ANTHROPOLOGIE • XLI/1–2 • pp. 145–155 • 2003

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DEVELOPMENT OF CHILDREN'S BODY MASS, HEIGHT AND BMI FROM BIRTH TO THE AGE OF FOURTEEN (BASED ON THE HUNGARIAN LONGITUDINAL GROWTH STUDY)

ABSTRACT: The authors give a draft picture on the Hungarian Longitudinal Growth Study. 1,808 boys and 1,743 girls examined at the age of 14 still make not less than 57% of the number at birth (2,984 boys and 2,701 girls).
Reference percentiles and reference mean values are given for the anthropometric data, the evaluation and examination of which is necessary the most often in paediatrician practice. They present percentile curves and mean values for body height (body length) and body mass, partly from birth to the age of 2, partly for the ages between 2–14 years.
Reference percentiles of the body mass index (BMI), serving for the approximate assessment of a child's nourishment, have been depicted from birth to the age of 14.
Reference percentiles of head and chest circumferences are shown for infancy (from birth to the age of 2).

KEYWORDS: Health and demographic survey of pregnant women and infants – Hungarian Longitudinal Growth Study – National representative sample – Body height (length) – Body mass – BMI – Head circumference – Chest circumference – Reference percentiles

INTRODUCTION

Nowadays examining the development of the body and nourishment of a child of a certain age to assess its health state and biological status is considered as a routine. In compliance with this necessity, paediatricians most often examine the height (length) and body mass of children, and more and more often the body mass index (BMI) is also calculated. Examination of the head and chest circumference is also important at the time of infancy.

In this paper we publish the reference data calculated from data taken from the Hungarian Longitudinal Growth Study. Body height (length), body mass and body mass index is shown for the ages between 0–14 years. For infancy (from birth to the age of 2) the head and chest circumference reference data are shown.

The research programme originally aimed to ensure reference data, i. e. standards for paediatricians, school doctors, general practitioners treating children and nurses dealing with the development of children to be able to assess whether body development and nourishment of children comply with their age. In order to meet this requirement we have compiled and are going to show this collection of figures and tables which has been worked out according to the needs of paediatricians for the manual entitled Paediatrical Vademecum (Békefi 2003).

SUBJECTS AND METHODS

The Hungarian Longitudinal Growth Study that our paper is based on is actually the phase of child-growth examination of the research programme entitled 'Health and demographic survey of pregnant women and infants' begun in 1979 (Joubert, Gárdos 1991). Pregnant women having applied for prenatal care between November 1979

and December 1982 on the national representative sample-area have been included in the prenatal-examination phase. Pregnant women, taken into care on the average from the 9th gestation week, have been re-examined and interviewed in the 20th, 27th and 34th weeks and at the end of pregnancy. The phase of the research programme called Longitudinal Growth Study began with the examination and anthropometric measurement of the examined pregnant women's liveborn infants. The re-measurement of children examined in 1980, 1981, 1982, 1983 at the time of infancy on the national representative sample-area took place every 30 days until the age of 6 months, every 60 days until the age of 1 year and every 3 months until the age of 24 months. Afterwards children were re-measured and re-examined on their each birthday until the age of 10 and every 6 months between the age of 10 and 14 (Joubert *et al*. 1996). The examinations were carried out by nurses trained according to the description of Martin (Martin, Saller 1962) and the IPB (Weiner, Lourie 1969), with measuring instruments meeting international requirements.

RESULTS AND EVALUATION

The longer period of life longitudinal growth studies embrace, the more significant the importance and professional value of their results. However, we must take into account that the longer phase of individual development is studied, the more significant disadvantages we have to consider. As the longer a longitudinal growth study lasts, the later its results concerning the whole period can be published. But we also have to take into consideration that the longer a follow-up study lasts, the more the sample number decreases because of dropping out (moving, denial of participation in further examination etc.).

In awareness of all these facts, the sampling of the research programme entitled Hungarian Longitudinal Growth Study, or rather the Health and Demographic Study of Pregnant Women and Infants, was planned. That is why it was necessary to go on sampling pregnant women for further 3 years on the national sample-area of 2%-representativity, thus increasing the original sample number threefold.

After such precedents the numbers of boys and girls included in the sample of the Hungarian Longitudinal Growth Study from birth to the age of 14 are presented in *Figure 1.* The rate of dropping out of the sample till the age of 1 is not more than 7%. By the age of 2 it is doubled (14%). The number of those examined at the age of 10 is 77% of the number examined at birth. It is clearly visible in the figure that the number of the children examined is decreasing more significantly from the age of 10, but at the age of 14 still more than half (56.6%) of the number at birth were examined.

In *Figures 2a* and *2b* reference percentiles of boys' and girls' body length and body mass are shown from birth to the age of 2. In *Figures 3/a* and *3/b* reference percentiles calculated for the period between the age of 2–14 can be seen. In *Tables 1* and *2* the number (n), reference mean values (x) ($\bar{x}$) and standard deviation (SD) of boys and girls are given from birth to the age of 14 (Joubert *et al*. 2003). The case numbers shown in tables are apparently smaller than those in *Figure 1*. The reason for this is that

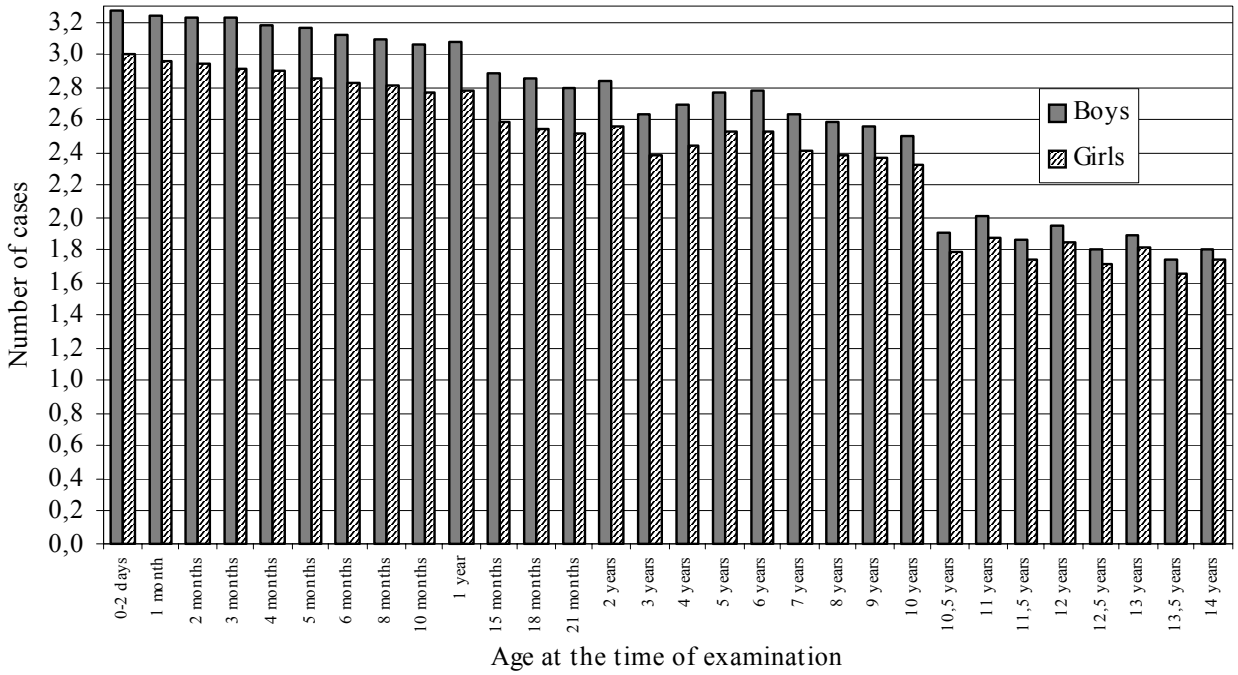

FIGURE 1. Decrease of sample numbers of the Hungarian Longitudinal Growth Study from birth to the age of 14.

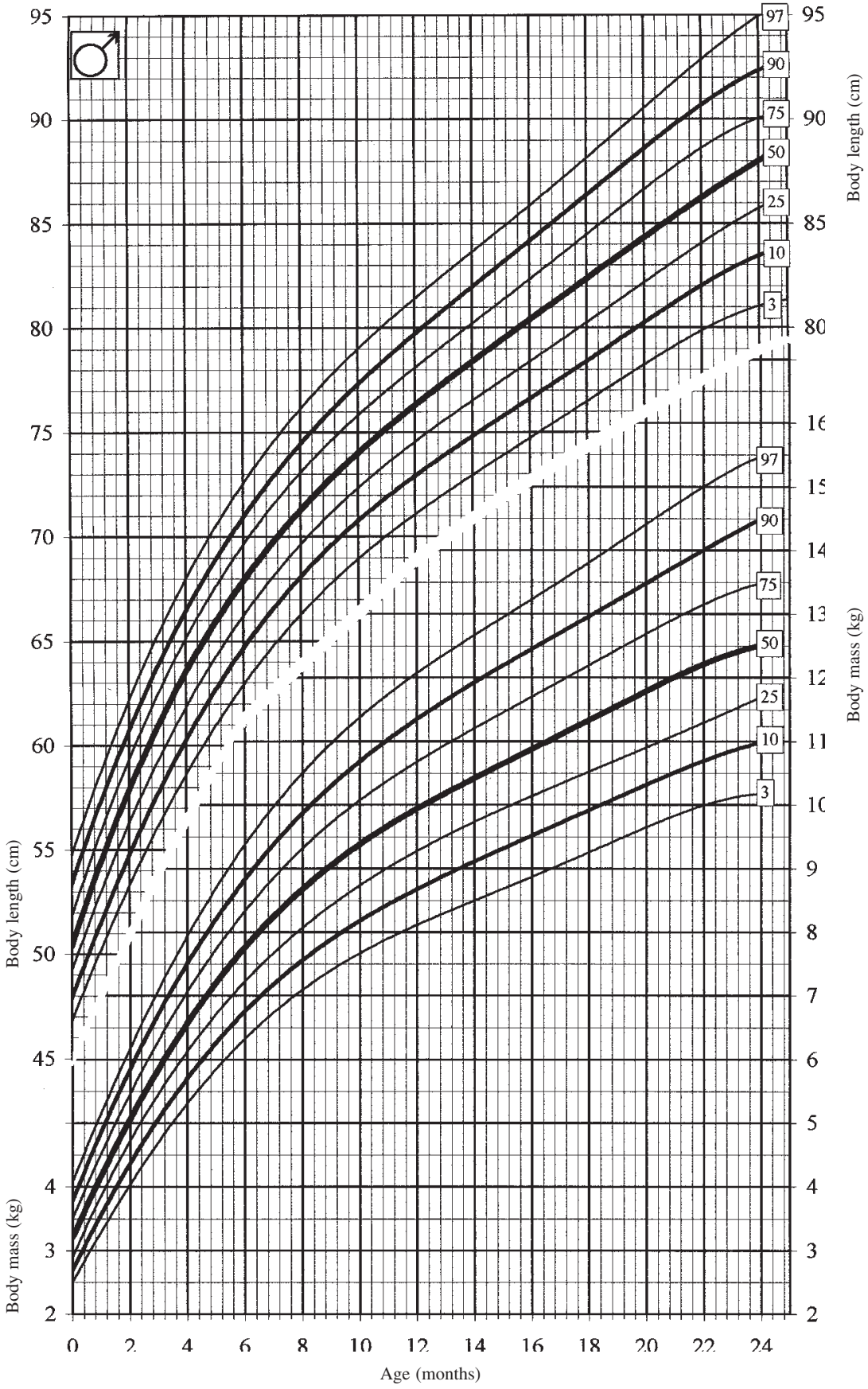

FIGURE 2a. Body length and body mass percentiles of boys from birth to the age of 2.

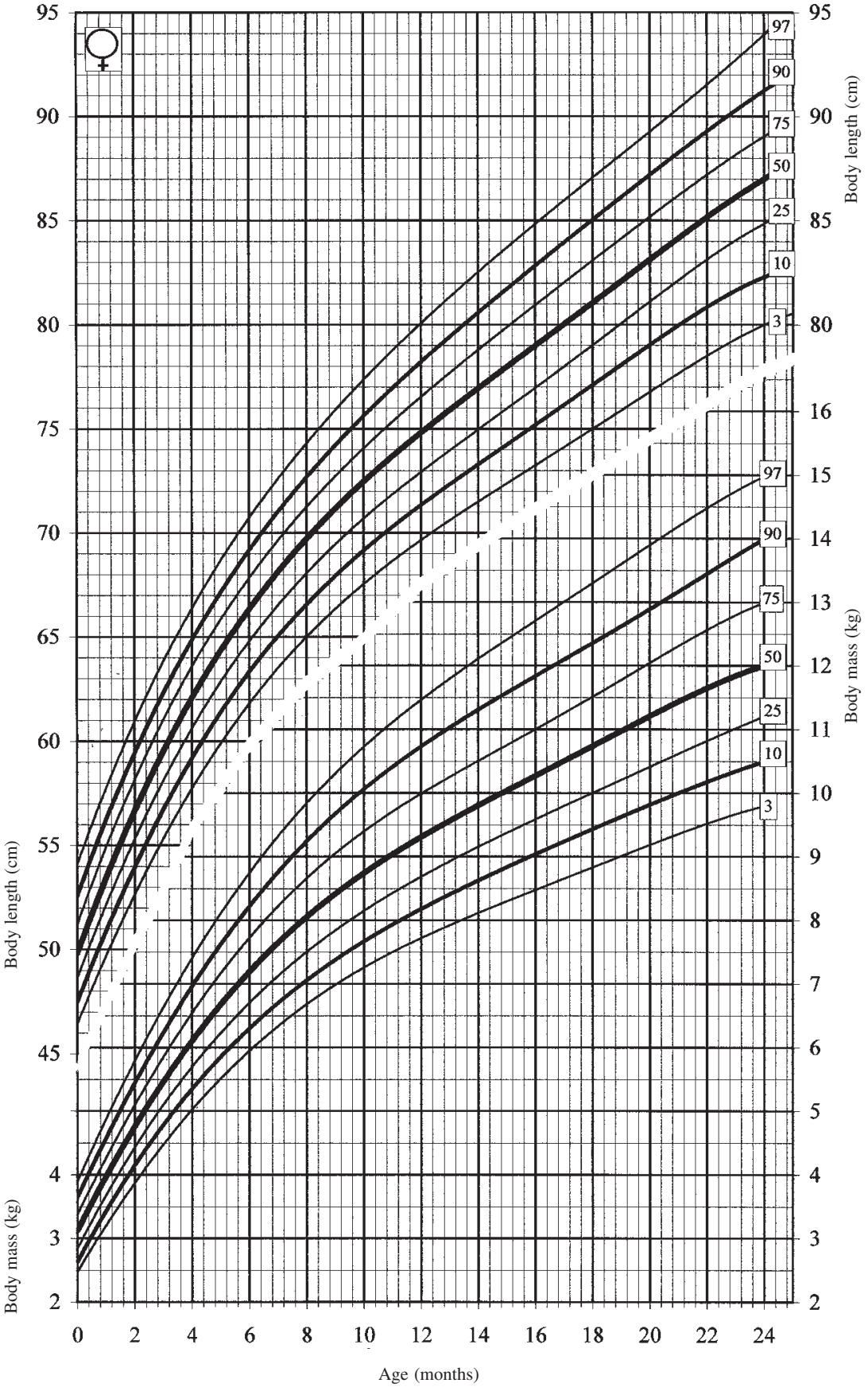

FIGURE 2b. Body length and body mass percentiles of girls from birth to the age of 2.

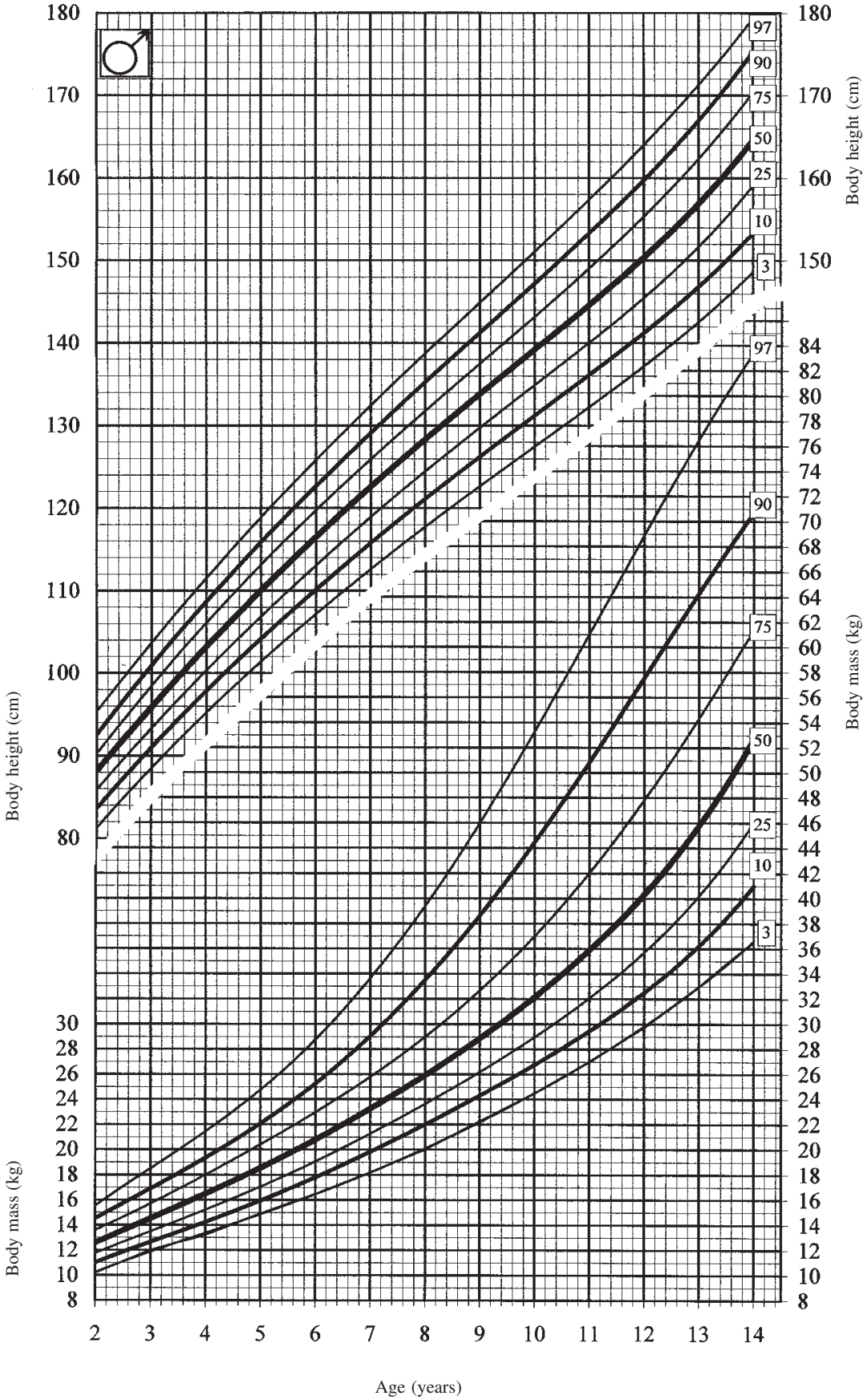

FIGURE 3a. Body height and body mass percentiles of boys between 2–14 years.

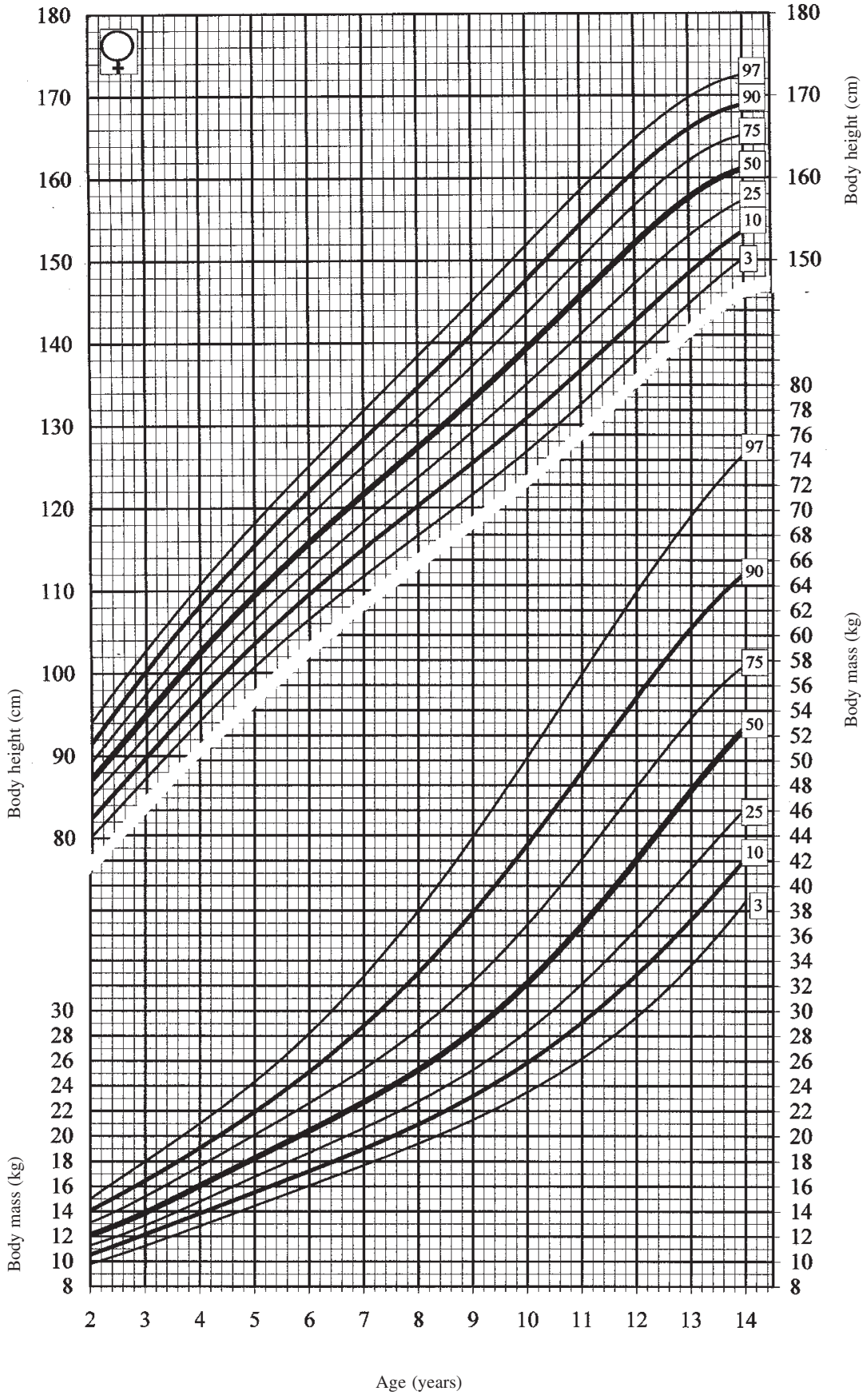

FIGURE 3b. Body height and body mass percentiles of girls between 2–14 years.

TABLE 1. Reference mean values of body height (body length) of boys and girls from birth to the age of 14.

Number of cases N	Standard deviation SD	Mean value $\bar{x}$ (cm)	Age	Mean value $\bar{x}$ (cm)	Standard deviation SD	Number of cases N
	Boys				*Girls*	
2 984	2.18	50.82	0–2 days	50.15	2.07	2 701
2 949	2.22	54.08	1 month	53.30	2.06	2 662
2 938	2.34	57.44	2 months	56.42	2.15	2 653
2 927	2.42	60.74	3 months	59.48	2.25	2 622
2 895	2.49	63.55	4 months	62.15	2.28	2 603
2 869	2.55	66.06	5 months	64.52	2.35	2 577
2 838	2.55	68.19	6 months	66.60	2.45	2 543
2 809	2.63	71.02	8 months	69.42	2.50	2 519
2 789	2.68	73.63	10 months	72.03	2.59	2 480
2 807	2.76	76.28	12 months	74.76	2.68	2 495
2 622	2.98	79.52	15 months	78.09	2.96	2 325
2 597	3.19	82.44	18 months	81.15	3.18	2 294
2 543	3.44	85.21	21 months	84.02	3.37	2 263
2 585	3.60	87.98	2 years	86.88	3.54	2 304
2 351	4.06	96.39	3 years	95.56	4.08	2 094
2 397	4.25	103.06	4 years	102.31	4.25	2 127
2 455	4.66	109.74	5 years	109.07	4.67	2 207
2 469	4.95	116.26	6 years	115.55	4.96	2 209
2 338	5.27	122.70	7 years	122.00	5.29	2 106
2 313	5.61	128.35	8 years	127.64	5.64	2 082
2 277	5.99	133.79	9 years	133.15	5.98	2 074
2 223	6.34	138.99	10 years	138.84	6.51	2 022
1 697	6.38	141.77	10.5 years	142.06	6.68	1 560
1 797	6.68	144.46	11 years	145.48	6.97	1 644
1 665	6.90	147.35	11.5 years	148.83	7.18	1 532
1 750	7.26	150.37	12 years	152.01	7.10	1 618
1 604	7.70	153.57	12.5 years	154.83	6.93	1 501
1 689	7.95	157.06	13 years	157.34	6.66	1 589
1 552	8.14	160.64	13.5 years	159.45	6.36	1 452
1 612	8.08	164.21	14 years	161.11	6.14	1 530

TABLE 2. Reference mean values of body mass of boys and girls from birth to the age of 14.

Number of cases N	Standard deviation SD	Mean value $\bar{x}$ (kg)	Age	Mean value $\bar{x}$ (kg)	Standard deviation SD	Number of cases N
	Boys				*Girls*	
2 990	0.42	3.31	0–2 days	3.20	0.39	2 703
2 949	0.49	4.09	1 month	3.89	0.44	2 662
2 939	0.57	5.05	2 months	4.72	0.49	2 654
2 929	0.64	5.92	3 months	5.49	0.58	2 622
2 898	0.71	6.67	4 months	6.18	0.64	2 604
2 874	0.76	7.30	5 months	6.77	0.70	2 579
2 842	0.82	7.84	6 months	7.29	0.76	2 546
2 815	0.92	8.64	8 months	8.06	0.84	2 522
2 793	0.99	9.35	10 months	8.76	0.92	2 483
2 810	1.07	10.01	12 months	9.42	1.01	2 496
2 625	1.15	10.73	15 months	10.15	1.10	2 326
2 600	1.24	11.41	18 months	10.85	1.21	2 293
2 546	1.33	12.04	21 months	11.49	1.31	2 262
2 590	1.43	12.66	2 years	12.15	1.41	2 307
2 353	1.84	14.82	3 years	14.37	1.84	2 094
2 398	2.17	16.68	4 years	16.30	2.20	2 127
2 455	2.70	18.79	5 years	18.43	2.77	2 206
2 469	3.41	21.24	6 years	20.84	3.48	2 209
2 335	4.19	24.07	7 years	23.56	4.25	2 102
2 306	5.17	27.12	8 years	26.50	5.17	2 077
2 275	6.31	30.42	9 years	29.71	6.12	2 071
2 223	7.65	34.05	10 years	33.33	7.22	2 023
1 691	8.42	36.11	10.5 years	35.46	7.74	1 560
1 794	9.26	38.24	11 years	38.07	8.53	1 642
1 662	10.06	40.61	11.5 years	40.68	9.23	1 532
1 750	10.73	43.00	12 years	43.42	9.62	1 615
1 604	11.33	45.73	12.5 years	45.96	9.67	1 494
1 688	11.79	48.58	13 years	48.50	9.65	1 589
1 550	12.09	51.52	13.5 years	50.70	9.62	1 450
1 616	12.23	54.33	14 years	52.60	9.59	1 526

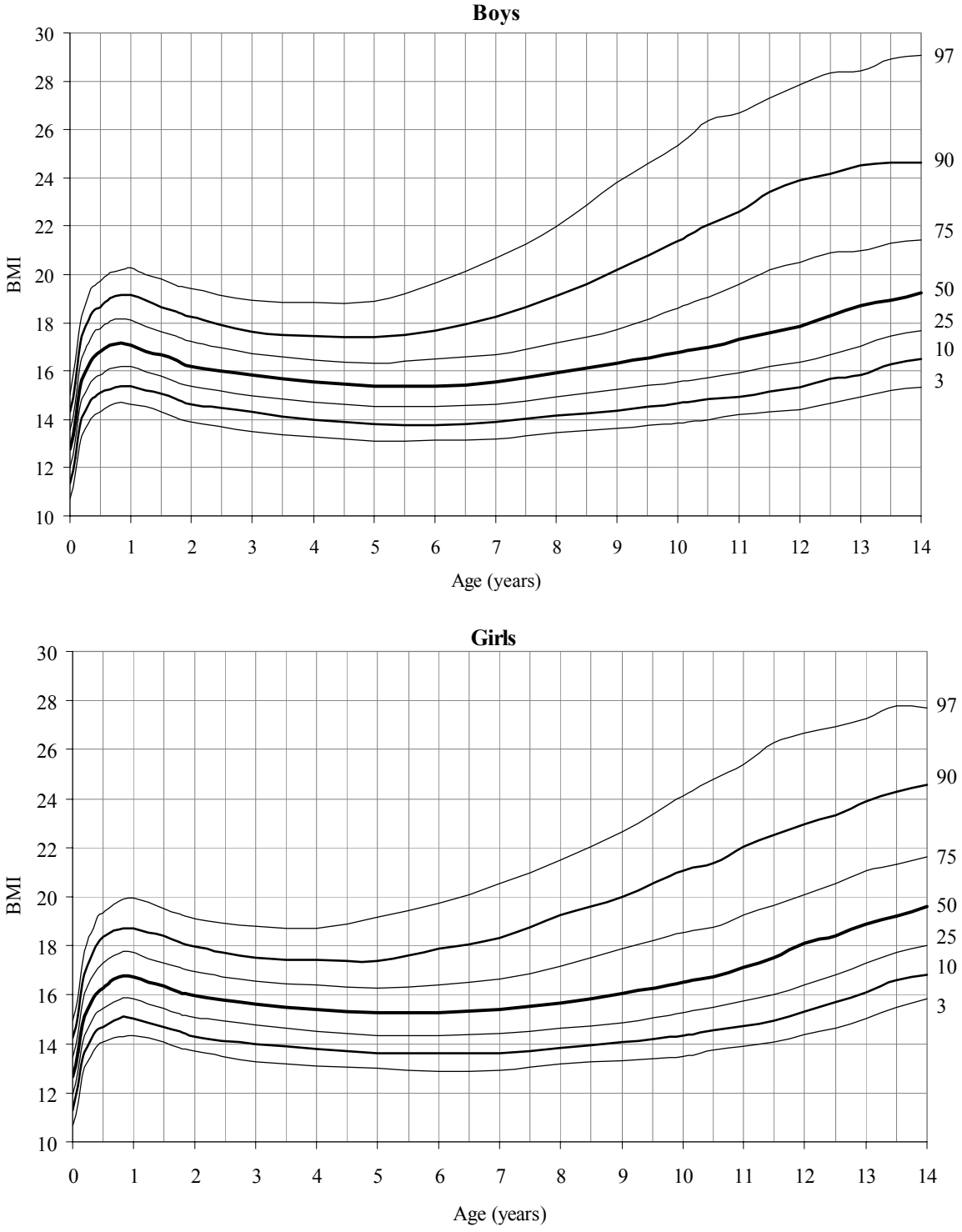

FIGURE 4. Percentile curves of Body Mass Index (BMI) from birth to the age of 14.

only children born with 2,500–4,500 g body mass and those suffering from no diseases affecting growth and development or other chronic illness were included in the reference data collection, with regard to the paediatricians' requirement.

Percentile curves of boys' and girls' body mass index (BMI) are shown in *Figure 4*. In most countries in the world body mass index (BMI) is used for the assessment of adults' nourishment according to the recommendation of the World Health Organisation (WHO). In developed countries the rate of the obese is growing year by year. The health risk of people is growing in parallel with obesity, which means a larger burden not only for individuals but also for the country. Obesity means accumulation of fat more than

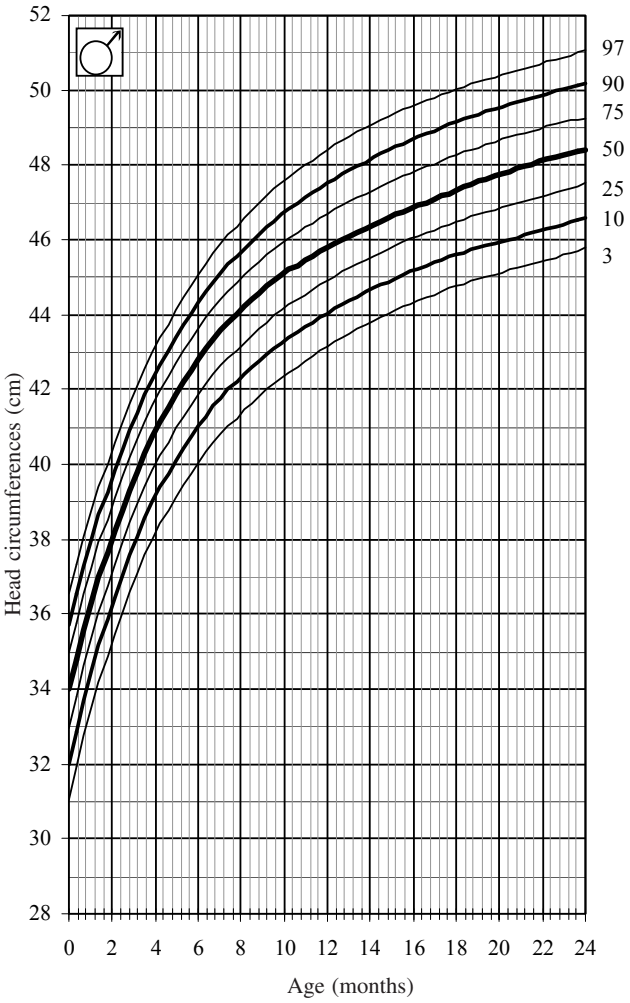

FIGURE 5a. Reference percentiles of boys' head circumferences from birth to the age of 2.

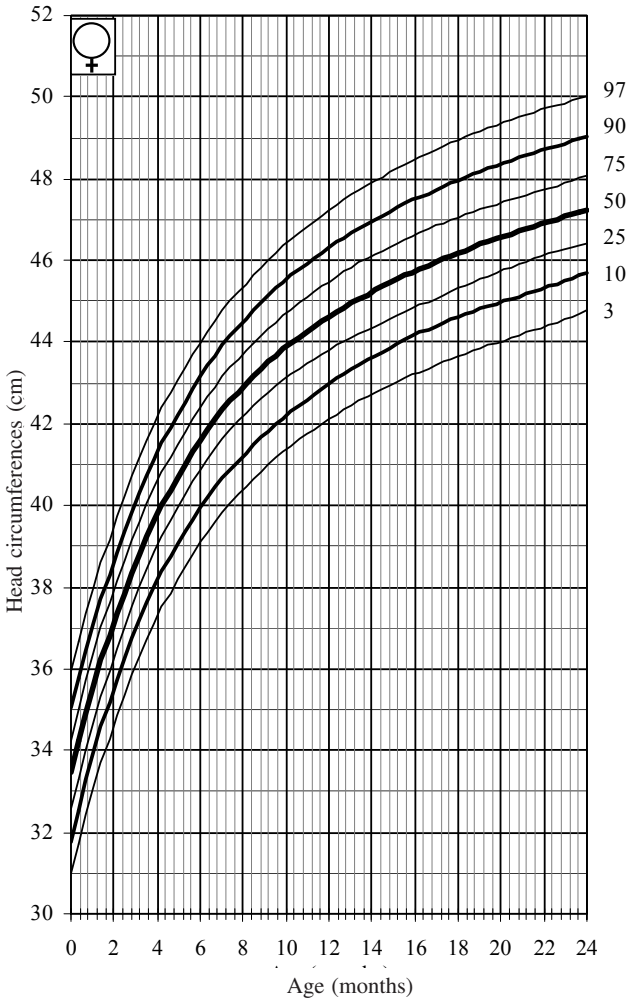

FIGURE 5b. Reference percentiles of girls' head circumferences from birth to the age of 2.

necessary on certain parts of the body. As the exact definition of the quantity of fat requires significant technical and professional expertise, the WHO recommends the calculation of body mass index (BMI = body mass/body height^2, kg/m^2) to assess nourishment and obesity (WHO Feature No. 190, 1996).

In the Commission Report of the European Childhood Obesity Group (ECOG), established in 1991 for the assessment of childhood nourishment, Poskitt (1995) states that the body mass index (BMI) can be used for the comparison of overweight or obesity of children of the same age.

On the basis of this we have worked out the reference percentiles of *Figure 4* based on the Hungarian Longitudinal Growth Study for practising paediatricians and nurses. In the collection for the assessment or monitoring of nourishment, the percentile data are naturally given in a table, too.

It is important to pay attention to head and chest circumferences during infancy and the first life-year of children. In *Figures 5a, 5b, 6a* and *6b* reference percentiles of head and chest circumferences for boys and girls are shown. Since each child has its head and chest circumference gauged at birth, development of both indicators can be tracked upon from birth in percentile figures and table data (that are not shown here for lack of space). Either exceeding or falling short of reference data typical at a certain age significantly requires a careful check-up (Joubert *et al.* 1995, Gárdos *et al.* 1995). It also requires attention if growth intensity of head circumference increases significantly and permanently, or slows down permanently, or even stops. In paediatrician practice, comparison of head circumference and chest circumference is often applied in the first 8 months of life to estimate hydrocephalus. When comparing the two magnitudes it is necessary to note that chest circumference is quite greatly dependent on individual organism (constitution).

SUMMARY

The authors give a draft picture on the Hungarian Longitudinal Growth Study in this paper. They outline the changing numbers of children (boys and girls) included in

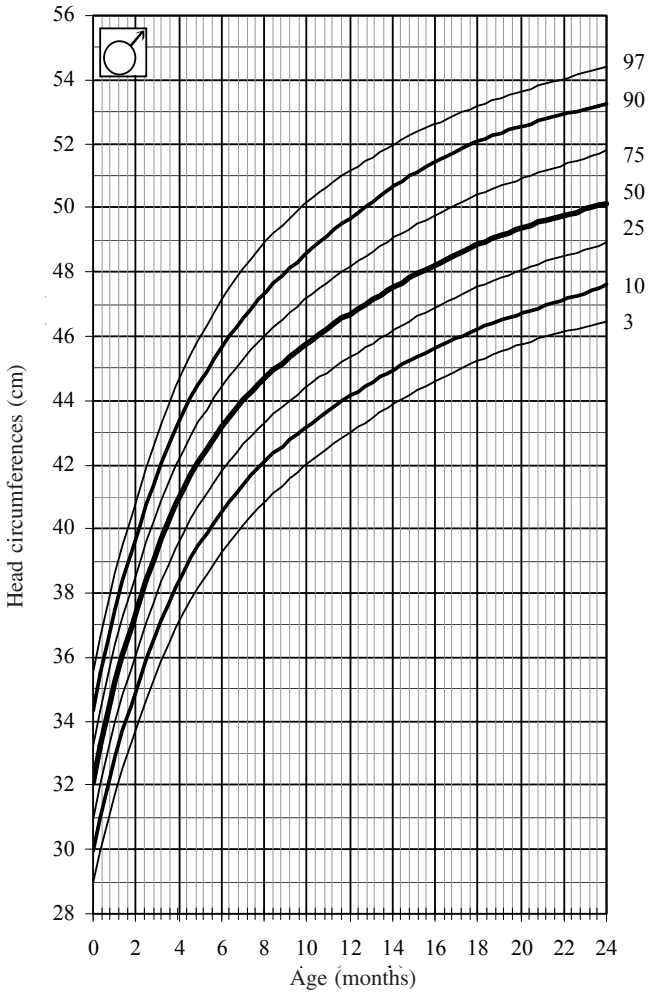

FIGURE 6a. Reference percentiles of boys' chest circumferences from birth to the age of 2.

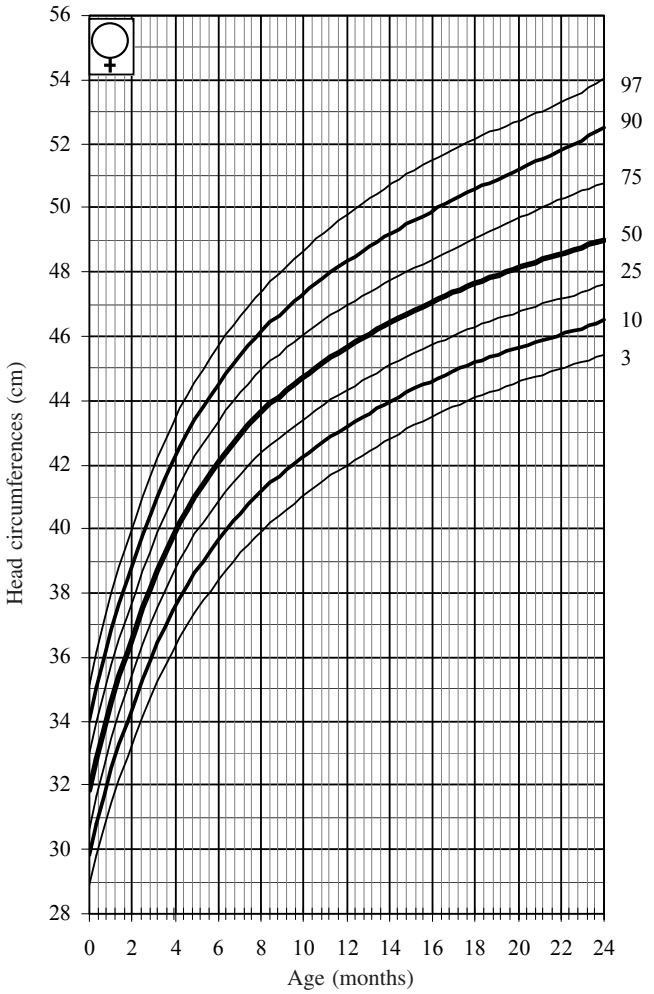

FIGURE 6b. Reference percentiles of girls' chest circumferences from birth to the age of 2.

the sample of the study from birth to the age of 14. The 1,808 boys and 1,743 girls examined at the age of 14 still make not less than 57% of the number at birth.

Reference percentiles and reference mean values are given for the anthropometric data, the evaluation and examination of which is necessary the most often in paediatrician practice. Therefore they present percentile curves for body height (body length) and body mass, partly from birth to the age of 2, partly for the ages between 2–14 years. These help the paediatricians to judge to what extent the body height (body length) and body mass of a child examined correspond with the characteristics of the age group.

Reference percentiles of the body mass index (BMI), serving for the approximate assessment of a child's nourishment, have been depicted from birth to the age of 14.

Reference percentiles of head and chest circumferences are shown for infancy (from birth to the age of 2). These are mainly used for monitoring hydrocephalus and microcephalous.

ACKNOWLEDGEMENTS

The results of the Hungarian Longitudinal Growth Study published here could not have been worked out but without the OTKA T 030795 and T 031822 competitions and the kind support of the National Health Promotion and Development Centre.

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