Validating the Body Mass Index (BMI) of School Children in Meiktila Township

MyoMyo[1]

Abstract

A total of 2537 school children from primary and middle schools, aged 5 - 17 years in Meiktila Township were assessed to examine the growth development of Body Mass Index (BMI) with reference to international growth standards, World Health Organization.A cross-sectional study was designated for anthropometric measurements. All individual level data were merged and analyzed with descriptive and inferential statistical analysis methods. The growth increments of school boys and girls showed positive correlation with strongly significant differences in their agesat $p < 0.01$ and $p < 0.05$.Mean height- and weight-for-age had lower z-scores value between – 1 and – 2 for boys and girls with the exception of 15.6 years girls and 14.6 years boys. These values were equivalent to the 3rd and 15thpercentiles below the median and indicated that they had short statures with thinness body compositions. Mean BMI-for-age z-scores revealed the negative residues for boys and girls with z-scores value between 0 and– 2 defined as normal BMI index with between 15th and 50th percentiles. However, BMI cutoff values indicated no the obese in school-aged children. The result of this is hoped toprovide positive lifestyle changes of school children towards achieving healthy objectives through educational information research program.

Key words: school children, age, sex, height, weight and body mass index

Introduction

The sustainable development of human growth depends on their healthy lifestyle as well as their nutritional diet and physical activity. To maintain their healthy status, the requirements of energy intake and regular exercise vary consistent with size, weight, age, sex, occupation and condition of body.

Monitoring the effects of school-based programs should be performed to assess the physical status of growth development in childhood and adolescence (Nihiser*et al.,* 2007). In this study, primary and middle school children in Meiktila Township were conducted to assess their healthy status. The correct identification and accurate measurements techniques of their growth development could be solved by body mass index (BMI) method (Phillips *et al.*, 2007).According to Nishida (2004),BMI values for Asian countriesdepend on ethnic and cultural subgroups, degree of urbanization, social and economic conditions, and nutrition transitions.

Therefore, right understanding on the effect of BMI values on each individual or population is important to maintain the healthy life. The aim of this study was to interpret the growth development of Myanmar school children with their ages and compare BMI percentiles and value of z-scores with reference to international growth standards, World Health Organization (WHO).

Materials and Methods

Experimental Sampling

A cross-sectional study was conductedfrom June 2017 to June 2018. The presented study included 2537 school children at the age groups of 5-17 years at No.(4), State Primary School,No.(30), State Primary School,No.(113), State Primary School,No.(1), State Middle

[1] Demonstrator, Department of Zoology, Meiktila University

School (BEHS- Branch), No.(2), State Middle School, No.(3), State Middle School (BEHS-Branch) and State Middle School- Branch (Set-Kyi) (Fig. 1).

Anthropometric Measurements

Anthropometric measurements - sex, date of birth, height and weight were recorded. Height was made to stand erectagainst the wall with the heel of the foot, buttocks, and shoulder and the head touching the wall. Weight was measured to the nearest 0.1 kg with a mechanical personal scale (Model: BR 9709) and height to the nearest 0.1 cm with a tailor tape. A single stable reading was recorded for height and weight.

Body Mass Index (BMI)

Body mass index was calculated by dividing weight in kilogram by the squared of the person's height in meter(BMI = kg/m^2). Classification of BMI was followed after WHO references(2007).

Statistical Analysis

The exact ages of school children were calculated with WHO Anthropometric Calculator (V.3.2.2). All individual level data were merged and investigated mean changes taken and evaluated through descriptive statistics and inferential statistics. Values for height, weight and BMI were analyzed by SPSS version.21 (SPSS, Inc., Chicago, IL, USA) at 0.01 and 0.05 level.

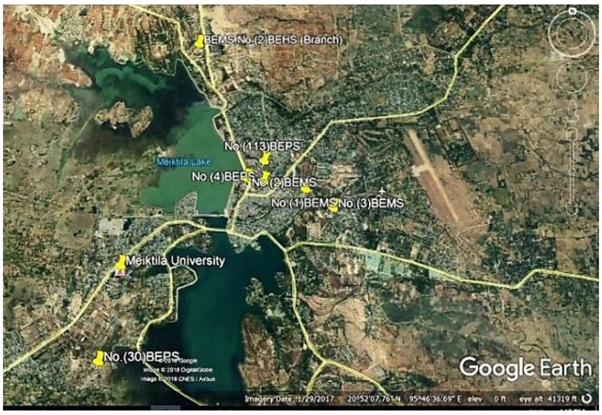


Fig.1. Map of Data Sampling Sites (Source:Google Map, 2018)

Results

The data was collected on 2537 school children aged at 5-17 years with 1257(49.54%) boys and 1280 (50.45%) girls from three primary and four middle schools in Meiktila Township.Figure (2) showed the comparison of school children's anthropometric measurements. In school boys mean height 126.46 ± 16.95 cm with C.I 0.94, mean weight 26.52 ± 10.02 kg with C.I 0.05 and mean BMI 16.04 ± 2.65with C.I 0.15. In school girls, mean height 127.19 ± 17.37 with C.I 0.95, mean weight 27.75 ± 11.26 kg with C.I 0.62, and mean BMI 16.48 ± 3.26 with C.I 0.18 (Table 1).

Height- andWeight-for-age

The mean increment of height in school boys had z-score values between – 1 and – 2 corresponding to the percentiles 3rd and 15th except along with at the aged 7.6 years, 8.6 years and 14.6 years. These values were very low increment compared toWHO standard(Fig.3).In school girls, the increment height revealed the z-scores value– 1 equivalent below the 15th percentiles indicated thatthey had short stature body compositions (Fig.4).The mean increment of weight for both school boys and girls revealedz-scores – 1 and – 2 below the normal that were accounted with the percentiles 3rd and 15th,except the boys at the aged 6 years under the

50^{th} percentile defined as normal body weight, indicated that all children had lower body weight status (Fig.5 and 6).

BMI-for-age

In school boys, the distribution of mean BMI values z-scores between 0 and– 2 coincided with percentiles 15^{th} and 50^{th} defined as normal BMI index with the exception atthe aged 6.6 years showed below 85^{th} percentiles (Fig.7).In school girls, z-scores 0 and – 2 defined as normal BMI index equivalent with the percentiles 15^{th} and 50^{th}, however, at theaged 5.6 years, 6 years, 8.6 years, 11.6years, 12 years and 16years fall below the 85^{th} percentile (Fig.8).

Correlation of Anthropometric Measurements

The increment of height showed positive correlation with the BMI at the aged 10 years($r = 0.298$), 11.6 years ($r = 0.269$), 12.6 years ($r = 0.219$), 13 years ($r = 0.284$) at $p < 0.05$ as well as at the aged 9 years ($r = 0.613$) and 11years ($r = 0.485$) at $p < 0.01$in school boys. However, the increment of height at the aged 13.6 – 16.6 years showed insignificantly difference with BMI values.In school girls, strongly positive correlation at the aged 10 years ($r = 0.325$), 11 years($r = 0.454$), 12 years ($r = 0.500$) at $p < 0.01$ and 12.6 years ($r = 0.225$) at $p < 0.05$. No significantly difference at the aged 9.6 years, 13 years, 13.6 years, 14 years, 14.6 years and 16 years. The increment of weight and BMI values showed strongly positive correlation at $p < 0.01$level (Table.2).

	Boys (n = 1257)			Girls (n = 1280)		
	Height (cm)	Weight (kg)	BMI	Height (cm)	Weight (kg)	BMI
Mean	126.46	26.52	16.04	127.19	27.75	16.48
Standard Deviation	16.95	10.02	2.65	17.37	11.26	3.26
Kurtosis	-0.54	1.30	3.65	-1.10	1.17	4.46
Skewness	0.31	1.16	1.19	-0.08	1.02	1.62
Confidence Level (95%)	0.94	0.55	0.15	0.95	0.62	0.18

Table 1. Descriptive statistics of anthropometric of school children

Table 2.Pearson correlation evaluated on height, weight and body mass index in school children

Age Classification Boys	Characters	Correlation	Height (cm)	Weight (kg)	Computed BMI	Girls	Height (cm)	Weight (kg)	Computed BMI
5 years	Height (cm)	Pearson Correlation	1	.504**	-.289**	n=94	1	.581**	-.280**
n=85		Sig. (1-tailed)		.000	.004			.000	.003
	Weight (kg)	Pearson Correlation	.504**	1	.678**		.581**	1	.616**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.289**	.678**	1		-.280**	.616**	1
		Sig. (1-tailed)	.004	.000			.003	.000	
5 years and	Height (cm)	Pearson Correlation	1	.462**	-.347*	n=37	1	.550**	-.158
		Sig. (1-tailed)		.006	.033			.000	.175
6 months	Weight (kg)	Pearson Correlation	.462**	1	.667**		.550**	1	.735**
n=29		Sig. (1-tailed)	.006		.000		.000		.000
	Computed BMI	Pearson Correlation	-.347*	.667**	1		-.158	.735**	1
		Sig. (1-tailed)	.033	.000			.175	.000	
6 years	Height (cm)	Pearson Correlation	1	.407**	-.402**	n=66	1	.454**	-.185
n=78		Sig. (1-tailed)		.000	.000			.000	.069
	Weight (kg)	Pearson Correlation	.407**	1	.669**		.454**	1	.788**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.402**	.669**	1		-.185	.788**	1
		Sig. (1-tailed)	.000	.000			.069	.000	
6 years and	Height (cm)	Pearson Correlation	1	.469**	-.252*	n=48	1	.366**	-.523**
6 months		Sig. (1-tailed)		.000	.026			.005	.000
n=60	Weight (kg)	Pearson Correlation	.469**	1	.733**		.366**	1	.596**
		Sig. (1-tailed)	.000		.000		.005		.000
	Computed BMI	Pearson Correlation	-.252*	.733**	1		-.523**	.596**	1
		Sig. (1-tailed)	.026	.000			.000	.000	
7 years	Height (cm)	Pearson Correlation	1	.608**	-.164	n=74	1	.526**	-.316**
n=91		Sig. (1-tailed)		.000	.061			.000	.003
	Weight (kg)	Pearson Correlation	.608**	1	.676**		.526**	1	.634**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.164	.676**	1		-.316**	.634**	1

Table 2. Continued

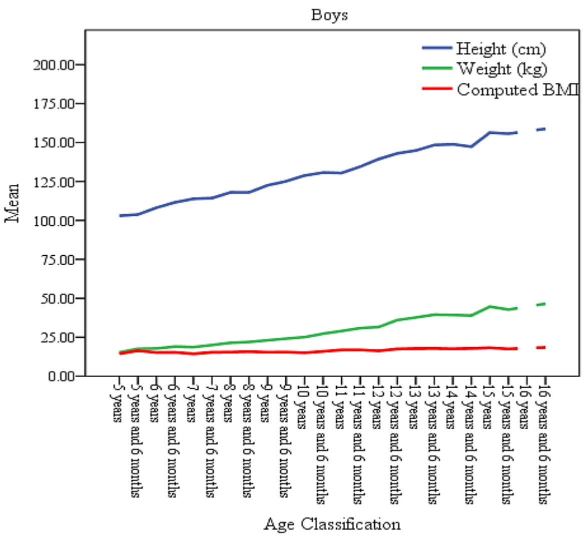
Age Classification Boys	Characters	Correlation	Height (cm)	Weight (kg)	Computed BMI	Girls	Height (cm)	Weight (kg)	Computed BMI
		Sig. (1-tailed)	.061	.000			.003	.000	
7 years and	Height (cm)	Pearson Correlation	1	.584**	-.456**	n=50	1	.490**	-.151
6 months		Sig. (1-tailed)		.000	.000			.000	.147
(n=57)	Weight (kg)	Pearson Correlation	.584**	1	.453**		.490**	1	.782**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.456**	.453**	1		-.151	.782**	1
		Sig. (1-tailed)	.000	.000			.147	.000	
8 years	Height (cm)	Pearson Correlation	1	.483**	-.329**	n=87	1	.428**	-.254**
(n=86)		Sig. (1-tailed)		.000	.001			.000	.009
	Weight (kg)	Pearson Correlation	.483**	1	.663**		.428**	1	.761**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.329**	.663**	1		-.254**	.761**	1
		Sig. (1-tailed)	.001	.000			.009	.000	
8 years and	Height (cm)	Pearson Correlation	1	.449**	-.283*	n=46	1	.314*	-.596**
6 months		Sig. (1-tailed)		.001	.030			.017	.000
(n=45)	Weight (kg)	Pearson Correlation	.449**	1	.726**		.314*	1	.552**
		Sig. (1-tailed)	.001		.000		.017		.000
	Computed BMI	Pearson Correlation	-.283*	.726**	1		-.596**	.552**	1
		Sig. (1-tailed)	.030	.000			.000	.000	
9 years	Height (cm)	Pearson Correlation	1	.613**	-.312**	n=67	1	.540**	-.364**
(n=77)		Sig. (1-tailed)		.000	.003			.000	.001
	Weight (kg)	Pearson Correlation	.613**	1	.546**		.540**	1	.571**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.312**	.546**	1		-.364**	.571**	1
		Sig. (1-tailed)	.003	.000			.001	.000	
9 years and	Height (cm)	Pearson Correlation	1	.575**	-.469**	n=48	1	.749**	.181
6 months		Sig. (1-tailed)		.000	.000			.000	.110
(n=55)	Weight (kg)	Pearson Correlation	.575**	1	.436**		.749**	1	.783**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.469**	.436**	1		.181	.783**	1
		Sig. (1-tailed)	.000	.000			.110	.000	
10 years	Height (cm)	Pearson Correlation	1	.780**	.298*	n=51	1	.641**	.325**
(n=37)		Sig. (1-tailed)		.000	.037			.000	.010
	Weight (kg)	Pearson Correlation	.780**	1	.824**		.641**	1	.931**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.298*	.824**	1		.325**	.931**	1
		Sig. (1-tailed)	.037	.000			.010	.000	
10 years and	Height (cm)	Pearson Correlation	1	.667**	-.022	n=62	1	.567**	-.021
6 months		Sig. (1-tailed)		.000	.430			.000	.436
(n=67)	Weight (kg)	Pearson Correlation	.667**	1	.721**		.567**	1	.809**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.022	.721**	1		-.021	.809**	1
		Sig. (1-tailed)	.430	.000			.436	.000	
11 years	Height (cm)	Pearson Correlation	1	.803**	.485**	n=65	1	.759**	.454**
(n=58)		Sig. (1-tailed)		.000	.000			.000	.000
	Weight (kg)	Pearson Correlation	.803**	1	.906**		.759**	1	.920**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.485**	.906**	1		.454**	.920**	1
		Sig. (1-tailed)	.000	.000			.000	.000	
11 years and	Height (cm)	Pearson Correlation	1	.702**	.268*	n=75	1	.628**	-.173
6 months		Sig. (1-tailed)		.000	.010			.000	.069
(n=74)	Weight (kg)	Pearson Correlation	.702**	1	.869**		.628**	1	.648**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.268*	.869**	1		-.173	.648**	1
		Sig. (1-tailed)	.010	.000			.069	.000	
12 years	Height (cm)	Pearson Correlation	1	.593**	-.339**	n=59	1	.744**	.500**
(n=47)		Sig. (1-tailed)		.000	.010			.000	.000
	Weight (kg)	Pearson Correlation	.593**	1	.545**		.744**	1	.945**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	-.339**	.545**	1		.500**	.945**	1
		Sig. (1-tailed)	.010	.000			.000	.000	
12 years and	Height (cm)	Pearson Correlation	1	.635**	.219*	n=90	1	.571**	.225*
6 months		Sig. (1-tailed)		.000	.024			.000	.017
(n=82)	Weight (kg)	Pearson Correlation	.635**	1	.887**		.571**	1	.925**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.219*	.887**	1		.225*	.925**	1
		Sig. (1-tailed)	.024	.000			.017	.000	
13 years	Height (cm)	Pearson Correlation	1	.681**	.284*	n=64	1	.520**	.021
(n=47)		Sig. (1-tailed)		.000	.027			.000	.433
	Weight (kg)	Pearson Correlation	.681**	1	.892**		.520**	1	.858**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.284*	.892**	1		.021	.858**	1

*Correlation is significant at the 0.01 level (1-tailed)

Table 2. Continued

Age Classification Boys	Characters	Correlation	Height (cm)	Weight (kg)	Computed BMI	Girls	Height (cm)	Weight (kg)	Computed BMI
		Sig. (1-tailed)	.027	.000			.433	.000	
13 years and 6 months (n=76)	Height (cm)	Pearson Correlation	1	.674**	.101	n=96	1	.406**	.002
		Sig. (1-tailed)		.000	.192			.000	.494
	Weight (kg)	Pearson Correlation	.674**	1	.800**		.406**	1	.911**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.101	.800**	1		.002	.911**	1
		Sig. (1-tailed)	.192	.000			.494	.000	
14 years (n=56)	Height (cm)	Pearson Correlation	1	.629**	.191	n=45	1	.446**	.112
		Sig. (1-tailed)		.000	.080			.001	.233
	Weight (kg)	Pearson Correlation	.629**	1	.879**		.446**	1	.937**
		Sig. (1-tailed)	.000		.000		.001		.000
	Computed BMI	Pearson Correlation	.191	.879**	1		.112	.937**	1
		Sig. (1-tailed)	.080	.000			.233	.000	
14 years and 6 months (n=23)	Height (cm)	Pearson Correlation	1	.790**	.264	n=30	1	.655**	.247
		Sig. (1-tailed)		.000	.111			.000	.094
	Weight (kg)	Pearson Correlation	.790**	1	.794**		.655**	1	.889**
		Sig. (1-tailed)	.000		.000		.000		.000
	Computed BMI	Pearson Correlation	.264	.794**	1		.247	.889**	1
		Sig. (1-tailed)	.111	.000			.094	.000	
15 years (n=14)	Height (cm)	Pearson Correlation	1	.625**	.161	n=12	1	.405	-.384
		Sig. (1-tailed)		.008	.291			.096	.109
	Weight (kg)	Pearson Correlation	.625**	1	.870**		.405	1	.688**
		Sig. (1-tailed)	.008		.000		.096		.007
	Computed BMI	Pearson Correlation	.161	.870**	1		-.384	.688**	1
		Sig. (1-tailed)	.291	.000			.109	.007	
15 years and 6 months (n=7)	Height (cm)	Pearson Correlation	1	.860**	.206	n=7	1	.431	-.241
		Sig. (1-tailed)		.006	.329			.167	.301
	Weight (kg)	Pearson Correlation	.860**	1	.672*		.431	1	.771*
		Sig. (1-tailed)	.006		.049		.167		.021
	Computed BMI	Pearson Correlation	.206	.672*	1		-.241	.771*	1
		Sig. (1-tailed)	.329	.049			.301	.021	
16 years	Height (cm)	Pearson Correlation	0	0	0	n=3	1	.955	.931
		Sig. (1-tailed)		0	0			.095	.119
	Weight (kg)	Pearson Correlation	0	0	0		.955	1	.997*
		Sig. (1-tailed)					.095		.023
	Computed BMI	Pearson Correlation	0	0	0		.931	.997*	1
		Sig. (1-tailed)					.119	.023	
16 years and 6 months (n=6)	Height (cm)	Pearson Correlation	1	.502	-.020	n=4	1	.635	-.142
		Sig. (1-tailed)		.155	.485			.182	.429
	Weight (kg)	Pearson Correlation	.502	1	.854*		.635	1	.674
		Sig. (1-tailed)	.155		.015		.182		.163
	Computed BMI	Pearson Correlation	-.020	.854*	1		-.142	.674	1
		Sig. (1-tailed)	.485	.015			.429	.163	

**Correlation is significant at the 0.05 level (1-tailed)



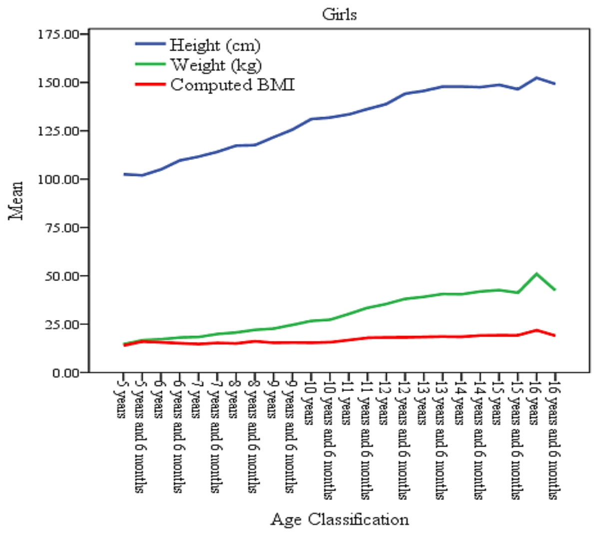


Fig.2 Comparison of height, weight and BMI in boys and girls

Fig. 3.Relation of percentilesand z scores in Height-for-age boys

Fig. 4.Relation of percentilesand z scores in Height-for-age girls

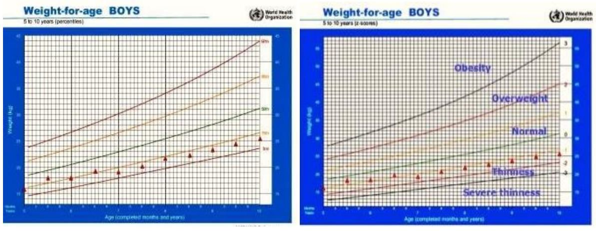


Fig. 5.Relation of percentilesand z scores in Weight-for-age boys

Fig. 6.Relation of percentilesand z scores in Weight-for-age girls

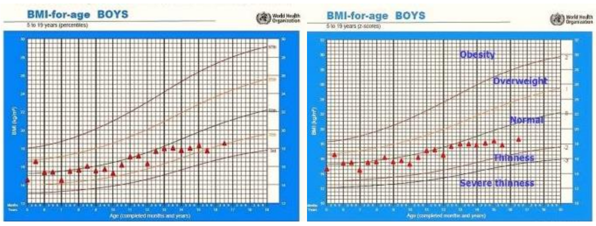


Fig. 7.Relation of percentilesand z scores in BMI-for-age boys

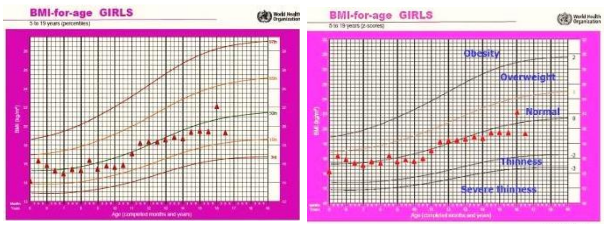


Fig. 8.Relation of percentilesand z scores in BMI-for-age girls

Discussion

It is important to interpret the real data of anthropometric measurements on each individual concerning with their growth development. Lack of measurement on precision leads to the null results. Different countries have different values of BMI index for growth performance of children and adults. Anthropometric measurements of school children in Meiktila Township were checked with WHO references (2007).Among 2537 school children aged at 5 – 17 years, involved in the study 1257(49.54 %) were boys and 1280 (50.45 %) were girls. The increment in height increased with their ages at C.I 0.94 in school boys and C.I 0.95 in school girls indicating that their height velocity completely increased, but they have low stature body composition compared to WHO standard.

In school girls, growth increment ceased at the aged 13.6 years to 15 years indicated that their growth period completed before they reach maturity. However, their growth development fluctuated in older age. The value of z-scores– 1 and – 2 were equivalent to 3rd and 15th percentiles indicated that short stature dealing with weight gain. The present finding agreedwith Komiya *et al* (2008) recommended that children with short stature had low BMI values.Afterthe age of 10.6 years, increment of weight in school girls wasmore pronounced than school boys. This observation was also similar to Hualke (1998) who reported that children of either sex are of the same height, weight and general body proportion's up to 10 or 11 years of age. In contrast, the height status by international standard is not equivalent with the growth performance of children and adult in specific countries.

In addition the velocity of weight status was significantly correlated to BMI values at $p < 0.01$ and $p < 0.05$ level indicating that low weight lead to thinness.The mean z-score 0 and – 2 in children defined as normal BMI value with 15th and 50th percentiles indicating that they maintain their healthy life. Pearson correlation revealed increment of weight of some school boys and girls waslow. Furthermore, no BMI cutoff values observed in the obese school-aged children. The present findings were agreed with the statement that normal BMI values in children and adolescent vary as they gain in height and weight status(Must *et al.*, 1991) and BMIs of less than 21 might reflect under nutrition in populations with current or recent widespread under nutrition (Komiya *et al*., 2008). The results on weight increment differed from the international standards. To implement the successful healthy life, long-term monitoring program should be established.Mei *et al*., (2016) recommended that long-term school-based interventions containing physical activities as a core component appeared to be effective in achieving healthier BMI.

To sum up, the velocity of BMI valuesappeared to be more variable in school girls than boys. However, there was no interfering the metabolic activities on their growth performance observed in most of the school children in accordance with the results of Pearson correlation. This study may provide early identification of weight concerns in school-based program to support families achieving the healthy life style of school children.

Conclusion

The distributions of height, weight and BMI of Myanmar school-aged children differed from those of children from WHOstandard and thus need to be considered.This study recommended that BMI values should be calculated and plotted annually or every six months.Further research for monitoring the longitudinal survey on school-based BMI programs are required in every school because children reach virtually all youth in later life.

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