Height of South Asian children in the Netherlands aged 0–20 years: secular trends and comparisons with current Asian Indian, Dutch and WHO references

Jeroen A. de Wilde, Paula van Dommelen, Stef van Buuren & Barend J. C. Middelkoop

Published online: 25 Jun 2014.

Submit your article to this journal

Article views: 88

View related articles

View Crossmark data

Citing articles: 2 View citing articles

RESEARCH PAPER

Height of South Asian children in the Netherlands aged 0–20 years: secular trends and comparisons with current Asian Indian, Dutch and WHO references

Jeroen A. de Wilde[1,2], Paula van Dommelen[3], Stef van Buuren[3,4], and Barend J. C. Middelkoop[5,6]

[1]Department of Youth Health Care, GGD (Community Health Service) Haaglanden, The Hague, The Netherlands, [2]Department of Child Health, [3]Department of Life Style, TNO, Leiden, The Netherlands, [4]Department of Methodology & Statistics, Faculty of Social Sciences, University of Utrecht, Utrecht, The Netherlands, [5]Department of Public Health and Primary Care, Leiden University Medical Center, Leiden, The Netherlands, and [6]Department of Epidemiology, GGD (Community Health Service) Haaglanden, The Hague, The Netherlands

Abstract

Background: People from Asian populations are generally shorter than other ethnic groups. It is unknown if current universal height references are suitable for affluent South Asian children in the Netherlands.
Aims: To develop height-for-age charts for contemporary South Asian children aged 0–20 years living in the Netherlands, to evaluate secular trends, and to compare the charts with current Asian Indian, Dutch and WHO references.
Subjects and methods: A population-based study measured 3315 South Asian children aged 0–20 years between 2007–2010. Among this cohort, 6876 measurements were taken. Another 7388 measurements were taken of a historical cohort of 1078 children born between 1974–1976 (aged 0–18 years).
Results: An upward trend in height was observed for South Asian children living in the Netherlands between 1992–2010. The height-for-age charts of the South Asian historical cohort were similar to current Asian Indian charts. South Asian children in the Netherlands were shorter than their Dutch contemporaries at every age; and these differences increased further during adolescence. Compared to the WHO height-for-age references, there were considerable discrepancies in height, with curves intersecting twice.
Conclusion: The discrepancies between the South Asian and Dutch and WHO height-for-age references indicate differences in growth patterns between the source populations.

Introduction

Height and body weight are important indicators of a child's physical and psychological wellbeing (World Health Organization, 1995). In optimal environmental and nutritional conditions it is assumed that children can attain their full genetic growth potential. Therefore, the assessment of growth has been widely used as a (screening) tool for detecting health problems and assessing nutritional status (World Health Organization, 1995).

The height of a child is usually evaluated by comparing his or her current height to a reference that represents the average height in the child's population. Ideally, the reference is derived from data of a population sample in which there are no constraints due to socio-economic factors, diet, disease and/or access to health services (Frongillo & Hanson, 1995; Ulijaszek, 2006). Thus, in developing countries, the reference is usually determined from a more affluent portion of the population in which negative factors impacting growth are limited. However, in many countries such optimal references are not available for the local population.

As the distribution of height was shown to be fairly similar in most ethnic groups up to the age of 5 years, the World Health Organization (WHO) developed a universal child growth standard for children aged 0–5 years, based on data from six affluent populations of all continents. As it represents all major ethnic groups (WHO multicentre growth reference study group, 2006), it was designed as a universally applicable standard, describing ''how children should grow''. As the WHO Child Growth Standard (subsequently referred to as WHO) is ethnic-independent, it assumes all ethnic groups have the same genetic potential.

A complementary height-for-age reference for school-aged children and adolescents aged between 5–19 years was added later, based on growth in a single population of US children in the late 1970s (de Onis et al., 2007). As this reference was based on a single population of Caucasian US children, it is unlikely to represent all ethnic groups. Large differences between school-aged children of affluent populations of other countries and this reference population have been reported

Correspondence: Jeroen de Wilde, Department of Youth Health Care, GGD (Community Health Service) Haaglanden, PO Box 12652, 2500 DP The Hague, The Netherlands. Tel: +31 (0)70 7526506. E-mail: jeroen.dewilde@denhaag.nl

previously (Haas & Campirano, 2006). For example, Dutch children aged 7–18 years were shown to be taller at most ages, whereas Asian children were generally shorter. Moreover, at age 17 adolescents from Northern European countries were found to be considerably taller than 17 year olds in the south of Europe, despite equivalent levels of prosperity. Therefore, the WHO reference may not be suitable for all ethnic groups (van Buuren & van Wouwe, 2008).

The physical growth of South Asian children in the Netherlands is monitored with growth charts developed for Dutch children (Schonbeck et al., 2013). However, since Dutch children are the tallest in the world (Schonbeck et al., 2013) and Asian children are generally among the shortest ethnic groups (Ulijaszek, 2001), the Dutch references may not adequately reflect the height of South Asian children living in The Netherlands. Recently, in India, height-for-age charts have been developed that were based on measurements of affluent children (Khadilkar et al., 2009), but it is unknown if these charts will reflect the growth of South Asian children living in the Netherlands.

The objectives of this study were to: firstly, construct height-for-age charts for South Asian children in the Netherlands aged 0–20 years; secondly, evaluate the secular trend in height in this group and, thirdly, determine if the height of contemporary South Asian children in the Netherlands differs from Asian Indian (Khadilkar et al., 2009), Dutch (Schonbeck et al., 2013) and WHO (de Onis et al., 2007; WHO multicentre growth reference study group, 2006) reference populations.

Methods

Population

The population of South Asians in the Netherlands is estimated at 180 000 (Oudhof et al., 2011). The city of The Hague has the largest population of ~40 000, most of whom are descendants of Asian Indians who migrated to the former Dutch colony of Suriname in the 19th century. Around the time of Suriname's independence in 1975, many South Asians migrated to the Netherlands. For this study, growth data were collected from South Asian children and adolescents living mostly in The Hague area.

Data collection

Youth Health Care services in the Netherlands periodically assess the health of all children at fixed ages (Wieske et al., 2012). Approximately 15 routine check-ups are generally performed between 0–4 years of age, with another three checks at ages 5–6, 9–10 and 13–15 years. The length or height is measured at each visit by trained physicians, nurses or physician's assistants. Customarily, the length of children up to 1.5–2.0 years is measured to the nearest 0.1 cm using a measuring board in a supine position with legs fully extended and heels touching a vertical backboard. From the age of 2 years, standing height is measured with a measuring tape (microtoise) or (portable) stadiometer to the nearest 0.1 cm.

To construct growth charts of contemporary South Asian children of 0–20 years, all available length/height data, measured between 2007–2010, were extracted from the digital

Youth Health Care record system of the city of The Hague. As not all ages were represented in these records, additional measurements were taken between 2008 and 2010 from South Asian children and adolescents aged outside the range of the standard check-ups (6–8, 11–12 and 15–20 years).

Supplementary data, such as date of birth, sex, the highest level of education achieved by both parents, parental country of birth, the family name of the child and parents, date of menarche, medicine use and the presence of diagnosed growth disorders were either acquired from the digital record system or from a questionnaire (additionally measured children). In the digital health records date of menarche was not uniformly registered and, therefore, omitted. The educational level of parents was subdivided in three categories; low, middle and high (Verweij, 2008). This part of the current study will be further referred to as ''the 2010 study''.

A second growth study, based on the growth data of a birth cohort born 1974–1976, was performed to investigate the secular trend of height. Measurements of this cohort, taken between 1974–1994, were extracted from paper Youth Health Care records alongside the supplementary data. In these records, date of menarche and parental educational level were not available. Contrary to current practice, where children from the age of 4 years are measured only three times, up until the early 1990s children aged between 4–18 years were measured every 2 years. In many records, length/height measurements were missing, as many children lived only a part of their childhood in the city and because, during most health assessments between birth and 2 years of age, only weight was measured and not length. We will refer to this part of the study as ''the 1976 study''.

The 2010 study was approved by the Ethical Board of Leiden University Medical Centre as part of the 5th National Growth Study. Written consent was obtained from the parents of children under 16 years and verbal consent from the child as well from 12 years. For the 1976 study ethical approval was not needed, as under Dutch law the use of routinely collected medical data from health records is allowed without consent, provided that privacy is protected (Central Committee on Research Involving Human Subjects, 2012). All data were anonymized before analysis.

Inclusion and exclusion criteria

South Asian origin was determined by the country of birth of both parents (born in a South Asian country). Surinamese South Asian ethnicity was determined by two criteria: Suriname (first generation parents) or the Netherlands (second generation) as country of birth of both parents and the presence of a typical (Surinamese) South Asian family name in both parents. Parents of children who were measured additionally were asked for their ethnicity, alongside the country of birth of parents and grandparents. Only children of whom both parents were of (Surinamese) South Asian descent were included in the study.

Prematurely born children (<37 weeks of gestation) and children with a birth weight <2500 g were included, similarly to the 5th Dutch growth study of 2009 (Schonbeck et al., 2013). Children with a diagnosed growth disorder or using medicine known to affect growth were excluded.

Statistical methods

The LMS method (Cole & Green, 1992) was used to construct growth charts. This method, which transforms data into a normal distribution, is summarized by three age-dependent curves, for skewness (L), median (M) and coefficient of variation (S), which are smoothed against age using natural splines. The amount of smoothing depends on the degrees of freedom of each curve and was determined by assessing worm plots with 16 age groups (van Buuren & Fredriks, 2001).

Age was transformed with a cube root to obtain a better fit during periods of rapid growth. This transformation stretches periods of greater height velocity, for instance during infancy, and compresses periods of slower growth such as the period between the age of 4 years and the beginning of puberty. After an optimal fit was established, the distribution was scaled back to the original age.

To enable the height distributions of the 2010 study to be compared with other references, all height data from the 2010 study were converted into z-scores using recent Asian Indian (Khadilkar et al., 2009), Dutch (Schonbeck et al., 2013) and WHO (de Onis et al., 2007; WHO multicentre growth reference study group 2006) references, as well as the references created in the 1976 study. Z-scores indicate the measurement's deviation from the mean in the reference population. To determine if the mean z-scores per age differed significantly from the mean of the specific reference, indicated by a value of 0 SD, ''estimated marginal means'' and 95% confidence intervals were calculated using a linear mixed-effects model. This model takes the correlation between repeated measurements on each subject into account as well as unbalanced designs, for example in studies with unequal numbers of repeated measurements between subjects. The estimated marginal means are calculated from the fitted model and adjusted for any of the other variables defined in the model. For the current study, z-score was the dependent variable and age category and parental educational level were independent variables.

The height reference values (LMS parameters) were calculated with R statistical software v3.0.2 and the GAMLSS package v4.2-6 (Stasinopoulos & Rigby, 2007), whereas the other data analyses were performed with IBM SPSS Statistics 20.

Results

2010 Growth charts

The 2010 study included 1644 boys and 1671 girls with 4520 length/height measurements at ages 0–4 years and 2356 at ages 5–20 years. Most children (99%) were of Surinamese South Asian ethnicity. The remainder were of Indian, Pakistani or Sri Lankan descent. Of the measurements 18.9%, 51.5% and 29.6% were of children with low, middle and high educated parents, respectively.

The height data were normally distributed. Therefore, *L*, the measure of skewness, had a fixed value of 1 at every age. After an optimal fit of the curve was established, the mean (*M*) and Standard Deviation (SD) were calculated (Table 1). In boys, the final height was reached at age 20 years (Table 1); in girls at 16.5 years of age. The mean age of menarche, based

Table 1. Height/length reference data for boys and girls aged 0–20 years of the Surinamese South Asian 2010 study and the Surinamese South Asian 1976 study.

	Boys				Girls			
	2010		1976		2010		1976	
Age	Mean	SD	Mean	SD	Mean	SD	Mean	SD
birth	NA	NA	49.2	2.3	NA	NA	48.4	2.3
0.0417	NA	NA	51.1	2.3	NA	NA	50.4	2.3
0.0833	52.4	2.2	53.5	2.3	51.3	2.3	52.1	2.3
0.1667	56.4	2.2	57.3	2.4	55.1	2.4	55.4	2.4
0.2500	59.8	2.2	60.3	2.4	58.1	2.5	58.4	2.4
0.5000	66.7	2.3	66.9	2.5	64.8	2.6	65.3	2.6
0.7500	71.1	2.4	71.4	2.6	69.6	2.6	69.8	2.8
1.0000	74.6	2.5	75.0	2.8	73.5	2.7	73.5	2.9
1.2500	77.9	2.6	77.9	3.0	76.9	2.8	76.5	3.1
1.5000	80.9	2.8	80.6	3.2	80.1	3.0	79.1	3.3
2.0000	86.5	3.1	85.6	3.5	85.8	3.2	84.2	3.6
3.0000	95.8	3.6	94.1	4.1	95.0	3.7	92.7	4.2
4.0000	103.9	4.1	101.4	4.6	102.8	4.1	100.5	4.7
5.0000	110.7	4.7	108.0	4.9	110.1	4.6	107.0	5.2
6.0000	116.9	5.1	114.2	5.2	116.7	5.0	113.5	5.6
7.0000	123.1	5.6	120.5	5.5	122.9	5.4	120.0	6.1
8.0000	129.4	6.0	126.6	5.9	129.1	5.7	125.9	6.5
9.0000	135.2	6.4	132.0	6.4	135.5	5.9	131.3	6.8
10.0000	140.8	6.7	137.1	6.9	141.7	6.1	137.8	7.0
11.0000	146.8	7.0	142.7	7.3	147.5	6.1	144.5	7.0
12.0000	153.1	7.2	148.9	7.5	152.4	6.2	149.8	7.0
13.0000	159.3	7.3	156.0	7.7	156.0	6.2	153.8	6.9
14.0000	164.7	7.4	162.2	7.7	158.2	6.1	156.4	6.8
15.0000	168.5	7.4	166.1	7.7	159.3	6.1	157.5	6.7
16.0000	170.9	7.3	168.4	7.6	159.6	6.1	158.1	6.6
17.0000	172.4	7.2	169.9	7.6	159.6	6.0	158.3	6.5
18.0000	173.4	7.2	171.1	7.5	159.6	6.0	158.3	6.4
19.0000	174.0	7.1	NA	NA	159.6	5.9	NA	NA
20.0000	174.3	7.0	NA	NA	159.6	5.9	NA	NA

SD, Standard Deviation; NA, Not Available.

on the reported date of menarche, was 11.4 years (*n* = 381; SD = 1.3).

Secular trend in height

In the 1976 study 551 boys and 527 girls were included with 3781 measurements of length/height at ages 0–4 years and 3596 at ages 5–18 years. Similar to the 2010 study the values of height were normally distributed. Table 1 shows the determined mean and SD values for height. Secular trends by age and sex were evaluated by comparing the mean values of the 2010 study with the values determined in the 1976 study, finding that in the first month after birth boys of the 2010 study were, on average, 1.1 cm and girls 0.8 cm shorter than the 1976 cohort (Table 1). This difference gradually decreased during infancy. From the first birthday, the height of both sexes in the 2010 study trended upward compared with the 1976 study until the age of 18. A maximum positive height difference of 4.2 cm was reached at age 11.5 years in boys and at 9.0 years in girls. At 18 years of age, boys of the 2010 study were 2.3 cm taller and girls were 1.3 cm taller.

Comparison with Asian Indian, Dutch and WHO references

The height-for-age charts of South Asian children in the Netherlands and of affluent children in India were very similar (Figure 1). The Asian Indian reference and the
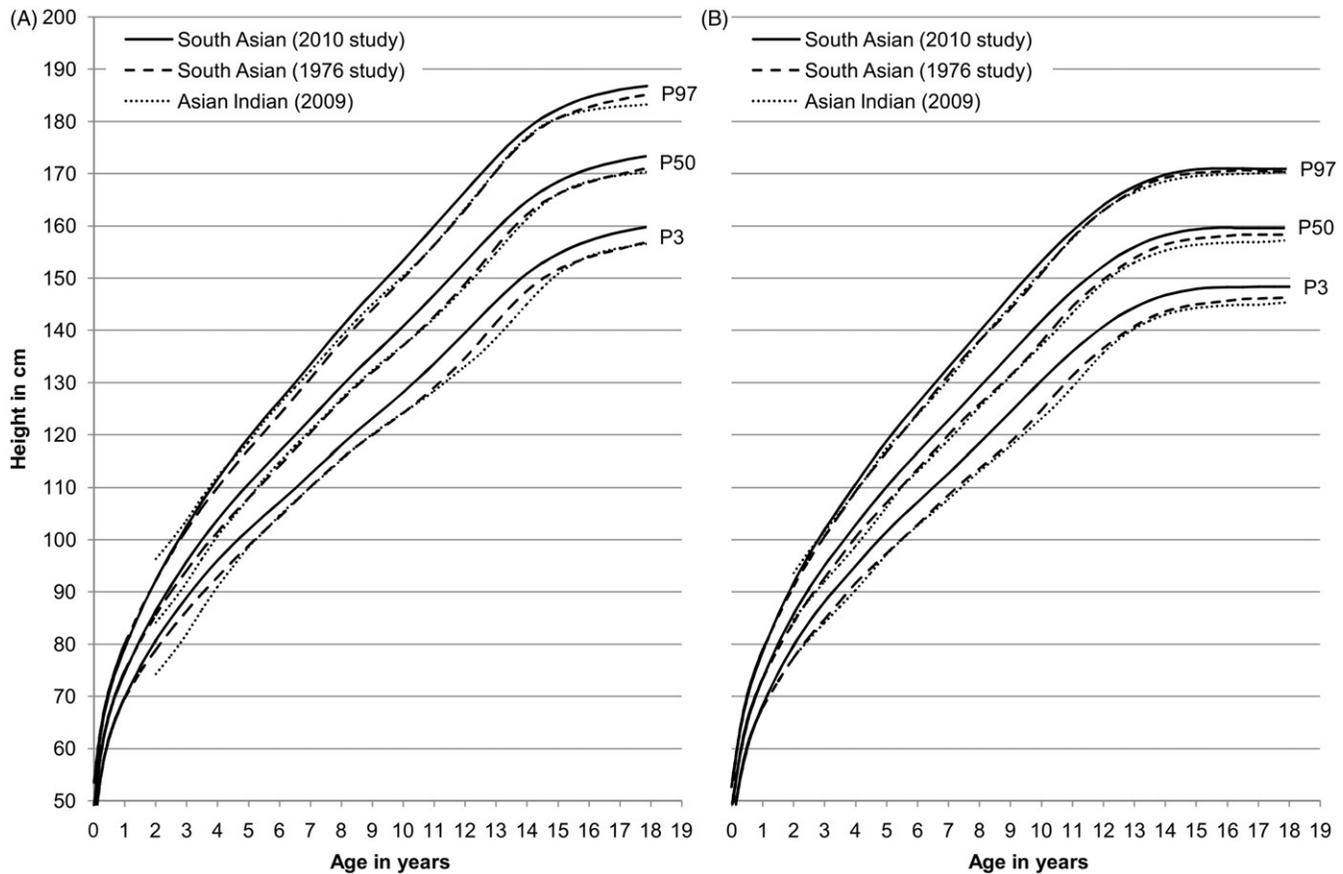
Figure 1. Boys (A) and girls (B) height-for-age charts for 0–18 years (P3, P50 and P97), combined South Asian 2010 study, South Asian 1976 study and Asian Indian 2009 charts.

reference of the historical cohort even coincided at most ages. Children of the 2010 study were significantly taller at ages 2–18 years ($p < 0.001$). The mean z-score based on the Asian Indian reference was 0.5 (SD = 0.9) both in boys and girls (Figure 2).

Compared with Dutch children, contemporary South Asian children in the Netherlands were shorter at every age between birth and 20 years of age (all p-values < 0.001). Four weeks after birth the mean z-score was −0.8 in boys and −1.0 SD in girls. However, these z-scores quickly rose in the first months to −0.5 in boys and −0.6 in girls, after which the values remained fairly stable up until the age of 12 years in boys and 10 years in girls. From that age, the difference in height between South Asian and Dutch children grew. At 20 years of age, the South Asian boys studied were 10.1 cm shorter and girls 11.1 cm shorter than their Dutch counterparts.

When applying the WHO reference to South Asian children of the 2010 study, a different growth pattern was found (Figure 2). Similar to the Dutch reference, in the first month after birth the mean z-scores were low, −1.1 in boys and −1.0 in girls, values that rapidly decreased up to the age of 6 months. However, the mean z-scores became significantly greater than 0 between the age of 5–14 years in South Asian boys, with a maximum positive difference of 0.6 SD ($p < 0.001$) at 9 years of age and in South Asian girls between 5–12 years, with the largest difference of 0.4 ($p = 0.004$) at 7 years of age. This indicates that South Asian children in the Netherlands were taller at these ages than the WHO population (US children). Mean height z-scores became

again significantly smaller than 0 from the age of 16 years in boys ($p < 0.001$) and from the age of 14 in girls ($p < 0.001$).

Discussion

With the two separate South Asian specific height-for-age references created in this study, an upward trend in height over the studied period was shown at most ages, except during infancy. In 2010, the final height at 18 years of age was 2.3 cm taller in boys and 1.3 cm in girls than in the 1976 cohort.

While the height-for-age reference charts of the 1976 study coincided to a large extent with current Asian Indian height-for-age charts, the average height of contemporary South Asian children in the Netherlands of the 2010 study was significantly greater at every age than in the population of affluent Asian Indian children upon which the Asian Indian reference was based. Furthermore, we found that South Asian children were shorter at every age than Dutch children, with the largest differences observed during infancy and adolescence. Compared with the WHO reference populations, even larger discrepancies in growth patterns over the whole age range were observed.

Strengths and limitations

A major strength of this study is that it is the first study in which South Asian-specific height-for-age charts were developed based on heights of affluent South Asian children living in a developed country. Other strengths are the relatively large sample sizes, the presence of historical data

Figure 2. South Asian (2010) boys (A) and girls (B) estimated marginal mean (EMM) height *z*-score by age, based on the 1976 study, Asian Indian, Dutch and WHO references.
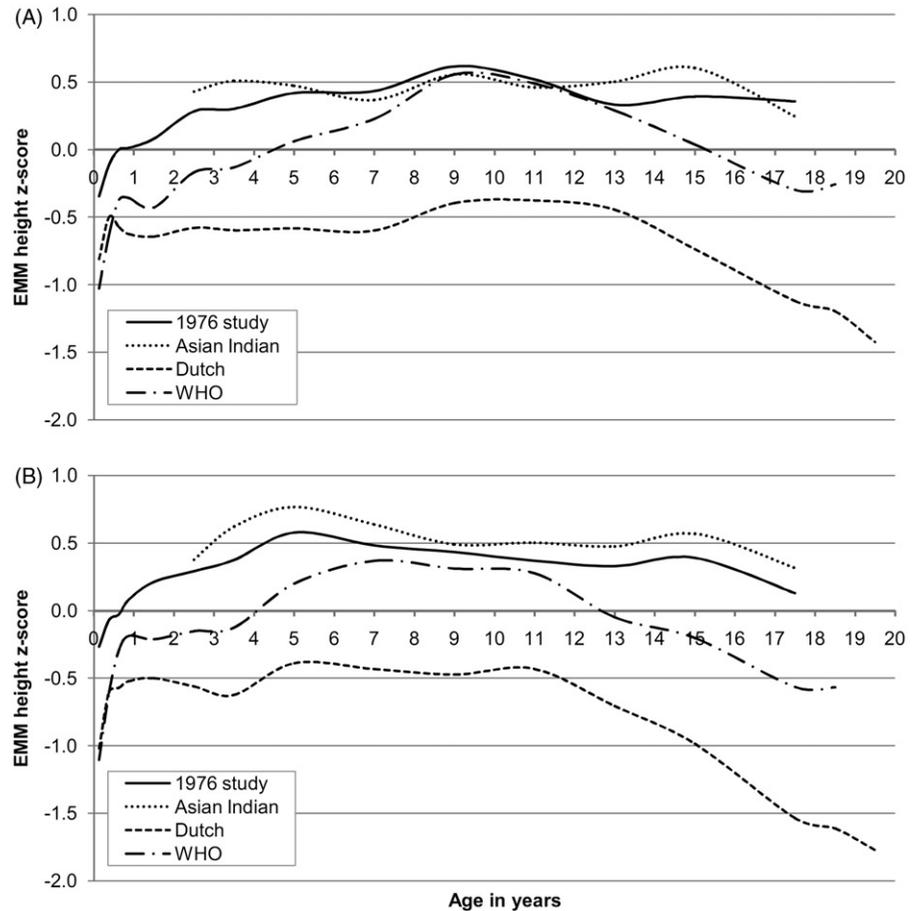
and the availability of important selection criteria, such as demographic data and information on medicine use and diseases/disorders that could have affected growth.

Although the numbers of children were not evenly distributed (larger numbers under the age of 4 years and between 9–16 years), so as to establish a good fit of the curves at the age periods of increased growth, the samples were generally large enough to determine statistically significant differences over the whole age range for most references used. However, statistical power was likely not large enough in certain age bands to determine if *z*-scores differed significantly from a value of 0, especially at the ages with *z*-scores near the 0 SD-line (WHO reference). Therefore, the exact ages at which the mean height of South Asian children deflects from the WHO reference (population) could not be precisely pinpointed. Nevertheless, the discrepancies in growth pattern between the South Asian and WHO population remain clear.

Another limitation of this study may be the generalizability of the results. It is currently unknown if South Asian children in the Netherlands differ genetically from South Asian populations in other countries, as mixed marriages with other ethnic groups may have occurred in Suriname or the Netherlands. Nonetheless, as most South Asians originating from Suriname have been shown to predominantly marry within their own ethnic group (Mungra, 1990; Oudhof & Harmsen, 2011), differences are likely to be minimal. In addition, as the growth charts of South Asian children in the Netherlands were almost identical to growth charts of

contemporary Asian Indian children, a large concordance in growth is expected. However, further research is needed to verify that the growth charts created in this study are suitable for monitoring height in other populations originating from the Indian sub-continent.

Differences in height between populations: Environment or genes?

Similar to the South Asian population in the Netherlands, also in the largest minority populations, the height of Turkish and Moroccan children is still increasing (Schonbeck & van Buuren, 2010). This secular increase in height of Turkish and Moroccan children is likely the result of improvements in socio-economic factors, as Turkish and Moroccan adults in the Netherlands move from a generally low level of education toward a higher education (Dagevos & Gijsberts, 2007). Compared with Turkish and Moroccan children, the adult height of South Asian children is on average 3 cm shorter. However, this difference is unlikely to be explained by differences in socioeconomic factors as the educational level of South Asian adults, used as proxy for socio-economic status, was already similar in the 1970s to that of Dutch adults (Ganzeboom & Sno, 2012). Also in the present study the level of parental education was highly comparable (Centraal Bureau voor de Statistiek, 2012).

Nevertheless, although socioeconomic circumstances in the Netherlands generally improved between 1974–2006 (Boelhouwer, 2010), the secular trend of increasing height

in children of Dutch origin was recently shown to have halted (Schonbeck et al., 2013). Additionally, in South Asian children of the current study the increase in final height since 1974 was relatively small, especially when compared with the secular trend found in Turkish and Moroccan children whose final heights increased by 2–3 cm in a time frame of only 13 years (Schonbeck & van Buuren, 2010). Also in India the upward trend in height of affluent children was relatively small in 2007 compared with height in a similar group measured in 1989 (Khadilkar et al., 2009).

Considering that the socioeconomic status of Dutch and South Asian populations in the Netherlands has been similar at least since the 1970s, environmental factors known to influence growth, such as disease, nutrition, physical environment and access to (child) healthcare (Frongillo & Hanson, 1995), are less likely to have played a role in the observed height differences. On the other hand, cultural differences between the Dutch and South Asians may affect nutrition, (health) behaviour and the social and physical environment, but the influence of such factors on growth are probably smaller than socioeconomic factors.

The similarity in growth trajectories of South Asian children in the Netherlands and children in India suggests that genetic factors may be more important than environmental factors in explaining differences in height between ethnic groups in the Netherlands. In general, the heritability of height has been estimated to be very high at 0.8–0.9, indicating that 80–90% of the variation in height between people may be explained by genetic differences (Perola et al., 2007; Silventoinen et al., 2003; Visscher et al., 2006). Also, the onset of pubertal development was shown to be controlled by genes to a large extent (Choi & Yoo, 2013). In the present study no clinical assessment of sexual maturation (Tanner staging) was performed to allow pubertal development to be taken into account. However, menarcheal age indicating completion of female puberty was available, which showed a 1.7 years earlier menarche (at 11.4 years) of South Asian girls compared with Dutch girls (Talma et al., 2013). As earlier menarche is associated with shorter adult stature (McIntyre & Kacerosky, 2011) this may explain the large difference in final height between South Asian and Dutch children. A similar mean menarcheal age was found in urban Asian Indian girls (11.4 years) (Ray et al., 2010) and in adopted Asian Indian girls in Sweden (11.6 years) (Proos, 2009).

Are universal height-for-age references suitable for South Asian children?

Because most Asian sub-populations generally have an earlier onset of pubertal development than most other ethnic groups and, consequently, a pubertal growth spurt at a younger age, doubts were raised about the suitability of a single universal reference for the assessment of pubertal growth in Asian adolescents (Ulijaszek, 2001). As the WHO reference 5–19 years was based on the heights of US children (de Onis et al., 2007), the difference in growth pattern between the South Asian and this US population likely reflects maturational differences between South Asian children and children of European descent. On the other hand, the WHO growth standard for ages 0–5 years, based on growth in six

populations of all continents, did not adequately correspond to the growth of South Asian children of 0–5 years as well. To some extent, the large difference in length at 4 weeks after birth may be the result of a difference in the inclusion criteria of the studies. Contrary to our study, WHO only included full-term and exclusively breast-fed babies. However, this is unlikely to entirely explain the discrepancy. A US study found that also term babies (>37 weeks of gestation) of Asian Indian descent were 0.8–1.1 cm shorter at birth than babies of European descent (Madan et al., 2002), which corresponds to a difference of 0.4–0.6 SD with the WHO reference. Nonetheless, the slightly shorter length of infants of the 2010 study compared with the 1976 study may be due to a 2-times higher prevalence of preterm birth, which was shown in a previous study (De Wilde et al., 2013).

Conclusion

In conclusion, an upward trend in height of South Asian children in the Netherlands was found at most ages. Also, South Asian children in the Netherlands are currently taller than contemporary affluent Asian Indian children. Compared with other minority groups in the Netherlands, South Asian children are shorter, despite a higher socio-economic status. WHO height-for-age references, both for ages 0–5 and 5–19 years, do not properly reflect the growth (pattern) of South Asian children and adolescents, which makes it more difficult to assess growth with these references. As the observed growth patterns of South Asian children living in the Netherlands and children living in India were similar, the South Asian-specific height-for-age charts from our study may be more appropriate for monitoring growth of children originating from the Indian sub-continent than the WHO references, although further research is needed to confirm its suitability.

Acknowledgements

Declaration of interest

References

Boelhouwer J. 2010. Wellbeing in the Netherlands: the scp life situation index since 1974. The Hague: Sociaal en Cultureel Planbureau. Available online at: http://www.scp.nl/english/Publications/Publications_by_year/Publications_2010/Wellbeing_in_the_Netherlands, (accessed March, 20 2014).

Centraal Bureau voor de Statistiek. 2012. Labour force; reached educational level by ethnicity, sex and age. The Hague: CBS (Statistics Netherlands). Available online at: http://www.cbs.nl/nl-NL/menu/themas/dossiers/allochtonen/cijfers/onderwijs/oplei-dingsniveau-sl.htm, (accessed November, 19 2013).

Central Committee on Research Involving Human Subjects. 2012. Step-by-step plan RC review. The Hague: CCMO. Available online at: http://www.ccmo-online.nl/main.asp?pid=10&sid=30&ssid=51, (accessed November 19, 2013).

Choi JH, Yoo HW. 2013. Control of puberty: genetics, endocrinology, and environment. Curr Opin Endocrinol Diabetes Obes 20:62–68.

Cole TJ, Green PJ. 1992. Smoothing reference centile curves: the LMS method and penalized likelihood. Stat Med 11:1305–1319.

Dagevos J, Gijsberts M. 2007. Year report integration 2007. Den Haag: Sociaal en Cultureel Planbureau. Available online at: http://www.scp.nl/dsresource?objectid=19608&type=org, (accessed November, 19 2013.

de Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. 2007. Development of a WHO growth reference for school-aged children and adolescents. Bull World Health Organ 85:660–667.

De Wilde JA, van Buuren S, Middelkoop BJ. 2013. Trends in birth weight and the prevalence of low birth weight and small-for-gestational-age in Surinamese South Asian babies since 1974: cross-sectional study of three birth cohorts. BMC Public Health 13:931.

Frongillo Jr EA, Hanson KM. 1995. Determinants of variability among nations in child growth. Ann Hum Biol 22:395–411.

Ganzeboom HBG, Sno TE. 2012. Social mobility and achieved status of Surinamese in Suriname en Surinamese in the Netherlands. Amsterdam: Vrije Universiteit, faculty of Social Sciences. Available online at: http://home.fsw.vu.nl/hbg.ganzeboom////Pdf/2012-ganzeboom-sno-surimob93.pdf, (accessed November, 19 2013).

Haas JD, Campirano F. 2006. Interpopulation variation in height among children 7 to 18 years of age. Food Nutr Bull 27:S212–S223.

Khadilkar VV, Khadilkar AV, Cole TJ, Sayyad MG. 2009. Crosssectional growth curves for height, weight and body mass index for affluent Indian children, 2007. Indian Pediatr 46:477–489.

Madan A, Holland S, Humbert JE, Benitz WE. 2002. Racial differences in birth weight of term infants in a northern California population. J Perinatol 22:230–235.

McIntyre MH, Kacerosky PM. 2011. Age and size at maturity in women: a norm of reaction? Am J Hum Biol 23:305–312.

Mungra G. 1990. Hindustani families in the Netherlands. Leiden: Centrum voor Onderzoek van Maatschappelijke Tegenstellingen, Rijksuniversiteit Leiden.

Oudhof K, Harmsen C. 2011. The social situation of Surinamese populations in the Netherlands. The Hague: CBS (Statistics Netherlands). Available online at: http://www.cbs.nl/NR/rdonlyres/F240F5ED-EE42-4DD4-8FE5-902E6EE5BC30/0/2011k4p46b15art.pdf, (accessed March, 20 2014).

Oudhof K, Harmsen C, Loozen S, Choenn C. 2011. Size and spread of Surinamese populations in the Netherlands. Rijswijk: CBS (Statistics Netherlands). Available online at: http://www.cbs.nl/NR/rdonlyres/E77E4C63-775E-4708-B347-1D1DA392B119/0/2011k2b15p97art.pdf, (accessed March, 20 2014).

Perola M, Sammalisto S, Hiekkalinna T, Martin NG, Visscher PM, Montgomery GW, Benyamin B, et al. 2007. Combined genome scans for body stature in 6,602 European twins: evidence for common Caucasian loci. PLoS Genet 3:e97.

Proos LA. 2009. Growth & development of Indian children adopted in Sweden. Indian J Med Res 130:646–650.

Ray S, Mishra SK, Roy AG, Das BM. 2010. Menstrual characteristics: a study of the adolescents of rural and urban West Bengal, India. Ann Hum Biol 37:668–681.

Schonbeck Y, Talma H, van DP, Bakker B, Buitendijk SE, Hirasing RA, van BS. 2013. The world's tallest nation has stopped growing taller: the height of Dutch children from 1955 to 2009. Pediatr Res 73:371–377.

Schonbeck Y, van Buuren S. 2010. Factsheet Results 5th national growth study. Leiden: TNO. Available online at: http://www.tno.nl/downloads/20100608%20Factsheet%20Resultaten%20Vijfde%20Landelijke%20Groeistudie1.pdf, (accessed November, 19 2013).

Silventoinen K, Sammalisto S, Perola M, Boomsma DI, Cornes BK, Davis C, Dunkel L, et al. 2003. Heritability of adult body height: a comparative study of twin cohorts in eight countries. Twin Res 6:399–408.

Stasinopoulos DM, Rigby RA. 2007. Generalized additive models for location scale and shape (GAMLSS) in R. J Stat Softw 23:1–46.

Talma H, Schonbeck Y, van DP, Bakker B, van BS, Hirasing RA. 2013. Trends in menarcheal age between 1955 and 2009 in the Netherlands. PLoS One 8:e60056.

Ulijaszek SJ. 2001. Secular trends in growth: the narrowing of ethnic differences in growth. Nutrion Bulletin 26:43–51.

Ulijaszek SJ. 2006. The international growth standard for children and adolescents project: environmental influences on preadolescent and adolescent growth in weight and height. Food Nutr Bull 27:S279–S294.

van Buuren S, Fredriks M. 2001. Worm plot: a simple diagnostic device for modelling growth reference curves. Stat Med 20:1259–1277.

van Buuren S, van Wouwe JP. 2008. WHO Child Growth Standards in action. Arch Dis Child 93:549–551.

Verweij A. 2008. Training and education: classification of level of education. Bilthoven: RIVM. Available online at: http://www.nationaalkompas.nl/bevolking/scholing-en-opleiding/indeling-opleidings-niveau/, (accessed November, 17 2013).

Visscher PM, Medland SE, Ferreira MA, Morley KI, Zhu G, Cornes BK, Montgomery GW, Martin NG. 2006. Assumption-free estimation of heritability from genome-wide identity-by-descent sharing between full siblings. PLoS Genet 2:e41.

WHO multicentre growth reference study group. 2006. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatr Suppl 450:76–85.

Wieske RC, Nijnuis MG, Carmiggelt BC, Wagenaar-Fischer MM, Boere-Boonekamp MM. 2012. Preventive youth health care in 11 European countries: an exploratory analysis. Int J Public Health 57:637–641.

World Health Organization. 1995. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser 854:1–452.