Height, weight, body mass index and pubertal development references for children of Moroccan origin in The Netherlands

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Aim: To provide growth and sexual maturation reference data for Moroccan children living in The Netherlands and to compare them with the reference data of children of Dutch origin. *Methods:* Cross-sectional growth and demographic data were collected from 2880 children of Moroccan origin and 14 500 children of Dutch origin living in The Netherlands in the age range 0–20 y. Growth references for length, height, weight, weight-for-height, body mass index (BMI) and head circumference were constructed with the LMS method. Predictive variables for height and BMI were assessed by regression analyses. Reference curves for sexual maturation were estimated by a generalized additive model. *Results:* Moroccan young adults were on average 9 cm shorter than their Dutch contemporaries. Mean final height was 174.7 cm for males and 161.3 cm for females. Height differences in comparison with Dutch children increase from 2 y onwards. Height SDS was predominantly associated with target height. Compared to Dutch children, maturation started 0.2 and 0.9 y later for girls and boys, respectively. Median age at menarche was 12.9 y, 3.6 mo earlier than in Dutch girls ($p = 0.001$). BMI of Moroccan children was above that of Dutch children, especially for girls. BMI SDS was associated with birthweight in the age group 0–≤5 y.

Conclusion: Moroccan children living in The Netherlands are substantially shorter than Dutch children. Girls have higher weight-for-height and BMI for age. Median age at menarche occurs earlier. Given these differences, separate growth charts for the Moroccan children are useful.

Key words: *Body height, body mass index, Morocco, pubertal development, target height*

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Optimal growth monitoring requires data from a representative sample of the population. Immigration leads to an increase in the genetic variation of the population. It is still unresolved how one could best deal with this increase. Nowadays over two-thirds of all children visiting "well baby care" and youth health care in large Dutch cities have foreign parents; a quarter of them having a Moroccan or North African origin (1). One option is to prepare reference data for the actual ethnic mix, but this would decrease its efficacy for detecting growth disorders. Most immigrant children are substantially shorter than the relatively tall Dutch children. Using the Dutch reference chart for children of immigrants implies that a substantial part of this group would be considered abnormally short for age.

Another option is to prepare references for the ethnic Dutch population and additional references for the largest immigrant populations. Besides being a better tool for growth monitoring, in separate groups, this would also provide the possibility to study the secular growth trend and (indirectly) the health status of these ethnic groups. This is the approach taken in the Fourth Dutch Growth Study. Data were collected from Dutch children (2), as well as from the two largest migrant groups, the Moroccan and the Turkish population.

In an earlier paper (3) we described growth of Turkish children. In the present paper we report growth references for height, weight, weight-for-height, body mass index, head circumference for age and sexual maturation for children of Moroccan origin in the age range 0–20 y, living in The Netherlands in 1997. We compared them with the 1997 Dutch data and with growth data of children living in Morocco (4–6). Finally we studied the association between height and body mass index (BMI) and demographic variables.

Patients and methods

Subjects

In a cross-sectional design, length, height, weight, head circumference and sexual maturation were measured in

2882 children of Moroccan origin living in one of the largest four cities in The Netherlands: Amsterdam, Rotterdam, The Hague and Utrecht. A child was classified as "Moroccan" if both biological parents were born in Morocco ($n = 2868$), or if one parent was born in Morocco and the other in another North African country ($n = 14$). Children with diagnosed growth disorders and those on medication known to interfere with growth were excluded from the sample ($n = 26$). In the same 1997 Dutch Growth Study, growth data from 14 500 children of Dutch origin were collected in a similar way throughout the country, including in the large cities ($n = 1505$). More details are described elsewhere (2).

Methods

Pubertal stages were determined by visual inspection, using the criteria and definitions described by Tanner (7). Age at menarche was determined by the "status quo method", by asking each girl when she had had her first period. A questionnaire, filled in by a health professional, was used to assess demographic variables. Duration of stay of the mother in The Netherlands was divided into <6.0, 6.0–<11.0, 11.0–<20.0, ≥20.0 y. The educational level of the child was determined at the time of measurement. If an adolescent of >15 y of age had left any educational system, the highest completed education was recorded. The highest completed educational level of the parents was used as an indicator of socio-economic status (SES). Family size was defined by the number of children in a household (1–2, 3–4, ≥5).

Other measures were target height, the percentage working (part-time/full-time) parents in families, and families with one or two parents. Additional data were collected for the 0–<5 years group: birthweight, smoking of the mother, alcohol consumed during pregnancy and having breastfed her child.

Statistical analysis

Reference SD curves were estimated by the LMS method (8, 2). This means that the distribution of the data is summarized by three spline curves—L, M and S—which vary over time: the Box-Cox transformation power that converts data to normality and minimizes the skewness of the dataset (L), the median (M) and the coefficient of variation (S). The fit of the model was assessed by the wormplot (9). Reference curves for menarche and the stages of secondary sex characteristics were estimated by generalized additive models (10).

Table 1. Differences between Moroccan and Dutch children. Given are number of children that responded (*n*), the percentages and the differences *(p)* per age group (0–<5, 5–<12.5 and over 12.5 y) for the demographic variables.

	0–<5 y		5–<12.5 y		12.5–20 y	
	% Moroccan	% Dutch	% Moroccan	% Dutch	% Moroccan	% Dutch
Duration of stay mother **	($n = 832$)		($n = 937$)		($n = 915$)	
<6 y	24.8	–	7.0	–	9.3	–
6–10 y	25.2	–	20.4	–	18.9	–
11–20 y	37.7	–	60.3	–	51.9	–
≥20 y	12.3	–	12.3	–	19.9	–
Educational level child**	($n = 916$)	($n = 5739$)	($n = 954$)	($n = 3340$)	($n = 905$)	($n = 5335$)
Primary education	–	–	97.1	94.8	11.2	2.7
Lower secondary education	–	–	1.5	1.3	68.3	45.0
Middle secondary education	–	–	0.5	1.8	15.2	40.3
Higher secondary education	–	–	–	–	0.3	10.1
Special education	–	–	0.9	2.1	5.0	1.9
Highest educ. level parents**	($n = 493$)	($n = 5613$)	($n = 925$)	($n = 3174$)	($n = 854$)	($n = 4001$)
None/primary	61.1	0.3	91.5	2.3	93.6	2.5
Lower secondary education	26.8	18.8	5.7	33.0	4.2	36.9
Middle secondary education	7.9	40.9	1.8	32.2	1.9	29.3
Higher secondary education	4.3	39.9	1.0	32.5	0.4	31.3
Size of family**	($n = 559$)	($n = 5732$)	($n = 975$)	($n = 3362$)	($n = 961$)	($n = 5401$)
1–2	44.0	81.4	7.8	60.2	6.2	67.2
3–4	32.0	17.2	35.8	37.3	24.4	29.8
≥5	24.0	1.3	56.4	2.2	69.3	3.0
Working mother outside*	9.4 ($n = 543$)	58.5 ($n = 5670$)	6.6 ($n = 965$)	53.6 ($n = 3183$)	5.8 ($n = 931$)	58.9 ($n = 4910$)
Working father outside**	53.1 ($n = 452$)	97.4 ($n = 5590$)	40.8 ($n = 920$)	94.4 ($n = 2454$)	33.3 ($n = 880$)	92.7 ($n = 3702$)
Two-parent family*	97.1 ($n = 559$)	97.6 ($n = 5735$)	94.9 ($n = 964$)	93.6 ($n = 3353$)	94.0 ($n = 933$)	87.4 ($n = 5388$)
Mean height mother **	160.9 ($n = 399$)	169.2 ($n = 5596$)	162.5 ($n = 649$)	168.3 ($n = 3288$)	163.0 ($n = 546$)	168.1 ($n = 4788$)
Mean height father	171.3 ($n = 318$)	182.3 ($n = 5511$)	171.5 ($n = 660$)	181.1 ($n = 3221$)	171.7 ($n = 553$)	180.5 ($n = 4744$)
Smoked during pregnancy	0.6 ($n = 538$)	23.1 ($n = 5499$)	–	–	–	–
Alcohol during pregnancy	0.0 ($n = 540$)	16.7 ($n = 5491$)	–	–	–	–
At least 2 wk breastfed	83.5 ($n = 537$)	69.0 ($n = 5480$)	–	–	–	–

– no data available; *$p < 0.05$, **$p < 0.0001$

Except for menarche, only p_{50} values were calculated, as the more extreme p-values were not sufficiently reliable because of insufficient numbers of children.

The difference in distribution of the demographic variables over the three age groups (0–<5.0, 5.0–<12.5 and ≥12.5 y) was tested by a χ^2 test. Associations between demographic variables, height SDS and BMI SDS were assessed by univariate and multivariate regression analyses in three age groups. Age and gender were included into the regression analyses.

Target height (TH) was calculated as (paternal height + maternal height ± 13)/2 + 2 cm (3). TH SDS was calculated as (TH—mean Moroccan height at 20 y of age)/SD at 20 y of age.

Results

Table 1 describes the Moroccan and Dutch samples in terms of demographics, birthweight and parental heights per age group. There were large differences between the Moroccan and Dutch samples, especially with respect to educational level, working status of the parents and size of the family. These differences tended to be smaller for the younger children. Very few Moroccan mothers used alcohol or smoked during pregnancy, and more infants were breastfed. The characteristics of the sample were similar to known statistics (11, 12).

Length, weight and head circumference of infants

Table 2 contains the reference data (mean and standard deviation (SD) for length, weight and head circumference) for Moroccans aged 0–60 wk. Hardly any length differences with the Dutch were observed. Until 22 wk of age Moroccan infants were slightly shorter (on average −0.5 cm), thereafter slightly longer, with a mean difference of +0.2 cm. Weights of Moroccan infants were similar to those of Dutch infants. Head circumference of Moroccan infants was on average 0.6 cm larger.

Height, weight and BMI for age for 1 to 20 y

For Moroccan boys and girls reference charts were constructed for height, weight-for-height and BMI (13). Figure 1 shows the Moroccan 0 and 2 SD lines. For reference, the Dutch SD lines are also plotted. The Moroccan SD lines are located approximately–1.5 SD below the corresponding Dutch SD lines. Table 3 contains references for height, weight and body mass index ages 1–20 y. At 1 y of age Moroccan boys were slightly taller (+0.6 cm) than Dutch boys, but from 2 y onwards the reverse occurred. The difference with the Dutch reference increased with age. Mean final height at 20 y of age was for boys 174.7 cm (Dutch 184.0 cm), and for girls 161.3 cm (Dutch 170.6 cm). About half of the final height difference was achieved by the age of 7 y. During puberty the difference increased by another 4 cm, similar to children of Turkish origin. Reference lines levelled out around 17.5 (boys) and 15.5 (girls) y,

Table 2. Reference data (0 SD, SD and ±2 SD, when appropriate) for length, weight and head circumference for boys and girls of Moroccan origin in The Netherlands in the age range of 3.0–60.0 wk in the 1997 Dutch Growth Study.

	Boys							Girls						
	Length		Weight			Head		Length		Weight			Head	
Age wk	Mean	SD	−2SD	0SD	+2SD	Mean	SD	Mean	SD	−2SD	0SD	+2SD	Mean	SD
3.0	53.2	2.0	3.4	4.4	5.3	38.6	1.3	52.1	2.4	2.9	3.9	4.9	37.4	1.2
4.0	54.0	2.0	3.5	4.5	5.5	38.9	1.3	52.9	2.4	3.0	4.1	5.1	37.7	1.3
6.0	55.5	2.0	3.8	4.9	6.0	39.7	1.3	54.4	2.4	3.3	4.4	5.6	38.4	1.3
8.0	57.0	2.0	4.1	5.3	6.4	40.4	1.3	55.9	2.5	3.6	4.8	6.0	39.0	1.3
10.0	58.5	2.1	4.4	5.6	6.8	41.0	1.3	57.3	2.5	3.8	5.1	6.4	39.5	1.3
12.0	59.9	2.1	4.6	6.0	7.3	41.6	1.4	58.7	2.5	4.1	5.4	6.8	40.1	1.3
14.0	61.2	2.1	4.9	6.3	7.7	42.2	1.4	60.0	2.5	4.3	5.8	7.3	40.6	1.4
16.0	62.4	2.1	5.2	6.6	8.1	42.7	1.4	61.2	2.6	4.6	6.1	7.7	41.1	1.4
18.0	63.6	2.2	5.4	7.0	8.5	43.1	1.4	62.4	2.6	4.8	6.4	8.1	41.6	1.4
20.0	64.7	2.2	5.6	7.3	8.9	43.5	1.3	63.5	2.6	5.0	6.7	8.4	42.1	1.4
22.0	65.8	2.2	5.9	7.5	9.2	43.9	1.3	64.6	2.6	5.3	6.9	8.8	42.5	1.4
24.0	66.8	2.2	6.1	7.8	9.6	44.2	1.3	65.6	2.6	5.5	7.2	9.2	43.0	1.5
26.0	67.9	2.2	6.3	8.1	9.9	44.5	1.3	66.5	2.6	5.7	7.5	9.5	43.4	1.5
28.0	68.8	2.3	6.5	8.3	10.2	44.9	1.3	67.4	2.6	5.9	7.7	9.8	43.7	1.5
32.0	70.6	2.3	6.9	8.8	10.8	45.4	1.3	69.0	2.6	6.3	8.2	10.5	44.4	1.5
36.0	72.2	2.4	7.2	9.2	11.3	46.0	1.3	70.5	2.6	6.6	8.6	11.0	44.9	1.5
40.0	73.6	2.4	7.5	9.6	11.8	46.4	1.3	71.7	2.6	6.9	9.0	11.6	45.3	1.6
44.0	74.9	2.5	7.8	10.0	12.3	46.8	1.3	72.9	2.6	7.2	9.4	12.1	45.6	1.6
48.0	76.1	2.6	8.1	10.3	12.7	47.1	1.3	73.9	2.6	7.5	9.7	12.5	46.0	1.6
52.0	77.1	2.6	8.3	10.6	13.1	47.5	1.3	74.9	2.6	7.8	10.1	13.0	46.2	1.6
56.0	78.1	2.7	8.5	10.8	13.4	47.7	1.3	75.9	2.6	8.0	10.4	13.4	46.5	1.6
60.0	79.0	2.8	8.7	11.1	13.8	48.0	1.3	76.8	2.6	8.2	10.6	13.8	46.7	1.6

reaching final height at a younger age than Dutch adolescents. If Moroccan children are compared to Dutch growth charts, 9.8% of the boys and 11.3% of the girls would have a height below −2SD, where less than 2.5% is expected in the Dutch population.

Table 4 shows weight-for-height reference data. Moroccan SD lines are located slightly above the Dutch lines over the whole age range, in girls more than in boys. BMI of Moroccan girls is consistently higher than that of the Dutch girls (3).

Sexual maturation

The p_{50}-values for pubic hair (PH), breast (B) and genital (G) development are shown in Table 5. Onset of puberty for Moroccan girls (p_{50} of stage B2) occurred 0.2 y later than for Dutch girls. However, other stages occurred earlier. Moroccan girls start puberty later but the progression through different stages seemed faster. However, the study has a cross-sectional design and longitudinal data are necessary for information about the tempo at which an individual child passed through the consecutive puberty stages. The median age at menarche (M) was 12.9 y, 0.3 y earlier than Dutch girls

(2), but close to the menarcheal age of Turkish girls in The Netherlands (12.8 y) (3). In the two oldest age groups, 3.1% of the girls used contraception pills (Dutch girls 16.7%). In Moroccan boys the onset of puberty (genital stage G2) was 0.9 y later, but they reached stage G5 almost at the same age as Dutch boys.

Demographic variables

Table 6 shows the results of univariate regression analyses for demographic variables with height SDS and BMI SDS in three age groups. Age and gender were included in the analyses; both had no significant effect. Few variables were related to height and BMI SDS. Height SDS was predominately predicted by target height. In the multivariate regression analysis, 18.4% of the variance in height SDS for the 0–<5 y group was explained by TH SDS and birthweight. For 5–≤12.5 y TH and working status of the mother (−) were predictors (variance 9.3%). In the oldest group the variance (11.4%) was explained by TH, size of the family (−) and educational level of the child (−). In the Dutch population, stronger effects for TH were seen and parental education was also a predictor for height SDS
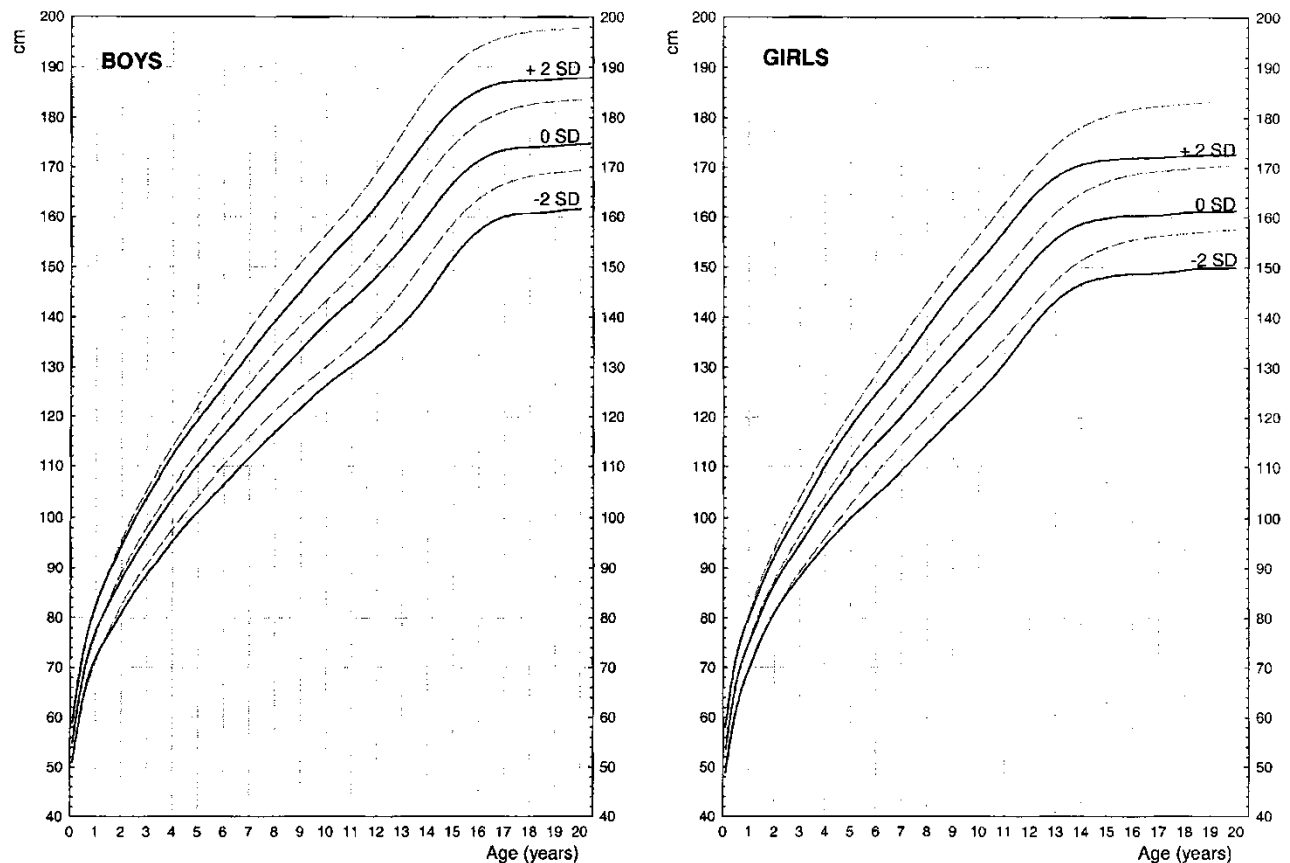

Fig. 1. 0 SD (mean) and ±2 SD height reference lines for Moroccan (solid) and Dutch (dotted) boys and girls in the age range 1–20 y, based on the Fourth Dutch Growth study (1997).

Table 3. Reference data (0 SD, SD and ±2 SD, when appropriate) for length (1 y of age, cm), height (cm), weight (kg) and BMI (kg/m^2) for boys and girls of Moroccan origin in The Netherlands aged 1–20 y in the 1997 Dutch Growth Study.

| | BOYS | | | | | | | | GIRLS | | | | | | | |
| | Height | | Weight | | | BMI | | | Height | | Weight | | | BMI | | |
Age	Mean	SD	−2SD	0SD	+2SD	−2SD	0SD	+2SD	Mean	SD	−2SD	0SD	+2SD	−2SD	0SD	+2SD
1.0	77.2	2.6	8.3	10.6	13.1	14.7	17.8	21.1	74.9	2.6	7.8	10.1	13.0	14.9	17.7	21.6
2.0	87.7	3.4	10.3	13.2	16.7	14.1	17.0	20.6	86.8	2.9	10.0	12.9	17.2	14.3	17.0	21.1
3.0	96.3	3.8	11.9	15.2	19.5	13.6	16.4	20.2	94.8	3.3	11.5	14.8	20.2	13.7	16.4	20.8
4.0	103.8	4.2	13.3	17.1	22.4	13.3	16.1	20.1	102.4	3.9	13.0	16.8	23.5	13.4	16.1	21.0
5.0	110.3	4.5	14.8	19.2	25.6	13.1	15.9	20.3	109.0	4.5	14.5	18.9	27.4	13.2	16.1	21.4
6.0	116.2	4.9	16.5	21.4	29.3	13.1	15.9	20.7	114.6	5.0	16.0	21.1	31.6	13.1	16.1	22.0
7.0	122.2	5.3	18.2	23.9	33.6	13.2	16.0	21.2	120.2	5.5	17.6	23.4	36.2	13.1	16.2	22.6
8.0	128.0	5.6	19.9	26.4	38.4	13.3	16.2	21.9	126.4	5.9	19.2	26.0	41.3	13.1	16.4	23.2
9.0	133.4	5.9	21.8	29.2	43.8	13.5	16.5	22.6	132.4	6.3	21.0	28.8	46.9	13.2	16.7	24.0
10.0	138.7	6.2	23.7	32.2	49.6	13.7	16.8	23.4	138.0	6.5	23.1	32.2	52.8	13.5	17.2	24.9
11.0	143.3	6.6	25.8	35.5	55.7	14.0	17.2	24.4	144.0	6.6	25.7	36.5	59.3	13.9	17.8	25.9
12.0	148.1	7.1	28.2	39.2	62.2	14.4	17.7	25.3	150.5	6.4	29.1	41.9	66.2	14.3	18.6	27.1
13.0	153.8	7.6	31.0	43.5	69.2	14.9	18.3	26.3	155.6	6.2	33.1	47.4	72.5	14.9	19.4	28.3
14.0	160.3	7.8	34.6	48.7	76.5	15.3	18.9	27.4	158.6	6.0	36.7	51.7	76.9	15.4	20.2	29.4
15.0	166.8	7.5	38.8	54.2	83.1	15.8	19.5	28.4	159.8	5.9	39.4	54.6	79.4	15.9	20.9	30.3
16.0	171.2	7.0	42.5	58.7	87.6	16.2	20.0	29.3	160.3	5.8	41.1	56.4	80.9	16.3	21.6	31.2
17.0	173.5	6.7	45.6	62.1	90.5	16.7	20.6	30.2	160.4	5.8	42.2	57.6	81.9	16.6	22.2	31.9
18.0	174.0	6.7	48.1	64.5	92.1	17.1	21.1	31.1	160.9	5.7	43.0	58.5	82.7	16.9	22.7	32.6
19.0	174.3	6.6	50.2	66.5	93.1	17.5	21.6	31.9	161.2	5.7	43.6	59.1	83.2	17.2	23.2	33.3
20.0	174.7	6.6	52.2	68.2	93.9	17.9	22.1	32.8	161.3	5.7	44.1	59.7	83.8	17.5	23.7	33.9

(28.5%). For the Moroccans, BMI was predicted by birthweight in the 0–≤5 y group, but the variance was small (7.5%). For the Dutch, TH, smoking, breastfeeding and working status of the mother were also associated (6.6%).

Discussion

This study provides growth references for length, height, weight, BMI, head circumference and pubertal development for Moroccan boys and girls aged 0–20 y, living in one of the four largest cities in The Netherlands. The sample consists of first- and second-generation immigrants. To date the third generation hardly exists, as 85% of the second generation is younger than 20 y. Most marriages occur with partners from Morocco (>80% of Moroccan women and 50% of Moroccan men) (14). The occurrence of the high proportion of Moroccan children that would be considered abnormally short by Dutch standards illustrates that separate growth charts for Moroccans in The Netherlands are useful.

Positive secular changes have been observed in many immigrant populations (15). Compared to the few available Moroccan growth data, heights of 17-y-old Moroccans (173.5 cm) in The Netherlands (first and second generation) were similar to those of the first generation Moroccan immigrant boys in Israel in high SES groups (173.8 cm; low SES: 170.8 cm). However, 17-y-old third-generation Moroccan boys in Israel were slightly taller (high SES: 174.3 cm; mean height: 172.9 cm) (5). If this is also to be the case in The Netherlands, a positive secular growth change can be expected. It is therefore interesting to include third-generation immigrants in future growth studies, and to include detailed data on duration of stay in The Netherlands.

Puberty started later, as in Dutch adolescents, but the progression of the pubertal stages seemed faster as Dutch and Moroccan boys reached G5 at the same time and Moroccan girls reached B4 earlier. Note that a cross-sectional design is not optimal for studying the longitudinal process of pubertal development. The median age at menarche for Moroccan girls in The Netherlands in 1997 was 12.9 y, 0.3 y earlier than Dutch girls. Similar results were found for Turkish adolescents (3).

A Moroccan study done in 1991 observed a median menarcheal age of 13.75 y for lower/middle class girls in Marrakesh. This was 0.55 y earlier in 1982 (14.3 y). Earlier menarche may be related to smaller families (9 to 7.73 children), better nutrition, improved standards of care and a decrease in the infection rate (4). Assuming a similar secular change, one would expect to observe a median age of 13.4 y by 1997. This is still much later than for Moroccan girls in The Netherlands in 1997 (12.9). It is not clear how one could explain this difference. It is possibly related to improved socio-economic conditions, smaller families (3.3 children) (16), the large coverage (96%) of the child health care system (12) and the relatively high prevalence of overweight.

In the Dutch population, educational level of the

Table 4. Weight for height reference data (0 SD and ±2 SD) for Moroccan children, aged 0–20 y, in two age groups, <16.0 y and ≥16.0 y.

Height (cm)	Boys Weight (kg)			Girls Weight (kg)		
Age <16.0 y	−2SD	0SD	+2SD	−2SD	0SD	+2SD
50	2.9	3.6	4.1	2.9	3.5	4.3
55	3.9	4.8	5.5	3.8	4.6	5.6
60	5.0	6.07	7.1	4.8	5.8	7.1
65	6.1	7.4	8.6	5.9	7.1	8.7
70	7.2	8.7	10.2	7.1	8.5	10.5
75	8.3	10.0	11.8	8.3	9.9	12.2
80	9.3	11.2	13.4	9.3	11.1	13.9
85	10.2	12.4	14.9	10.3	12.3	15.5
90	11.2	13.6	16.5	11.3	13.5	17.3
95	12.2	14.8	18.1	12.3	14.8	19.1
100	13.3	16.2	19.9	13.4	16.1	21.2
105	14.5	17.6	21.9	14.6	17.6	23.5
110	15.8	19.2	24.2	15.9	19.3	26.1
115	17.3	21.0	26.7	17.4	21.1	29.0
120	18.9	23.0	29.6	18.9	23.2	32.3
125	20.7	25.2	32.9	20.7	25.5	36.0
130	22.7	27.7	36.6	22.6	28.1	40.3
135	25.0	30.5	40.9	24.8	31.2	45.1
140	27.4	33.6	45.7	27.3	34.6	50.5
145	30.1	36.9	51.0	30.0	38.4	56.4
150	32.9	40.4	56.8	32.9	42.5	62.8
155	35.9	44.1	63.1	35.9	46.9	69.5
160	39.1	48.0	69.9	38.8	51.3	76.4
165	42.3	52.0	77.3	–	–	–
170	45.6	56.0	85.2	–	–	–
175	49.0	60.1	93.7	–	–	–
180	52.3	64.2	103.1	–	–	–
Age ≥16.0 y						
160	35.8	47.2	62.4	38.9	53.0	72.2
170	46.7	61.6	81.4	46.2	62.9	85.8
180	53.3	70.4	92.9	–	–	93.5

– insufficient data

parents is a predictor for height. The explained variance by socio-economic status was low for height and BMI in the Moroccans. Working Moroccan mothers had shorter children, but in contrast to Dutch mothers, there was no relation between working status and BMI. This might be explained by a homogeneous SES group with low educational level. The distribution of the demographic variables was largely different from the Dutch sample, especially for educational level, working status of the parents and sizes of the families. However, in the age group 0–≤5 y these differences decreased.

The effect of duration of stay of the mother in The Netherlands was small. A positive association with height was found in the 5–≤12.5 y old, but this effect disappeared in the multiple variable analyses. In the more than 5 y olds, 72% of the mothers had stayed more

Table 5. p_{50}-ages (y) of reaching the stages of secondary sex characteristics for Moroccan and Dutch boys and girls in the 1997 Dutch Growth Study.

Boys		Moroccan p_{50}	Dutch p_{50}	Girls		Moroccan p_{50}	Dutch p_{50}
Pubic hair	PH 2	12.5	11.7	Pubic hair	PH 2	11.0	11.0
	PH 3	13.2	12.9		PH 3	11.8	11.9
	PH 4	13.9	13.8		PH 4	12.4	12.7
	PH 5	15.2	15.0		PH 5	12.5	13.8
Genitalia	G 2	12.4	11.5	Breast	B 2	10.9	10.7
	G 3	13.2	12.9		B 3	11.7	11.9
	G 4	13.6	13.9		B 4	12.4	12.8
	G 5	15.2	15.3		B 5	12.6	14.3
				Menarche*		12.9	13.2

*The Moroccan p_{10}- and p_{50}-ages for menarche were 11.5 and 14.4 y, for the Dutch 11.8 and 14.9 y, respectively.

Table 6. Association of height SDS and BMI SDS. The significant demographic variables for the Moroccan (M) and the Dutch (D) group are shown in three age groups (I: 0–<5 y; II: 5–<12.5 y; and III: ≥12.5 y).

| | Univariate regression analysis | | | | | |
| | I | | II | | II | |
Age group	ß M	ß D	ß M	ß D	ß M	ß D
HEIGHT SDS						
Duration of stay mother (y)		–	0.08**	–		–
Educational level child	–	–			0.11**	0.09**
Educational level parents			0.07*	0.10*	0.09**	0.11**
Familysize			−0.07*		−0.11***	
Birthrank			−0.08*			
Birthweight (kg)	0.35***	0.80***	–	0.40***	–	0.40***
Target height SDS	0.26***	0.52***	0.29***	0.66***	0.26***	0.72***
Two parent home		0.34**				
Smoking during pregnancy		−0.21***	–	–	–	–
Breastfed (at least 2 wk)		0.06*	–	–	–	–
BMI SDS						
Educational level child	–	–		−0.33*		−0.07*
Educational level parents				−0.15***		−0.16***
Familysize			−0.06*			−0.05**
Birthrank					−0.08*	0.04*
Birthweight (kg)	0.28***	0.40***	–	0.20***	–	0.10***
Target height SDS						−0.08***
Mother working outside						0.08**
Smoking during pregnancy	0.09*	−0.09*	–	–	–	–
Alcohol during pregnancy		0.08*	–	–	–	–

For group II, educational level is defined as 1 = primary education, 0 = special education. For group III, educational level for children is defined for parents as 1 = middle/higher secondary education, 0 = primary of lower secondary education. Gender 0 = boy, 1 = girl. Other variables 1 = yes, 0 = no. – = no data available. ß = standardized ß.

* $p \geq 0.01$–$p < 0.05$; ** $p \geq 0.001$–$p < 0.01$; *** $p < 0.001$

than 10 y in the Netherlands, in the younger ones this was 50%. An expected benefit of environmental circumstances, however, is not seen yet.

Target height was the most prominent predictor for height, but its contribution to the explained variance was lower than observed in the Dutch population. In our study the majority of parental heights were not measured, but asked from the parents joining the children. Older children all received a personal invitation letter asking for birthweight and parental heights. Maternal heights for the older children may have been overestimated as the reported mothers' mean heights were curiously found to be 1.9 cm taller than those of 20-y-old girls in 1997. On the other hand, the differences between parents' heights were low (9 cm). Our experience in another study was that the mean self-reported final height differed by + 0.4 cm, with a median of the absolute difference of +0.7 cm (17). Maternal heights for the younger children were more or less as expected, and on average similar to 20-y-old girls in 1997. Measured parental heights are recommended in future studies. For both the Moroccan and Turkish populations we used a formula in which we assume a secular change of 2 cm in one generation (3).

In conclusion, given the large differences in children of Dutch origin and given the growing size of the group, separate growth charts for children of Moroccan origin living in The Netherlands are certainly useful. Moroccan children are substantially shorter. In addition, girls have higher weight-for-height and BMI for age. Puberty starts later than in Dutch children. Median age at menarche (12.9 y) occurs 3.6 mo earlier than in Dutch girls.

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