative at the national level (Cornu *et al.*, 1990, 1991) while the second concerns only the central Plateaux area and is unpublished.

The four representative samples were selected in a two-stage procedure. First, enumeration areas from the last national census were chosen randomly and then households within areas were also randomly selected, provided the household had at least one preschool child. The first surveys were focused on preschool children and their mothers, but later ones were extended to other family members to allow the identification of at-risk groups on a family basis. Therefore the 1986/87 surveys give data on mothers only, while the 1991/92 surveys included all adults; in every case, ages <18 years were excluded from the analysis.

Anthropometric measurements were done by a team of trained nutritionists. Weights were measured within 200 g with calibrated electronic scales and heights were measured with a portable gauge (microtoise) to the nearest millimetre, according to standardized procedures. In keeping with Ferro-Luzzi *et al.* (1992) we have considered BMI <18.5 kg/m^2 as potential cases of CED and a BMI >25 as potential cases of obesity.

A set of socio-economic variables was collected during the surveys from the heads of households and from the mothers. Two separate socio-economic scales were constructed for urban and rural samples, independently of BMI, by a correspondence analysis which gives an optimal linear combination of the variables, once coded by a binary indicator matrix (Lebart, Morineau & Warwick, 1984). It provided us with an efficient synthetic index of socio-economic status and we have therefore divided the populations studied in quintiles according to individual scores on this axis. In Brazzaville, this scale clearly shows a marked regular gradient for the main variables, either the percentage of employment (from 41.2% unemployed heads of households in the first quintile to 11.9% in the fifth one), the percentage with electricity (0–91.1%) or with piped water (14.6–96.1%), or the percentage of families without assets (92.6–2.2%). Another scale was constructed on the same basis ,for the rural Plateaux, although the number of variables was reduced, since the rural families of this region are basically very poor.

These factors were also introduced in a logistic regression analysis (Bouyer, 1991) in order to calculate adjusted odds ratios (OR) for CED: each risk factor has been coded as a binary variable (1 for the presence of the risk factor and 0 for its absence) and exp (b_i) gives the odds ratio for this factor adjusted for the other variables in the model. The estimation of the parameters b_i is done by the maximum likelihood estimation method using the iteratively reweighted least-squares algorithm. Comparisons of prevalences of CED between 1986 and 1991 in Brazzaville were assessed by standard χ^2-tests; interaction between economic adjustment and factors like age or socio-economic levels of households were assessed

Table 1. Anthropometric characteristics of subjects by survey: mean (SD)

Survey	*Group*	*n*	*Age (years)*	*Weight (kg)*	*Height (cm)*	*BMI (kg/m²)*
Brazzaville 1986	Mothers	900	27.7 (6.6)	58.2 (11.2)	159.3 (5.8)	23.1 (4.0)
Rural National 1987	Mothers	1272	28.4 (7.9)	52.8 (8.3)	157.6 (6.0)	21.2 (2.9)
Brazzaville 1991	Men	1198	34.3 (13.2)	63.6 (10.5)	169.7 (7.0)	22.1 (3.3)
	Women	1806	30.2 (11.3)	59.5 (12.5)	159.7 (6.2)	23.2 (4.5)
Rural Plateaux 1992	Men	498	40.6 (17.4)	56.3 (8.1)	166.7 (7.0)	20.2 (2.2)
	Women	846	35.1 (14.2)	51.0 (7.5)	157.6 (5.9)	20.5 (2.6)

by a stratified analysis allowing for comparisons of odds ratios between strata. All data analysis and statistical calculations were performed with SAS software (SAS Institute Inc., Cary, NC, USA).

Results

Prevalence of low BMI in urban and rural settings

Table 1 gives the number of subjects in each sample, their mean age, weight, height and BMI. In the rural samples men and women are shorter and lighter than in Brazzaville and their average BMI is also lower.

From the 1986 and 1987 surveys, prevalences of CED can be given at a national level for mothers. The prevalence of low BMIs followed the gradient from the large cities to the villages: Brazzaville 6.8%, country towns with >2000 persons 10.8%, villages 15.3%. In addition the prevalence of low BMIs was significantly lower in northern forest areas (7.3%) than in the south (13.2–17.9%).

From the 1991 survey in Brazzaville and from the 1992 survey in the central Plateaux region, prevalences of CED can be given for representative samples of all men and women over 18 years: the total prevalence of CED was 10.8% (grade III: 0.8%, grade II: 1.9%, grade I: 8.1%) in Brazzaville and 21.4% in the Plateaux (grade III: 1.6%, grade II: 4.4%, grade I: 15.4%). There are no significant differences between means according to sex.

However, the distribution of BMI categories by age varied according to sex and settings (Fig. 1). In the rural Plateaux the prevalence of low BMI in women increased regularly from 18 years through older ages, from 12% up to 50%. For men the situation was different, the prevalence of low BMI decreasing during young adulthood, but then rising sharply after 40 years, up to 37%. On a general basis, a low BMI was very common for both sexes at older ages.

The situation in the capital city was slightly better since the prevalence of low BMI decreased after 25 years and was no more than 15% at older ages. In contrast, the prevalence of high BMI rose significantly with age, particularly in women.

Relationship with socio-economic variables

Table 2 shows the prevalence of CED and obesity by quintiles of the socio-economic

Table 2. Prevalence of chronic energy deficiency (CED) and obesity by socio-economic quintiles

	Brazzaville 1991			*Rural 1992*		
Socio-economic scale	*n*	*CED %*	*Obese %*	*n*	*CED %*	*Obese %*
Quintile 1	541	15.3	15.7	258	19.8	4.3
Quintile 2	534	11.2	16.5	263	23.6	3.0
Quintile 3	535	10.3	23.0	247	21.9	2.8
Quintile 4	542	9.4	27.9	277	22.4	3.6
Quintile 5	538	9.6	34.9	260	16.9	6.9
P (χ^2-test)		=0.01	<0.0001		=0.36	=0.12

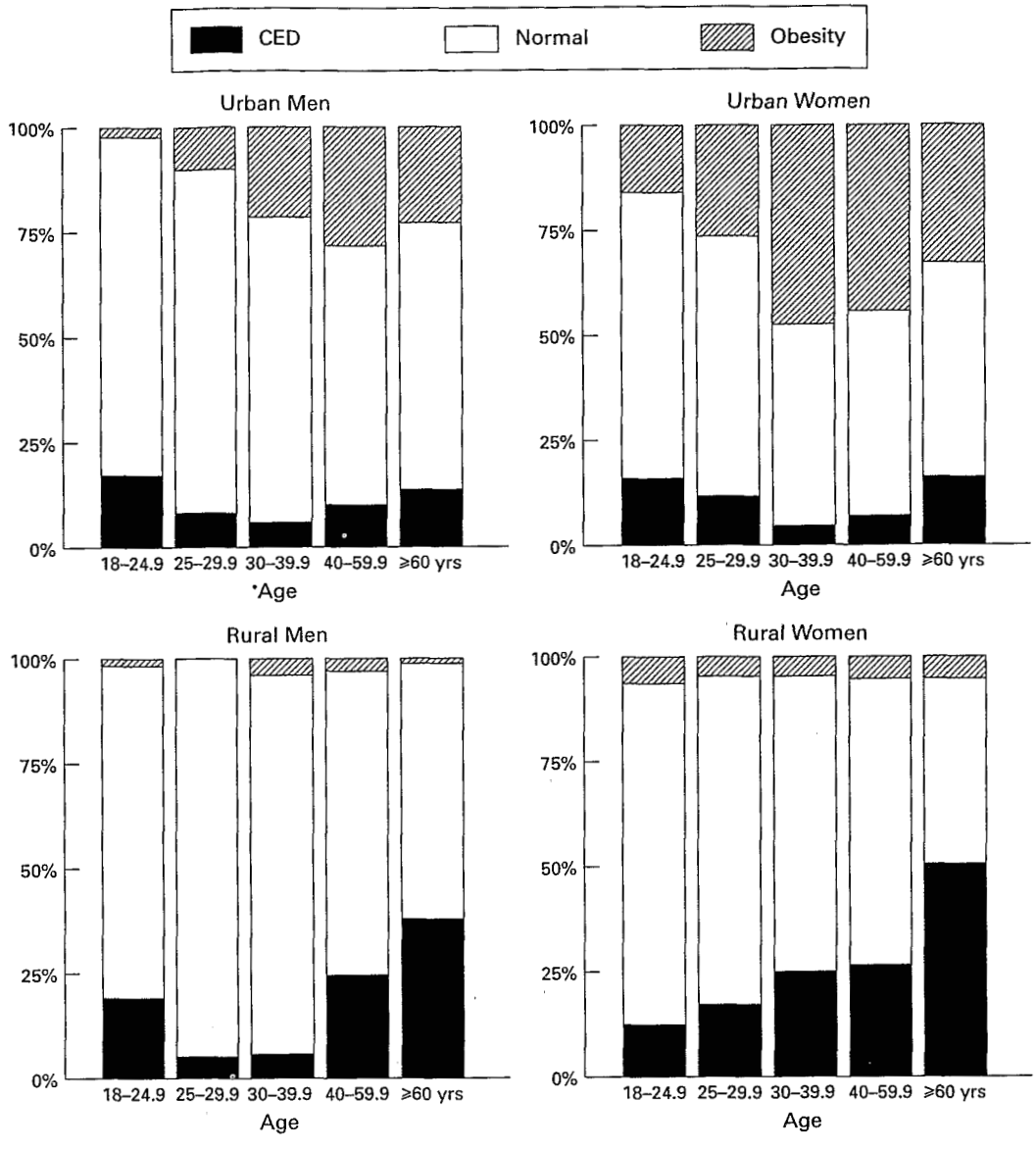

Fig. 1. Percentage distribution of body mass index categories by age.

scales. In Brazzaville, CED and obesity followed opposite trends with a more marked gradient for obesity. In the rural Plateaux, CED was largely predominant, with a prevalence constantly around 20%, except for the highest quintile.

As shown in Fig. 2, the differential pattern by age and sex was amplified by the socio-economic level, particularly in the rural areas.

Table 3 gives the adjusted odds-ratios of the variables entered in the logistic regression. In rural areas, the major risk factor for CED was old age; then the female sex and then education, i.e. no schooling. In the city of Brazzaville, poverty and youth (<25 years old) were the main risk factors.

Patterns of BMI within a context of socio-economic adjustment

Our two surveys designed on a same sample basis clearly confirm the increase of unemployment in

Fig. 2. Prevalence of chronic energy deficiency by age, sex and socio-economic level.

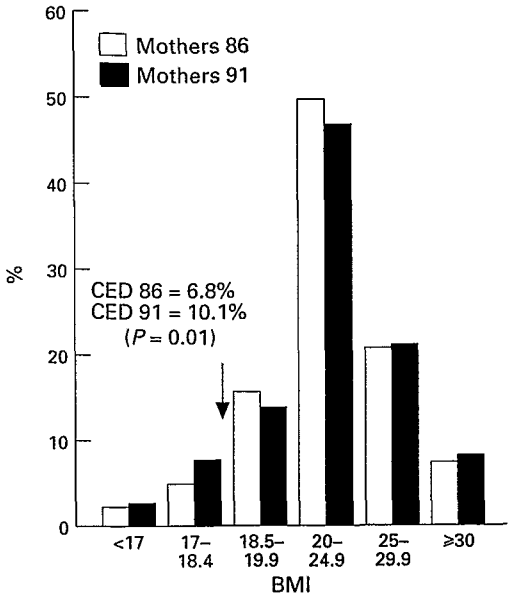

Fig. 3. Percentage distribution of mothers in 1986 and 1991 by BMI categories in Brazzaville.

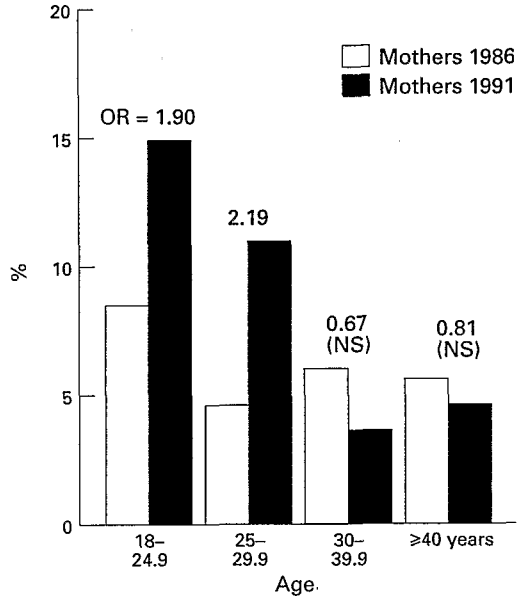

Fig. 4. The prevalence of chronic energy deficiency by age: in 1986 and 1991 in Brazzaville. The odds ratios (OR) are also given.

Brazzaville between 1986 and 1991 either for the heads of family (from 14.0% to 29.2%) or for the mothers themselves (from 49.6% to 67.0%). However, some other indicators improved despite the economic adjustment: the percentage of mothers with no schooling fell from 22.3% to 15%; those without electricity from 70.0% to 67.9%; those without piped water from 55.4% to 41.4% and those without assets from 58.4% to 47.4%. The changes in family conditions thus appear to vary.

Although mean BMIs were not different between the two surveys (23.1 ± 4.1 and 23.2 ± 4.3) the total prevalence of CED, as shown in

Table 3. Risk factors for chronic energy deficiency adjusted by logistic regression

Variables	*Brazzaville 1991*		*Rural Plateaux 1992*	
	Adjusted odds ratio	*95% CI*[b]	*Adjusted odds ratio*	*95% CI*[b]
Sex				
Male[a]	1		1	
Female	0.89	0.69–1.15	1.36	1.00–1.90
Age				
30–40[a]	1		1	
18–25	3.43	2.36–4.98	0.83	0.51–1.36
25–30	2.17	1.43–3.30	0.77	0.44–1.35
40–60	1.61	1.01–2.56	1.35	0.89–2.06
>60	2.57	1.37–4.84	2.83	1.66–4.82
Education				
Secondary school[a]	1		1	
No schooling	1.08	0.71–1.65	1.63	1.00–2.69
Primary school	1.17	0.82–1.65	1.34	0.86–2.11
High school	0.88	0.60–1.29	0.53	0.12–2.44
Socio-economic class				
3[a]	1		1	
1	1.73	1.23–2.43	0.99	0.63–1.56
2	1.18	0.82–1.70	1.14	0.73–1.76
4	1.04	0.72–1.52	0.91	0.59–1.41
5	1.13	0.77–1.65	0.63	0.40–1.00

[a]Category takén as reference.
[b]Odds ratios with confidence interval which exclude 1 are significant.

Fig. 3, significantly increased, from 6.8% to 10.1%. Conversely, the percentage of those with normal BMIs decreased and the prevalence of obesity remained constant.

The stratified analysis by age groups provides evidence that the prevalence of low BMIs had increased only in young mothers <30 years old (Fig. 4). In mothers >30 years old the prevalence of CED tended to decrease although the differences were not significant. There thus appears to be an effect of age on the development of CED during the period of economic adjustment. In addition, this increased proportion of low BMIs in the young mothers was amplified by a low economic status: in the 40% poorest group, the prevalence of CED increased from 8.5% to 17% ($P = 0.01$) while in the 40% 'richest' group the increase in CED was not significant (6.9% and 10.6%). As a result the disparity between low and high economic levels regarding CED grew during the period of adjustment.

Discussion

The Congo offers highly contrasted situations with respect to the prevalences of CED, and these depended on the ecological zone and degree of urbanization. BMI therefore appears to be a good indicator of nutritional transition. The main features were a significant degree of maternal depletion with age in rural areas and a large trend towards obesity in the capital city

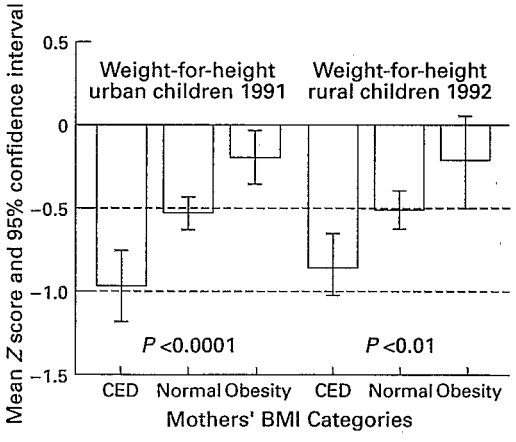

Fig. 5. Mean weight-for-height of children 1–3 years old by body mass index category of their mothers.

despite the persistence of a proportion of adults with CED.

The BMI in mothers also appears to be linked with the degree of wasting in their children, as shown in Fig. 5. The mean weight-for-height of <5-year-old children in Brazzaville and in the rural Plateaux was significantly different between categories of mothers' BMI, being lower for CED mothers than for mothers with a normal BMI or for obese mothers. This relationship may be a true causal one: that is mothers with CED tend to have low birth weight babies or poorly growing infants: alternatively there may be various confounding factors, i.e. factors leading to CED in mothers that also produce some degree of wasting in children such as a low food availability in the household. Unfortunately we cannot confirm this at present because we need more in depth studies. But the existence of such a link allows us to use mothers' BMI in the Congo as a more general indicator of the nutritional risk of both mothers and children.

From the present data we can also conclude that the prevalence of low BMIs is clearly linked with the socio-economic level and is particularly sensitive to economic changes over time. In parallel we have observed that the prevalence of wasting (weight-for-height <−2 SD) in infants has also changed between 1986 and 1991, from 1.8% to 5.9%; ($P <$ 0.001). As both maternal and child changes are rather tightly linked, this reinforces our view that BMI in such situations of rapid economic changes may be used as a core indicator for nutritional surveillance purposes in the Congo.

Our results also suggest that the analysis of BMI population data must be done by age groups and by gender as each group may be affected differently over time without a change in the total population's BMI.

Finally, we should ask whether low BMI values have the same significance in women and in men, in the young and the old? Are the changes strictly linked to poverty or could they reflect some physiological differences? Although the comparison between rural and urban populations tends to favour the view that poverty is the key, studies on body composition would be helpful to solve these questions. We are therefore currently implementing studies of bio-impedance analysis in the Congo to further assess this issue.

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