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ORIGINAL PAPER

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Height, weight, body mass index and pubertal development reference values for children of Turkish origin in the Netherlands

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Abstract The aim of this study was to provide growth and sexual maturation reference data for Turkish children living in The Netherlands. We also compared these references with the reference data of children of Dutch origin and with Turkish reference data collected in Turkey and elsewhere in Europe. Cross-sectional growth and demographic data were collected from 2,904 children of Turkish origin and 14,500 children of Dutch origin living in the Netherlands in the age range 0–20 years. Growth references for length, height, weight for height, body mass index (BMI) and head circumference were constructed with the LMS method. Reference curves for sexual maturation and menarche were estimated by a generalised additive model. Predictive variables for height and BMI were assessed by univariate and multivariate regression analyses. Young Turkish adults were 10 cm shorter than their Dutch contemporaries. Mean height was 174.0 cm for males and 160.7 cm for females. Height differences in comparison with Dutch children started at 3 years. Height SDS was predominantly associated with target height. The height of Turkish children living in the Netherlands was similar to Turkish children in Germany and to children from high socio-economic classes in Istanbul. Compared to Dutch children, maturation stages started 0.5–0.7 years later for both sexes. In girls, median age at menarche was 12.8 years, 5 months earlier than in Dutch girls. BMI of Turkish children was higher than that of Dutch children at all ages. BMI SDS was associated with birth weight and the duration of stay of the mother in the Netherlands. *Conclusion*: Turkish children are considerably shorter and more overweight than Dutch children. Separate growth charts for Turkish children in The Netherlands are useful for growth monitoring.

Keywords Body mass index · Height · Pubertal development · Target height · Turkey

Abbreviations *BMI* body mass index · *SD* standard deviation · *SES* socio-economic status · *TH* target height

Introduction

For optimal growth monitoring, up-to-date reference growth data on representative samples from the population are necessary. In a country of immigration like the Netherlands, the dilemma is whether one should use growth references derived from a representative sample from the whole (multiethnic) population or a growth reference for the ethnic Dutch population and appropriate reference data on the largest ethnic groups living in the Netherlands. One of the disadvantages of the first option is that the reliability and efficiency of growth monitoring would decrease because children with a growth disorder of a relatively tall subpopulation would more often be considered normal versus the multiethnic reference, while children with a growth disturbance from a relatively short subpopulation would be overdiagnosed [8]. Furthermore, the secular trend could no longer be studied. Disadvantages of the second option are that there would be more than one growth reference in the country and that it would be impossible to provide specific reference data for all ethnic groups. Besides, within ethnic groups the composition of the population changes continuously through new immigration and intermarriage.

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During the preparation of the last Dutch growth study (the 4th nation-wide study in 1997), it was decided to use the same inclusion and exclusion criteria as the previous studies. This resulted in the publication of updated growth references for children of Dutch descent [10]. In addition, we collected growth data from the two largest ethnic minority groups living in the Netherlands, who were obviously shorter, the Turkish and the Moroccans. At this moment, 35% of the first and 85% of the Turkish second generation are under 20 years of age [6]. A so called "third generation", with both parents born in the Netherlands, is still very small because the second generation is mainly younger than 20 years and most marriages continued to take place with partners from Turkey [2].

In this paper we present the reference data on length/height, body mass index (BMI, kg/m^2), head circumference and sexual maturation for Turkish subjects aged 0–20 years living in the large cities in the Netherlands, collected in 1997. Height and maturation references are compared with the 1997 Dutch data and with available references of Turkish children in Turkey [19, 20, 21, 22, 27,28], Germany [1] and Sweden [17]. We also investigated the association between demographic variables and these measures.

Subjects and methods

Length, height, weight and head circumference were cross-sectionally measured in 2,904 children of Turkish origin living in the largest four cities in the Netherlands: Amsterdam, Rotterdam, Utrecht, and The Hague. From 9 years of age (863 boys and 780 girls), pubertal stages were determined by trained staff. The analysis of sexual maturation is based on a sample of 118 boys (14%) and 108 girls (14%) and 428 girls (55%) answered the question about menarche. Children were included if both biological parents were born in Turkey. Children with diagnosed growth disorders and those on medication known to interfere with growth were excluded from the sample ($n = 23$).

Until 4 years of age, measurements were performed during the regular periodical health examinations by instructed health professionals in the Well Baby Clinics. From 4 years onwards, all Turkish children in a school class were measured during regular preventive health assessments in Municipal Health Services (at mean ages 5.5 and 7.5 years). From 9 years of age, children received a personal invitation based on a stratified sample from the Municipal Register Office, additional measurements took place at randomly selected secondary schools from different socio-economic neighbourhoods, at colleges and at universities [10]. In the same 1997 Dutch Growth Study, growth data of 14,500 children of Dutch origin were similarly collected over the country, including 1505 in the large cities [10].

Measurements

Until 2 years of age, the length of infants was measured in a supine position, thereafter standing height was measured. Infants up to 15 months of age were weighed naked on calibrated baby-scales, older children on calibrated mechanical or electronic step-scales, wearing underwear only. Pubertal stages were determined according to the definitions described by Tanner [25]. The age at menarche was determined by asking each girl when she had had her first period.

A questionnaire, completed by a health professional, was used to assess demographic variables. Duration of maternal residence in the Netherlands was divided into < 6.0, $6.0 - < 11.0$, and > 20 years $11.0 - < 20.0$ years. The educational level of the child was determined at the time of measurement. If an adolescent of > 15 years of age had left any educational system, the highest completed education was recorded. As an indicator of socio-economic status (SES), the highest completed educational level of the parents was used. Other variables were family size (the number of children in a household), target height, working status of parents, one or two parent families, and in the group $0 - < 5.0$ years if the mother breastfed her child and smoked or consumed alcoholics during pregnancy. Birth weight and parental height were obtained by questioning the parents themselves. For the older children this was asked for in the personal invitation letter.

Statistical analysis

Reference standard deviation (SD) curves for height, weight, BMI and head circumference for age were estimated by the LMS method [7]. Reference curves for menarche and the stages of secondary sex characteristics were estimated by generalised additive models [13]. Except for menarche, only P_{50} values could be calculated, as the more extreme percentile values were not sufficiently reliable because of insufficient numbers of children. The association between demographic variables and height SDS and BMI SDS were assessed by univariate and multivariate regression analyses. The influence of a demographic variable can differ according to age or gender. Therefore we used three age-groups ($0 - < 5$ years, $5 - < 12.5$ years and ≥ 12.5 years) and both age and gender were included into the regression analyses (covariates). The difference in distribution of the demographic variables over the three age-groups was calculated by a chi squared test. Target height was calculated by the formula according to Tanner (paternal height + maternal height $\pm$ mean difference between male and female)/2 + secular trend. The mean height difference between Turkish parents (11.4 cm) and between Turkish boys and girls of 20-year-olds (13.3 cm) were close to the mean height difference of ± 13 cm between men and women observed in the Dutch data and most growth studies. We estimated the average secular trend in one generation (more than 50% age had their first pregnancy at 21 years [2]) as the difference between mean height of Turkish 20-year-olds and recorded parental heights in this study (2.9 cm for men, 1 cm for women). The adapted target height (TH) formula for Turkish children was thus: (paternal height + maternal height $\pm$ 13)/2 + 2 cm. TH SDS was calculated as follows: (TH - mean Turkish height at 20 years of age)/SD at 20 years of age.

Results

The distribution of demographic variables in the sample was relatively close to the available national minority statistics [24] for parental education (87% none or primary education), child education (69% lower, 1.5% higher secondary education), family size (51% four or more children), working status of the parents (60% fathers, 16% mothers worked), and one (6%) or two parent families. In the age-group $0 - < 5$ years, 90% of the mothers breastfed their infant for at least 2 weeks, 0.3% drank alcohol and 19% smoked during pregnancy.

For Turkish boys and girls aged 0–20 years, reference charts for height, weight for height, BMI and sexual maturation were constructed indicating both Turkish

Table 1 Reference data (0 SD, SD and ±2 SD, when appropriate) for length, weight and head circumference for boys and girls of Turkish origin living in the Netherlands in the age-range 3.0–60.0 weeks in the 1997 Dutch Growth Study

Age (weeks)	Boys							Girls						
	Length (cm)		Weight (kg)			Head circumference (cm)		Length (cm)		Weight (kg)			Head circumference (cm)	
	Mean	SD	–2 SD	0 SD	+2 SD	Mean	SD	Mean	SD	–2 SD	0 SD	+2 SD	Mean	SD
3.0	53.0	2.0	3.1	4.0	5.0	37.0	1.1	52.7	2.2	3.0	4.0	4.9	37.0	1.1
4.0	53.8	2.0	3.4	4.4	5.5	37.8	1.1	53.4	2.3	3.1	4.2	5.2	37.3	1.1
6.0	55.2	2.1	3.7	4.8	6.0	38.5	1.1	54.7	2.3	3.4	4.5	5.6	38.0	1.1
8.0	56.7	2.1	4.1	5.2	6.5	39.3	1.1	56.1	2.4	3.6	4.9	6.0	38.6	1.2
10.0	58.2	2.1	4.4	5.6	6.9	40.1	1.1	57.4	2.4	3.9	5.2	6.5	39.2	1.2
12.0	59.6	2.1	4.7	5.9	7.4	40.8	1.1	58.6	2.5	4.1	5.5	6.9	39.8	1.2
14.0	61.0	2.1	4.9	6.3	7.9	41.4	1.1	59.8	2.5	4.4	5.9	7.3	40.3	1.2
16.0	62.3	2.1	5.2	6.6	8.3	42.0	1.1	60.9	2.5	4.6	6.2	7.7	40.8	1.2
18.0	63.6	2.2	5.5	7.0	8.7	42.5	1.1	62.0	2.6	4.8	6.5	8.1	41.2	1.2
20.0	64.8	2.2	5.7	7.3	9.1	42.9	1.1	63.1	2.6	5.1	6.7	8.4	41.7	1.2
22.0	65.9	2.2	6.0	7.6	9.5	43.4	1.1	64.1	2.6	5.3	7.0	8.8	42.1	1.2
24.0	67.0	2.2	6.2	7.9	9.8	43.8	1.1	65.1	2.6	5.5	7.3	9.1	42.4	1.2
26.0	68.0	2.2	6.4	8.1	10.2	44.1	1.1	66.1	2.7	5.7	7.5	9.4	42.8	1.2
28.0	68.9	2.2	6.6	8.4	10.5	44.5	1.1	67.0	2.7	5.9	7.8	9.7	43.1	1.2
32.0	70.6	2.2	7.0	8.9	11.1	45.0	1.1	68.7	2.7	6.2	8.2	10.3	43.7	1.2
36.0	72.1	2.3	7.3	9.3	11.7	45.5	1.1	70.2	2.7	6.5	8.6	10.8	44.2	1.2
40.0	73.4	2.3	7.6	9.7	12.2	45.9	1.1	71.5	2.8	6.8	9.0	11.2	44.7	1.2
44.0	74.7	2.4	7.9	10.1	12.6	46.3	1.1	72.8	2.8	7.1	9.3	11.7	45.1	1.3
48.0	75.9	2.4	8.2	10.4	13.1	46.7	1.2	74.0	2.8	7.3	9.6	12.1	45.5	1.3
52.0	77.0	2.6	8.4	10.7	13.4	47.0	1.2	75.2	2.8	7.5	9.9	12.4	45.8	1.3
56.0	78.1	2.6	8.6	11.0	13.8	47.3	1.2	76.2	2.9	7.8	10.2	12.8	46.1	1.3
60.0	79.1	2.7	8.9	11.3	14.2	47.5	1.2	77.3	2.9	8.0	10.4	13.1	46.4	1.3

and Dutch SD lines [26]. Table 1 summarises the mean and SD for length, weight and head circumference for 3–60 week-olds. Until 24 weeks of age, Turkish boys were approximately 0.5 cm smaller, thereafter on average 0.5 cm longer than Dutch boys. For girls, the maximal difference was 0.2 cm. From 4 weeks of age onwards, Turkish infants were 0.1 kg heavier than Dutch infants, increasing to 0.6 kg at 60 weeks (boys mean difference of 0.3 kg, girls of 0.5 kg). Head circumferences were approximately similar to Dutch infants.

Table 2 shows height, weight and BMI references for age-group 1–20 years for both Turkish sexes. From 3 years of age onwards, and for boys slightly earlier, height differences between the Dutch and Turkish populations were apparent and a difference of approximately 5 cm (50% of the final difference) was achieved during childhood. In prepuberty (3–10 years), on average 13.6% boys and 7.8% girls had heights below the Dutch –2 SD lines for height and 4.1% and 1.3%, respectively, below the Dutch –2.5 SD line. During puberty, the height difference increased by another 5 cm so that the difference with mean height of Dutch 20-year-olds further increased to 10 cm, approx. 1.5 SD in the Dutch reference diagrams. Mean final height for boys was 174.0 cm (Dutch 184.0 cm) and for girls 160.7 cm (Dutch 170.6 cm). The additional loss during puberty may be explained by a faster progression through pubertal stages (see below). The BMI of the Turkish population was consistently higher than that of the Dutch [11].

Heights of children of Turkish origin in the Netherlands compared with available references in Turkey [3, 20,27] and Germany [1] showed that these were quite similar to Turkish children in Germany and children of high SES in Istanbul [4,20]. Boys in the lowest SES group in Istanbul, from various social levels in Ankara [27] and of high SES in Trabzon (Eastern Black Sea urban region) [3], were slightly shorter. In contrast, Turkish children in Sweden were slightly shorter than those of high SES children in Istanbul [17]. For girls we observed similar findings.

Sexual maturation

The median age at onset of breast development (B2) in Turkish girls was 11.3 years, 0.6 years later than in Dutch girls later ($t = -2.53$, $P = 0.006$). However, the median age at menarche was 12.8 years, 4.8 months earlier than Dutch girls ($t = 3.05$, $P = 0.001$). Also the other pubertal stages in Turkish girls occurred earlier than in Dutch girls. Thus, Turkish girls started puberty later but the progression through different stages seemed faster, on a population level. Longitudinal data are necessary for information about the rate at which an individual child passes through the consecutive stages. For Turkish boys a similar pattern was observed. Stage G2 occurred at 12.2 years, 0.7 years later, but they achieved stage G5 (14.5 years) at a younger age (about 1 year faster).

Table 2 Reference data (0 SD, SD and ±2 SD, when appropriate) for length(1 year of age), height, weight and BMI for boys and girls of Turkish origin in the Netherlands in the age-range 1.0–20.0 years in the 1997 Dutch Growth Study

Age (years)	Boys								Girls							
	Height (cm)		Weight (kg)			BMI (kg/m^2)			Height (cm)		Weight (kg)			BMI (kg/m^2)		
	Mean	SD	–2 SD	0 SD	+2 SD	–2 SD	0 SD	+2 SD	Mean	SD	–2 SD	0 SD	+2 SD	–2 SD	0 SD	+2 SD
1.0	77.3	2.6	8.1	10.2	12.8	15.1	17.8	21.4	75.2	2.8	7.5	9.9	12.4	14.3	17.3	21.0
2.0	88.0	3.3	10.4	13.0	16.4	14.5	17.0	20.8	87.6	3.3	9.9	12.9	16.4	13.8	16.8	20.7
3.0	97.1	3.7	12.1	15.2	19.3	14.0	16.5	20.5	96.6	3.7	11.9	15.5	20.0	13.6	16.6	20.7
4.0	104.8	4.1	13.8	17.4	22.4	13.8	16.3	20.6	104.1	4.0	13.7	17.9	23.5	13.5	16.5	20.9
5.0	111.5	4.5	15.5	19.8	25.9	13.6	16.3	21.0	109.9	4.2	14.9	19.7	26.3	13.2	16.4	21.1
6.0	117.6	4.8	17.4	22.4	29.8	13.7	16.4	21.7	114.9	4.5	16.1	21.5	29.4	13.1	16.3	21.4
7.0	122.8	4.9	19.3	25.0	34.0	13.7	16.6	22.5	120.6	4.8	17.6	23.8	33.5	13.1	16.5	22.1
8.0	128.1	5.0	21.2	27.9	38.6	13.9	17.0	23.5	127.1	5.3	19.5	26.9	39.4	13.3	16.9	23.1
9.0	134.1	5.3	23.2	30.8	43.5	14.1	17.4	24.5	133.4	5.9	21.7	30.8	47.4	13.6	17.5	24.4
10.0	138.9	5.8	25.2	33.8	48.6	14.3	17.8	25.5	139.5	6.4	24.1	35.4	56.3	14.0	18.2	25.9
11.0	143.4	6.5	27.4	37.2	54.3	14.6	18.3	26.5	145.3	6.7	26.7	40.4	64.5	14.5	18.9	27.5
12.0	149.1	7.3	30.0	41.5	60.8	15.0	18.8	27.5	151.3	6.6	30.3	45.5	71.7	15.1	19.7	29.1
13.0	156.3	7.8	33.3	46.8	68.3	15.4	19.4	28.5	155.7	6.3	34.5	50.2	77.8	15.7	20.5	30.5
14.0	163.4	7.7	37.6	52.9	76.1	15.8	20.0	29.5	157.9	6.0	38.1	53.7	82.4	16.2	21.1	31.9
15.0	167.9	7.1	42.5	58.8	82.8	16.2	20.6	30.4	159.2	5.8	40.5	55.9	85.7	16.7	21.7	33.1
16.0	170.8	6.5	47.0	63.8	87.7	16.6	21.2	31.2	159.5	5.8	42.0	57.2	87.6	17.1	22.2	34.1
17.0	172.5	6.1	50.7	67.4	91.1	17.0	21.8	31.9	159.7	5.7	42.8	58.0	88.6	17.5	22.6	35.1
18.0	173.3	5.9	53.4	70.1	93.4	17.3	22.2	32.5	159.9	5.7	43.3	58.3	89.2	17.8	23.0	36.0
19.0	173.5	5.9	55.4	72.0	95.1	17.5	22.7	33.1	160.2	5.6	43.5	58.6	89.5	18.1	23.4	36.9
20.0	174.0	5.8	57.2	73.7	96.5	17.8	23.1	33.6	160.7	5.5	43.8	58.8	89.8	18.4	23.8	37.8

Association with demographic variables

By univariate analysis, height SDS was predicted by birth weight (+), target height (+), family size (-) and duration of maternal residence in the Netherlands (+). Children attending special education and with lower educated parents showed lower height SDS. In the multivariate regression analysis, 17.2% of the variance in height SDS was explained by TH SDS and birth weight for the Turkish 0–< 5.0 years group. In the older age-groups, the predictive effect of TH SDS on height SDS increased and also the duration of maternal residence was associated (+) (variance 16.8%). Similar but stronger effects for TH were seen in the Dutch population (variance 27.9%). For the Turkish children, BMI SDS was predicted by birth weight (+) and a longer duration of maternal residence in the Netherlands (+) in the 0–< 5.0 years group, but the explained variance was only 7.1%. For the Dutch, smoking (+), breastfeeding (+) and working status of the mother (+) were also associated; however, the variance for prediction of BMI SDS was also small ($r^2 = 6.6$).

Discussion

This study provides up-to-date growth references for length, height, weight, BMI and head circumference for age, weight for height, and pubertal stages for Turkish children living in the Netherlands. We excluded third generation Turkish children (parents of Turkish origin but both born in the Netherlands) but national statistics showed that this generation is as yet very small [2]. The constructed charts can be particularly used for monitoring growth of Turkish children who have heights below –2 SD on the regular Dutch growth charts. About 10% of the prepubertal Turkish children were below the Dutch –2 SD lines, of whom the majority should still be labelled as growing normally according to the Turkish growth chart.

With respect to body height, differences compared to the Dutch population were small during infancy but increased to approximately −1.5 SD (or 10 cm) at 20 years of age. However, mean heights were similar to those of Turkish children in Germany [1] and to children living in a higher socio-economic class in urban Turkey in the 1970s [20], as well as more recently (male final height 174.2 cm) [4]. Within Turkey, however, large height differences have been observed between high and low groups and between urban and rural regions [19]. The majority of Turkish children in the Netherlands came from rural areas, which suggests that they are taller than their age-peers living in rural Turkey.

The mean secular trend appears close to 2 cm/20 years, which is similar to findings from a recent study in Turkish children aged 5–11 years in a high SES group in Ankara [19]. It is difficult to predict whether the secular change will further increase as has been found in most ethnic groups [8], with more integration into Dutch culture, the health system and nutritional status. The secular change might be smaller than expected because family forming has continued to occur with partners from Turkey [6].

The height differences between the Dutch and Turkish population in the Netherlands are probably mainly due to genetic differences, but also environmental

determinants could be involved. There is a difference in health indicators, illustrated by a 2–3 times higher mortality of Turkish and Moroccan children than of Dutch children, associated with accidents and infections during summer visits to Turkey and congenital disorders [23]. With respect to nutrition, Turkish children more often skip their breakfast [5] (11%, compared with 2.5% in Dutch children). Also after a longer stay in the Netherlands, 80% still consume traditional food, possibly because most mothers belonged to first generation immigrants [5,16]. The educational level, another determinant for growth, is relatively low and similar to observations of Turkish families in Sweden [17]. However, in the 0–< 5.0 years group in our study, the demographic profile showed significantly higher parental educational levels and more paternal employment than in the two older age-groups.

Compared to available Turkish data on pubertal development, stage G2 was 0.6 years later than in high SES boys in Elazig (11.6 years) and in good agreement with English, North American and South African data [28]. In older urban studies, G2 ran from 11.0 to 12.0, the higher the SES the earlier G2 [12, 14,22]. In girls, menarche occurred almost 5 months earlier compared to Dutch girls, at 12.8 years. Part of the difference in age at menarche may be associated with the higher BMI values for age [15,18]. These data are in good agreement with Turkish girls in Istanbul (12.8 years, 12.4 high SES, 13.2 low SES) [21] and Turkish girls in Bremen (12.9 years) [9].

Only a few demographic variables were associated with measures of height and BMI and we did not find any significant effect of educational level. This might be caused by the fact that 80% of the parents had none, primary or low secondary level education, resulting in a homogeneous SES group, also found in the educational level of the child. The positive effect of duration of maternal residence in the Netherlands for height was strongest in children after puberty. In this age-group, 26% of the mothers had resided for more than 20 years in the Netherlands and possibly the effect can be detected better over this long period, with a longer benefit of the environmental circumstances, than in the 0–< 5 years group where we found no effect.

In conclusion, separate growth charts for Turkish children in the Netherlands are useful for clinical purposes. Turkish children have lower mean heights and higher weight for height and BMI values. They start puberty later compared to Dutch children, but pubertal progression seemed faster; however, for interpretation one should be aware that our data are derived from a cross-sectional study. Median age at menarche (12.8 years) is 5 months earlier compared to children of Dutch origin.

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