Eur J Nutr 42 : 165 – 170 (2003)
DOI 10.1007/s00394-003-0407-5

ORIGINAL CONTRIBUTION

Sabine Verwied-Jorky
Andreas Sönnichsen
Jürgen Weineck
Berthold Koletzko

Height and weight of German primary school children in the Family Intervention Trial (FIT) Erlangen

Received: 19 June 2002
Accepted: 20 January 2003

S. Verwied-Jorky · A. Sönnichsen · Berthold Koletzko, MD, PhD (✉)
Div. Metabolic Diseases and Nutritional Medicine
Dr. von Haunersches Kinderspital
Ludwig-Maximilians-University of Munich
Lindwurmstr. 4
80337 München, Germany
Tel.: +49-89/51 60-39 67
Fax: +49-89/51 60-33 36
E-Mail: bkoletz@helios.med.uni-muenchen.de

J. Weineck
Institute of Sports and Sport Sciences
University of Erlangen
Erlangen, Germany

Summary Many anthropometric reference data for children are based on studies conducted up to 40 years ago. We assessed height and weight distribution of a population of German primary school children and compared the results with national and international reference data. In February 1998 weight and height were measured in 427 first grade school children (195 boys, 232 girls) aged 6 to 7 years who participated in the family intervention trial Erlangen. Compared to studies in the 1980s, weight showed a marked but height only a minimal increase. Mean weight-for-height is similar to previously published reference data, but upper percentile values are much higher. Mean weight-for-height and the proportion of overweight children are similar for children of German and of foreign origin. We conclude that overweight and obesity have clearly increased in primary school children in recent years.

Key words weight – height – overweight – ethnic differences – primary school children

Introduction

Anthropometric parameters are an important indicator of health and nutritional status of children [1, 2]. Many of the available national and international reference data for children are based on studies of the 1960s and 1970s. A secular trend was apparent in the 1960s and 1970s with an increase of height and weight in school-age children [3–5], which has been related in part to nutrition in early childhood. It is less clear whether this secular trend has continued in recent years in industrialized countries [5]. In many western societies the relation of weight-for-height has changed with an increase of overweight children [6, 7].

The aim of the present study is to describe the height and weight distribution of 6 and 7 year old first grade primary school children of the city of Erlangen who participated in a prospective preventive health trial and to compare them with other national and international surveys. The data of the German children were compared to those children of other ethnic origin in Erlangen.

Methods

Subjects

At the start of the school year 1997/98 (September) parents and teachers of the first graders from all primary schools in Erlangen were informed by letter and personally at parents' meetings about the study. Prerequisition for a study participation was the children's verbal agreement as well as an informed written consent by the parents.

The study was approved by the ethical review board of the Bavarian College of Physicians, by the local school authority and by the Bavarian State Department for Education.

Anthropometric measurements

Measurements were performed in February 1998 by trained observers in each primary school between 08.00–09.30 a. m. Standing height was measured without shoes to the nearest 0.5 cm using a calibrated measuring board. Body weight was determined to the nearest 0.2 kg using a precision electronic scale (TBF 305, Tanita Corp. Sindelfingen, Germany). Subjects were weighed in light clothes (without shoes, pants, sweaters) which was accounted for by subtraction of 0.6 kg from the measured weight.

Anthropometric data were classified by gender, age and height, respectively, for which percentiles, mean and standard deviation (SD) were calculated using SPSS 6.1.3 Chicago, Illinois, USA. The normality of data distribution was evaluated by the Kolmogorov-Smirnoff test.

To evaluate gender, age or height specific differences the unpaired Student t-test was performed when data were normally distributed. By deviation from normality the Mann-Whitney rank sum U-test was performed. Statistical significance was accepted when p values were < 0.05 (two-tailed).

For comparison with reference data standard deviation (Z)-scores (SDS) were calculated according to reference data distribution [1, 8, 9]. Z-scores from a subsample of children from Erlangen with foreign nationality were calculated according to the data distribution from the children with German nationality.

Results

In this cross-sectional study, anthropometric data were collected from 41 % (n = 427) of all first grade students from the 16 primary schools located in the city center and in the suburban area of Erlangen. The 195 boys and 232 girls were healthy children aged 6 to 7 years (6.6 ± 0.5 yrs), 78.7 % were children of German parents, and 21.3 % were of foreign nationality.

The socioeconomic structure of the participating families is characterized predominately by a higher middle to upper class assessed by the education and professional status of the father. Some 61.1 % were white collar employees, of these 52 % had an academic education and 25.7 % were in a leading position. 18.2 % of the male adults were blue collar workers, 63.7 % of these were skilled workers. A proportion of 8.1 % worked as civil servants, 8.6 % were self employed and 4 % foremen.

While 12.5 % of all first grade school children of the school year 1997/98 in Erlangen were children of foreign origin [10, 11], the proportion in our sample was almost twice as high. Of the parents of foreign origin who gave information about their origin in the questionnaire, 28.1 % were of Central and Eastern European descent, while 19.5 % were Western European origin, 22.5 % were Asian and 17.3 % Turkish, respectively. The remaining 15.8 % originated mainly from South and North America and the Middle East.

Height and weight

Table 1 describes heights and weights of the study population in percentiles, mean and standard deviation as well as minimum and maximum values. In both age groups height and weight were normally distributed in both genders. There were no significant gender specific differences for weight, while there was only a significant height difference between 7 year old boys and girls.

There was no significant mean difference in height between six year old German and non-German boys; however, seven year old boys of foreign origin were significantly smaller (–0.61 SDS, $p < 0.01$) compared to their German classmates. No significant difference in height was observed in 6 or 7 year old girls of German and foreign nationality (Table 2). Mean weight tended to be slightly higher (n. s.) in six and seven year old children of foreign origin compared to their German classmates (Table 2).

Weight-for-height

For comparison with other studies, gender specific height classification was performed in 5 cm sections with corresponding weight percentiles (Figs. 1 and 2). Data distribution was normal in both genders. There was no significant difference in weight between boys and girls in any height group.

Height related weight tended to be higher in boys and girls of foreign nationality (+ 0.56 SDS and 0.23 SDS, respectively, n. s.) compared to German children. A significant difference ($p < 0.05$) was only observed for foreign boys in height group 2 (at 123 cm) and 4 (at 133 cm) (Table 3). After exclusion of data for foreign children mean weights were reduced about 0.25 kg (0.09 SDS) in boys and about 0.18 kg (0.05 SDS) in girls.

Discussion

This population is taller than children reported some 20 or 30 years ago (Table 4), but height data are similar to other more recent German studies [12, 17]. In contrast, body weight is clearly higher than in various previous studies [2, 12, 14–16], predominantly for the upper percentile values. For instance, 7 year old boys of Erlangen had a mean weight of 32.8 kg at the 90th percentile, while the 90th percentile for boys in the Heidelberg study of

Table 1 Height (cm) and weight for age (kg) percentiles, minimum, maximum, mean and SD for gender and age

	Height (cm)									
Age (y)	N	Min	3rd	10th	50th	90th	97th	Max	x	SD
Boys[a]										
6	62	111.0	111.9	115.0	123.0	128.0	133.1	134.0	122.3	5.2
7	133	114.0	117.0	120.0	127.0	132.0	135.0	138.0	126.4	4.8
Girls[a]										
6	95	113.0	113.0	114.6	122.0	130.0	131.1	132.0	122.2	5.4
7	137	112.0	115.0	118.0	125.0	132.0	134.8	137.0	125.0*	5.3
	Weight (kg)									
Age (y)	N	Min	3rd	10th	50th	90th	97th	Max	x	SD
Boys[c]										
6	62	17.1	17.5	18.9	23.2	29.6	33.1	34.0	23.6	3.6
7	133	19.2	20.0	21.3	25.0	32.8	38.4	40.0	26.1	4.4
Girls[b]										
6	95	16.8	17.2	18.0	22.6	29.0	33.3	42.2	23.3	4.4
7	137	17.0	18.1	19.8	25.0	30.8	37.1	41.4	25.2	4.5

height: [a] $p < 0.001$: t-test between six and seven year old boys and girls; * $p < 0.05$: gender specific differences of each age (t-test)
weight: [b] $p < 0.01$; [c] $p < 0.001$: t-test between six and seven year old boys and girls

Table 2 Height (cm) and weight for age (kg) percentiles, minimum, maximum, mean and SD for gender, age and ethnicity

	Height (cm)									
Age (y)	N	Min	3rd	10th	50th	90th	97th	Max	x	SD
Boys – German nationality										
6	47	111.0	111.4	115.0	123.0	128.2	132.6	133.0	122.0	5.3
7	106	117.0	118.4	121.0	127.0	132.3	135.0	138.0	127.0	4.6
Boys – foreign nationality										
6	15	115.0	115.0	115.6	122.0	129.8	–	134.0	123.0	5.2
7	27	114.0	114.0	117.2	124.0	132.4	–	135.0	124.2*	5.4
Girls – German nationality										
6	81	113.0	113.0	114.2	122.0	130.0	130.5	132.0	122.3	5.4
7	102	112.0	114.1	117.3	125.0	132.0	133.9	135.0	124.9	5.5
Girls – foreign nationality										
6	14	114.0	114.0	114.5	121.5	131.0	–	132.0	122.1	5.9
7	35	116.0	116.1	118.6	125.0	131.2	136.8	137.0	125.0	4.9
	Weight (kg)									
Age (y)	N	Min	3rd	10th	50th	90th	97th	Max	x	SD
Boys – German nationality										
6	47	17.1	17.3	18.4	23.4	29.3	32.7	34.0	23.5	3.6
7	106	19.2	20.4	21.4	25.0	32.2	38.0	40.0	26.0	4.3
Boys - foreign nationality										
6	15	19.8	19.8	20.2	22.8	31.4	–	33.0	24.0	3.6
7	27	19.6	19.6	20.2	25.4	35.8	–	38.8	26.3	5.2
Girls – German nationality										
6	81	16.8	17.2	18.0	22.6	28.0	32.7	42.2	23.2	4.3
7	102	17.0	18.1	19.8	24.6	30.8	39.0	41.4	25.1	4.7
Girls - foreign nationality										
6	14	17.6	17.6	18.3	22.4	33.0	–	36.6	23.8	5.1
7	35	18.0	18.1	19.8	25.0	31.5	36.3	36.6	25.4	4.2

height: * $p < 0.01$: Significant differences between nationality and age (t-test)

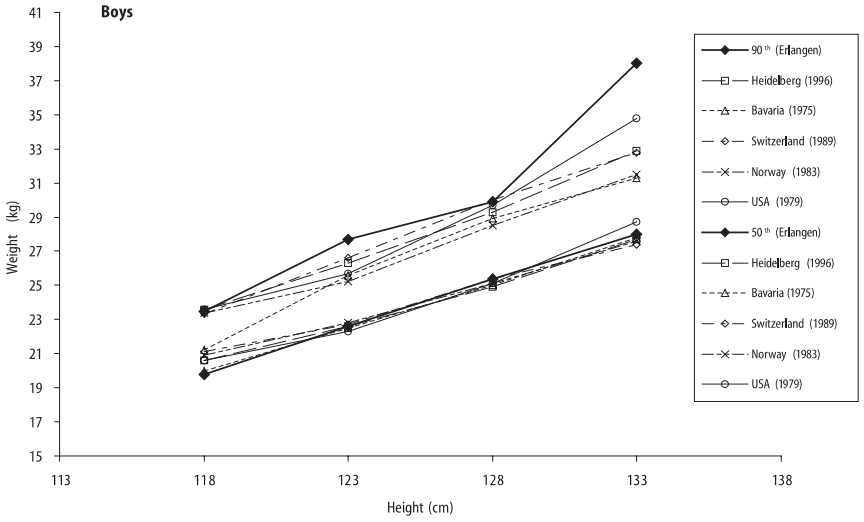

Fig. 1 Comparison of weight-to-height of boys of Erlangen (thick line at the 50th and 90th percentile) with national [3, 12] and international [2, 14, 16] studies (thin lines). Year of publication in parenthesis

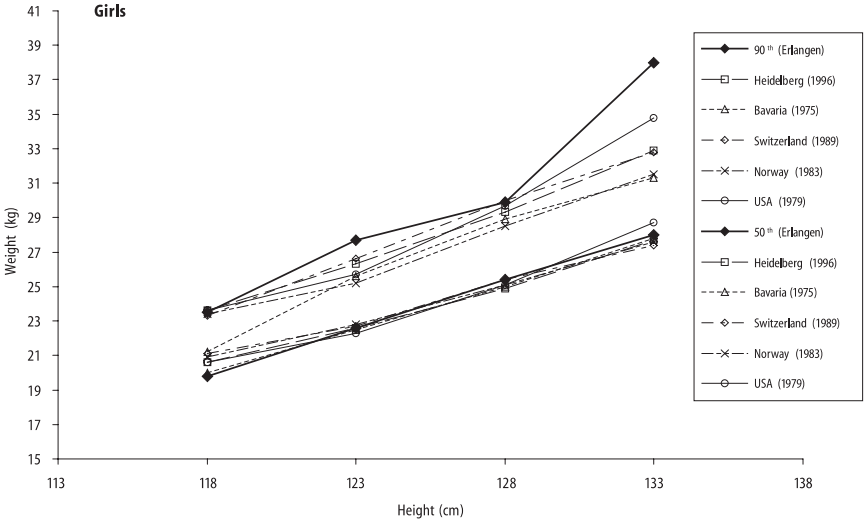

Fig. 2 Comparison of weight-to-height of girls of Erlangen (thick line at the 50th and 90th percentile) with national [3, 12] and international [2, 14, 16] studies (thin lines). Year of publication in parenthesis

1996 [12] was 4.1 kg lower, in the Dortmund study of 1980 [13] 4.4 kg lower, and in international studies [2, 14–16] it was 5.1 kg lower. Even larger is the difference at the upper percentiles [2, 12, 14, 16]. These data show that the secular increase of height and weight in German children continued in the past 25 years (Table 4), and weight also increased markedly in the recent past. Similarly, Kromeyer-Hauschild and Jaeger [17] found a marked increase in weight in children of Jena over the period from 1985 to 1995, with a negligent change of height.

The nutritional status and health of a child is frequently assessed by weight-for-height. The weight-for-height percentiles (Figs. 1 and 2) of the Erlangen children show higher values for the 90th and higher percentiles compared to the previous studies. At a mean height of 133 cm, the 90th weight centile is at 37.8 kg for the children of Erlangen, which is about 3.4 kg heavier than American children in the 1970s [2], 6.8 kg heavier than Swiss children in the 1980s [14] and 4.8 kg higher than the children of Heidelberg in the 1990s [12]. In contrast, median values were similar in the various populations [2, 3, 12, 14, 16]. Thus, the proportion of overweight and obese children has become substantially higher in the population of Erlangen.

Erlangen is a medium-size town with about 100,000 inhabitants in Southern Germany (Bavaria) with a highly industrialized and university structure, which is reflected by a high proportion of qualified professions. Although the study sample represents all social classes, it is likely that the higher proportion of socially privileged families is not consistent with the social structure of other medium or large size cities. This leads us to speculate that the prevalence of overweight might be even higher in some areas in Germany with a lower socioeconomic structure.

Table 3 Weight-for-height (kg/cm) in percentiles and mean and SD for gender, age and ethnicity (Height groups: 1 = < 120 cm, 2 = 120–124.5 cm, 3 = 125–129.5 cm, 4 = > 130 cm)

	Weight (kg)									
	N	Min	3rd	10th	50th	90th	97th	Max	x	SD
Height group	Boys – German nationality									
1	18	17.1	17.1	17.6	19.6	24.3	–	25.0	20.5	2.5
2	47	20.4	20.5	21.0	22.6	25.1	27.7	28.0	22.9*	1.8
3	48	20.8	20.9	22.1	25.0	29.6	32.6	34.0	25.6	2.8
4	40	23.2	23.5	24.9	28.7	36.5	39.7	40.0	29.7*	4.1
Height group	Boys - foreign nationality									
1	7	19.6	19.6	19.6	21.8	–	–	22.8	21.3	1.5
2	15	20.2	20.2	20.3	23.0	30.5	–	33.0	24.4	3.5
3	15	21.4	21.4	21.5	25.2	32.4	–	35.8	25.7	3.7
4	5	30.4	30.4	30.4	33.2	–	–	38.8	34.0	3.4
Height group	Girls - German nationality									
1	42	16.8	16.9	17.3	19.8	23.4	29.0	30.0	20.2	2.7
2	57	18.6	18.8	20.0	22.4	28.1	31.3	32.8	23.2	3.1
3	46	19.4	20.1	21.5	25.3	29.1	32.4	32.6	25.3	2.7
4	38	21.2	21.7	24.4	27.8	39.3	42.1	42.2	29.0	5.1
Height group	Girls - foreign nationality									
1	10	17.6	17.6	17.6	20.0	24.3	–	24.4	20.3	2.1
2	13	19.2	19.2	19.4	23.8	28.4	–	29.4	23.5	2.9
3	19	21.2	21.2	21.4	26.2	32.0	–	36.6	26.6	3.8
4	7	25.0	25.0	25.0	28.8	–	–	36.6	30.0	3.9

* $p < 0.05$: Significant differences of weight-for-height between nationality (t-test)

Table 4 Comparison of data from Erlangen with other German and international reference data: height for age (cm) (mean ± SD) and weight for age (kg) (median). Year or time period of the measurements in parenthesis

Age (y)	Erlangen (1998)	Jena (1995)	Heidelberg (1989–1990)	Dortmund (1968–1978)	Switzerland (1954–1976)	Norway (1971–1974)	USA (1971–1974)	England (1965)
				Height (cm)				
Boys							(median)	(median)
6	122.3±5.2	–	124.5±5.6	118.4±4.3	117.3±4.8	118.7±5.3	116.1	114.6
7	126.4±4.8	125.9±5.4	125.5±5.6	125.1±4.9	123.6±5.2	123.9±5.3	121.7	120.5
Girls								
6	122.2±5.4	–	124.7±5.3	117.9±4.6	115.6±4.3	117.3±4.6	114.6	113.4
7	125.0±5.3	126.7±5.4	125.7±5.4	124.7±4.6	122.0±4.6	123.2±4.9	120.6	119.3
				Weight (kg)				
Boys								
6	23.2	–	22.6	21.6	20.7	21.6	20.7	20.5
7	25.0	24.5	23.6	24.2	23.0	23.6	22.9	22.6
Girls								
6	22.6	–	22.2	21.4	20.4	20.9	19.5	20.4
7	25.0	25.0	22.9	24.1	23.0	22.9	21.8	22.6

In the past two decades, a large immigration of young families from other ethnic groups has occurred in Germany. We observed no significant difference in mean height and weight between children of German origin and the small subsample of foreign nationality. The observed trend for a slightly higher weight-for-height up to the 90th percentile in foreign children compared to German children might result from a lower social status of the foreign families [5]. Moreover the children of foreign origin were mainly born in Germany or came to Germany at a very young age, thus a certain degree of adaption to German lifestyle habits is probable in these young families of foreign nationality [5]. Georgi et al. [12] have investigated Turkish children living in Ger-

many and showed that they differ in mean height-related weight about 0.5 SDS from children of German origin, which is similar to our results.

We conclude that data obtained during the last ten years indicate only minimal changes in height, while the prevalence of overweight and obesity is increasing. In view of serious health consequences of overweight and obesity, the development of effective prevention and treatment strategies of childhood obesity is urgently needed [18].

Acknowledgments We gratefully acknowledge financial support of the Bavarian Ministry for Nutrition, Agriculture and Forestry, Munich, the city of Erlangen and the Child Health Foundation, Munich, which made this investigation possible. We thank the School Administration of Erlangen; the school directors and teachers; all the children and their parents for their support. Furthermore, we thank Anke Ballerstedt from the Institute of Nutritional Sciences, Giessen Germany, for her valuable help measuring anthropometric data and Dr. Wiseman from the Leibniz Computing Center of the Bavarian Academy of Sciences for his statistical support.

References

1. Dibley MJ, Staehling NW, Nieburg P, Trowbridge FL (1987) Interpretation of Z-score anthropometric indicators derived from the international growth reference. Am J Clin Nutr 46:749–62
2. Hamill PVV, Drizd TA, Johnson CL, Reed RB, Roche AF, Moore WM (1979) Physical growth: national center for health statistics percentiles. Am J Clin Nutr 32:607–629
3. Kunze D, van Eimeren W (1975) Aktueller Stand der Akzeleration von Schulkindern in Bayern mit Demonstration eines neu erstellten Somatogramms. Monatsschr Kinderheilkd 123: 489–490
4. Maaser R (1974) Eine Untersuchung gebräuchlicher Längen/Gewichtstabellen – zugleich ein Vorschlag für ein neues Somatogramm 0–14jähriger Kinder. Monatsschr Kinderheilkd 122:146–152
5. Gracey M (1991) Nutrition and physical growth. In: Himes JH (ed) Anthropometric Assessment of Nutritional Status. Wiley-Liss, New York
6. Seidell JC (1995) Obesity in Europe: scaling an epidemic. Int J Obes 19 (suppl 3):S1–S4
7. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL (1994) Increasing prevalence of overweight among US adults. JAMA 272:205–211
8. Dibley MJ, Goldsby JB, Staehling NW, Trowbridge FL (1987) Development of normalized curves for the international growth reference: historical and technical considerations. Am J Clin Nutr 46: 736–48
9. Waterlow JC, Buzina R, Keller W, Lane JM, Nichaman MZ, Tanner JM (1977) The presentation and use of height and weight data for comparing nutritional status of groups of children under the age of 10 years. Bull WHO 55:489–98
10. Schulverwaltungsamt Erlangen. Schulbericht 1997/98. Stadt Erlangen, Erlangen
11. Statistisches Amt der Stadtverwaltung Erlangen. Jahresbericht 1998, Stadt Erlangen
12. Georgi M, Schaefer F, Wühl E, Schärer K (1996) Body height and weight in healthy schoolchildren and adolescents in the Heidelberg region. Monatsschr Kinderheilkd 144:813–824
13. Reinken L, Stolley H, Droese W, van Oost G (1980) Longitudinale Körperentwicklung gesunder Kinder II. Größe, Gewicht, Hautfettfalten von Kindern im Alter von 1,5 bis 16 Jahren. Klin Pädiat 192:25–33
14. Prader A, Largo RH, Molinari L, Issler C (1989) Physical growth of Swiss children from birth to 20 years of age. Helv Paediatr Acta 52 (suppl):1–125
15. Tanner JM, Whitehouse RH, Takaishi M (1966) Standards from birth to maturity for height, weight, height velocity, and weight velocity: British children, 1965. Arch Dis Child 41:613–635
16. Waaler, E (1983) Anthropometric studies in Norwegian children. Acta Paediatr Scand 308 (suppl):1–41
17. Kromeyer-Hauschild K, Jaeger U (1998) Growth studies in Jena, Germany: changes in body size and subcutaneous fat distribution between 1975 and 1995. Am J Hum Biol 10:597–587
18. Koletzko B, Girardet JP, Klish W, Tabacco O (2002) Obesity in children and adolescents worldwide: current views and future directions. J Ped Gastroenterol Nutr 35:S205–S212