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Growth in length and weight from birth to 2 years of a representative sample of Netherlands children (born in 1988–89) related to socio-economic status and other background characteristics

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Summary. Of nearly 1900 live-born singletons, born from April 1988 to October 1989 inclusive, nine measurements of length and weight have been taken between the ages of 1 and 24 months. In the first part of the study, differences in attained length and weight at 1 and 2 years of age are analysed according to socioeconomic status (SES). Multiple regression analyses are used to investigate the association of SES and other background characteristics with length and weight. The second part focuses on the analysis of differences in linear length and weight gain in the first 2 years of life, using a two-step regression technique. At 1 and 2 years of age, differences in attained length and weight and in length and weight gain according to SES are small and not significant, except for the children of Mediterranean parents in the low-SES group, who are significantly heavier than children of all other groups and gain significantly more in weight compared to children of Dutch parents in the low-SES group. Of all the factors studied it appears that parental height, birthweight, parity and ethnic descent of the parents are associated with attained length and weight at 1 and 2 years of age. Of these factors, ethnic descent, however, is not associated with length gain. A small but statistically significant catch-up growth is found in children of mothers who smoked during pregnancy.

1. Introduction

The existence of social disparities in the health of children has been shown in many studies (Grundy and Lewis-Faning 1957, Douglas and Blomfield 1958, Butler and Bonham 1963, Chamberlain and Simpson 1979, Leon, Vågerö and Otterblad Olausson 1992); also, social status is related to the stature of populations, which reflects the differences in average well-being and nutritional status between classes and between dwelling areas. Data on the height of eighteenth-century German boys give evidence of the relationship between secular changes of economic conditions and of height (Komlos 1990). In the Netherlands Brinkman, Drukker and Slot (1988) showed a close relationship between median heights of conscripts of the 1900–40 drafts and the national income per capita. Attained height at different ages is still a sensitive indicator for the health status of children, especially in developing countries (Preece 1989). Differences in body size of infants and children in relation to socioeconomic status (SES) in a number of developing and developed countries have been extensively studied by Meredith (1984). His study shows that weight and length differ strongly between socioeconomic groups, and that these differences are larger in developing and poor countries. In the abovementioned studies of British children, differences in height between children according to socioeconomic group also became apparent, which shows that long after 1950 these differences still exist. In The Netherlands differences in length and height of children according to the SES of the fathers were found in the data of the nation wide growth surveys in 1964–66 and 1980 (Van Wieringen 1972, Roede and Van Wieringen 1985). However, an important finding was that in 1980 the differences in length were smaller than in 1964–66, especially in children aged 1–3 years (Mackenbach 1991).

This paper reports the results of a study of the relationship between background characteristics of nearly 1900 singletons born in The Netherlands in the period April 1988–October 1989, their lengths and weights at 1 and 2 years of age and their linear length and weight gain, respectively. The purpose is to clarify separate influences of SES, ethnic descent, biological factors and smoking of the mother during pregnancy. These factors are often found to be of influence in studies of variations in growth, but have not previously been studied concurrently in a Dutch sample.

2. Subjects and methods

Data for this study are derived from the Social Medical Survey of Children Attending Child Health Clinics (SMOCC). The initial study cohort ($n = 2151$) included all infants who were live-born in the period from April 1988 to October 1989 inclusive. These children were born of mothers who, at the time of birth, were living in the geographically defined catchment areas of 21 child health clinics (CHC) in several parts of The Netherlands. This sample of children is representative for the Dutch population with respect to the distribution of age and parity and, although to a lesser degree, educational level of the mothers (Herngreen, Reerink, van Noord-Zaadstra, Verloove-Vanhorick and Ruys 1992).

All co-workers of the participating CHC were instructed to measure according to the protocol of the 1980 nationwide growth survey in The Netherlands. Measurements of length and weight have been taken at the average ages of 1, 2, 3, 6, 9, 12, 15, 18 and 24 months. Up to and including the second birthday length was measured in supine position on a measuring board and recorded in centimetres and millimetres. Weights were measured with the instruments of the CHC that were in use at the time of this investigation: a baby scale for babies 0–15 months of age, calibrated in decagrams, and a chair fixed on a beam scale, calibrated in hectograms, for older children.

The recording of the background data took place within an average period of 3 weeks after birth during a routine home visit by the district nurses of the participating CHC.

The following explanatory variables for predicting length and weight are used: socioeconomic status (SES), ethnic descent of father and mother, parity and age of the mother, smoking during pregnancy, height of mother and father, birthweight and gestational age (table 1). SES is defined by the highest attained formal educational level of the mother and categorized as low, mid-low, mid-high and high. Ethnic descent of the parents, which indicates the sociocultural background of the family, is defined by the country of origin and categorized as Dutch, Mediterranean and other. Parity is defined as the number of live-births and still-births after a gestation of 23 weeks or more, including the index child. The age of the mother at delivery is calculated in completed years. The parents orally reported their heights to the district nurses who participated in the survey. These heights are subsequently recorded in complete centimetres. Birthweight of the infants is recorded in grams. Gestational age is calculated in completed weeks, using the expected date of delivery (based on the first day of the reported last menstrual period) and the actual birth date. When the expected date was unknown, the gestational age is based on obstetrical clinical assessment. To avoid the confounding effect of multiple birth (1·7% in the SMOCC study), data of such children ($n = 65$) are omitted from the analyses.

Table 1. Overview of explanatory variables.

Variable	Score	*n* (%)	Comment
SES of mother	Low	108 (5·4)	Primary education; secondary education not finished
	Mid-low	905 (45·5)	Junior vocational training/lower secondary general training
	Mid-high	644 (32·4)	Senior vocational training/higher secondary general training
	High	330 (16·6)	Vocational colleges/university education
	Not known	74	
Ethnic descent mother	Dutch	1798 (88·7)	
	Mediterranean	104 (5·1)	
	Other	124 (6·1)	
	Not known	35	
Ethnic descent father	Dutch	1798 (89·2)	
	Mediterranean	110 (5·5)	
	Other	107 (5·3)	
	Not known	46	
Parity	1	863 (42·6)	
	2	687 (33·9)	
	≥3	477 (23·5)	
	Not known	34	
Age of mother	Continuous		Mean = 28·9 years
Smoking of mother during pregnancy	Yes	527 (25·6)	
	Not known	36	
Height of mother	Continuous		Mean = 168·3 (145–194) cm
Height of father	Continuous		Mean = 180·7 (152–203) cm
Birthweight	Continuous		Mean = 3433 (780–5320) g
Gestational age	Continuous		Mean = 39·4 (25–44) weeks

To correct for differences in age at the time of measurement and sex, length and weight data are expressed as standard deviation (SD) scores of the 1980 national growth references (Roede and Van Wieringen 1985). For attained length this is done by computing SD scores directly from the means and standard deviations of the reference tables, after which these were linearly interpolated to the proper age. For attained weight, percentiles are computed as the heights of a smooth surface fitted to the cumulative weight distribution conditional on age. SD scores were derived from these by a probit transformation. The probit transformation assumes an underlying normal distribution, which may not be appropriate for weight. However, since this paper concentrates on comparing different groups within the sample, and not on comparing sample and reference, this is unlikely to be a major problem: any distributional errors will be equally made for all groups of interest. The 1980 growth tables start at an age of 3 weeks, so SD scores for birthweight and birth-length could not be calculated.

The first part of this study consists of a cross-sectional investigation of disparities in length and weight between children in the SES groups at 1 and 2 years of age. Multiple stepwise linear regression analysis was performed on the length and weight SD scores for SES and all the other independent variables. Categorical variables were dummy-coded. Parity and ethnic descent of the father and the mother are included in the analyses as grouped variables to assess the joint effects of these categories on the variance in the models. Because of interaction between SES and ethnic background, the SES-low group was stratified in two subgroups: children of which *both* parents are of Mediterranean descent, and children of at least one parent of Dutch or other (western or non-western) descent.

The second—longitudinal—part of the study focuses on the analysis of differences in length and weight gain in the group of children with seven or more observations ($n = 1491$). To this end, for each child linear regressions of SD scores for length and weight with age from 1 to 24 months were computed, following the equation

$$Y_{it} = \alpha_i + x_{it}\beta_i + \epsilon_{it}$$

where $i = 1, \ldots n$,indicates the subject and $t = 1 \ldots$, and t indicates the age of person i at occasion t, so that x_{it} expresses age in weeks. Quantity y_{it} is the SD score of length and of weight for child i at the measurement occasion t. Each intercept (α_i) of a regression equation can be interpreted as the predicted SD score at age zero (the onset of the growth patterns) of the child, while each β_i indicates a positive or negative slope of the individual growth pattern compared to a theoretical, horizontal stable curve of the SD scores. Subsequently, linear regression models were fitted to the onsets (α) and slopes (β) of the growth patterns to determine the relationship between SES and the other variables, and growth. The coefficients resulting from the analyses of β express the change in SD score per year.

Figure 1 illustrates some concepts used in the longitudinal analysis. Figure 1a plots the crude length data (in centimetres) for a selected sample of five children in a diagram with the 1980 standard curves. This figure also gives an impression of the spread of the actual ages at which measurements were taken. This spread made it necessary to use SD scores for the original data. Figures 1b and 1c contain the same measurements, but now expressed in percentiles (1b) and SD scores (1c). One child has a catch-up growth (positive β), while another shows a deceleration in growth (negative β). The other three curves are almost horizontal (with a β of about zero) and differ in offset (α). Note that a change in percentiles is not equivalent to a change in SD scores.

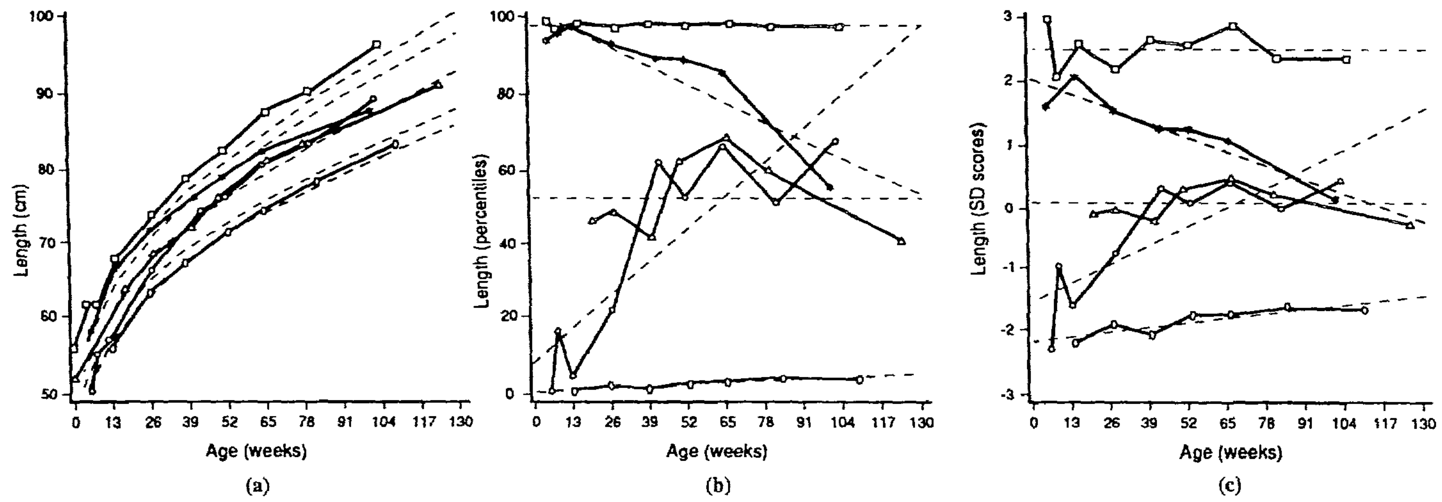

Figure 1. Attained length of 5 children of the SMOCC visualized in three ways: (a) along percentile curves of the Dutch 1980 growth diagrams; (b) with percentile scores at different ages and individual regression lines of percentiles with age; (c) with SD scores at different ages and individual regression lines with age.

An increase from the 10th to the 20th percentile yields the same β as a change from the 40th to the 50th percentile. However, both changes correspond to a different increase in centimetres. On the other hand, for different ages, changes in SD scores are approximately proportional to differences in centimetres, so larger changes in centimetres lead to larger β values. In longitudinal studies, SD scores are therefore preferable to percentiles, though SD scores are irrelevant in studying the phenomenon of growth velocity (Tanner 1986). A potential problem of the two-step longitudinal method is that the summary of growth patterns in α_i and β_i parameters may be more representative for some subgroups than for others. One way to assess the adequacy of the method is to compute the standard deviation of ϵ_i around each individual regression line. Using SD(ϵ_i) as the dependent variable in a stepwise backward regression method appeared to eliminate all explanatory variables except birthweight, which means that the straight-line model for lengths and weights gains in adequacy as birthweight increases. No further significant differences are found, so it was decided that summarizing growth patterns into α_i and β_i does not favour specific subgroups.

In order to detect the variables which are significantly associated with length and weight gain, multiple stepwise backward regressions for intercepts and slopes are performed including SES and the other explanatory variables. In all multiple regression analyses the significance level of $p=0{\cdot}005$ for the deviation of the coefficients from the intercepts has been decisive for keeping a variable in the models.

3. Results

3.1. Length and weight at 1 and 2 years of age

At 1 year of age the number of children in the analyses accounts for nearly 90% of the initial cohort of singletons in the SMOCC. At 2 years of age the number of children accounts for 93% of the number at 1 year of age, so in the total follow-up period the losses amounted to 16%, which is acceptable for prospective studies of this kind (Bax 1983) (table 2). There are virtually no differences between the distribution of the children over the SES categories at 1 and 2 years of age. At 1 year of age differences in attained length according to SES are minimal, while the attained weight of only the children of the Mediterranean SES-low group is higher than that of the other SES groups. At 2 years of age the length of the children of the Mediterranean SES-low group lags nearly 1 cm behind that of the higher SES groups, while their weight still exceeds that of the other groups. The children of which the SES is unknown were not indicated in the following analyses.

The cross-sectional analysis shows greater attained lengths for the middle and higher SES groups compared to the lower SES groups, but these differences are not significant at $p=0{\cdot}05$ (table 3). Differences in attained weight at 1 year of age are smaller than at 2 years of age. At both ages, children of the Mediterranean SES-low group are significantly heavier than children of all other groups. After inclusion of all explanatory variables it appears that children at 1 and 2 years are taller with increasing birthweight and increasing heights of the mother and of the father (table 4). Children of mothers with one or two previous pregnancies are shorter than children of primiparous mothers. The ethnic group of the father is also associated with attained length: children of fathers of Mediterranean origin, after allowing for the other variables, are taller at 1 and 2 years of age than children of Dutch or other origin. Mediterranean origin of the father, height of father, height of mother and birthweight are positively associated with attained weight at 1 year of age, and parity is inversely related. These factors are also associated with attained weight at 2 years of age, except

Table 2. Mean lengths, median weights and numbers (%) of singletons at 1 year (10·5–13·5 months) and 2 years (21–30 months) by SES.

SES	Length (mean cm)						Weight (median kg)					
	1 year	*n*	(%)	2 years	*n*	(%)	1 year	*n*	(%)	2 years	*n*	(%)
SES-low (Dutch/other)	67·4	42	(2·2)	88·8	36	(2·1)	7·65	42	(2·2)	12·45	36	(2·1)
SES low (Mediterranean)	67·4	52	(2·8)	88·3	51	(2·9)	8·27	52	(2·8)	13·60	52	(2·9)
SES mid-low	67·4	842	(45·1)	89·0	799	(45·9)	7·64	844	(45·9)	12·90	801	(45·9)
SES mid-high	67·6	591	(31·6)	89·3	550	(31·7)	7·66	593	(31·6)	13·00	551	(31·6)
SES high	67·6	314	(16·8)	89·1	282	(16·2)	7·61	316	(16·8)	13·00	285	(16·3)
not known	67·2	28	(1·5)	87·3	21	(1·2)	7·64	28	(1·5)	12·90	21	(1·2)
Total		1869	(100·0)		1739	(100·0)		1875	(100·0)		1746	(100·0)

Table 3. Attained length and weight of singletons at 1 year (10·5–13·5 months) and 2 years (21–30 months) by SES: coefficients (95% confidence interval) of bivariate regression analysis of SD scores of length and weight.

	1 year		2 years	
	Coefficient	(95% CI)	Coefficient	(95% CI)
Length				
SES low (Dutch/other)	−0·16		−0·11	
SES low (Mediterranean)	0·22	(−0·21; 0·64)	−0·10	(−0·52; 0·32)
SES mid-low	0·24	(−0·09; 0·58)	0·18	(−0·15; 0·51)
SES mid-high	0·33	(−0·01; 0·67)	0·25	(−0·08; 0·59)
SES high	0·27	(−0·07; 0·62)	0·22	(−0·12; 0·56)
	F = 1·403; p = 0·230; d.f. = 1724		F = 2·178; p = 0·069; d.f. = 1695	
Weight				
SES low (Dutch/other)	0·01		−0·28	
SES low (Mediterranean)	0·51	(0·09; 0·94)*	0·48	(0·05; 0·91)*
SES mid-low	0·09	(−0·24; 0·41)	0·21	(−0·13; 0·55)
SES mid-high	0·13	(−0·20; 0·46)	0·26	(−0·06; 0·61)
SES high	0·08	(−0·26; 0·42)	0·29	(−0·06; 0·65)
	F = 2·477; p = 0·042; d.f. = 1731		F = 1·651; p = 0·159; d.f. = 1695	

*p < 0·05.

Table 4. Length and weight of singletons at 1 year (10·5–13·5 months) and 2 years (21–30 months) of age: coefficients (95% confidence interval) from stepwise backward regression analyses of SD scores of length and weight with SES of the mother and ethnic descent of the parents, gestational age, birth weight, parity, smoking of the mother during pregnancy, age of the mother and heights of the parents (variables in the models are adjusted for all other variables; all (groups of) variables in the remaining models are significant at p = 0·005).

	1 year		2 years	
	Coefficient	(95% CI)	Coefficient	(95% CI)
Length				
Intercept	−13·12		−13·55	
Birthweight (kg)	0·63	(0·55; 0·71)	0·47	(0·40; 0·55)
Height of mother (m)	3·56	(2·92; 4·21)	3·84	(3·20; 4·48)
Height of father (m)	2·86	(2·29; 3·43)	3·13	(2·55; 3·70)
Parity‡				
2	−0·22	(−0·32; −0·13)	−0·25	(−0·33; −0·16)
≥3	−0·34	(−0·44; −0·24)	0·28	(0·38; −0·17)
Ethnic descent father†				
Mediterranean	0·66	(0·46; 0·87)	0·45	(0·25; 0·64)
Other origin	0·28	(0·08; 0·48)	0·22	(0·02; 0·43)
	R^2 0·289; d.f. = 1724		R^2 0·272; d.f. = 1695	
Weight				
Intercept	−7·85		−7·16	
SES low (Dutch)§				
SES low (Mediterranean)	—		0·62	(0·23; 1·01)
SES mid-low	—		−0·12	(−0·43; 0·18)
SES mid-high	—		−0·18	(−0·50; 0·13)
SES high	—		−0·17	(−0·49; 0·15)
Gestational age	—		−0·06	(−0·09; −0·03)
Birthweight (kg)	0·64	(0·56; 0·72)	0·72	(0·62; 0·82)
Height of mother (m)	1·42	(0·74; 2·10)	1·88	(1·19; 2·57)
Height of father (m)	1·90	(1·29; 2·50)	2·19	(1·58; 2·79)
Parity‡				
2	−0·18	(−0·27; −0·08)	−0·16	(−0·26; −0·07)
≥3	−0·17	(−0·28; −0·06)	−0·19	(−0·30; −0·08)
Ethnic descent father†				
Mediterranean	0·77	(0·55; 0·98)	—	
Other origin	0·08	(0·13; 0·29)	—	
	R^2 0·186; d.f. = 1731		R^2 0·208; d.f. = 1695	

‡Primipara = reference group. †Dutch origin = reference group. §SES-low (mother non-Mediterranean) = reference group.

for ethnic descent, while there is an inverse relationship of weight with gestational age. SES also appears to be related to attained weight at 2 years of age, but this effect is mainly to be ascribed to the higher weights of the children of the Mediterranean SES-low group.

3.2. *Length and weight gain in the first 2 years*

The bivariate regression analysis of the length intercepts (α) from the individual regressions with SES reveals significant differences: at the onset of their growth pattern the SES mid-high and high groups are taller as compared to the SES-low group (table 5). The coefficients for the slopes (β) of length show that, compared to the Dutch SES-low group, the Mediterranean children have the lowest gain in length. In the Dutch SES-low group a catch-up growth can be observed. The weight analysis shows that children of the Mediterranean SES-low group have the largest (negative) mean slope. The differences between groups are illustrated by the mean linear growth patterns for each SES group, which are plotted in figure 2. For length (figure 2a) the Dutch SES-low group starts at a lower mean SD score than the other groups, and has a catch-up growth. The Mediterranean SES-low group has a growth pattern with the most negative slope. The weight growth pattern of all groups (figure 2b) shows a declination, and the decline in weight gain is the steepest in the Mediterranean SES-low group as compared to the other groups.

Table 5. Length and weight gain of singletons in the first 2 years of life by SES: coefficients (standard error) of bivariate regression analyses of intercepts (α) and slopes (β) from the individual regressions of length and weight SD scores with age.

	α		β	
	Coefficient	(95% CI)	Coefficient	(95% CI)
Length				
SES low (Dutch/other)	−0·36		0·15	
SES low (Mediterranean)	0·29	(−0·25; 0·82)	−0·21	(−0·48; 0·05)
SES mid-low	0·34	(−0·03; 0·70)	−0·07	(−0·25; 0·11)
SES mid-high	0·43	(0·06; 0·80)*	−0·08	(−0·26; 0·10)
SES high	0·54	(0·16; 0·91)*	0·17	(−0·35; 0·02)
	$F=3\cdot169$; $p=0\cdot013$; d.f. = 1490		$F=2\cdot399$; $p=0\cdot048$; d.f. = 1490	
Weight				
SES low (Dutch/other)	0·04		−0·11	
SES low (Mediterranean)	0·92	(0·43; 1·41)*	−0·31	(−0·62; −0·01)*
SES mid-low	0·27	(−0·06; 0·60)	−0·09	(−0·29; 0·11)
SES mid-high	0·40	(0·07; 0·74)*	−0·15	(−0·35; 0·05)
SES high	0·38	(0·04; 0·72)*	−0·12	(−0·34; 0·09)
	$F=5\cdot157$; $p=0\cdot001$; d.f. = 1492		$F=1\cdot790$; $p=0\cdot128$; d.f. = 1492	

*$p<0\cdot05$.

The comparison of weight for length patterns suggests that at all ages from 1 to 24 months weight for length differs between groups, and that the children of the Mediterranean SES-low group are relatively heavier than others. To illustrate this phenomenon graphically, smoothed weight SD score curves for length were computed (figure 3). Observations of length as well as weight for children outside the range from 50 to 90 cm are sparse in the SMOCC cohort, so these cases had to be omitted from the computation of the curves. The length and weight growth patterns of the SES-mid (low and high) and SES-high groups, which are situated very close to each other, were taken together as one category for clarifying purposes. The graph shows a clear

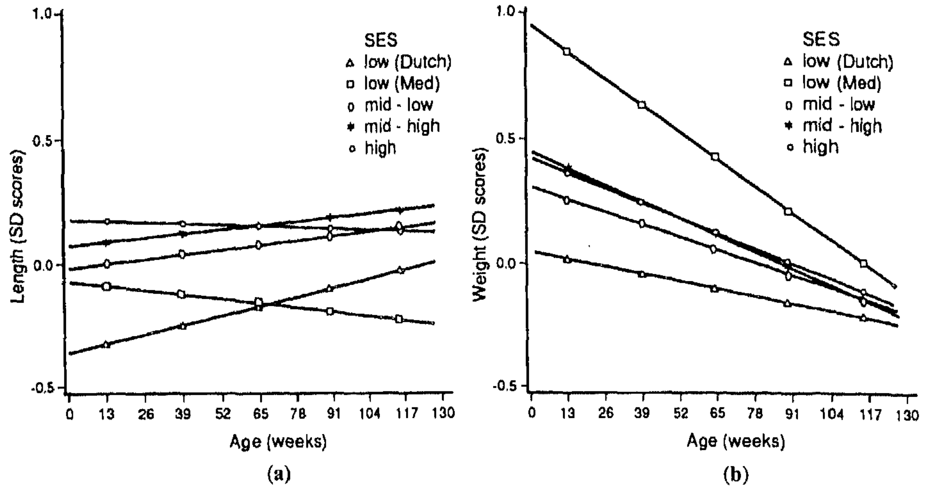

Figure 2. Plots of the regression of mean α and mean β of length (a) and weight (b) with SES.

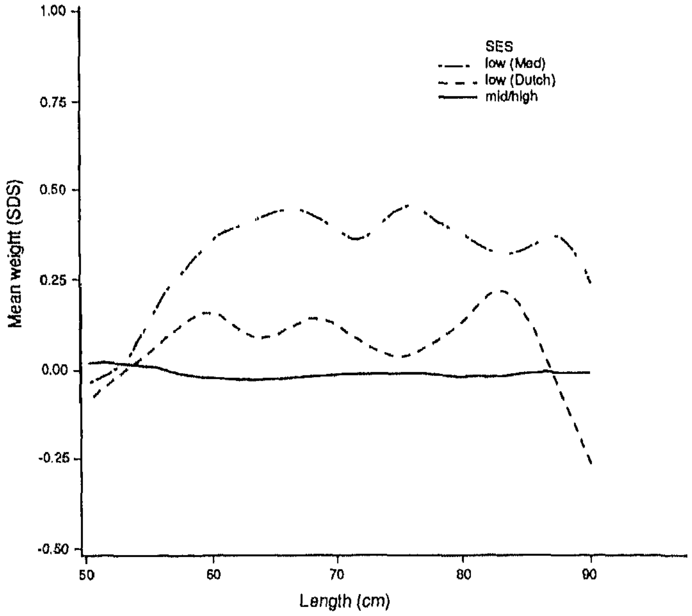

Figure 3. Mean SD scores of weight by length with SES.

difference between the weight SD scores for length between the Mediterranean SES-low, the Dutch SES-low and the other groups.

The multivariate analyses indicate that gestational age, birthweight, heights of the parents, and non-Dutch descent of the mother are positively associated with the predicted length at birth (table 6). Children of a higher birth order are smaller than children of primiparous mothers. Gestational age, birthweight and parity are negatively associated with gain in length. Parental height is positively related to length

Table 6. Length and weight gain of singletons in the first 2 years of life: coefficients (standard error) from stepwise backward regression analyses of intercepts (a) and slopes (β) from the individual regressions of SD scores of length and weight SD scores with age, with SES of the mother and ethnic descent of the parents, gestational age, birthweight, parity, age of the mother, smoking during pregnancy and heights of the parents (variables in the models are adjusted for all other variables; all (groups of) variables in the remaining models are significant at $p = 0 \cdot 005$).

	α		β	
	Coefficient	(95% CI)	Coefficient	(95% CI)
Length				
Intercept	−14·67		0·93	
Gestational age	0·10	(0·07; 0·12)	−0·07	(−0·08; −0·06)
Birthweight (kg)	1·12	(1·03; 1·20)	−0·37	(−0·43; −0·32)
Height of mother (m)	2·15	(1·55; 2·75)	1·12	(0·78; 1·47)
Height of father (m)	1·89	(1·37; 2·41)	0·73	(0·43; 1·03)
Smoking	—		0·08	(0·03; 0·13)
Parity‡				
2	−0·11	(−0·19; −0·02)	−0·10	(−0·16; −0·06)
≥3	−0·21	(−0·31; −0·12)	−0·04	(−0·10; 0·01)
Ethnic descent of mother†				
Mediterranean	0·51	(0·28; 0·75)	—	
Other origin	0·21	(0·03; 0·38)	—	
	$R^2$0·533; d.f. = 1490		$R^2$0·329; d.f. = 1490	
Weight				
Intercept	−5·39		0·42	
Gestational age	—		−0·04	(−0·06; −0·02)
Birthweight (kg)	1·13	(1·06; 1·20)	−0·29	(−0·35; −0·22)
Height of mother (m)	—		1·26	(0·80; 1·72)
Height of father (m)	1·01	(0·49; 1·53)	—	
Parity‡				
2	—		−0·10	(−0·16; −0·04)
≥3	—		−0·09	(−0·17; −0·02)
Ethnic descent of mother†				
Mediterranean	0·64	(0·40; 0·88)	−0·13	(−0·32; 0·05)
Other origin	0·17	(0·01; 0·35)	−0·21	(−0·35; −0·08)
	$R^2$0·411; d.f. = 1492		$R^2$0·139; d.f. = 1492	

‡Primipara = reference group.
†Dutch origin = reference group.

gain of their children. Children of mothers who smoked during pregnancy tend to gain more in length after birth compared to other children. Height of the father and non-Dutch descent of the mother are positively associated with the predicted weight at the onset of the growth patterns. Weight gain is inversely related to gestational age, birthweight and parity, while taller mothers tend to have children with larger weight gain. Children of parents of other than Dutch or Mediterranean descent have a significant deceleration in weight gain.

4. Discussion

First, some comment is necessary on the type of analysis used in this study. Linear regression analysis of SD scores was used for ease of interpretation. In the transversal analyses the coefficients show the differences in SD scores between categories, while the slope parameter (β) in the longitudinal analyses gives the increase of SD score per time unit. A more generally used method is to fit polynomial regressions using a quadratic time factor. Though these models fitted the data better, the results are not reported, since a satisfactory interpretation of the quadratic regression parameter could not be given. In addition, it was found that the use of linear regression did not favour one SES group over the other (i.e. the spread around the regression lines is the same in all groups), so regression can be said to be fair with respect to the comparison of interest.

In this study the educational level of the mother was used as the indicator for SES, whereas in growth studies occupational or social prestige indicators are often used (Topp, Cook, Holland and Elliott 1970, Goldstein 1971, Van Wieringen 1972, Roede and Van Wieringen 1985, Gulliford, Chinn and Rona 1991). These studies revealed social class disparities for growth parameters of children at different ages, although Topp *et al.* (1970) supposed biasing effects due to the influence of concurrent factors acting at the same time. The use of educational level of the mother as a proxy for the SES of children may have some advantages because of the simplicity of collection and categorization of educational data, the relative stability of educational level over time, and consistently high correlations with a variety of outcome variables (Liberatos, Bruce and Kelsey 1988). Moreover, Abramson, Gofin, Habib, Pridan and Gofin (1982) found in a comparative study of indicators for SES that the patterns of associations with health variables were similar for groups according to occupational, educational or income level. However, on the basis of the fairly low correlations among the social class parameters themselves they suggest that there may be advantages in using more than one indicator, unless existing knowledge of the relationship between social class and health characteristics indicates that one measure will suffice. For a study in children aged 0–2 years, as presented in this paper, the use of educational level of the mother as an indicator for SES was considered to be appropriate because it categorizes the mothers according to their general abilities and knowledge with respect to health behaviour, feeding practices and the health of their children (Berkel-Van Schaik and Tax 1990). Furthermore, evidence that the educational level of the mother is a better indicator for SES to reveal socioeconomic differences in health has been given by Haglund, Cnattingius and Nordström (1993), who found a stronger relationship between mother's formal educational level and infant mortality than between the household socioeconomic level and infant mortality. Eiben (1989), in his study of anthropometric data of Hungarian children, concluded that the educational level of the parents is a more important environmental factor influencing growth than their professional status.

The SMOCC data show that attained lengths and weights of children vary according to SES at 1 and 2 years of age, but the differences are significant only for weight in the Mediterranean SES-low group as compared to the Dutch SES-low group. After allowing for other variables, SES is no longer associated. The same is true for the analyses of length and weight gain. These results agree with those of many other studies in western countries, as far as white children are involved (Meredith 1984).

The results with respect to ethnic descent of the parents are noteworthy. The influence of sociocultural characteristics in this study became especially apparent in the differences in growth between children of the Mediterranean SES-low group and the other groups. One may speculate that differences in growth between children of Mediterranean and Dutch families in the SES-low group are, at least partially, to be ascribed to differences in feeding practice. In a study of breastfeeding patterns in this study group it was found that children of mothers of Mediterranean origin have about the same chance to start with only breast-feeding as do children of mothers of Dutch origin. However, mothers of all ethnic descents in lower and middle SES groups start significantly less often with only breast-feeding than mothers of the higher SES group

(Herngreen, Reerink, Van den Doel, Verloove-Vanhorick and Ruys 1993). Further exploration of these data revealed that more mothers of Mediterranean origin than Dutch mothers in this study start with combined breast and formula feeding, while at 6 months 9·3% of the Mediterranean mothers and 24·8% of the Dutch mothers still feed their children with both formula and breast milk. Dewey, Heinig, Nommsen, Peerson and Lönnerdal (1992) have found that the mean weight of breast-fed infants dropped below the median of the US reference data at 6–8 months and was significantly lower than that of the formula-fed group between 6 and 18 months.

The results of this study agree to some extent with those of Goldstein (1971) for 7-year-old children and of Gulliford *et al.* (1991) for children 5–11 years of age, as far as the influence of biological characteristics on growth are concerned, except for age of the mother. Although it seems controversial to single out one risk factor from the prenatal period, whereas so many factors are of influence on growth, Goldstein (1971) found that schoolchildren of mothers who had smoked during pregnancy were shorter than other children. Unexpectedly, the result of the analysis in the SMOCC cohort indicates an increased gain in length after birth (catch-up growth) of children who have been exposed to the smoking behaviour of mothers during pregnancy (26% of the SMOCC cohort). Smoking during pregnancy is not associated with either attained lengths or weights at 1 and 2 years. One could argue that this is a reassuring result for mothers who smoke, because their babies showed some ability to recover from the detrimental influence. However, we feel that any disadvantage from exposure to the noxious effects of maternal smoking, which is particularly clear in lower birthweights, should preferably be avoided altogether. Children of mothers of a parity of two or more are shorter at the onset of their growth pattern and have smaller attained lengths at 1 and 2 years of age than children or primiparous mothers. In addition, they show less length gain compared to first-born children. Parity, and hence the number of older children in the family, which is roughly indicated by parity, seems to influence length growth, but diverse biological and environmental factors should be assumed here. In particular, differences in environment, and subsequently in care, for these children depend on family size and may have contributed to the relatively smaller length gain of later-born children.

Among the factors studied in this investigation, parental heights contribute strongly to the variations in length and weight of the children, which may reflect environmental as well as genetic influences (Kuh and Wadsworth 1989). In the SMOCC cohort the difference in mean height between mothers of low and high SES is 7·8 cm; the difference in mean height between the fathers of low and high SES is 6·4 cm. As far as the stature of the parents itself depends on their well-being and nutritional status during childhood, the influence of the parental heights on the growth of the children is, at least partially, a SES-related factor. This being the case, the results of this study indicate at least a partial relationship between growth of young children and SES in The Netherlands. The positive secular change in height as found in The Netherlands can be considered the effect of increasing well-being, even in lower SES groups. At the same time, the still-existing height differences between certain groups indicate that differences in living conditions and lifestyles are reflected in growth of young children.

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Zusammenfassung. An fast 1900 im Zeitraum April 1988 bis Ende Oktober 1989 lebendgeborenen Einzelkindern wurden im Alter von 1 bis 24 Monaten neun Messungen der Länge und des Gewichts durchgeführt. Im ersten Teil der Studie werden die erreichten Längen und Gewichte im Alter von ein und zwei Jahren in Abhängigkeit vom Sozialstatus (SES) analysiert. Der Zusammenhang zwischen der Länge und dem Gewicht einerseits sowie dem SES und anderen Backgroundvariablen andererseits wurde mittels multipler Regressionsanalyse untersucht. Der zweite Teil der Studie beschäftigt sich mit Unterschieden im linearen Längen- und Gewichtszuwachs in den ersten zwei Lebensjahren, zu deren Analyse eine zweistufige Regressionstechnik herangezogen wurde. Im Alter von ein und zwei Jahren sind die Unterschiede in den erreichten Längen und Gewichten sowie in den Längen- und Gewichtszuwachsraten in Abhängigkeit vom SES gering und nicht signifikant. Eine Ausnahme stellen Kinder von Eltern aus Mittelmeerländern in der Gruppe mit niedrigem SES dar. Sie sind signifikant schwerer als Kinder aller anderen Gruppen und nehmen signifikant mehr an Gewicht zu als Kinder holländischer Eltern aus der niedrigen SES-Gruppe. Von allen untersuchten Faktoren scheint die Körperhöhe der Eltern, das Geburtsgewicht, die Geburtenordnung und die ethnische Abstammung der Eltern mit der erreichten Länge und dem erreichten Gewicht im Alter von ein und zwei Jahren assoziiert zu sein. Von diesen Faktoren ist die ethnische Abstammung jedoch nicht mit der Längenzunahme assoziiert. Ein geringes aber statistisch signifikantes Catch-up-Wachstum konnte bei Kindern von Müttern nachgewiesen werden, die während der Schwangerschaft geraucht haben.

Résumé. Neuf mensurations de taille et de poids ont été prises entre les âges de 1 et 24 mois, sur un échantillonnage de 1900 enfants non jumeaux, nés entre avril 1988 et octobre 1989 inclus. Dans la première partie de l'étude, les différences entre taille et poids atteints aux âges de un et deux ans sont analysées en fonction du statut socio-économique (SSE). Des analyses de régression multiple sont utilisées pour rechercher l'association entre le SSE et d'autres caractéristiques d'arrière-plan avec la taille et le poids. La deuxième partie est consacrée à l'analyse des différences en taille linéaire et en gain de poids pendant les deux premières années de la vie, au moyen d'une technique de régression à deux niveaux. Aux âges de un et deux ans, les différences en taille et poids atteints et en gains de taille et de poids selon le SSE, sont petites et non significatives, sauf pour les enfants de parents méditerranéens dans le groupe de SSE défavorable, qui sont significativement plus lourds que les enfants de tous les autres groupes et gagnent significativement plus de poids que les enfants de parents hollandais de SSE similaire. Il apparait que la taille des parents, le poids à la naissance, la parité et l'origine ethnique des parents, sont des facteurs associés avec la taille et le poids atteints aux âges de un et deux ans. L'origine ethnique n'est toutefois pas associée au gain linéaire. Un rattrapage modeste mais significatif, est rencontré chez les enfants dont les mères fumaient pendant la grossesse.