Variation in the Nutritional Status of Adults Living in Contrasting Ecological Zones in the Southern Province of Zambia

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Abstract

In the previous annual report (Yamauchi, 2009), we described 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 (Upper flat land zone, Middle slope zone and Lower flat land zone) in Southern Zambia. We demonstrated that adults living in the Lower zone were taller and heavier than their counterparts living in the other two zones (Yamauchi, 2009).

In this report, we illustrate the month-by-month variations in body weight and body mass index (BMI) by sex in the three contrasting living environments during a 16-month period. Common patterns of variation in both body weight and BMI were observed in sex-regional subgroups, which suggest that they are related to variations in the climate (precipitation) and the agricultural cycle. Furthermore, men and women had quite similar patterns of variation of both body weight and BMI. We expect that there are similar patterns of diet and physical activity between men and women living in the same environment.

Consistent with the findings of our previous report, the Lower zone men and women were heavier than their counterparts from the Middle and Upper zones, although the BMI of the Lower zone men was the lowest of the three groups because these men were taller. There were contrasting sex differences in the BMI among the three zones: the sex difference was largest in the Lower zone, moderate in the Middle zone, and slight in the Upper zone.

Further studies are needed to clarify the mechanisms of these findings; for instance, to examine the relationship in the variation of body weight and BMI with the annual climate (precipitation) variation, food production and consumption. It would also be desirable to carry out dietary surveys, behavioral observations and estimations of energy expenditure.

1. Introduction

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, to examine the influence of decreased water and food availability caused by drought (Yamauchi et al., 2008). We have reported 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: the Upper flat land zone on the plateau, the Middle slope zone and the Lower flat land zone near Lake Kariba. Adults living in the Lower zone were taller and heavier than their counterparts living in the other two zones

(Yamauchi, 2009).

This article describes month-by-month variations in adults' nutritional status by sex and living environment (zone) during the 16-month period between November 2007 and February 2009, using weekly body weight data and calculated BMI (= body weight (kg) / height $(m)^2$).

2. Subjects and Methods

2.1 Study populations

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, comprising two (Sianemba and Siameja) from the Lower zone, two (Chanzika and Kanego) from the Middle zone and one (Siachaya) from the Upper zone. Forty-eight households were selected, 16 from each of the three zones: 4 in Sianemba, 12 in Siameja, 8 in Chanzika, 8 in Kanego and 16 in Siachaya.

2.2 Subjects

Among the adults (≥ 18 years old) in the 48 households, those whose data had not been obtained for more than two months were excluded from the analyses. The average number of monthly datapoints obtained was 11.4 ± 3.2 (mean ± SD), ranging between 3 and 15 months. The monthly sample sizes for body weight and BMI are shown by sex and zone in Table 1. No data were obtained for any sex-regional subgroup in June 2008, for people from the 'Upper' zone in January 2008 or for women from the 'Middle' zone in October and November 2008 (Table 1).

Table 1. Sample numbers for body weight and BMI in each month Nov 2007–Feb 2009 by sex and zone

Body weight

	2007		2008												2009	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Men																
Lower	9	11	10	11	8	8	7	0	4	4	8	9	9	11	11	8
Middle	6	10	12	12	14	17	17	0	17	18	18	15	20	20	19	17
Upper	8	9	0	10	14	14	13	0	13	14	14	14	14	14	13	12
All	23	30	22	33	36	39	37	0	34	36	40	38	43	45	43	37
Women																
Lower	13	20	21	21	19	18	20	0	14	12	16	20	22	21	20	20
Middle	16	19	17	17	20	21	21	0	20	19	20	0	0	19	21	18
Upper	17	19	0	17	23	24	20	0	21	23	23	23	21	21	22	18
All	46	58	38	55	62	63	61	0	55	54	59	43	43	61	63	56

BMI

	2007		2008												2009	
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Men																
Lower	8	10	10	10	8	9	8	0	5	5	9	10	10	11	11	9
Middle	7	11	13	13	15	18	18	0	18	19	19	16	21	21	20	18
Upper	9	10	0	11	15	15	14	0	14	15	15	15	15	15	14	13
All	24	31	23	34	38	42	40	0	37	39	43	41	46	47	45	40
Women																
Lower	14	21	22	22	20	19	21	0	15	13	17	21	23	22	21	21
Middle	17	20	18	18	21	22	22	0	21	20	19	0	0	19	20	18
Upper	19	19	0	17	24	23	20	0	22	22	23	23	22	21	23	19
All	50	60	40	57	65	64	63	0	58	55	59	44	45	62	64	58

2.3 Anthropometric measurements

The details of the anthropometric measurements are given elsewhere (Yamauchi et al., 2008). Briefly, height was measured to the nearest 1 mm using a portable stadiometer (SECA 214, Germany). Height was measured monthly; however, the initial values were used for analysis (Yamauchi, 2009). Body weight was measured weekly to the nearest 0.1 kg using battery-operated digital scales (Tanita HD-654, Japan). Weekly body weight was averaged over each month. BMI was calculated using the height (constant) and the body weight (monthly average) for each subject. The subjects' nutritional status was defined based on their BMI as ‘underweight’ (BMI < 18.5), ‘normal’ ($18.5 \leq$ BMI ≤ 25.0) or ‘overweight’ (BMI > 25.0) (World Health Organization, 2000).

2.4 Statistical analyses

Regional differences in height, body weight and BMI 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. Overall nutritional status by sex and zone during the 16 months

The initial values for height and the monthly averaged body weight and BMI during the 16-month period are shown in Table 2. The mean BMI values for all sex-zone subgroups were within the normal range ($18.5 \leq BMI \leq 25.0$), suggesting that the nutritional status of the subjects was generally good.

According to multiple comparison analysis, the Lower zone men and women were significantly taller than the Middle zone men and women, respectively ($P < 0.05$). A similar tendency was found for body weight and women's BMI, while the opposite trend was observed for men's BMI. The Lower zone men had a significantly lower BMI than the other two groups, which was because they were significantly taller than the men in the other zones (Table 2).

Table 2. Initial height and monthly averaged body weight and BMI during the 16-month period (mean, SD and CV*)

	Height (cm)		Body weight (kg; mean over 16-mo period)				BMI (mean over 16-mo period)			
	N[1]	Mean	N[2]	Mean	SD	CV (%)	N[2]	Mean	SD	CV (%)
Men										
Lower	12	172.7	15	58.7	1.6	2.8	15	20.0	0.8	3.9
Middle	21	165.9	15	56.2	1.0	1.9	15	20.2	0.4	2.1
Upper	14	166.4	14	56.8	0.9	1.5	14	20.5	0.3	1.5
ANOVA		$P < 0.05$		$P < 0.0001$				$P < 0.0001$		
Women										
Lower	22	159.6	15	54.0	1.2	2.2	15	21.6	0.5	2.4
Middle	21	157.6	13	51.6	1.0	1.8	13	21.0	0.3	1.7
Upper	24	155.7	13	50.7	1.0	2.0	13	20.7	0.4	1.8
ANOVA		$P < 0.05$		$P < 0.01$				$P < 0.01$		

*Coefficient of variation.
[1]Number of subjects measured.
[2]Average number of monthly datapoints.

3.2. Month-by-month variation in body weight: 1) raw values

Variations in body weight are shown by sex and zone in Fig. 1. Subjects in the Lower zone were heavier than those in the other two zones, for both sexes, throughout the 16-month period. In contrast, the variation was similar between the Middle and Upper zones, for both sexes.

Overall, the variations in body weight were classified into three periods: 1) the body weight for the Lower zone men and women tended to decrease from November 2007 to March 2007, while that for both the Middle and Upper zone groups tended to increase during the same period (Fig. 1). 2) From March 2007, the body weight of all the sex-zone subgroups tended to increase until June 2008 for which there were no data. 3) Body weight tended to decrease from July 2008 to the end of the study (February 2009).

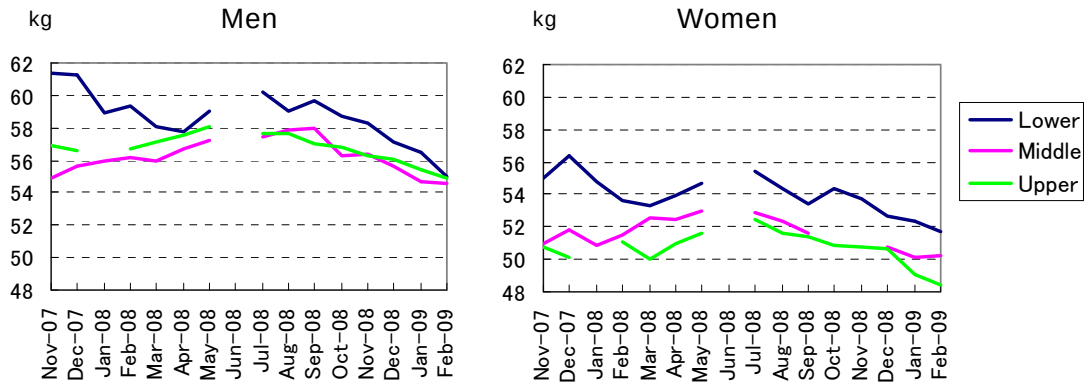

Fig. 1. Month-by-month variations in body weight by zone

Sex differences are illustrated by zone in Fig. 2. The pattern of variation in body weight was similar between men and women for all zones, although men were heavier than women by 4–6 kg throughout the 16-month period. The results imply that dietary intake and physical activity were similar between men and women in each zone.

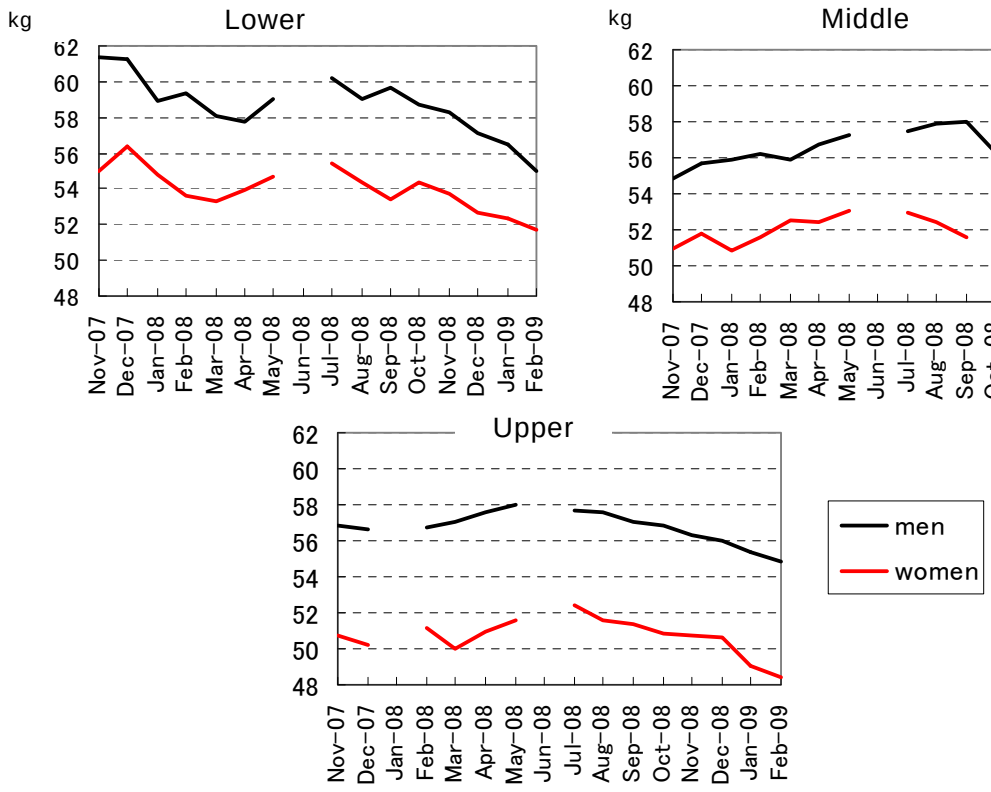

Fig. 2. Month-by-month variations in body weight for men and women in the three zones

3.3. Month-by-month variation in body weight: 2) adjusted by mean

Further analyses on the variation in body weight were conducted by adjusting body weight by the mean values during the 16-month period (Fig. 3). Throughout the 16 months, the adjusted body weight varied from the mean between +1–2 and –2 kg. The pattern of body weight variation was consistent for both sexes and across all zones: 1) decreasing (Nov 2007–Jan 2008), 2) increasing (Jan 2008–May 2008) and 3) decreasing (Jul 2008–Feb 2009). This may reflect climatic variation (especially precipitation), the agricultural cycle and variations in food production and consumption.

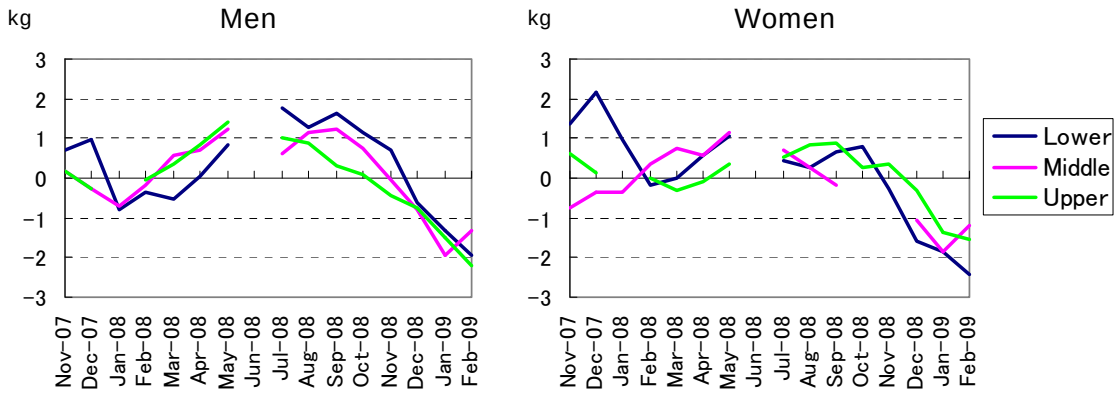

Fig. 3 Month-by-month variations in body weight (adjusted by mean)

3.4. Month-by-month variations in the BMI (raw values)

Variations in the BMI during the 16-month period are shown by sex and zone in Fig. 4. The patterns of variation in BMI were similar to those observed for body weight. Throughout the observation period, the values ranged between 18.5 and 25.0, indicating that the subjects maintained a good nutritional status for the 16 months.

When the three zones were compared, the BMI for the Lower zone men was different from that for men in the other two groups. First, similar to the adjusted body weight for the Lower zone women (Fig. 3), the BMI for the Lower zone men behaved differently from that for the other two groups in the initial three-month period. Second, a rapid drop was observed in Aug 2008. The body weight data showed a similar but much milder drop in Aug 2008 (Figs. 1 and 2), suggesting that the small decrease in body weight reflected the steeper drop in the BMI. In addition, the small sample size at this time (n = 5; Table 1) might have skewed the results. In contrast, for women, the trends in BMI variation were much more similar among the three zones, although the BMI of the Lower zone women tended to be higher than that in the other two zones in the first three-month period.

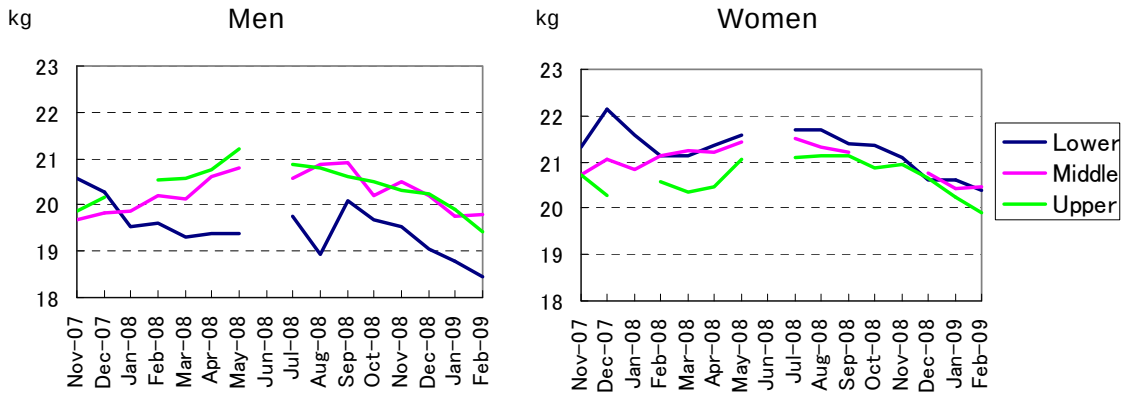

Fig. 4 Month-by-month variations in BMI

Sex differences in BMI variation are illustrated by zone in Fig. 5. Similar to body weight (Fig. 2), the BMI varied in parallel between men and women. However, in contrast to body weight, women had generally higher values than men did. The extent of the sex difference differed between the three zones: a large difference was observed in the Lower zone, there was a moderate difference in the Middle zone and a slight difference in the Upper zone. Such sex differences in BMI according to the living environment are interesting. One explanation may be the gender difference in the division of labor among the three zones. In addition, the difference in food availability and gender distribution of food might reflect the sex differences in the BMI. Further studies are needed to clarify the mechanisms causing the sex differences in the BMI.

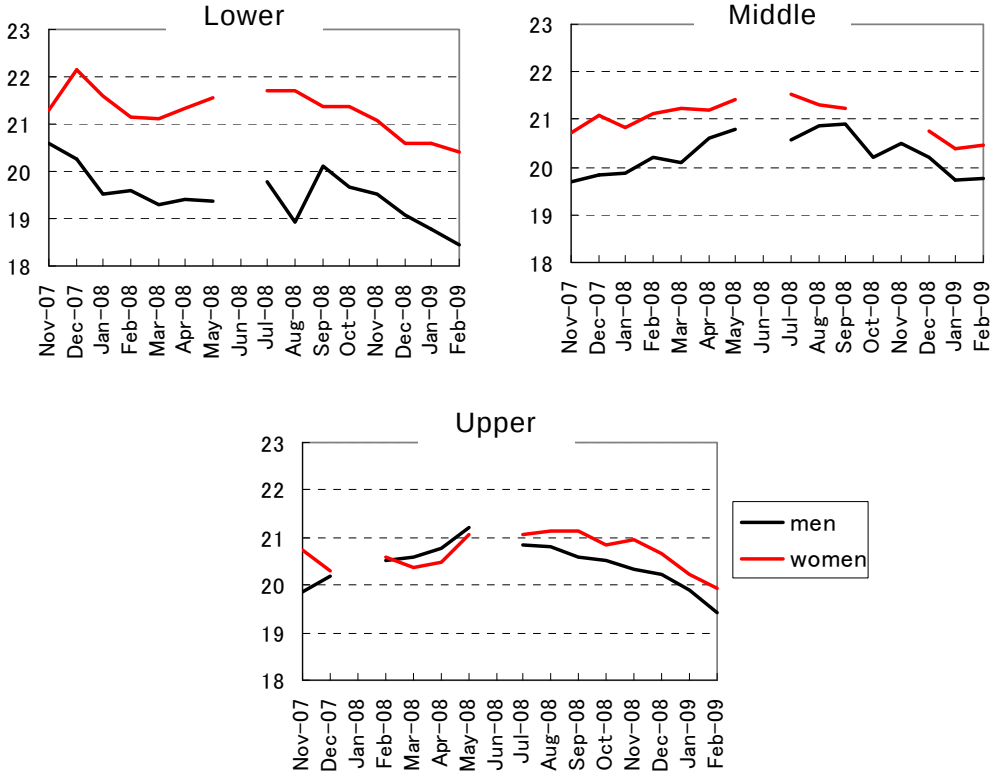

Fig. 5 Month-by-month variations in BMI for men and women by zone

4. Summary and Future Perspective

We examined variations in body weight and BMI by sex in three contrasting living environments during a 16-month period. We showed that: 1) variations in body weight and BMI were common, and were independent of either sex or location; 2) men and women had similar patterns in the variation of both body weight and BMI; 3) consistent with the findings of our previous report, Lower zone men and women were heavier than their counterparts from the Middle and Upper zones, although the BMI of the Lower zone men was the lowest among the three groups because these men were taller; and 4) contrasting sex differences in the BMI were observed among the three zones: there was a larger sex difference in the Lower zone, a moderate one in the Middle zone and a small difference in the Upper zone.

Further studies are needed to examine the relationship between the variation in body weight and BMI with annual climate (precipitation) variation, food production and consumption. It would be desirable to carry out dietary surveys, behavioral observations and estimations of energy expenditure.

In this report, we focused on the sex and regional differences in the month-by-month variation of body weight and BMI. If individual data were used, it would be possible to analyze at the household level, which would be expected to clarify strategies for households to adapt to climate change and maintain food security. Finally, it must be noted that it is important to support and re-train enumerators to encourage participation and enhance the quality and quantity of the data.

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