Growth and Nutritional Status of Children and Adults Living in Contrasting Ecological Zones in the Southern Province of Zambia

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Abstract

Zambia has been facing erratic and poor distribution of rainfall in many parts of the country, particularly the low-veldt areas of the southern, western and north-western provinces. In October 2007, we started a longitudinal survey of growth and nutritional status, monitoring local people dwelling in five villages located in the Sinazongwe district in the southern province of Zambia, in order to examine the influence of decreased water and food availability caused by drought.

We report on the nutritional status of adults and children and growth status of children in the initial stages of a longitudinal survey of people living in three ecologically contrasting zones: the upper flat land zone on the plateau, the middle slope zone, and the lower flat land zone near Lake Kariba. More than 70 % of adults were classed as 'normal' in terms of their body mass index (BMI), which suggests that the nutritional status of adult subjects was generally good. Adults who live on the lower flat land were relatively taller and heavier than their counterparts living on the middle slopes and on the upper flat land. In contrast to the adults, the growth and nutritional status of children were poor. Compared with US reference data, the height and weight of the children was approximately equal to or less than the 3rd percentile of the US population. Moreover, the nutritional status of children was worse than that of adults. Thirty-five percent of boys and 45 % of girls were classed as 'underweight'.

It is expected that with the increase in available data in the future, it will be necessary to adjust the figures reported here. In addition, when sufficient data has been obtained for each individual, it will be possible to conduct not only cross-sectional analyses, as in this report, but also longitudinal analyses. These will enable us to examine in more detail the influences of environmental change, particularly rainfall, on the growth and nutritional status of adults and children.

1. Introduction

Geographical variation in the amount of rainfall influences the quality and location of vegetation, and rain stimulates changes in livestock nutrition and productivity. In particular, drought causes water shortages and decreased availability of food, which affects the health and nutritional status of local residents. Thus it can be said that rainfall is indirectly linked to the health and nutritional status of the people.

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(Yamauchi 2007). In October 2007, we started a longitudinal survey of growth and nutritional status, monitoring local people dwelling in five villages located in the Sinazongwe district in the southern province of Zambia, in order to examine the influence of decreased water and food availability caused by drought (Yamauchi et al., 2008).

This report aims to examine the nutritional status of adults and the growth of children in the initial stages of the survey, as well as to compare the growth and nutritional status of subjects living in the three contrasting ecological zones.

2. Subjects and Methods

2.1 Village Location and Subject Households

The slope area around Lake Kariba can be divided into three ecological zones: the upper flat land zone on the plateau (‘Upper’), the middle slope zone (‘Middle’), and the lower flat land zone near Lake Kariba (‘Lower’) (Sakurai 2008). We chose five villages consisting of two villages (Sianemba and Siameja) from 'Lower', two villages (Chanzika and Kanego) from 'Middle' and one village (Siachaya) from 'Upper'. Forty-eight households were selected in total, 16 from each of the three zones (‘Lower’, ‘Middle’ and ‘Upper’): 4 in Sianemba, 12 in Siameja, 8 in Chanzika, 8 in Kanego and 16 in Siachaya.

In this article, adults are defined those older than 18 years and children as 18 years old or less. For children, those whose ages were not known were excluded from the analyses.

2.2 Anthropometric Measurements

The details of the anthropometric measurements are given elsewhere (Yamauchi et al., 2008). I explain them briefly here.

2.2.1. Height

Height was measured at monthly intervals. Height was measured to the nearest 1 mm using a wall mounted metal tape measure (200 cm in height), specially made by a local carpenter.

2.2.2. Weight

These measurements were done at weekly intervals. Body weight was measured to the nearest 0.1 kg using battery-operated digital scales. In this paper, we limit the report to height, weight and body mass index (BMI = weight (kg) / height $(m)^2$).

2.2.3. Determining the Nutritional Status of Adults and Children, and the Growth of Children

The adults' nutritional status was defined based on their BMI as 'underweight (BMI < 18.5)', 'normal (BMI = 18.5 - 25.0)' or 'overweight (BMI > 25.0)' (WHO, 2000). For children, the sex- and age-dependent BMI cut-offs proposed by the International Obesity Taskforce (IOTF, Cole et al., 2000, 2007) were used to classify each child as 'underweight', 'normal', or 'overweight' in the same way as the adults. Furthermore, the height and weight of the children were plotted on US reference growth data (percentile curves, Centers for Disease Control and Prevention (CDC) 2000).

2.2.4. Statistical Analyses

Sex difference was examined using the unpaired t-test, and regional differences were evaluated with analysis of variance with multiple comparisons (Tukey HSD test). All analyses were conducted with the JMP statistical package (SAS Institute, Cary, NC, USA) with statistical significance assigned at $P < 0.05$.

3. Results and Discussion

3.1. Sample Sizes for Anthropometric Measurements

The sample sizes for height, weight and BMI are shown separately for adults (Table 1A) and children (Table 1B). The sample sizes were almost balanced among the three ecological zones in both adults and children for both sexes. Adult sample size varied between 113 (for BMI) and 140 (for weight). The sample size was larger for children than for adults, even though those children whose ages were not known were excluded from the analysis. We expect to obtain more data in the future by improving the data input and obtaining more age information for the children.

Table 1A Sample size (adults > 18 years)

Sex	Zone	Age	Height	Weight	BMI
Men	Lower	17	15	20	15
	Middle	18	19	28	19
	Upper	20	21	21	20
	All	55	55	69	54
Women	Lower	21	20	22	18
	Middle	13	17	22	17
	Upper	25	25	27	24
	All	59	62	71	59
Total		114	117	140	113

Table 1B Sample size (children ≤ 18 years)

Sex	Zone	Age	Height	Weight	BMI
Boys	Lower	28	26	28	25
	Middle	28	26	28	26
	Upper	30	27	29	26
	All	86	79	85	77
Girls	Lower	26	26	26	26
	Middle	21	19	21	19
	Upper	30	27	30	27
	All	77	72	77	72
Total		163	151	162	149

3.2. Nutritional Status of Adults

Table 2 shows the mean and SD of height, weight and BMI of the adults by sex. The mean age was not significantly different between men and women. Significant sex differences were found in that men were significantly taller and heavier than women.

Table 2 Physical characteristics of adults

	Age (year)		Height (cm)		Weight (kg)		BMI	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Men	33.1	13.8	165.3	9.0	54.3	9.1	19.7	2.4
Women	35.6	13.2	156.7	5.5	51.5	7.5	20.9	2.9
P	NS		< 0.0001		0.0455		0.0183	

In contrast, the average BMI of women was higher than that of men. The mean BMI fell between 18.5 and 25.0 in both sexes, suggesting that the nutritional status of the adults was generally good. Individual BMI values revealed that 28 % of men and 15 % of women were classed as 'underweight (BMI < 18.5)' and no men and 7 % of women were classed as 'overweight (BMI > 25.0)'.

Regional differences in height, weight and BMI of the subjects were compared among the three zones (Fig. 1). Significant group differences were found in height and weight ($P < 0.05$ for both measurements). According to multiple comparison analysis, the lower zone women were significantly taller than the middle zone women ($P = 0.020$), and the lower zone men were significantly heavier than the upper zone men ($P = 0.024$). These results suggest that subjects living on the lower flat land had a larger physique than the other two groups. In contrast, no significant difference was observed in BMI among the three ecological groups. This might be due to the offset of height and weight in calculation of the BMI.

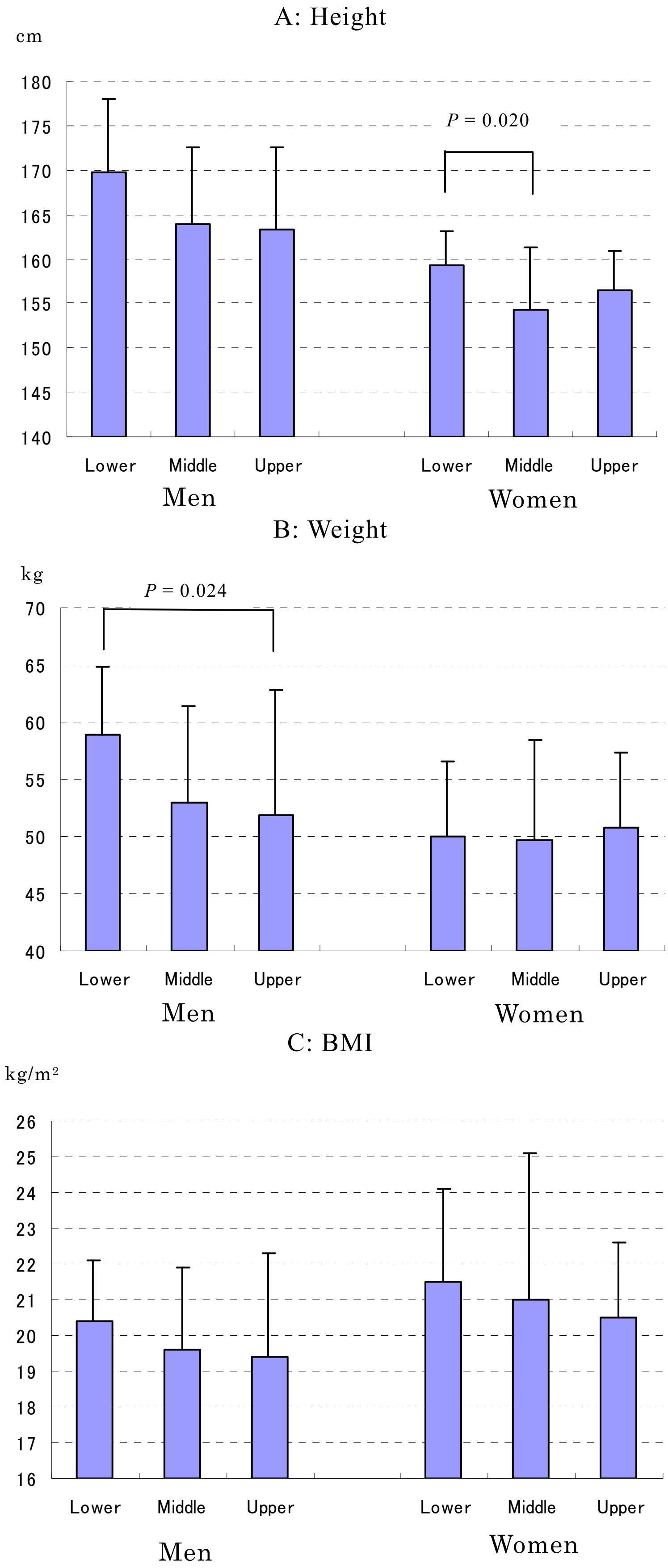

Fig. 1 Physical characteristics in the three ecological zones

3.3. Growth in Children

The heights and weights of different age groups and sexes are shown by sex in figures 2 (height) and 3 (weight). Five percentile curves for height (50th, 25th, 10th, 5th and 3rd), and four for weight (50th, 25th, 10th and 3rd), taken from US reference data (2000 CDC growth charts, Kuczmarski et al., 2002) were superimposed on the graphs. The smoothed curves from the Zambian data (broken lines) correspond to approximately the 3rd percentile of the US reference data for both height and weight in boys, and weight in girls, but the smoothed curve for height in girls was below the 3rd percentile of the US data (Fig. 2).

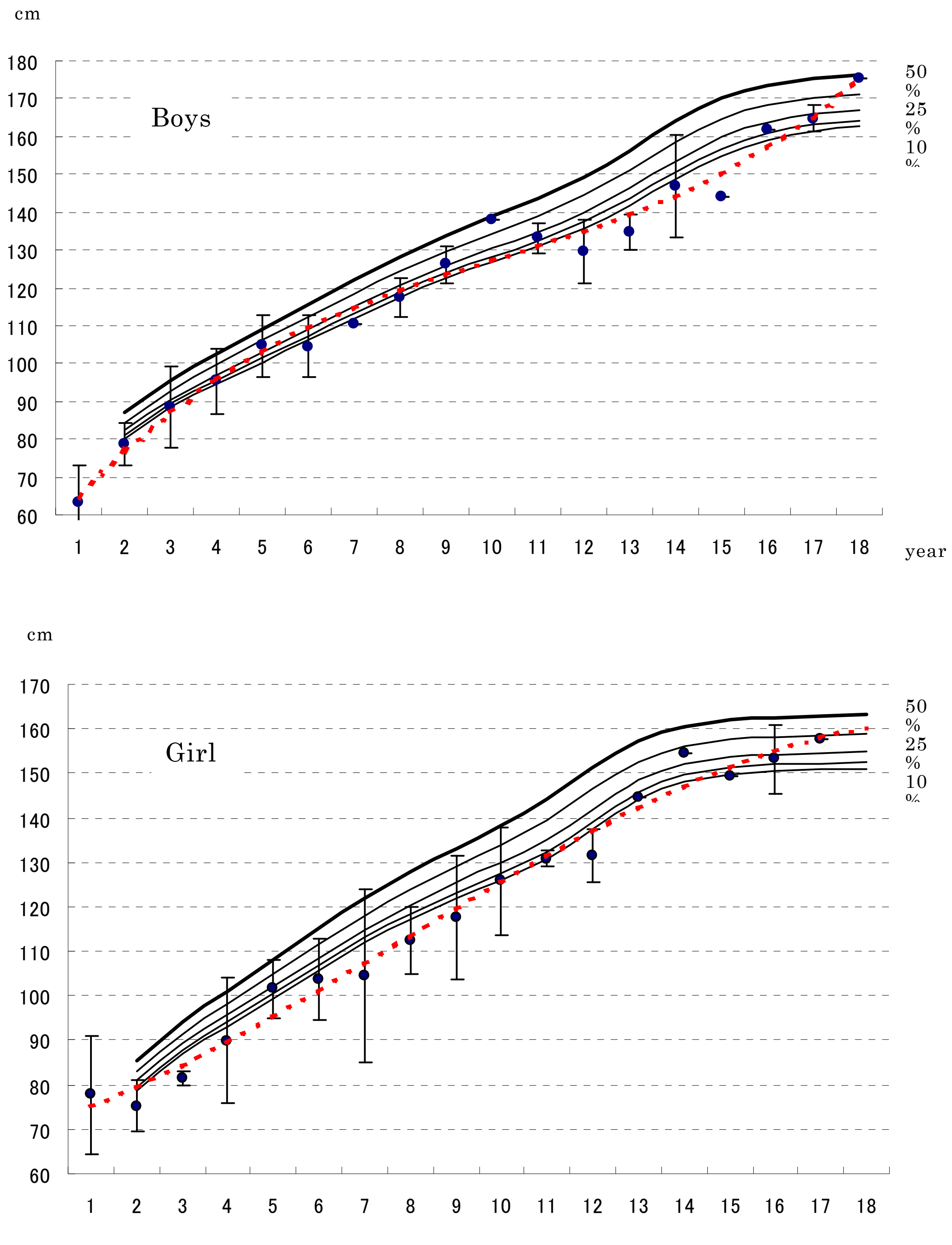

Fig. 2 Growth in height of boys and girls (mean and SD) compared with US reference percentiles

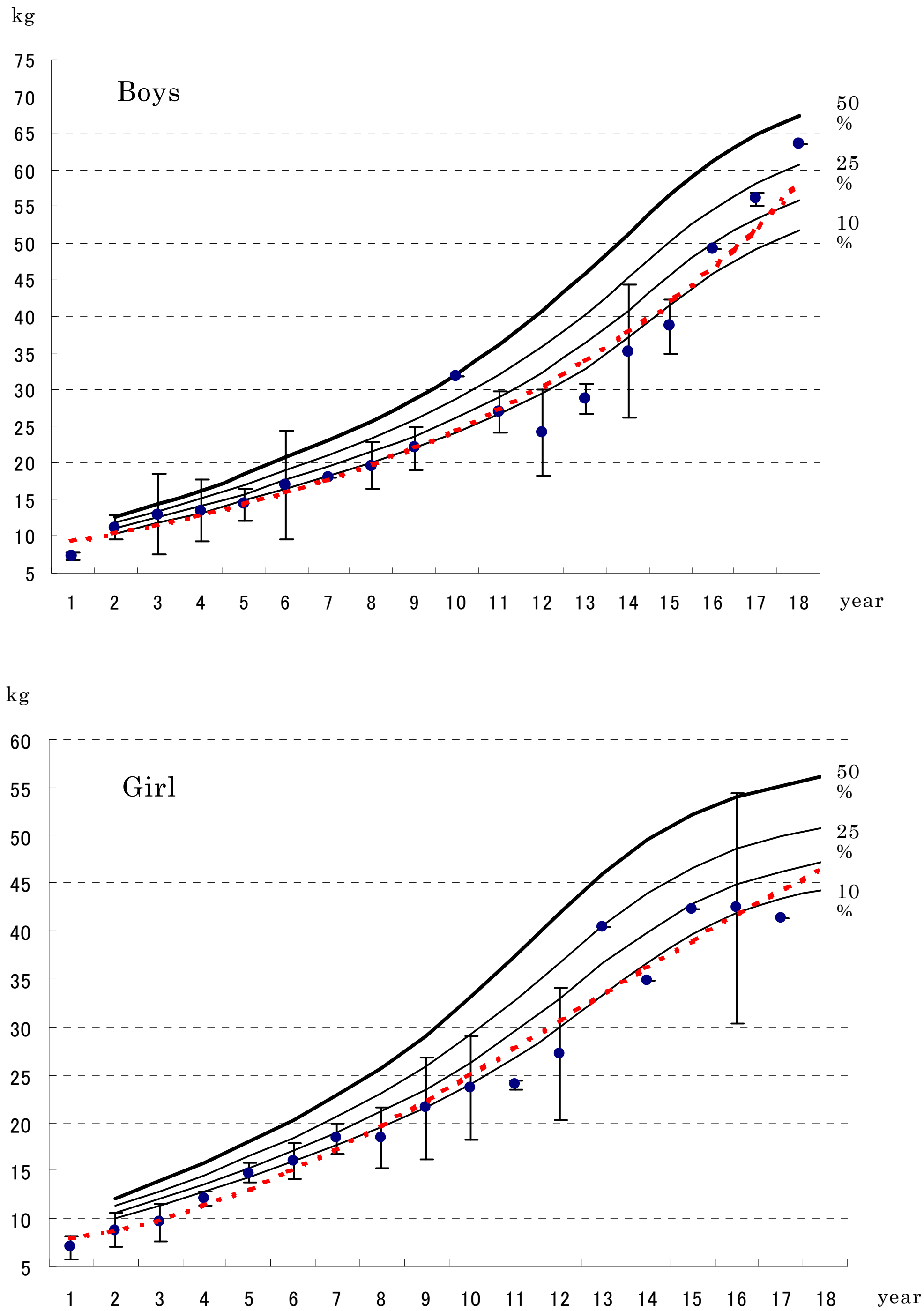

Fig. 3 Growth in weight of boys and girls (mean and SD) compared with US reference percentiles

Table 3 shows the nutritional status of children based on their BMI. Based on the age- and sex-dependent BMI cut-offs proposed by the IOTF (Cole et al., 2000, 2007), 35 % of boys and 45 % of girls were classed as 'underweight'. The results of both the growth curves and the BMI indicate that the nutritional status of children in this study was poor and that they might be suffering from low food availability and unfavorable environmental conditions.

Furthermore, the proportion of ‘underweight’ children was higher than in adults (28 % and 15 % in men and women, respectively), suggesting that under-nutrition was more severe in children than in adults.

Table 3 Nutritional status of children based on BMI (%)

	Underweight	Normal	Overweight	All
Boys	34.7	58.3	6.9	100.0
Girls	44.6	44.6	10.8	100.0

4. Summary and Future Perspective

Unfortunately, we have limited data at present, due to a delay in the input of data to computers in Zambia. In addition, the available data is not systematic and the sample size differs among the various anthropometric measurements (see Table 1A,B). Using these limited data, we report on the nutritional status of adults and children and the growth status of children in the initial stages of a longitudinal survey of people living in three ecologically contrasting zones in Zambia.

More than 70 % of adults were classed as 'normal' in terms of their BMI, which suggests that the nutritional status of adult subjects was generally good. Adults who live on the lower flat land were relatively taller and heavier than their counterparts living on the middle slopes and on the upper flat land. In contrast to the adults, the growth and nutritional status of children were poor. Compared with US reference data, the height and weight of the children was approximately equal to or less than the 3rd percentile of the US population. Moreover, the nutritional status of children was worse than that of adults. Thirty-five percent of boys and 45 % of girls were classed as 'underweight'.

It is expected that with the increase in available data in the future, it will be necessary to adjust the figures reported here. In addition, when sufficient data has been obtained for each individual, it will be possible to conduct not only cross-sectional analyses, as in this report, but also longitudinal analyses. These will enable us to examine in more detail the influences of environmental change, particularly rainfall, on the growth and nutritional status of adults and children. We are also conducting household interviews to obtain socio-economic information at the same time as obtaining the anthropometric measurements. We will be able to clarify individual households’ strategies to cope with future variation in rainfall, and analyze the socio-economic information together with the individual longitudinal data on growth and nutritional status.

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