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Body Mass Index Distributions and Sociodemographic Factors Affecting BMI of Children Living in Anyang, Korea

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ABSTRACT

Body mass index(BMI) is recognized as one of the most useful indexes for adiposity in children and adults. This study was conducted to provide information on BMI distribution by age and sex in Korean children, and to identify sociodemographic factors that affected BMI among children. The study was conducted on 2376 children(boys 1184, girls 1192) living in a middle-size city in Korea. Subjects were selected from the primary schoolchildren in grades 1 – 6 using the two-stage sampling method. Their mean age was 9.4 years. The percentile of BMI tended to increase as age increased in both sexes. The 85th percentile for boys, aged 6 – 12 years, was 19.8kg/m^2, and the 95th percentile was 22.5kg/m^2. The 85th percentile for girls, aged 6 – 12 years, was 18.9kg/m^2, and the 95th percentile was 21.5kg/m^2. Multiple regression analysis was carried out to predict BMI from percent ideal body weight (PIBW), age and sex. After adjusting PIBW and age, BMI for boys was 0.062kg/m^2 lower than that for girls. One year of age increased BMI by 0.55kg/m^2. The prevalence rate of overweight and obesity based on PIBW was 15.8% and 15.0% for boys, and 14. 0% and 11.0% for girls, respectively. Demographic factors such as sex, age, and parents' obesity influenced children's BMI. After adjusting for sex, age and parents' BMI, the presence of another children in family, and mother's employment status showed a strong effect on children's BMI. The results suggest an age-sex specific BMI distribution of Korean children. The present study also provides direct evidence of a correlation between early life environmental factors, such as presence of siblings or mother's employment, and BMI level in Korean children. (*Korean J Community Nutrition* 1(2) : 81~87, 1999)

KEY WORDS : obesity · body mass index · percent of ideal body weight · children · sociodemographic factor.

Introduction

Obesity, defined as an excess of body fat, is a well-known risk factor for major chronic diseases such as diabetes mellitus, hypertension, cardiovascular disease, and some cancers(NIH 1985). Moreover overweight and obesity may be the cause of significant metabolic, and psychological complications in children and adolescents(Must 1996 ; Rosenbaum & Leibel 1988). Obesity in childhood is a predictor of obesity in later life(Guo et al. 1994 ; Hawk & Brook 1979) and is also related to an increase of morbidity and mortality in adulthood(Must et al. 1992 ; Nieto et al. 1992). The precise determination of the amount of body fat requires technically sophisticated methods, which are available only in research laboratories. Therefore simple and convenient anthropometric measurements are recommended for public health studies and clinical practice. For population studies the body mass index(BMI) is considered to be a simple but adequate measure of body fat(Deurenberg et al. 1991 ; Deurenberg et al. 1997 ; Garrow & Webster 1985). The advantage of the BMI over other methods in assessing body fat, such as skinfold thickness or bioelectrical impedance, is that the method requires only a scale and a stadiometer. Moreover the method is very easy to perform with no or with only minor between-observer variance. It also makes it possible to make comparisons for populations, or countries without any reference weight for sex, age, and height-specificity(Macdonald 1999). The committee on Clinical Guidelines for Overweight in Adolescent Preventive Service has recommended the use of BMI to help define childhood(6 – 10y), and adolescent(11 – 21y) obesity(Hims & Dietz 1994).

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As changes in body composition occur during growth, age-dependent reference data for BMI are necessary for children. Numerous BMI standards have been published showing differences among populations(Must et al. 1991 ; Falorni et al. 1998). For this reason, national reference charts, specific for ethnic characteristics and geographic areas, are needed. Sex and age specific BMI percentiles, to define normal and overweight subjects for epidemiological or screening purposes, are discordant. From the first National Health and Nutrition Examination Survey (NHANES I), overweight was defined as the sex and age-specific 85th percentile values of BMI, and severe overweight(obesity) was defined as the 95th percentile(Must et al. 1991).

Childhood obesity is a result of an interaction between genetic and environmental factors(Parsons et al. 1999). Evidence of the genetic influences on obesity has been demonstrated by many studies(Maes et al. 1997 ; Stunkard et al. 1990). Environmental factors shown to be associated with childhood obesity include parent's obesity, higher income, smaller family size, and the only child (Mo-Suwan & Geater 1996 ; Sobal & Stunkard 1989).

With the increasing prevalence of childhood obesity in Korea(Han et al. 1995), a study of the factors associated with childhood obesity is needed to understand its causes and determine the appropriate preventive interventions. This study examines the sex and age specific BMI distribution in a sample of Korean children. We also report on the relative contribution of sociodemographic influences on BMI in childhood.

Subjects and Methods

1. Subjects

Subjects were selected from primary schoolchildren in grades 1 – 6 using the two-stage sampling method, in Anyang city, Kyunggi province, Korea. Five primary schools(2 were in newly structured town areas, and 3 were in old town areas) were randomly selected from the 12 primary schools in Anyang. From each school two classes of each grade were randomly selected, and all students in the sample classes became subjects. Children aged between 6 and 12 years, free from any physical handicaps, were accepted into the study. The study was conducted from September to December in 1995, and 2376 students(boys 1184, girls 1192) were included in the study.

2. Methods

Anthropometric data were collected for each participant wearing underwear and without shoes. Height and sitting height were measured to the nearest 0.1 of a centimeter on a Harpenden stadiometer. Weight was measured to the nearest 0.5 of a kilogram on a standard plat-

Table 1. Sociodemographic backgrounds of the subjects

Variables	Mean±SD, N(%)
Sex Boys	1184(49.8%)
Girls	1192(50.2%)
Age(yrs)	9.4 ± 1.8
Number of children in family	
One	266(11.2%)
Two	1627(68.5%)
Three	350(14.7%)
Child order	
1st	1267(53.3%)
2nd	828(34.9%)
3rd	151(6.4%)
4th or over	
Parent's age(yrs)	
Father	40.0±3.9
Mother	36.7±3.5
Parent's BMI(kg/m^2)	
Father	23.1±5.5
Mother	21.4±2.4
Parent's education level	
Father : Primary	34(1.5%)
Middle school	233(10.2%)
High school	1112(48.5%)
Mother : Primary	
Middle school	82(3.6%)
High school	452(19.7%)
College or over	1324(57.7%)
Parent's occupation status	
Father : Office worker	983(42.5%)
Professional	110(4.8%)
Self-employed	994(43.0%)
Official	217(9.4%)
Laborer	6(0.3%)
Mother : Office worker	237(10.8%)
Professional	90(4.1%)
Self-employed	292(13.3%)
Official	10(0.4%)
Laborer	25(1.1%)
Unemployed(house wife)	1546(70.3%)
Monthly household income(won)	
Less than 799,999	228(9.9%)
800,000 – 999,999	545(23.7%)
1,000,000 – 1,499,999	889(38.7%)
1,500,000 – 1,999,999	596(25.9%)
Over 2,000,000	41(1.8%)

form scale. Chest and arm circumferences were me-asured using non-extensible Rollfix type tape. Body mass index was calculated by body weight in kilograms divided by the height in meters squared. The children's percent ideal body weight(PIBW) were calculated using the median weight for height relationships of the Korean Children Growth Chart(1999). Subjects were classified as underweight, normal, overweight, or obese if their PIBW values were under 90, 90－110, 110－120, or over 120%. All students were asked for information about their birthday, school year, and sex. Age at the end of testing month was computed for each student. Sociodemographic backgrounds of the subjects were obtained by a questionnaire supplied by parents. It consisted of subject's family size, child order, parent's age, weight, height, education, occupation, and monthly household income. Statistical analysis was performed using the SAS program(ver 6.12). Data were represented as mean±standard deviation. The Wilcoxon rank sum test and Kruskal-wallis k-sample test were used to compare the mean value. Multiple regression analysis was used to analyze the variables, which predict the BMI of the children.

Results and Discussion

The characteristics of sociodemographic backgrounds of children are shown in Table 1. The mean(S.D.) age of children was 9.4(1.8) years. Sixty-eight percent of the subjects were in families of two children, 53.3% of children were first children, and 34.9% were second children. The mean(S.D.) ages of fathers and mothers were 40.0(3.9), and 36.7(3.5), respectively. Answers about parents' education indicated that 88.5% of fathers and 76.7% of mothers of subjects graduated from high school or attended college. Therefore most subjects had relatively well educated parents. In terms of occupation status, 42.5% of fathers were office workers, and 43.0% of them were self-employed. 70.3% of mothers were unemployed. In terms of monthly household income, 33.6% of family had incomes under 1,000,000 won, 38.7% reported incomes of 1,000,000－1,499,9999 won, and 27.7% reported over 1,500,000 won.

Anthropometric data according to sex and age are shown in Table 2. Age-specific mean value of height, weight, sitting height, chest circumference, and arm circumfer-

Table 2. Anthropometric data of the children according to sex and age

Variables	Boys						
	6yr	7yr	8yr	9yr	10yr	11yr	12yr
N	32	184	203	177	208	193	186
Height(cm)	118.6± 4.1	122.8± 4.7	127.3± 5.6	131.6± 5.1	137.3± 6.0	143.5± 6.6	147.9± 7.3
Weight(kg)	22.3± 2.1	24.3± 3.7	27.2± 5.0	29.0± 5.0	33.7± 7.0	37.5± 7.7	40.4± 9.1
Sitting height(cm)	65.6± 3.5	67.1± 3.8	69.5± 4.0	70.5± 4.4	73.9± 3.7	75.6± 4.9	78.9± 3.9
Chest circumference(cm)	59.4± 3.7	61.6± 4.6	63.7± 5.1	65.6± 5.7	67.7± 6.5	71.6± 6.4	72.2± 6.9
Arm circumference(cm)	18.0± 1.3	18.5± 1.8	19.4± 2.6	20.7± 3.5	21.4± 2.9	22.2± 3.2	22.6± 3.2
BMI[a]	15.9± 1.3	16.0± 1.7	16.7± 2.2	16.7± 2.3	17.7± 2.8	18.1± 2.8	18.3± 2.9
PIBW[b]	104.1± 8.7	104.1±10.6	107.0±13.3	105.4±14.0	108.8±16.0	107.3±15.6	105.3±14.7
	Girls						
	6yr	7yr	8yr	9yr	10yr	11yr	12yr
N	42	190	204	178	209	188	179
Height(cm)	118.3± 4.7	120.4± 4.8	125.1± 5.4	131.4± 5.9	137.0± 6.3	143.5± 6.8	148.0± 7.0
Weight(kg)	21.4± 3.0	22.8± 3.2	25.5± 4.4	28.2± 5.4	32.3± 6.4	35.8± 7.0	40.2± 8.1
Sitting height(cm)	64.4± 4.0	65.9± 3.8	67.7± 4.5	70.2± 4.7	73.5± 3.9	75.6± 5.0	79.9± 4.0
Chest circumference(cm)	58.0± 4.1	59.7± 4.7	62.3± 5.2	64.7± 5.7	66.1± 6.5	70.3± 6.7	72.8± 7.0
Arm circumference(cm)	17.7± 1.9	18.1± 1.9	19.2± 2.2	20.2± 2.4	20.6± 2.5	21.3± 2.5	22.4± 3.0
BMI	15.3± 1.6	15.7± 1.6	16.2± 2.1	16.3± 2.2	17.1± 2.3	17.3± 2.4	18.2± 2.8
PIBW	102.2±10.6	104.8±10.6	106.7±13.7	104.1±13.1	104.9±13.0	98.5±13.0*	98.1±14.9*

a : BMI(Body Mass Index ; kg/m^2), b : PIBW(Percent Ideal Body Weight),
*Significantly different from boys at $p<0.05$ by Wilcoxon rank sum test

Table 3. Body Mass Index distribution for children according to sex and age

Variables	Boys									
	6yr	7yr	8yr	9yr	10yr	11yr	12yr	6-9yr	10 – 12yr	Total (6 – 12yr)
5th percentile	13.9	13.9	14.0	14.0	14.5	14.6	14.7	13.9	14.6	14.2
15th percentile	14.2	14.5	14.7	14.5	15.2	15.6	15.6	14.5	15.5	14.9
25th percentile	15.2	14.8	15.2	15.1	15.9	16.3	16.1	15.0	16.0	15.5
50th percentile	16.0	15.8	16.3	16.3	17.1	17.6	17.7	16.1	17.4	16.6
75th percentile	16.6	16.7	17.6	17.8	18.8	19.3	19.6	17.4	19.3	18.3
85th percentile	17.2	17.7	19.3	18.9	21.0	20.9	21.5	18.2	20.9	19.8
95th percentile	18.1	19.3	21.2	21.7	23.6	24.2	23.7	20.7	23.6	22.5
Korean Reference[a]	15.4	15.7	16.0	16.6	16.8	17.8	18.7			
US white[b]	14.6	15.2	15.7	16.2	16.8	17.4	17.9			
US black[b]	14.5	15.0	15.5	16.0	16.5	17.1	17.6			
Italian[c]	15.5	15.9	16.5	17.1	17.8	18.4	19.1			
Variables	Girls									
	6yr	7yr	8yr	9yr	10yr	11yr	12yr	6 – 9yr	10 – 12yr	Total (6 – 12yr)
5th percentile	13.2	13.1	13.5	13.6	14.1	13.9	14.5	13.4	14.2	13.6
15th percentile	13.8	13.9	14.2	14.2	14.8	15.1	15.5	14.1	15.1	14.5
25th percentile	14.2	14.5	14.9	14.6	15.5	15.5	16.4	14.6	15.6	15.1
50th percentile	14.9	15.7	15.7	15.8	16.6	17.0	17.6	15.7	17.1	16.4
75th percentile	16.4	16.7	17.3	17.4	18.3	18.4	19.4	17.0	18.8	17.9
85th percentile	16.8	17.5	18.4	18.6	19.7	19.5	20.8	17.9	20.1	18.9
95th percentile	18.0	18.5	20.7	21.0	21.5	21.9	24.0	20.0	22.5	21.5
Korean Reference[a]	15.3	15.6	15.6	16.1	16.6	17.4	18.4			
US white[b]	14.3	15.0	15.7	16.4	17.0	17.7	18.4			
US black[b]	13.8	14.6	15.3	16.0	16.7	17.4	18.1			
Italian[c]	15.5	15.9	16.5	17.1	17.8	18.5	19.1			

a : Korean reference BMI(Median value) for children by age and sex, which suggested by Korean Pediatric Society(1999), b : US median BMI value for children by age and sex, which suggested by NHANES I study(Must et al. 1991), c : Central Italian median BMI value for children by age and sex(Falorni et al. 1998)

ence increased with age in both boy and girl groups. Age-specific mean BMI also increased with age, ranging from 15.9kg/m^2 to 18.3kg/m^2 for boys and 15.3kg/m^2 to 18.2kg/m^2 for girls. However age-specific mean PIBW showed narrow range from 104.1 to 108.8 for boys. As for PIBW of girls, the mean value decreased sharply from age 11. PIBW for girls at age 11 and age 12 were significantly lower than for boys according to Wilcoxon rank sum test($p<0.05$). There were no statistically significant differences between boys and girls' age-specific anthropometric results and BMI.

The 5th, 15th, 25th, 50th(median), 75th, 85th, and 95th percentile values of BMI for boys and girls are reported in Table 3. The percentile values of BMI tended to increase as age increased in both sexes. The 85th age and sex specific percentile for boys ranged from 17.2kg/m^2 to 21.5kg/m^2. The 85th percentile for boys, aged 6 – 12 years was 19.8kg/m^2. The 95th age and sex specific percentile for boys ranged from 18.1kg/m^2 to 24.2kg/m^2, and mean 95th percentile for boys was 22.5kg/m^2. For girls, the 85th age and sex specific percentile ranged 16.8kg/m^2 to 20.8kg/m^2. The mean 85th percentile for girls was 18.9kg/m^2. The 95th age and sex specific percentile for girls ranged 18.0kg/m^2 to 24.0kg/m^2, and mean 95th percentile for girls was 21.5kg/m^2. In comparison with the Korean children reference median values of BMI, suggested by the Korean Pediatric Society(1999), our data were similar except at age 12. Our subject median BMI values for 12 year old boys and girls were slightly lower than the Korean age and sex specific referencing BMI. When compared to NHANES I results(Must et al. 1991), the median BMI value changes by age of Korean children were similar to those of American white or black children. However, the median BMI of Korean children was lower than those of central Italian children(Falorni et al. 1998).

Table 4 demonstrates that children BMI could be predicted from PIBW, age, and sex, through multiple regression, resulting in the prediction equation.

For 6-12 year-old children : BMI=-4.557+0.157×PIBW+0.550×Age+0.062×Sex(girl=1, boy=0)

For 6-9 year-old children : BMI=-2.016+0.156×PIBW+0.254×Age-0.376×Sex(girl=1, boy=0)

For 10-12 year-old children : BMI=-8.670+0.163×PIBW+0.843×Age+0.552×Sex(girl=1, boy=0)

From the above equation, the BMI for boys, aged 6-12 years was 0.062 kg/m^2 lower than for girls. One year of age increased BMI to 0.55 kg/m^2, on the average.

The prevalence rate of overweight and obesity based on PIBW are shown in Table 5. In boys, the prevalence of overweight and obesity tended to increase with age. In all boy subjects aged 6-12 years, 15.8% of them were estimated to be overweight and 15.0% of them were estimated to be obese, based on PIBW. In girls, the prevalence of overweight and obesity tended to decrease with age. In the age 6 girl group, 21.4% of girls were found to be overweight and 4.8% of them to be obese. The prevalence of overweight decreased steadily to 9.5% in the 12-year-old girl groups. The increase in prevalence of obesity in girls, was followed by a decrease, with a plateau ranging between 8 to 10-year-olds. Therefore in 6-9 year old children, the prevalence of overweight was lower for boys(13.6%) than for girls(16.4%), whereas the prevalence of obesity was higher for boys(12.6%) than for girls(11.6%). In 10-12 year olds, the prevalence of overweight and obesity for girls was much lower than for boys. The prevalence of overweight and obesity based on PIBW was higher than the prevalence based on the BMI cut-off point, which defined overweight as the 85th percentile and obesity as the 95th percentile, based on NHANES I study(Must et al. 1991).

Comparisons of BMI according to sociodemographic factors of the subjects are shown in Table 6. Boys showed significantly higher BMI than girls($p<0.001$). Older children had significantly higher BMI than younger children($p<0.000$). BMI was not significantly different with reference to child order. However BMI of children was affected by number of children in family, only child had significantly higher BMI when two or more children were in the family. The higher risk of childhood obesity in only child has been reported previously(Jacoby et al. 1975 ; Ravelli & Belmont 1979). Overprotection and overfeeding are the probable mechanisms leading to obe-

Table 4. Parameter estimates for the multiple regression model assessing the relation between Body Mass Index(BMI) and percent ideal body weight(PIBW) after adjusting age and sex of the children

Variables	b	SE	T	P
Model 1(All), Model R^2=0.862				
Intercep	-4.577	0.187	-24.530	0.000
PIBW	0.157	0.001	112.882	0.000
Age	0.550	0.108	51.029	0.000
Sex(girl=1, boy=0)	0.062	0.038	1.608	0.108
Model 2(Age 6-9), Model R^2=0.961				
Intercep	-2.016	0.138	-14.662	0.000
PIBW	0.156	0.001	170.353	0.000
Age	0.254	0.013	20.154	0.000
Sex(girl=1, boy=0)	-0.376	0.023	-16.378	0.000
Model 3(Age 10-12), Model R^2=0.812				
Intercep	-8.670	0.559	-15.504	0.000
PIBW	0.163	0.002	69.564	0.000
Age	0.843	0.042	19.973	0.000
Sex(girl=1, boy=0)	0.552	0.070	7.883	0.000

b(Regression coefficient) SE(Standard error)

Table 5. Distribution of underweight, normal weight, overweight, and obesity based on PIBW according to sex and age of the children

Group(PIBW) \ Age	Boys									
	6yr	7yr	8yr	9yr	10yr	11yr	12yr	6-9yr	10-12yr	All(6-12yr)
Underweight(< 90)	6.3	3.8	4.4	9.6	4.3	10.4	13.4	5.9	9.2	7.5
Normal weight(90=<110)	71.9	76.1	63.2	64.4	59.1	54.4	51.6	68.0	55.2	61.7
Overweight(110<=<120)	15.6	12.5	16.2	11.3	17.8	18.1	18.3	13.6	18.1	15.8
Obesity(120<=)	6.3	7.6	16.2	14.7	18.8	17.1	16.7	12.6	17.5	15.0
Group(PIBW) \ Age	Girls									
	6yr	7yr	8yr	9yr	10yr	11yr	12yr	6-9yr	10-12yr	All(6-12yr)
Underweight(< 90)	9.5	8.4	7.8	10.1	11.0	26.1	31.8	8.8	22.4	15.4
Normal weight(90<= <110)	64.3	63.2	62.7	63.5	59.3	58.0	49.2	63.2	55.7	59.6
Overweight(110<= <120)	21.4	20.5	14.2	13.5	14.4	10.1	9.5	16.4	11.5	14.0
Obesity(120<=)	4.8	7.9	15.2	12.9	15.3	5.9	9.5	11.6	10.4	11.0

Table 6. Comparisons of BMI according to sociodemographic characteristics of children

Variables	Mean±SEM	P
Sex Boys	17.2±0.1	0.001
Girls	16.7±0.1	
Age 6 yrs	15.5±0.2	0.000
7 yrs	15.9±0.1	
8 yrs	16.5±0.1	
9 yrs	16.5±0.1	
10 yrs	17.4±0.1	
11 yrs	17.7±0.1	
12 yrs	18.3±0.2	
Child order, 1st	17.2±0.1	0.124
2nd	16.9±0.1	
3rd	17.0±0.2	
4th or over	16.6±0.3	
N. of children in family		0.038
1	17.3±0.2	
2	16.9±0.1	
3	16.9±0.1	
4 or over	16.6±0.2	
Parent's obesity		0.001
Father : BMI≥25.0	17.3±0.2	
BMI<25.0	16.5±0.2	
Mother : BMI≥25.0	17.1±0.3	0.029
BMI<25.0	16.8±0.2	
Mother's occupation		0.000
Yes	17.2±0.1	
No	16.9±0.1	
Parent's education level		0.607
Father : Primary	17.2±0.5	
Middle school	17.1±0.1	
High school	16.9±0.1	
College or over	16.8±0.2	
Mother : Primary	17.3±0.3	0.721
Middle school	17.0±0.1	
High school	17.0±0.1	
College or over	17.0±0.2	
Monthly household income(won)		0.306
Less than 500,000	17.0±0.1	
500,000 - 799,999	16.9±0.1	
800,000 - 999,999	17.0±0.1	
1,000,000 - 1,499,999	17.0±0.1	
1,500,000 - 1,999,999	17.2±0.1	
Over 2,000,000	17.3±0.1	

Statistical analysis by student t-test or Kruskal-Wallis k sample test

sity. As reported by Jacoby et al.(1979), intakes of animal protein and fat were significantly higher in only child than in children of large families. From out results, the father's occupation had not influenced BMI in their children, but mother's employment showed a strong correlation with higher BMI values. Parent's education level

Table 7. Multiple regression model assessing the relation between Body Mass Index(BMI) and indicated sociodemograpic variables after adjusting age and sex of the children

Independent variables	b	SE	T	P
Model R^2=0.184				
Intercep	5.568	0.842	6.615	0.000
Number of children in family	-0.301	0.099	-3.045	0.002
Child order	-0.187	0.115	-1.618	0.105
BMI of father	0.166	0.023	7.120	0.000
BMI of mother	0.197	0.022	8.712	0.000
Employment of mother	0.227	0.032	0.413	0.000
Household income	0.002	0.001	1.368	0.171
Father's education level	-0.018	0.100	-0.181	0.856
Mother's education level	0.175	0.001	1.668	0.096

b(Regression coefficient), SE(Standard error)

and monthly household income level had not changed children's BMI. Family income has been found to be related to childhood obesity, but the socioeconomic risk group is still contradicting. Data from the Ten-State Nutrition Survey(TSNS) in the United States, and results from Thailand demonstrated that children from the higher socioeconomic status(SES) group had greater overweight than those from the lower SES group(American Academy of Pediatrics 1976 ; Mo-suwan & Geater 1996). By comparison, Booth et al.(1999) reported findings of higher prevalence of obesity among lower SES class children in Australia. Multiple regression analysis also showed that presence of another children in the family and mother's employment had a strong correlation to children's BMI, after adjusting genetic factors such as sex, age, and parent's BMI(Table 7).

In this study we used the two-stage cluster sampling method. This sampling approach, while convenient, had the disadvantage of reducing the effective sample size. Individuals within a cluster were more likely to have similar socioeconomic backgrounds compared with individuals selected at random. This reduction in sample randomization was taken into account in the sample size calculations. Even though these results are not from a representative population group of Korea, they suggest the sex and age specific BMI distribution information for a sample of Korean children. The findings also identify genetic as well as environmental influences on obesity in Korean children. These could use to plan intervention programs against childhood obesity in Korea.

Conclusion

BMI of Korean children increased as age increased in both sexes, especially in boys. From the age and sex specific BMI percentile distribution, the 85th and 95th percentiles of BMI for boys from 6-12 years of age were 19.8kg/m^2 and 22.5kg/m^2, respectively, and those for girls were 18.9kg/m^2 and 21.5kg/m^2, respectively. The prevalence of overweight and obesity, based on percent ideal body weight, increased successively for boys, with the highest in 10 to 12-year-olds. However, for girls, the prevalence of overweight tended to decrease with increase of age. Sex, age, and parent's BMI influenced BMI values of children. Moreover, the number of children in a family and mother's employment were important predictors for children's BMI values, and thereby enable to plan preventive programs to be focused on high risk groups. Even though these results are not from a representative population group of Korea, they nevertheless do supply meaningful sex and age specific BMI distribution information for a sample of Korean children and additionally, provide meaningful information on the relative effects of sociodemographic influences on BMI in Korean children.

References

American Academy of Pediatrics(1976) : Trends in fatness and origins of obesity. *Pediatrics* 59(3) : 443-456

Booth ML, Macaskill P, Lazarus R, Baur AL(1999) : Sociodemographic distribution of measures of body fatness among children and adolescents in New South Wales, Australia. *Int J Obes* 23(5) : 456-462

Deurenberg P, Ge K, Hautvast JGAJ, Jingzhong W(1997) : Body mass index as predictor for body fat : Comparison between Chinese and Dutch adult subjects. *Asia Pacific J Clin Nutr* 6(2) : 102-105

Deurenberg P, Weststrate JA, Seidell JC(1991) : Body Mass Index as a measure of body fatness : age and sex specific prediction formulas. *Brit J Nutr* 65(1) : 105-114

Falorni A, Galmacci G, Bini V, Papi F, Molinari D, De Giorgi G, Faraoni F, Celi F, Di Stefano G, Barioli MG, Contessa G, Bacosi ML(1998) : Fasting serum leptin levels in the analysis of body mass index cut-off values : are there useful for overweight screening in children and adolescents? A school population-based survey in three provinces of central Italy. *Int J Obes* 22(12) : 1197-1208

Garrow JS, Webster J(1985) : Quetelet's index(W/H2) as a measure of body fatness. *Int J Obes* 9(1) : 147-153

Guo SS, Roche AF, Chumlea WC, Gardner JD, Siervogel RM(1994) : The predictive value of childhood body mass index value for overweight at age 35y. *Am J Clin Nutr* 59(4) : 810-819

Han BH, Kim DH, Park YK, Lee JO, Kim HS(1995) : Incidence and complications of obesity in pubescent school children. *J Korean Pediatric Soc* 38(4) : 500-528

Hawk L, Brook C(1979) : Influence of body fatness in childhood on fatness in adult life. *Brit Med J* 278(1) : 151-152

Hims JH, Dietz WH(1994) : Guidelines for overweight in adolescent preventive services : recommendations from an expert committee. *Am J Clin Nutr* 59(2) : 307-316

Jacoby A, Altman DG, Cook J, Holland WW(1975) : Influence of some social and environmental factors on the nutrient intake and nutritional status of school children. *Br J Prev Soc Med* 29(1) : 116-120

Korean Pediatric Society(1999) : 1998 Korean Children and Adolescent Growth Standard Chart. Kwangmoonchulpansa, Seoul, Korea

Macdonald SM(1999) : Obesity : World wide prevalence and trends. *Healthy Weight J* 13(6) : 84-86

Maes HHM, Neale MC, Eaves LJ(1997) : Genetic and environmental factors in relative body weight and human adiposity. *Behav Genet* 27(3) : 325-351

Mo-Suwan L, Geater AF(1996) : Risk factors for childhood obesity in a transitional society in Thailand. *Int J Obes* 20(8) : 697-703

Must A(1996) : Morbidity and mortality associated with elevated body weight in children and adolescents. *Am J Clin Nutr* 63(suppl) : s445-s447

Must A, Dallal GE, Dietz WH(1991) : Reference data for obesity : 85th and 95th percentiles of body mass index(wt/ht2) and triceps skinfold thickness. *Am J Clin Nutr* 53(4) : 839-846

Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH(1992) : Long term morbidity and mortality of overweight adolescents. *N Eng J Med* 327(6) : 1350-1355

National Institutes of Health Consensus Development Conference Statement(1985) : Health implications of obesity. *Ann Intern Med* 103(6) : 1073-1077

Nieto FJ, Szklo M, Comstock GW(1992) : Childhood weight and growth rate as predictors of adult mortality. *Am J Epidemiol* 136(2) : 201-213

Parsons TJ, Power C, Logan S, Summerbell CD(1999) : Childhood predictors of adult obesity : a systematic review. *Int J Obes* 23(suppl 8) : s1-s107

Ravelli GP, Belmont L(1979) : Obesity in nineteen-year-old men : family size and birth order associations. *Am J Epidemiol* 109(1) : 66-70

Rosenbaum M, Leibel RL(1988) : Pathophysiology of childhood obesity. *Adv Pediatr* 35(1) : 73-138

Sobal J, Stunkard AJ(1989) : Socioeconomic status and obesity : a review of the literature. *Psychol Bull* 105(2) : 260-275

Stunkard AJ, Harris JR, Pederson NL, McClearn GE(1990) : The body mass index of twins who have been reared apart. *N Eng J Med* 322(4) : 1483-1487