Possible Urban-Rural Difference in Habitus of School Children in Sendai

HARUO NAKATSUKA, HIROSHI SATOH, TAKAO WATANABE*
and MASAYUKI IKEDA†

*Department of Environmental Health, Tohoku University
School of Medicine, Sendai 980, *Miyagi College of
Education, Sendai 980, and †Department of Public Health
Kyoto University Faculty of Medicine, Kyoto 606*

NAKATSUKA, H., SATOH, H., WATANABE, T. and IKEDA, M. *Possible Urban-Rural Difference in Habitus of School Children in Sendai.* Tohoku J. Exp. Med., 1990, **160** (1), 11-17 — Right after a large-scale merge involving 2 cities and 2 towns in 1987-1988 to form an enlarged city of Sendai, the body habitus of school children (in the 6th year-grade in primary schools and 3rd year-grade in junior high schools) were compared among the 4 regions (called by the pre-merge names of Akiu, Izumi, Miyagi and Sendai). The analysis showed that primary school boys in Sendai are taller and heavier than the boys in Izumi, and Izumi boys are heavier than Akiu boys. In junior high schools, Izumi girls are taller than Sendai girls with smaller Rohrer's and Quetlet's index. The observation indicates that the difference in body habitus is present in agreement with variation in the extent of urbanization in the regions. — body habitus; height; school children; urbanization; weight

Children in urbanized areas once tended to be taller and/or heavier than their counterparts in rural areas (Kondo et al. 1978), but such urban-rural difference in body habitus has gradually faded out in the city of Sendai in accordance with the expansion of urban areas and disappearance of surrounding farming zones (Ikeda et al. 1983; Nakatsuka et al. 1988a). In 1987-1988, there was a large-scale merge involving two cities of Sendai and Izumi, and two towns of Miyagi and Akiu to form a new and enlarged city of Sendai. This implies that the new Sendai again embraces farming areas in its expanded territory.

The purpose of this study is to examine if the body habitus of the children is uniform through-out the core and newly joined part of the city. Taking advantage of the opportunity of the merge, an analysis was made to compare height, weight and two body habitus indices of 6th year-grade primary school

Received September 4, 1989; revision accepted for publication December 6, 1989.

Offprint requests at: Prof. M. Ikeda, Department of Public Health, Kyoto University Faculty of Medicine, Kyoto 606, Japan.

A part of this work was presented at the 38th Annual Meeting of Tohoku Association of School Health, held on 31st August, 1989, in Morioka, Iwate, Japan.

children and 3rd year-grade junior high school children in the 4 pre-merge regions.

MATERIALS AND METHODS

The merge of the 4 regions of Sendai, Miyagi, Izumi and Akiu proceeded in 2 steps as shown in Table 1; the town of Miyagi merged with the city of Sendai in 1987, and the city of Izumi and the town of Akiu joined to form an enlarged Sendai in 1988.

In the city of Sendai, the habitus of each and every child of the 6th year-grade in primary schools and 3rd year-grade in junior high schools has been monitored by the October measurement since 1930's (Kondo et al. 1978). Accordingly, height (in m) and weight (in kg) of the children in the two year-grades were measured in October, 1988, by school health teachers in the 4 regions in the enlarged city of Sendai; measurements in October were made on every child but limited to those in the two year-grades. The measures were offered by the Education Commission of Sendai City to Department of Environmental Health, Tohoku University School of Medicine for statistical analysis, including calculation of Rohrer's (kg/m^3) and Quetlet's index (kg/m^2).

The measures and indices were grouped by pre-merge regions (called by pre-merge names for convenience) for comparison. Statistical evaluation of the difference between means was made by *t*-test. The calculation was conducted utilizing the computer in Tohoku University Computer Center, Sendai, Japan.

RESULTS

The number of children (Table 2) were not even among the 4 regions and greater in Sendai and then in Izumi, and quite less in Miyagi and Akiu, reflecting the difference in total populations in the 4 regions (Table 1). The habitus of the children appeared not the same among the 4 regions (mean $\pm$ s.d. values by the region are shown in Table 2); for example, the 6th year-grade primary school boys in Akiu seemed to be shorter and lighter than those in other 3 regions, and the mean body weight of girls in Izumi in the 3rd year of the junior high schools was apparently smaller than counterpart values in other 3 regions. For precise comparison, statistical significance of the difference in height, weight, Rohrer's index and Quetlet's index was examined among the 4 regions.

The comparison (Table 3) shows that Sendai primary school boys were significantly taller and heavier than their counterparts in Izumi ($p < 0.01$), and

TABLE 1. *Populations of the 4 regions at the time of merge*

4 regions merged	Population ^a at the time of merge on	
	1st Nov., 1987	1st March, 1988
Sendai	697,193	727,796
Miyagi	29,093	— ^b
Izumi		137,413
Akiu		5,051
Total		870,260

^aPopulation was on the day before the day of merge.

^bIncluded in the Sendai population.

TABLE 2. *Height, weight, Rohrer's index and Quetlet's index of school children in the 4 regions in 1988*

School children Boy/Girl	Region	<i>n</i>	Height (m)	Weight (kg)	Rohrer's index	Quetlet's index
6th year-grade in primary schools						
Boys	Sendai	4915	1.481 $\pm$ 0.074	40.7 $\pm$ 8.4	12.46 $\pm$ 1.79	18.45 $\pm$ 2.79
	Miyagi	239	1.477 $\pm$ 0.078	40.6 $\pm$ 9.3	12.52 $\pm$ 2.05	18.48 $\pm$ 3.16
	Akiu	41	1.453 $\pm$ 0.061	37.5 $\pm$ 5.2	12.21 $\pm$ 1.46	17.72 $\pm$ 2.00
	Izumi	1400	1.475 $\pm$ 0.072	40.0 $\pm$ 8.1	12.40 $\pm$ 1.72	18.28 $\pm$ 2.67
	Total	6595	1.479 $\pm$ 0.074	40.6 $\pm$ 8.4	12.45 $\pm$ 1.78	18.41 $\pm$ 2.78
Girls	Sendai	4594	1.492 $\pm$ 0.063	41.4 $\pm$ 7.7	12.39 $\pm$ 1.69	18.49 $\pm$ 2.64
	Miyagi	241	1.490 $\pm$ 0.059	41.1 $\pm$ 6.9	12.38 $\pm$ 1.62	18.44 $\pm$ 2.47
	Akiu	34	1.504 $\pm$ 0.068	43.6 $\pm$ 9.4	12.71 $\pm$ 1.95	19.13 $\pm$ 3.18
	Izumi	1300	1.493 $\pm$ 0.063	40.8 $\pm$ 7.0	12.19 $\pm$ 1.46	18.20 $\pm$ 2.29
	Total	6169	1.492 $\pm$ 0.063	41.3 $\pm$ 7.5	12.35 $\pm$ 1.65	18.43 $\pm$ 2.57
3rd year-grade in junior high schools						
Boys	Sendai	5089	1.667 $\pm$ 0.062	57.2 $\pm$ 10.0	12.31 $\pm$ 1.84	20.50 $\pm$ 3.06
	Miyagi	211	1.660 $\pm$ 0.068	56.6 $\pm$ 10.6	12.33 $\pm$ 1.88	20.46 $\pm$ 3.17
	Akiu	59	1.651 $\pm$ 0.064	56.2 $\pm$ 10.6	12.44 $\pm$ 1.77	20.54 $\pm$ 3.07
	Izumi	1453	1.669 $\pm$ 0.061	56.7 $\pm$ 9.0	12.18 $\pm$ 1.64	20.30 $\pm$ 2.71
	Total	6812	1.667 $\pm$ 0.062	57.0 $\pm$ 9.8	12.28 $\pm$ 2.00	20.46 $\pm$ 2.99
Girls	Sendai	4796	1.570 $\pm$ 0.050	50.9 $\pm$ 7.2	13.16 $\pm$ 1.74	20.64 $\pm$ 2.62
	Miyagi	215	1.562 $\pm$ 0.051	51.0 $\pm$ 7.0	13.25 $\pm$ 1.81	20.74 $\pm$ 2.66
	Akiu	35	1.564 $\pm$ 0.054	51.9 $\pm$ 8.1	13.56 $\pm$ 1.81	21.19 $\pm$ 2.80
	Izumi	1370	1.575 $\pm$ 0.050	50.8 $\pm$ 6.6	13.03 $\pm$ 1.61	20.49 $\pm$ 2.49
	Total	6416	1.571 $\pm$ 0.050	50.9 $\pm$ 7.0	13.14 $\pm$ 1.72	20.61 $\pm$ 2.57

Values in the table are means $\pm$ s.d.

The region is described by the pre-merge name.

n, the number of children.

Izumi boys were heavier ($p < 0.01$) than Akiu boys. Accordingly, Quetlet's index was larger in Sendai boys than Izumi and Akiu boys ($p < 0.05$ for both). Comparison between Akiu and Miyagi shows that Miyagi boys were heavier than Akiu boys ($p < 0.01$) with no significant ($p > 0.05$) difference in height between them, resulting in significantly ($p < 0.05$) larger Quetlet's index in Miyagi boys than in Akiu boys. Among primary school girls, the difference is not remarkable except that Sendai girls are heavier and therefore have larger Rohrer's and Quetlet's indices than Izumi girls ($p < 0.01$ for all 3 pairs). In junior high schools, the difference among boys is not remarkable, whereas Izumi girls are taller than Sendai girls and accordingly both Rohrer's and Quetlet's indices are smaller in

TABLE 3. *Difference in height, weight, Rohrer's index and Quetlet's index of school children among the 4 regions*

Item	Primary school ^a						Junior high school ^a					
Region	Miyagi		Akiu		Izumi		Miyagi		Akiu		Izumi	
	Boy(Girl)		Boy(Girl)		Boy(Girl)		Boy(Girl)		Boy(Girl)		Boy(Girl)	
Height												
Sendai	—	(—)	S	(—)	SS	(—)	—	(—)	S	(—)	—	(II)
Miyagi			—	(—)	—	(—)			—	(—)	—	(—)
Akiu					—	(—)					I	(—)
Weight												
Sendai	—	(—)	SS	(—)	SS	(SS)	—	(—)	—	(—)	—	(—)
Miyagi			MM	(—)	—	(—)			—	(—)	—	(—)
Akiu					II	(—)					—	(—)
Rohrer's index												
Sendai	—	(—)	—	(—)	—	(SS)	—	(—)	—	(—)	S	(SS)
Miyagi				(—)	—	(—)			—	(—)	—	(—)
Akiu					—	(—)					—	(—)
Quetlet's index												
Sendai	—	(—)	S	(—)	S	(SS)	—	(—)	—	(—)	S	(S)
Miyagi			M	(—)	—	(—)			—	(—)	—	(—)
Akiu					—	(—)					—	(—)

The statistical significance of the difference is shown by the initial of the region of the larger value (two letters for $p < 0.01$ and one letter for $p < 0.05$), and—indicates that the difference is insignificant ($p > 0.05$). For example, SS(—) at the cross of Sendai and Izumi in height of primary school children indicates the height of primary school boys in Sendai is significantly ($p < 0.01$) larger than that in Izumi, whereas that of girls is not different ($p > 0.05$) between the two regions. The region is described by the pre-merge name.

^a6th year-grade in primary schools and 3rd year-grade in junior high schools.

Izumi girls than in Sendai girls.

DISCUSSION

The present analysis demonstrates that there exists regional difference in body habitus of children in the 4 regions compared, probably reflecting the differences in the extent of urbanization among the 4 regions. Namely, Sendai is a prefectural city, and Izumi has been rather recently growing as residential areas for the people who work in Sendai, whereas two regions of Miyagi and Akiu are known to be rich in farming and maintain natural environment better than others (Kahoku Shimpo 1982). The lack of statistical significance in some cases, e.g., the comparison of Sendai and Akiu boys in 6 year-grade of primary schools, may probably be due to small number of children in one region; this difficulty will be solved by combining the data of several years to come for comparison.

TABLE 4. *Height and weight of school children in agricultural and urbanized prefectures*

Prefecture	North latitude ^a (°)	Percentage of agricultural population ^b	6th year-grade in primary schools				3rd year-grade in junior high schools			
			Boys		Girls		Boys		Girls	
			Height (m)	Weight (kg)	Height (m)	Weight (kg)	Height (m)	Weight (kg)	Height (m)	Weight (kg)
Agricultural prefectures in northern Japan										
Aomori	40-41	24.1%	1.456	39.8	1.474	40.7	1.650	55.9	1.568	51.6
Iwate	39-40	25.3%	1.445	38.1	1.467	39.8	1.643	54.1	1.560	51.1
Akita	39-40	21.8%	1.459	39.7	1.469	39.6	1.652	55.5	1.576	51.5
Yamagata	38-39	20.1%	1.445	38.2	1.472	39.4	1.649	54.9	1.568	50.6
Urbanized prefectures in central Japan										
Tokyo	35-36	0.6%	1.445	38.0	1.455	38.0	1.649	54.9	1.564	49.5
Kanagawa	35-36	1.7%	1.444	37.5	1.457	38.4	1.640	53.3	1.564	49.5
Aichi	35-36	4.6%	1.439	37.1	1.455	38.3	1.634	53.0	1.558	49.3
Kyoto	35	4.6%	1.432	36.6	1.458	38.2	1.647	53.8	1.565	49.4
Osaka	34-35	1.0%	1.439	37.0	1.461	38.5	1.644	53.8	1.567	50.3
Agricultural prefectures in southern Japan										
Kochi	33-34	19.8%	1.439	37.3	1.454	38.7	1.638	53.1	1.558	49.8
Miyazaki	31-32	21.9%	1.429	36.6	1.452	38.1	1.625	51.7	1.565	48.8
Kumamoto	32-33	21.1%	1.432	36.0	1.463	38.5	1.635	52.1	1.560	49.9
Kagoshima	31-32	22.5%	1.428	36.0	1.444	37.4	1.631	52.7	1.558	49.6

Unless otherwise specified, the values are mean height and weight cited from Ministry of Education, Science and Culture (1989).

^aLocation of the prefectural capital.

^bCited from Statistics Bureau (1987).

In previous analyses in the effect of urbanization on the body habitus of school children on the basis of whole Japan, it was observed that the urban-rural difference once evident in 1950's and 1960's (Kondo et al. 1978) was no longer remarkable in late 1970's (Ikeda et al. 1983). Similar analysis with the latest national school health data (Ministry of Education, Science and Culture 1989) confirmed that there is no significant urbanization-related difference in height and weight of school children and that only north-south difference persists. Namely, the data summarized in Table 4 show that both boys and girls in the northern agricultural prefectures (identified by the results of census 1985; Bureau of Statistics 1987) are taller and heavier than their counterparts in the southern agricultural prefectures, whereas the habitus of those in the urbanized prefectures in central Japan is just between those in the northern and southern agricultural prefectures. Despite this general trend of disappearance of urban-rural difference when examined on Japan as a whole, the present observation points out that the interregional difference may be present when comparison is made topographically. The national school health data on the body habitus of children are based on the stratified sampling at a rate of 3 to 4% (Ministry of Education, Science and Culture 1989). Such analysis of a topographic scale as the present study is hardly possible unless each and all children are examined like the October measurement done in the city of Sendai (Kondo et al. 1978; Ikeda et al. 1983; Nakatsuka et al. 1989).

The body habitus of children in the present day society is an integrated expression of both genetic and environmental factors (Annest et al. 1983; Berkowitz et al. 1985; Kramer et al. 1985; Ikeda and Watanabe 1985; Nakatsuka et al. 1989), and much more complex than it was in 1950's when a single factor of nutrition played almost a decisive role (Kondo et al. 1978). In fact, nutritional surveys conducted in the vicinity of the present study regions proved that women in agricultural areas take nutrients as sufficient as their peers in urban areas (Ikeda et al. 1988; Nakatsuka et al. 1988b). Further studies focussed on the contributing factors other than nutrition are apparently warranted.

Acknowledgments

We are grateful to the Education Commission of Sendai City for their generous support to this work.

References

- 1) Annest, J.L., Sing, C.F., Biron, P. & Mongeau, J.G. (1983) Familial aggregation of blood pressure and weight in adoptive families. III. Analysis of the role of shared genes and shared household environment in explaining family resemblance for height, weight and selected weight/height indices. *Am. J. Epidemiol.*, **117**, 492-506.
- 2) Berkowitz, R.I., Agras, S., Korner, A.F., Kraemer, H.C. & Zeanah, C.H. (1985) Physical activity and adiposity: A longitudinal study from birth to childhood. *J. Pediatr.*, **106**, 734-737.
- 3) Bureau of Statistics, Prime Minister's Office, the Government of Japan (1987)

- Census 1985, Vol. 3. Ministry of Finance Printing Bureau, Tokyo (Japanese)
- 4) Ikeda, M. & Watanabe, T. (1985) Constant growth of primary school children throughout four seasons of year. *Tohoku J. Exp. Med.*, **145**, 413-418.
 - 5) Ikeda, M., Watanabe, T., Koizumi, A. Kumai, M. & Fujita, H. (1983) Growth deceleration in Japanese school-children with special reference to those in the city of Sendai. *Tohoku J. Exp. Med.*, **139**, 113-119.
 - 6) Ikeda, M., Watanabe, T., Kasahara, M. & Nakatsuka, H. (1988) Nutrient intake of women in rural and urban areas in Japan. *Asia-Pacific J. Publ. Health*, **2**, 28-32.
 - 7) Kahoku Shimpo (1982) Encyclopedia on Miyagi Prefecture. Kahoku Shimpo Press, Sendai. (Japanese)
 - 8) Kondo, S., Takahashi, E., Kato, K., Takahashi, S. & Ikeda, M. (1978) Secular trends in height and weight of Japanese pupils. *Tohoku J. Exp. Med.*, **126**, 203-213.
 - 9) Kramer, M.S., Barr, R.G., Leduc, D.G., Boisjoly, C. & Pless, B. (1985) Infant determinants of childhood weight and adiposity. *J. Pediatr.*, **107**, 104-107.
 - 10) Ministry of Education, Science and Culture, the Government of Japan (1989) Gakko Hoken Tokei Chosa Hokokusho (School Health Statistics) 1988. Ministry of Finance Printing Bureau, Tokyo. (Japanese)
 - 11) Nakatsuka, H., Ohashi, M., Watanabe, T. & Ikeda, M. (1988a) Small, yet steady secular gain in height and weight of school children in the city of Sendai in past 15 years. *Tohoku J. Exp. Med.*, **156**, 341-350.
 - 12) Nakatsuka, H., Kasahara, M., Watanabe, T., Hisamichi, S., Shimizu, H., Fujisaku, S., Ichinowatari, Y., Ida, Y., Suda, M., Kato, K. & Ikeda, M. (1988b) Urban-rural differences in food habits in north-eastern Japan. *Ecol. Food Nutri.*, **21**, 77-87.
 - 13) Nakatsuka, H., Kasahara, M., Watanabe, T. & Ikeda, M. (1989) Continuity of leanness/obesity from childhood to adolescence. *Tohoku J. Exp. Med.*, **157**, 381-392.
-