

Prevalence of overweight and obesity in children aged 6–13 years—alarming increase in obesity in Cracow, Poland

Aneta Bac · Renata Woźniacka · Stanislaw Matusik ·
Joanna Golec · Edward Golec

Received: 15 April 2011 / Accepted: 14 June 2011 / Published online: 7 July 2011
© The Author(s) 2011. This article is published with open access at Springerlink.com

Abstract This study in children aged 6–13 years ($n=1,499$) was performed between October 2008 and March 2009. Height and weight measurements were taken to calculate BMI. The prevalence of overweight and obesity was determined by means of IOTF cut-offs with respect to age. Alarming is the fact that the percentage of obese children in Cracow increased dramatically from 1.04% in boys and 0.20% in girls in 1971 to 7% in boys and 3.6% in girls in 2009. In this report, a higher percentage of overweight boys was observed in rural boys (28.14%) than in urban ones (27.31%). Obesity was identified in an almost twice as high percentage of urban boys (7.78%) as in rural ones (3.52%). A higher percentage of overweight girls was registered in rural areas (16.49%) than in urban ones (16.09%). Obesity was prevailing in rural girls (4.12%) relative to their urban counterparts (3.44%). The highest number of overweight

urban boys was diagnosed in the group of 12-year-olds ($n=48$) and rural boys in the group of 10-year-olds ($n=39$), as well as in urban girls aged 11 ($n=17$) and rural girls aged 9 ($n=9$). The highest number of obesity was observed in rural boys aged 12 ($n=3$) and in urban boys aged 9 and 10 ($n=9$ in both groups). In the group of girls, obesity prevailed in urban 9-year-olds ($n=5$) and in rural 7-year-olds ($n=5$). **Conclusions:** Overweight and obesity affect boys almost twice as frequently as girls. Obesity is twice as frequent in urban boys as in their rural peers.

Keywords Children · Overweight · Obesity · Urban · Rural

Introduction

The prevalence of adult overweight and obesity has been increasing all over the world. This tendency has been observed for over 30 years [14]. In the United States, in the years 1980 and 2002, the number of obese people above 20 years of age doubled [18]. In Thailand, in the period 1991–2004, the incidence of overweight in adult men increased from 13% to 22.4%, whereas in women the value rose from 23.2% to 34.3% [1]. Unfortunately, the problem of progressive overweight and obesity affects children as well. In the United States, in the years 1980–2002, the prevalence of overweight in children and adolescents tripled [18]. In Germany, the data collected in the years 1985–1997 (Arbeitsgemeinschaft Adipositas im Kindesund Jugendalter 2000) show that the prevalence of overweight in children increased twice [14]. Subsequently, German children and adolescent health surveys (KIGGS 2006) carried out in children aged 3–17 years revealed the prevalence of overweight in 15% of the examined cases out of which 6.3% were diagnosed as obese [14]. In

A. Bac · J. Golec · E. Golec
Orthopedics Rehabilitation Department,
Faculty of Motor Rehabilitation,
The Bronisław Czech University of Physical Education,
Kraków, Poland

R. Woźniacka (✉)
Department of Anatomy, Faculty of Motor Rehabilitation,
The Bronisław Czech University of Physical Education,
Al. Jana Pawła II 78,
31–571 Kraków, Poland
e-mail: renatawozniacka@wp.pl

S. Matusik
Statistic and Computer Science Division,
The Bronisław Czech University of Physical Education,
Kraków, Poland

E. Golec
Traumatic Surgery and Orthopedics Clinic, 5th Military Clinical
Hospital and Policlinic, Independent Public Healthcare Facility,
Kraków, Poland

Thailand, in the group of children aged 6–12 years, the incidence of overweight rose from 5.8% in 1997 to 6.7% in 2001 [1].

In some of the European countries, the percentage of children diagnosed as overweight and obese is high. However, this tendency is different depending on the country. The highest rates of obesity are observed in eastern and southern European countries [13]. In Malta and southern Italy overweight or obesity are diagnosed in 35% of children, whereas the same conditions are observed in 15% of cases in Scandinavia and in 12% in the Netherlands [15].

In the year 2000, a research that was carried out in Cracow, the third largest city in Poland, revealed that overweight and obesity were identified in 15.13% of boys and 11.79% of girls. During the 1971–2000 period, a gradual increase in overweight and obesity in children aged 7–18 years ($n=3,733$) was observed. The most remarkable increase was registered in boys aged 7–12 ($n=859$) and in girls aged 7–10 ($n=483$) [6].

In many countries, including Poland, a gradual increase in the number of overweight and obese children was an incentive to carry out a research in order to determine the extent of adiposity in the young population. In Cracow, such a study was performed in a group of children aged 6–13, inhabitants of the city proper as well as neighbouring rural areas. The purpose was to estimate the prevalence of overweight and obesity in preschool and school children with reference to gender and place of residence.

Material and method

At the end of 2008 and the beginning of 2009, a sample of 1,499 children aged 6–13 years, residences of Cracow and neighbouring rural areas, was selected. The examined group consisted of 748 boys (549 urban and 199 rural ones) and 747 girls (553 urban and 194 rural ones). The group of rural subjects comprised the children between the ages of 7 and 12 years. The urban research group encompassed 6-year-olds and 13-year-olds. The measurements were taken according to the Martin-Saller method [17]. The measurement of weight and height allowed the calculation of body mass index (BMI) for every examined child.

$$\text{BMI} = \text{weight (kilogrammes)}/\text{height (metres)}^2$$

The BMI is widely used to evaluate the incidence of overweight and obesity. In the case of adults, the ratio above 25 kg/m² indicates overweight and above 30 kg/m²—obesity. [14]

BMI values estimated in children differ depending on gender and age of the examined subjects but the correlation

is not the same as in adults [21]. Therefore, as far as children are concerned, it is best to use cut-off points applicable for children and adolescents that correspond with their age and gender. In the examination performed the prevalence of overweight and obesity in children was determined by means of the International Obesity Task Force cut-offs with respect to age [8]. This method is applied in many international research centres. It allows for a comparison of the results of the authors' own research with the data provided in worldwide publications.

Additionally, overweight and obesity values in girls were determined according to age groups corresponding with the degree of sexual maturity. They were divided into two age groups: childhood (7–10 years) and early adolescence (11–13 years). Taking into consideration the difference in the pubertal progress in boys and girls, the division allows for other age categories: childhood and early adolescent. The examined subjects were grouped according to the criteria established by Chrzanowska et al. [6].

Statistical analysis

Sex-related differences in all anthropometric indicators were analysed by the Student's *t* test. The chi-square test was used to determine the differences between groups. The significance level was 0.05.

The Mann–Whitney–Wilcoxon test (also called the Wilcoxon rank-sum test or *W* test) was used to determine whether the medians of the BMI in boys and girls included in data sets were equal. It was used instead of the Student's *t* test in a case of non-normal distributions of variables.

Results

The comparison of body height in the examined subjects did not reveal any statistically significant differences in

Table 1 Median values, ranges, mean values and standard deviation of weight and height in all boys and girls

	All				
	Number	Med.	Ranges	Mean	SD
Boys	748				
Height [cm]		140.0	103.5–177.0	139.9	12.9
Weight [kg]		35.0	16.1–106.5	37.3	11.58
Girls	747				
Height [cm]		138.8	103.3–170.7	139.2	13.9
Weight [kg]		33.8	16.1–83.0	35.5	11.19

Med. median values, *SD* standard deviation

Table 2 Median values, ranges, mean values and standard deviation of weight and height in boys and girls from urban and rural areas

	Urban					Rural				
	Number	Med.	Ranges	Mean	SD	Number	Med.	Ranges	Mean	SD
Boys	549					199				
Height [cm]		140.1	103.5–172.2	140.7	13.3		138.5	116–177	139.8	11.6
Weight [kg]		35.5	16.1–106.5	37.5	11.8		34	20.8–79.6	36.7	10.9
Girls	553					194				
Height [cm]		138.6	103.3–170.7	138.9	14.3		139.3	115–169	139.8	12.5
Weight [kg]		33.7	16.1–83	35.56	11.7		34.7	17.7–65.3	35.18	9.63

Med. median values, SD standard deviation

gender groups and in place of residence groups. In terms of BMI, girls significantly differed from boys ($p < 0.01$). The differences in body mass in gender groups with respect to place of residence were not statistically significant. Mean values, median values and standard deviation of weight and height in gender groups and in place of residence groups are presented in Tables 1 and 2.

Descriptive statistics of BMI in the group of boys and girls was presented in Tables 3 and 4. Median values, ranges, mean values and standard deviation were shown with respect to gender and place of residence depending on age categories of the examined children.

The Wilcoxon test was used to compare BMI values in age categories with reference to place of residence. Changes were not statistically significant.

On the basis of BMI values obtained in the examined group, overweight and obese children were distinguished. The classification was done following the IOTF criteria [8]. Table 5 presents overweight and obesity in boys. The results were put forward separately for urban and rural children. The prevalence of overweight in the groups of urban and rural boys is not statistically significant. A slightly higher percentage of overweight boys was observed in rural ones (28.14%). In the case of urban boys, those overweight were diagnosed in 27.31% of the examined subjects. On the other hand, obesity was observed in almost twice as high percentage of urban boys (7.78%) as in rural ones (3.52%). This difference is statistically significant ($p = 0.05$).

The prevalence of overweight and obesity in the group of girls according to age and place of residence was shown in Table 6. A higher percentage of girls diagnosed as overweight was observed in rural areas and equalled 16.49% as opposed to 16.09% in the case of urban girls. Obesity was also prevailing in a higher number of rural girls and was 4.12% as opposed to 3.44% in urban girls. The prevalence of overweight and obesity in the group of girls was not statistically significant.

The highest number of overweight boys was diagnosed in the group of 12-year-olds regardless of place of residence. Half of the 12-year-old rural boys were overweight, while in the case of their urban peers the number was 48. The incidence of overweight in 12-year-olds was almost twice as high as in the remaining age groups. However, it must be mentioned that in the group of 13-year-old boys the number of overweight children decreases remarkably and totalled nine subjects. In 12-year-old rural boys, the number of obesity was also the highest and

Table 3 Median values, ranges, mean values and standard deviation of BMI in all examined groups

Age	All				
	Number	Med.	Ranges	Mean	SD
Boys	748	17.87	13.1–38.2	18.62	3.29
6	33	16.46	14.4–19.7	16.51	1.34
7	94	16.59	13.2–24.4	17.16	2.22
8	108	17.46	13.1–26.4	17.65	2.37
9	116	17.34	13.3–27.0	18.11	2.69
10	103	17.87	13.7–34.7	19.18	3.60
11	108	18.56	13.8–34.3	19.13	3.47
12	137	19.49	14.2–38.2	20.13	3.80
13	49	19.28	13.8–30.8	19.87	3.52
Girls	747	17.39	11.9–32.0	17.86	2.92
6	35	16.05	13.4–28.4	16.80	2.70
7	83	16.00	11.9–23.3	16.37	2.36
8	119	16.18	13.4–27.3	16.75	2.28
9	97	17.14	13.4–25.5	17.53	2.55
10	113	17.42	13.4–28.8	17.77	2.62
11	134	17.84	13.6–26.8	18.30	3.21
12	118	19.05	14.5–32.0	19.43	2.85
13	48	19.21	15.3–27.8	19.86	3.12

Med. median values, SD standard deviation

Table 4 Median values, ranges, mean values and standard deviation of BMI in boys and girls from urban and rural areas

Age	Urban					Rural				
	Number	Med.	Ranges	Mean	SD	Number	Med.	Range	Mean	SD
Boys	549	17.95	13.1–38.2	18.68	3.36	199	17.72	13.9–33.7	18.44	3.09
6	33	16.46	14.4–19.7	16.51	1.34	–	–	–	–	–
7	63	16.39	13.2–24.4	17.31	2.52	31	16.96	13.9–19.4	16.85	1.49
8	72	17.07	13.1–26.4	17.57	2.57	36	17.63	14.5–23.6	17.80	1.98
9	85	17.47	13.3–27.0	18.40	2.93	31	17.03	14.4–20.9	17.28	1.70
10	64	17.90	13.7–34.7	19.32	3.85	39	17.76	15.3–30.5	18.93	3.22
11	78	18.55	13.8–34.3	19.17	3.52	30	18.56	14.4–30.8	19.03	3.46
12	106	19.54	14.2–38.2	19.93	3.69	32	19.16	15.1–33.7	20.71	4.21
13	48	19.28	13.8–30.8	19.72	3.58	–	–	–	–	–
Girls	553	17.60	12.6–32.0	18.03	3.01	194	17.23	11.9–27.0	17.68	2.61
6	35	16.05	13.4–28.4	16.80	2.70	–	–	–	–	–
7	53	16.16	12.6–20.8	16.25	1.97	30	15.84	11.9–23.3	16.59	2.94
8	89	16.45	13.4–27.3	16.75	2.25	30	16.02	13.9–22.4	16.71	2.41
9	67	16.91	13.4–25.5	17.53	2.68	30	17.43	13.5–22.2	17.53	2.26
10	80	17.22	13.4–28.8	17.58	2.74	33	17.65	14.2–23.7	18.22	2.31
11	96	18.06	13.8–26.7	18.50	3.46	38	17.19	13.6–26.8	17.78	2.40
12	85	19.17	14.5–32.0	19.58	2.91	33	18.59	15.5–27.0	19.04	2.68
13	48	19.21	15.3–27.8	19.86	3.12	–	–	–	–	–

Med. median values, SD standard deviation

equalled three cases. The highest number of obese urban children ($n=9$) was observed in 9- and 10-year-olds.

The examination did not register such big differences in the prevalence of overweight in urban girls as it did in the case of boys. The highest number of overweight girls was observed in 11-year-olds ($n=17$) and the lowest in 6-, 10- and 13-year-olds ($n=9$ in all three age categories). The highest number of obese urban girls was in the group of 9-year-olds ($n=5$). Noticed remarkable changes in the prevalence of overweight and obesity depending on the age was registered in rural girls. The highest number of overweight children was in the group of 9-year-olds and it equalled nine subjects. However,

no instances of obesity were registered. In 7-year-olds, the number of obese girls was higher than that of overweight children and totalled five and four cases, respectively.

Taking into consideration the degree of sexual maturity, the incidence of obesity was more frequent in younger children regardless of the gender. A higher percentage of overweight was also registered in younger children with the exception of urban girls.

The greatest difference in overweight incidence in the examined sample was observed in gender groups. Regardless of place of residence, a higher percentage of overweight children was in the group of boys. Obesity was more prevalent

Table 5 Prevalence of overweight and obesity in boys based on IOTF criteria [8] by place of residence and age

Age	Urban			Rural		
	Number	OW(n)	OB(n)	Number	OW(n)	OB(n)
6	33	7	0	–	–	–
7	63	12	8	31	9	0
8	72	20	6	36	10	1
9	85	20	9	31	5	0
10	64	16	9	39	10	2
11	78	19	3	30	6	1
12	106	48	6	32	16	3
13	48	9	2	–	–	–
Total	549	151 (27.31%)	43 (7.78%)	199	56 (28.14%)	7 (3.52%)
Childhood	501	142	41	199	56	7
Early adolescent	48	9	2	–	–	–

IOTF International Obesity Task Force, OW(n) number of overweight, OB(n) number of obesity

Table 6 Prevalence of overweight and obesity in girls based on IOTF criteria [8] by place of residence and age

Age	Urban			Rural		
	Number	OW(<i>n</i>)	OB(<i>n</i>)	Number	OW(<i>n</i>)	OB(<i>n</i>)
6	35	9	2	–	–	–
7	53	10	2	30	4	5
8	89	12	2	30	5	1
9	67	10	5	30	9	0
10	80	9	2	33	7	0
11	96	17	4	38	2	1
12	85	14	1	33	5	1
13	48	9	1	–	–	–
Total	553	90 (22.2%)	19 (3.8%)	194	32 (16.49%)	8 (4.12%)
Childhood	324	50	13	123	25	6
Early adolescent	229	40	6	71	7	2

IOTF International Obesity Task Force, *OW(n)* number of overweight, *OB(n)* number of obesity

in urban boys in comparison with other groups in which the values were similar (Fig. 1).

Discussion

Overweight and obesity pose a serious social and health problem in many developed and developing countries [2, 9, 19]. Despite economic, social, cultural and religious differences among them, overweight and obesity are becoming a widespread issue common for all infrequently distant countries.

The authors’ own research on the incidence of overweight and obesity that was carried out in 2009 in the group of children from Cracow diagnosed 28% of boys as overweight and 7% as obese. In girls, 16.2% were overweight and 3.6% obese. Comparing the authors’ own results with the ones acquired on the basis of a research project performed in three cycles in Cracow in 1971, 1983 and 2000 [6] a distinct increase in the prevalence of overweight and obesity in children and adolescents can be observed. In the years 1971–

2000, the incidence of overweight and obesity in children from Cracow doubled from 7.5% to 15.2% in boys and from 6.5% to 11.8% in girls. The results obtained in 2009 revealed a further increase in the percentage of overweight and obese children reaching 35% in boys (28% overweight (OW) and 7% obesity (OB)) and almost 20% in girls (16.2% OW and 3.6% OB) [6]. A higher percentage of obese children regardless of the gender of the examined subjects was observed in younger groups (6–12 years of age in boys and 6–10 years in girls). Similar correlations are found in the publication by Jebb et al. [11] or Chrzanowska et al. [6]. Alarming is the fact that the percentage of obese children increased dramatically from 1.04% in boys and 0.20% in girls in 1971 to 7% in boys and 3.6% in girls in 2009 [6]. A quick increase in the prevalence of obesity has been observed in Germany [14]. During the period of 2003–2006, the number of children diagnosed as obese doubled. Similarly, disturbing statistics are reported by Zimmerman et al. [23]. In Switzerland in the years 1990–2002, the percentage of obese children aged 6–12 years increased from 0.61% to 3.8% in boys and from 0.8% to 3.7% in girls.

On the basis of a continuous research within China Health and Nutrition Survey performed on school children and carried out in eight provinces in the years 1991–1997, the occurrence of obesity depending on the place of residence was determined. In urban areas, the incidence of overweight increased from 7.7% to 12.4%, whereas in rural areas the increase was lower and changed from 5.9% to 6.4% [22]. Chrzanowska and Łaska-Mierzejewska [7] analysed the prevalence of overweight and obesity in girls living in rural areas in four regions of Poland. They observed that the incidence of overweight and obesity had increased by 7.4% in the years 1987–2001.

Many authors seek the causes of an increasing prevalence of overweight and obesity in economic and cultural changes that have taken place in Poland following the emergence of a

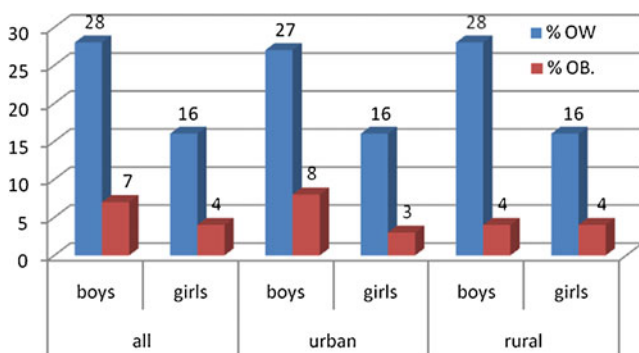


Fig. 1 Prevalence of overweight and obesity in gender groups by place of residence

free market economy as well as in the media influence and nutritional changes, mainly a growing fast food availability [3, 12]. An increase in the occurrence of overweight and obesity in children since 2000 has been partly connected with subsequent changes that followed the accession of Poland to the European Union and the opening of borders. People in big cities such as Cracow have experienced a visible improvement in the standard of living and have become attracted to a more consumptive lifestyle which may lead to the growing prevalence of overweight and obesity. The paper of Jebb and Lambert [10] stressed that the data on overweight and obesity in children and adolescents are dominated by studies in Northern and Western Europe and that their values are closest to US data due to a similar economic level of those countries. At the same time, authors showed that in the available literature there are few reports from European countries with lower economic status. Our research presents data from Eastern Europe which complement the knowledge on the prevalence and trends of overweight and obesity in European children and adolescents.

In the authors' own research, overweight and obesity reach higher values in the group of boys. The earlier research performed on the population of Cracow confirms this observation although the differences were not as big as in 2009. In children from Warsaw, overweight was twice as frequent in boys as in girls [4]. In the Czech Republic, another East European country which has undergone the process of transformation in recent years, the situation is the same as in Poland [20]. In Hungary, obesity was more common in men but at the same time more women were diagnosed as overweight [2].

In countries such as China [21, 22] and Thailand [1], the incidence of overweight and obesity is more frequently observed in boys than in girls, whereas in the United Arab Emirates there are more girls diagnosed as overweight and obese [16]. In western countries with high economic status, the tendency is opposite [5, 11].

Conclusions

The research performed and the analysis of the findings permit the conclusion that overweight and obesity occur in a remarkably high percentage of children in Cracow, particularly in younger age groups. Overweight and obesity are almost twice as frequent in boys as in girls. The differences related to place of residence are small and statistically insignificant excepting obesity which occurs twice as frequently in urban boy as in their rural peers ($p=0.05$).

A gradual increase in prevalence of overweight and obesity has been observed in Cracow since 1971. A

dramatic increase in obesity, registered in the authors' own research in the studies carried out in various centres all over the world, is particularly alarming.

Open Access This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author(s) and source are credited.

References

1. Aekplakorn W, Mo-Suwan L (2009) Prevalence of obesity in Thailand. *Obes Rev* 10(6):589–592
2. Antal M, Peter S, Biro L, Nagy K, Regöly-Merei A, Arato G, Szabo C, Martos E (2009) Prevalence of underweight, overweight and obesity on the basis of body mass index and body fat percentage in Hungarian schoolchildren: representative survey in Metropolitan Elementary Schools. *Ann Nutr Metab* 54:171–176
3. Bielicki T, Szklarska A, Kozieł S, Welon Z (2003) Transformacja ustrojowa w Polsce w świetle antropologicznych badań 19-letnich mężczyzn. Wrocław: Monographs of Institute of Anthropology, Polish Academy of Sciences 23:62–69
4. Charzewska J, Chabros E, Jajszczyk B, Rogalska-Niedźwiedz M, Chwojnowska Z (2004) Wysokość ciała młodzieży z Warszawy na tle kolejnych okresów ekonomii. In: Kaczanowski K, Bergman P, Charzewska J, Piechaczek H (eds) *Trendy sekularne na tle zmian cywilizacyjnych*. AWF, Warszawa, pp 75–84
5. Chinn S, Rona RJ (2001) Prevalence and trend in overweight and obesity in three cross sectional studies of British Children 1974–94. *Br Med J* 322:24–26
6. Chrzanowska M, Kozieł S, Ulijaszek SJ (2007) Changes in BMI and the prevalence of overweight and obesity in children and adolescents in Cracow, Poland, 1971–2000. *Econ Hum Biol* 5:370–378
7. Chrzanowska M, Łaska-Mierzejewska T (2009) Nadwaga i otyłość w populacji dziewcząt wiejskich w Polsce—zmiany w okresie 1987–2001. *Anthropol Rev suppl* 6:30
8. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 320:1240–1243
9. de Assis MAA, Rolland-Cachera MF, Crosseman S, de Vescocelos FAG, Luna MEP, Calvo MCM, Barros MVG, Pires MMS, Bellisle F (2005) Obesity, overweight and thinness in schoolchildren of the city of Florianopolis, Southern Brazil. *Eur J Clin Nutr* 59:1015–1021
10. Jebb SA, Lambert J (2000) Overweight and obesity in European children and adolescents. *Eur J Pediatr* 159(Suppl 1):2–4
11. Jebb SA, Rennie KL, Cole TJ (2003) Prevalence of overweight and obesity among young people in Great Britain. *Public Health Nutrition* 7(3):461–465
12. Kozieł S, Welon Z, Bielicki T, Szklarska A, Ulijaszek S (2004) The effect of the economic transition on the body mass index of conscripts in Poland. *Econ Hum Biol* 2:97–106
13. Livingstone B (2000) Epidemiology of childhood obesity in Europe. *Eur J Pediatr* 159(Suppl 1):14–34
14. Lob-Corzilius T (2007) Overweight and obesity in childhood—a special challenge for public health. *Int J Hyg Environ Health* 210:585–589
15. Lobstein T, Baur L, Uauy R (2004) Childhood obesity in children and young people: a crisis in public health. Report to the world health organization. *Obes Rev* 5(suppl 1):4–85

16. Malik M, Bakir A (2007) Prevalence of overweight and obesity among children in the United Arab Emirates. *Obes Rev* 8(1):15–20
17. Martin R, Saller K (1957) *Lehrbuch der Anthropologie*. Fischer, Stuttgart
18. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM (2006) Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA* 295(13):1549–1555
19. Rolland-Cachera MF, Castetbon K, Arnault N, Bellisle F, Romano MC, Lehingue Y, Frelut ML, Herberg S (2002) Body mass index in 7-9-y-old French children: frequency of obesity, overweight and thinness. *Int J Obes* 26:1610–1616
20. Vignerova J, Humenikova L, Brabec M, Riedlova J, Blaha P (2007) Long-term changes in body weight, BMI, and adiposity rebound among children and adolescents in the Czech republic. *Econ Hum Biol* 5:409–425
21. Wang Y, Wang JQ (2002) A comparison of international references for the assessment of child and adolescent overweight and obesity in different populations. *Am J Clin Nutr* 56:973–982
22. Zhou H, Yamauchi T, Natsuhara K, Yan Z, Lin H, Ichimaru N, Kim SW, Ishii M, Ohtsuka R (2006) Overweight in urban schoolchildren assessed by body mass index and body fat mass in Dalian, China. *J Physiol Anthropol* 25(1):41–48
23. Zimmermann MB, Gubelli C, Püntener C, Molinari L (2004) Overweight and obesity in 6–12 years old children in Switzerland. *Swiss Med Wkly* 134:523–528