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Chapter 5

Ethnic differences in term birth weight; the role of constitutional and environmental factors

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Abstract

It is not clear to what extent ethnic differences in the term birth weight distribution are constitutional or pathological. This study explored term birth weight heterogeneity between ethnic groups and the explanatory role of constitutional and environmental factors. As part of a prospective cohort study, the Amsterdam Born Children and their Development study, 8266 pregnant women filled out a questionnaire during early pregnancy. Ethnic groups were categorized as: native Dutch group; first and second generation Surinamese, Antillean, Turkish, Moroccan, Ghanaian, and other non-Dutch groups. Only singleton live births with 37.0 or more weeks of gestation and with complete data were included for analysis (n = 7118). We performed linear regression analyses to estimate the association between ethnicity and for gestational age standardized birth weight at term, adjusted for constitutional (fetal sex, parity, maternal age, height) and environmental (education, cohabitation status, maternal BMI, smoking, alcohol consumption, depression, work stress) determinants respectively. Mean birth weight ranged from 3223 g (second generation Surinamese newborns) to 3548 g (Dutch newborns). Adjustment for constitutional factors substantially reduced the ethnic differences in birth weight, while adjustment for environmental factors provided little additional explanation. Surinamese (first generation: regression coefficient *(B)* = −98.3 g, $P < 0.001$; second generation: $B = -159.3$ g, $P < 0.001$), first generation Antillean ($B = -102.0$ g, $P = 0.037$), and Ghanaian ($B = -120.7$ g, $P = 0.001$) newborns remained significantly smaller than Dutch newborns after adjustment for all determinants. Term birth weight differences between Dutch newborns and Turkish, Moroccan, and other non-Dutch newborns were largely explained by constitutional rather than environmental determinants, limiting the need for prevention. Surinamese, Antillean, and Ghanaian (mainly black) newborns remained unexplainably smaller after adjustment, leaving room for both a constitutional or pathological underlying mechanism.

Introduction

For decades, researchers worldwide have investigated the incidence of low birth weight (LBW; <2500 g) and its association with adverse health outcomes.[1] Currently, LBW is considered a poor indicator for health outcomes on the population level.[2] This is because newborns defined as LBW are a mixture of preterm born, growth restricted, and constitutionally small babies; all three groups show quite different infant health outcomes. Wilcox[1] proposed to separate preterm from term births (≥37.0 weeks gestation) when studying health outcomes on the population level. The proportion of preterm births should be used as an indicator of a population's infant mortality risk and the birth weight distribution of the remaining term births as a valid measure of fetal growth. Useful as this distinction may be, term birth weight heterogeneity between groups can still be the result of either pathological growth restriction or a "natural" limited growth potential by constitutional profile.

Worldwide, large ethnic differences in the term birth weight distribution are observed.[1,3] Previous studies explained some differences by adjusting for major determinants, such as smoking.[4] However, from a preventive point of view, it is important to explore to what extent ethnic differences in the birth weight distribution can be explained by two main determinant groups: (a) constitutional determinants (e.g., maternal height), which are difficult to modify determinants that physiologically influence fetal growth in a natural way, or (b) environmental determinants (e.g., smoking), which are more or less modifiable determinants that impair fetal growth.[5] A predominant role for constitutional factors would add to a natural explanation of birth weight heterogeneity, with no need for preventive actions, whereas predominance of environmental factors would suggest acquired pathology with, theoretically, a higher probability of short- and long-term adverse health outcomes.

In the present study we explored, in a large prospective multi-ethnic cohort of pregnant women, (i) term birth weight heterogeneity among ethnic groups, and (ii) the roles of constitutional and environmental factors, using a hierarchical model. Taking advantage of the presence of sufficiently sized groups of first and second generation ethnic minority groups we additionally explored intergenerational differences in the birth weight distribution at term.

Methods

The present study is part of the Amsterdam Born Children and their Development (ABCD) study. The ABCD study is a prospective, unselected, and community-based cohort study, which examines the relationship between maternal lifestyle and psychosocial conditions during pregnancy and the child's health at birth and in later life. The primary focus is on the explanation of the existing ethnic disparities in maternal and child health. Approval of the study was obtained from the Central Committee on Research involving Human Subjects in

the Netherlands, the Medical Ethical Committees of participating hospitals, and from the Registration Committee of the Municipality of Amsterdam.

Study population

Between January 2003 and March 2004, all pregnant women living in Amsterdam were invited to enroll in the ABCD study at their first antenatal visit (around the 12th week of gestation) to participating obstetric care providers (general practitioners, midwives, and hospital gynecologists; overall participation rate 96%). Two weeks after their first antenatal visit a pregnancy questionnaire was mailed to all approached women (n = 12 373), to be returned by prepaid mail. The questionnaire was in Dutch, and accompanied by an English, Turkish, or Arabic copy depending on the woman's country of birth. Reminders were sent two weeks after the initial mailing to improve response. The questionnaire was filled out by 8266 women (response rate 67%). For this study only singleton live births with a pregnancy duration of 37.0 or more weeks were included (n = 7318). We did not exclude the pregnancies with fetal malformations in absence of a specific relation between birth weight in fetal malformations and ethnicity. Overall, 7118 women had complete data on all study variables. Mean birth weight of the excluded term births with incomplete data was not significantly different from the mean birth weight of included cases.

Outcome variable

The primary outcome variable was birth weight (in grams) of neonates born at term (gestational duration ≥ 37.0 weeks). Information on the pregnancy outcomes (birth weight, gestational age, and fetal sex) were obtained from the Youth Health Care registration at the Municipal Health Service in Amsterdam. Duration of pregnancy (in weeks and days) was based on ultrasound or, when unavailable (<10%), on the first day of the last menstrual period (calculation by the obstetric care provider).

Determinants

Ethnicity was based on the country of birth of the pregnant woman and her mother. Country of birth included the following categories, based on the Amsterdam main ethnic populations: The Netherlands, Surinam, The Antilles/Aruba, Turkey, Morocco, Ghana, and other non-Dutch countries. Ethnic minority groups were distinguished into first (born outside the Netherlands) and second (born in the Netherlands, but with a mother born in another country) generation women. Because only two women were classified as second generation Ghanaian, these women were merged with the first generation Ghanaians. The native Dutch group (pregnant woman and her mother born in the Netherlands) was used as the reference group.

Determinants of fetal growth, known to be associated with both birth weight and ethnicity, were collected through the pregnancy questionnaire, except for fetal sex and gestational age

(GA) (see above). Birth weight was standardized for GA (linear and quadratic term) in all logistic regression analyses. We distinguished two groups of determinants: constitutional and environmental determinants. Constitutional determinants were: fetal sex, parity (0 vs. ≥1), maternal age (≤24, 25–34, ≥35 year), and maternal height (cm). Environmental determinants were: educational attainment (years of education after primary school: ≤5, 6–10, ≥11 year), cohabitation status (living together with partner vs. not living together/single), maternal prepregnancy BMI (underweight: BMI < 18 kg/m^2, normal weight: 18–24.9, overweight: 25–29.9, obesity: ≥ 30), smoking (average number of cigarettes per day in early pregnancy: none, <1, 1–5, >5 cigarettes), alcohol consumption during early pregnancy (no vs. yes), depression (a score on the CES-D scale[6] of lower vs. higher than the 90th percentile), and work stress (no paid job, paid job without high work stress, paid job with high work stress). High work stress is defined as ≥32 working hours per week combined with having high job strain.[7] Job strain was measured by the validated Dutch version of the Job Content Questionnaire (JCQ).[8] Missing values of maternal weight and height were imputed by means of a random imputation method using linear regression,[9] accounting for the differences among the ethnic groups.

Statistical analysis

Differences in the distribution of constitutional and environmental characteristics between the Dutch and ethnic minority groups and between generations were tested with either the Chi-square test for categorical variables or ANOVA with Bonferroni correction for continuous variables. Descriptive statistics were used to obtain the mean birth weights, birth weight percentiles and mean gestational ages per ethnic group.

Linear regression analyses were performed to estimate the size of differences in birth weight, standardized for GA, among ethnic groups, adjusting for above-mentioned determinants of birth weight. All covariates, except for maternal height, were treated as categorical variables. Analysis followed a predefined hierarchical format. Firstly, univariate analyses were performed to obtain the associations of ethnicity and all determinants separately with birth weight for GA. Secondly, two multiple linear regression models (forced entry method) were explored. The first model examined the association of ethnicity with birth weight for GA, adjusted for the constitutional determinants. The second model additionally adjusted for the environmental determinants. Data were analyzed using SPSS version 14.0 (SPSS Inc., Chicago, IL, USA). In all analyses a P-value < 0.05 was considered significant.

Results

Large differences in the prevalence of constitutional and environmental determinants were observed between Dutch and all ethnic minority groups (**Table 5.1**). Compared to the ethnic minority women, Dutch pregnant women were older, taller, higher educated, less often

depressed, had a lower BMI, and had more often a paid job in the first trimester of pregnancy. Dutch women were more frequently expecting their first child than the first generation ethnic minority women. Large differences were found for cohabitation status: while 50–64% of the Surinamese, Antillean, and Ghanaian women lived together with a partner, about 90% of the other women did. Smoking in the first trimester of pregnancy was most common among second generation Turkish women, while alcohol consumption was most common among Dutch women. Second generation ethnic groups were on average younger, taller, higher educated, and more frequently expecting their first child compared to the first generation women.

Mean birth weight ranged from 3223 g (second generation Surinamese newborns) to 3548 g (Dutch newborns) (**Table 5.2**). Birth weight distributions of all ethnic minority groups were shifted to the left compared to the Dutch birth weight distribution. Comparisons with the Bonferroni test showed a significantly lower mean birth weight for first and second generation Surinamese and Ghanaian newborns, and for first generation Antillean and other non-Dutch newborns. The Surinamese groups showed a significantly lower mean gestational age than the Dutch group. Within ethnic groups, no significant differences were found between the mean birth weights and gestational ages of infants born to first and second generation women.

Univariate linear regression analysis showed a significant association between all determinants and birth weight for GA (**Table 5.3**). All ethnic minority groups had lower mean birth weights for GA compared to the Dutch group, although not all group differences were significant. After adjustment for constitutional determinants (Model 1), ethnic differences in birth weight decreased substantially for all groups. Further adjustment for environmental determinants (Model 2) provided a little additional decrease or for some groups an increase in the ethnic differences in birth weight. The adjusted birth weights of Surinamese newborns remained lower than the Dutch birth weights, with a significant difference in weight of 98 g for the first generation and 159 g for the second generation ($P < 0.001$). Also Ghanaian and first generation Antillean women had significantly smaller newborns after adjustment (a difference of 121 g ($P = 0.001$) and 102 g ($P = 0.037$) respectively).

Table 5.1 Characteristics of the pregnant women, separated for first and second generation ethnic minority groups (n = 7118)

	Ethnicity – First generation							Ethnicity – Second generation				
	Dutch	Surinamese	Antillean	Turkish	Moroccan	Ghanaian	Other	Surinamese	Antillean	Turkish	Moroccan	Other
Number of women	3859	363	76	289	510	137	1187	180	28	72	119	298
Constitutional determinants												
Boy, %	49.9	52.6	48.7	49.8	53.7	46.7	49.6	51.7	39.3	51.4	47.1	48.7
Nulliparity, %	59.0	38.6*	64.5	37.0*	39.6*	33.6*	54.1*	65.6§	75.0	73.6*§	65.5§	60.1
Maternal age, %												
≤24 year	5.6	17.9*	31.6*	40.5*	25.9*	13.1	12.2*	53.9*§	25.0*	63.9*§	53.8*§	9.4
25–34 year	66.9	56.2	51.3	48.1	60.2	58.4	64.1	38.9	60.7	36.1	46.2	63.1
≥35 year	27.5	25.9	17.1	11.4	13.9	28.5	23.7	7.2	14.3	0.0	0.0	27.5
Maternal height (cm), mean (SD)	171 (6)	164 (6)*	168 (6)*	162 (5)*	164 (6)*	164 (7)*	165 (7)*	167 (6)*§	169 (6)	164 (6)*	166 (6)*§	169 (7)*§
Environmental determinants												
Education, %												
≤5 year	8.8	43.0*	35.5*	62.6*	60.2*	55.5*	28.3*	29.4*	17.9	43.1*§	30.3*§	12.1§
6–10 year	35.8	46.0	31.6	31.5	34.5	39.4	41.4	52.8	42.9	50.0	60.5	36.2
≥11 year	55.4	11.0	32.9	5.9	5.3	5.1	30.2	17.8	39.3	6.9	9.2	51.7
Living together with partner, %	90.8	57.3*	51.3*	95.5*	93.5*	53.3*	89.3	50.6*	64.3*	94.4	84.0*§	87.6
Maternal BMI, %												
Underweight	2.3*	4.7*	5.3*	2.4*	1.8*	0.0*	5.4*	6.7*§	7.1	4.2*	4.2*	3.4§
Normal weight	81.0	55.9	64.5	65.7	52.0	45.3	73.2	70.0	71.4	56.9	56.3	84.6
Overweight	13.0	24.5	18.4	21.5	33.3	35.8	16.8	16.1	14.3	26.4	33.6	8.7
Obesity	3.7	14.9	11.8	10.4	12.9	19.0	4.6	7.2	7.1	12.5	5.9	3.4

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Table 5.1 (continued)

	Ethnicity – First generation							Ethnicity – Second generation				
	Dutch	Surinamese	Antillean	Turkish	Moroccan	Ghanaian	Other	Surinamese	Antillean	Turkish	Moroccan	Other
Smoking, %												
None	89.8	87.6	97.4	82.7	97.5*	98.5	95.4	84.4	85.7	68.1*	96.6	85.9
<1 cigarette/day	2.9	4.4	0.0	4.8	0.4	0.0	0.8	3.9	7.1	5.6	0.0	4.4
1–5 cigarettes/day	3.9	3.6	1.3	6.6	1.2	1.5	1.6	8.9	3.6	19.4	0.8	5.0
>5 cigarettes/day	3.3	4.4	1.3	5.9	1.0	0.0	2.2	2.8	3.6	6.9	2.5	4.7
Alcohol consumption, %	29.5	12.1*	11.8*	0.7*	0.2*	10.2*	17.9*	8.9*	14.3	1.4*	0.8*	30.5
Depressed, %	6.9	20.9*	21.1*	21.8*	15.7*	10.2	13.8*	16.1*	17.9*	27.8*	27.7*§	9.1§
Work stress, %												
No paid job	17.5	46.8*	42.1*	78.2*	75.9*	69.3*	52.5*	52.8*	35.7*	58.3*§	57.1*§	17.4§
Low	76.7	48.5	56.6	19.0	22.0	25.5	43.8	40.0	64.3	33.3	38.7	78.2
High	5.8	4.7	1.3	2.8	2.2	5.1	3.7	7.2	0.0	8.3	4.2	4.4

** Significantly different from the Dutch group (P < 0.05).*

§ Significantly different from the first generation (P < 0.05).

Table 5.2 Birth weight distribution and gestational age per ethnic group, separated for first and second generation ethnic minority groups

		Birth weight distribution (in grams)			Gestational age (in weeks)
		Mean (SD)	25th percentile	75th percentile	Mean (SD)
Dutch		3548 (484)	3220	3850	39.7 (1.2)
Surinamese	1st generation	3311 (489)*	2990	3600	39.2 (1.2)*
	2nd generation	3223 (493)*	2865	3480	39.3 (1.3)*
Antillean	1st generation	3351 (511)*	3155	3658	39.5 (1.3)
	2nd generation	3475 (501)	3098	3834	39.5 (1.2)
Turkish	1st generation	3469 (463)	3150	3780	39.6 (1.3)
	2nd generation	3429 (433)	3129	3780	39.5 (1.2)
Moroccan	1st generation	3527 (482)	3182	3879	39.8 (1.3)
	2nd generation	3419 (455)	3142	3695	39.7 (1.3)
Ghanaian	1st + 2nd generation	3366 (454)*	3050	3658	39.4 (1.2)
Other	1st generation	3466 (469)*	3140	3780	39.7 (1.3)
	2nd generation	3511 (474)	3195	3773	39.7 (1.3)

** Significantly different from Dutch group (P < 0.05).*

Discussion

In this study term birth weight distributions of all ethnic minority groups were shifted to lower birth weights compared to the indigenous distribution. Constitutional determinants largely explained these ethnic disparities, while environmental determinants provided only a slightly additional explanation. An unexplained difference in birth weight persisted for black, i.e., Surinamese, Ghanaian, and (first generation) Antillean newborns, compared to Dutch newborns.

Previous studies in the Netherlands found similar patterns of crude birth weights in Dutch and ethnic minority groups, with the birth weight distributions of minority groups shifted to the left.[10-13] Also in other countries, like the USA and UK, large and unexplainable differences in the birth weights of newborns with a different ethnic background (white vs. black) have been observed.[14,15] Most studies, however, presented birth weights over the whole gestational age spectrum, leaving room for ambiguity by preterm birth. The Wilcox-Russell approach in our view is a valid tool to prevent such ambiguities.

Our distinction between constitutional and environmental determinants has few precedents. This distinction, in our view, is justified given the different consequences of lower birth weight depending on the underlying mechanism; if the normal birth weight distribution is shifted to lower birth weights without affecting mortality risk, preventive actions are less relevant. Furthermore, the general claim for ethnic disparities should be specified to those groups really in need for action (here the black group). The distinction between constitutional

Table 5.3 Results of the hierarchical linear regression analyses: differences in birth weight (in grams) – standardized for gestational age – between the ethnic groups, adjusted for constitutional and environmental determinants

		Univariate[a]		Model 1[b]		Model 2[c]	
		B	95% CI	*B*	95% CI	*B*	95% CI
Ethnicity							
Dutch (reference)		0.0		0.0		0.0	
Surinamese	1st generation	−161.7	−209.6, −113.9	−94.3	−141.6, −47.1	−98.3	−146.8, −49.7
	2nd generation	−255.3	−321.6, −189.0	−168.5	−233.7, −103.2	−159.3	−224.8, −93.9
Antillean	1st generation	−152.4	−253.0, −51.9	−82.1	−178.3, 14.1	−102.0	−197.6, −6.3
	2nd generation	−40.6	−205.2, 124.1	32.4	−124.4, 189.2	36.9	−117.7, 191.4
Turkish	1st generation	−54.0	−106.9, −1.0	42.3	−11.5, 96.1	36.6	−18.6, 91.7
	2nd generation	−82.2	−185.5, 21.1	62.7	−38.0, 163.2	68.0	−31.9, 167.9
Moroccan	1st generation	−21.4	−62.3, 19.5	49.0	7.5, 90.4	6.2	−38.2, 50.6
	2nd generation	−119.8	−200.6, −39.0	−24.3	−103.0, 54.5	−53.6	−132.0, 24.9
Ghanaian	1st + 2nd generation	−133.5	−209.0, −57.9	−74.6	−147.4, −1.7	−120.7	−195.1, −46.3
Other	1st generation	−72.1	−100.9, −43.3	8.6	−20.6, 37.8	5.2	−24.9, 35.4
	2nd generation	−33.6	−85.8, 18.6	5.3	−44.5, 55.1	18.9	−30.2, 67.9
Constitutional determinants							
Fetal sex							
Boy		0.0		0.0		0.0	
Girl		−134.9	−155.4, −114.4	−135.5	−155.1, −115.9	−136.4	−155.7, −117.1
Parity							
0		0.0		0.0		0.0	
≥1		156.7	136.2, 177.3	170.7	149.8, 191.5	160.7	139.6, 181.9
Age							
≤24 year		−110.6	−141.6, −79.6	−35.0	−67.0, −2.9	−11.9	−45.2, 21.3
25–34 year		0.0		0.0		0.0	
≥35 year		27.8	2.9, 52.6	−14.7	−38.8, 9.4	−17.3	−41.1, 6.6
Maternal height (cm)							
Linear		12.7	11.3, 14.1	13.6	12.1, 15.1	14.3	12.7, 15.8
Environmental determinants							
Education							
≤5 year		0.0				0.0	
6–10 year		21.7	−5.9, 49.3			2.3	−26.1, 30.7
≥11 year		77.3	49.8, 104.7			19.2	−13.2, 51.5
Living together with partner							
Yes		0.0				0.0	
No		−98.2	−128.7, −67.7			−21.3	−52.7, 10.2

(continued)

Table 5.3 (continued)

	Univariate[a]		Model 1[b]		Model 2[c]	
	B	95% CI	*B*	95% CI	*B*	95% CI
Maternal BMI						
Underweight	−189.8	−249.2, −130.3			−169.5	−225.5, −113.5
Normal weight	0.0				0.0	
Overweight	71.0	43.3, 98.8			90.1	63.2, 117.0
Obesity	116.8	72.8, 160.7			163.0	120.7, 205.3
Smoking						
No cigarettes	0.0				0.0	
<1 cigarettes/day	−135.0	−200.8, −69.3			−117.4	−179.7, −55.2
1–5 cigarettes/day	−145.1	−200.2, −90.0			−125.4	−177.8, −73.1
>5 cigarettes/day	−215.6	−275.1, −156.1			−205.6	−262.7, −148.6
Alcohol consumption						
No	0.0				0.0	
Yes	27.7	2.5, 52.9			−8.7	−33.6, 16.1
Depression						
No	0.0				0.0	
Yes	−53.1	−86.1, −20.2			−25.0	−56.6, 6.7
Work stress						
No paid job	−28.3	−50.4, −6.3			8.3	−16.1, 32.6
Low	0.0				0.0	
High	−116.8	−165.5, −68.2			−82.6	−128.0, −37.1

[a] *Univariate analysis (B: unstandardized regression coefficient; 95% confidence interval).*
[b] *Model 1: Multiple regression, adjusted for constitutional determinants.*
[c] *Model 2: Multiple regression, adjusted for constitutional and environmental determinants.*

and environmental determinants can be debated. In contrast to other studies[5] we did not include prepregnancy maternal weight as a constitutional determinant of fetal growth, because the size of the fetus is determined more by maternal height than by maternal weight.[16] Only weights at the extremes (i.e., under- and overweight for height) influence fetal growth, resulting in either pathologically restricted or enlarged newborns.[17]

At first sight, the birth weight distribution of all ethnic minority groups was shifted to lower birth weights compared to the Dutch group. After standardization for GA and adjustment for constitutional determinants of fetal growth, Turkish, Moroccan and other non-Dutch newborns appeared to have a comparable size at birth as Dutch newborns. This suggests a limited constitutional growth potential rather than a pathological growth restriction for the majority of newborns in these groups. Maternal height was by far the most important determinant of birth weight at term ($R^2 = 0.048$; followed by parity: $R^2 = 0.022$), stressing the

dominance of constitutional rather than environmental determinants in ethnic differences in birth weight. This minimal role of environmental determinants interferes with the commonly held preventive view that much can be gained here. Smoking, maternal BMI and high work-related stress are significant and modifiable environmental determinants of fetal growth on the individual level, certainly in need for preventive actions, but their potential to reduce the ethnic disparities in birth weight is low.

Although constitutional rather than environmental determinants were also responsible for a large shift in the birth weight distribution of the Surinamese, Ghanaian and Antillean group, these newborns remained substantially smaller than the Dutch newborns. Additional explanation by other environmental factors, like diabetic[18] and hypertensive disorders,[19] or nutritional habits[20,21] (e.g., folic acid, fatty acids) must be investigated. The role of nutrition in this cohort is currently being examined in detailed analysis. Another explanation could probably be find in the arising field of cumulative risk.[22] A cumulative exposure to multiple risk factors during pregnancy may substantially increase the risk of a lower birth weight at term, especially among the vulnerable ethnic minority groups. Instead of such additional pathological explanations of the lower birth weights among black newborns, a broader constitutional explanation (including genetics) might also be appropriate.[23] Lower population birth weights at term are not necessarily related to higher perinatal morbidity and mortality,[24-26] suggesting some genetic influences. Whether the majority of black newborns is pathologically growth restricted or constitutionally small is not yet clear and needs further investigation.

We expected the ethnic disparities in birth weight to decrease across generations as a result of the higher educational attainment of the second generation, however, we found the opposite for most groups. Previous studies in the UK and the USA also reported lower or similar birth weights in second generation ethnic minority groups compared with the first generation.[27-30] This lack of an intergenerational increase in birth weight at term supports the minimal role of environmental determinants. That both first and second Surinamese newborns were substantially smaller than the Dutch newborns after adjustment can either be the result of genetic influences[30,31] and/or the result of unspecified sociocultural determinants shared by the different generations.[30] Because the last explanation requires the identification of new, strong, and independent environmental risk factors,[4,33] a genetic role seems more likely to us. More evidence for a genetic component in fetal growth should be explored by comparing the birth weights of third and next generation ethnic groups, or by exploring DNA markers using admixture mapping.[34]

Our study population consisted of a large, unselected cohort of pregnant women, which adequately represented the main ethnic groups in Amsterdam.[35] Although there was selective participation, with a higher participation rate among the Western groups, selection bias was absent.[36] The exclusion of women with incomplete data might also have led to a relative healthier sample for analysis. The small number of (second generation) Antillean women limited the power for detailed analysis, although the numbers were still larger than

comparable studies.[11,12] We could not split the Surinamese group into a Creole and Hindustani group as detailed information was available only for a sub sample of women. However, as we did not observe significant differences in birth weight between known Hindustani and Creole newborns (results not shown), we felt it appropriate to include both in the Surinamese group.

In conclusion, the birth weight differences between Dutch newborns and Turkish, Moroccan, and other non-Dutch newborns were largely explained by constitutional determinants, limiting the need for prevention. The substantially lower birth weights of black newborns, however, remains to be elucidated. Future research should focus on the underlying mechanism of this disparity, by searching for unexplored environmental risk factors or for cumulative risk effects, and by investigating the weight-related population mortality rates. Within the ABCD study, future research will focus on whether constitutional and environmental risk factors explain the ethnic differences in preterm birth. Considering the small influence of the investigated modifiable environmental factors, the potential to reduce ethnic disparities in term birth weight on a population level seems limited. Nevertheless, preventive actions on in particular smoking, maternal BMI, and working-related stress remain important to improve the individual health of newborns.

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References

1. Wilcox AJ. On the importance - and the unimportance - of birthweight. Int J Epidemiol 2001;30:1233–41.
2. Adams M, Andersen AM, Andersen PK, et al. Sostrup statement on low birthweight. Int J Epidemiol 2003;32:884–5.
3. Evans S, Alberman E, Pashley J, Hampton B. International Collaborative Effort (ICE) on birthweight; plurality; and perinatal and infant mortality. II: Comparisons between birthweight distributions of births in member countries from 1970 to 1984. Acta Obstet Gynecol Scand 1989;68:11–7.
4. Goldenberg RL, Cliver SP, Mulvihill FX, et al. Medical, psychosocial, and behavioral risk factors do not explain the increased risk for low birth weight among black women. Am J Obstet Gynecol 1996;175:1317–24.
5. Mamelle N, Cochet V, Claris O. Definition of fetal growth restriction according to constitutional growth potential. Biol Neonate 2001;80:277–85.
6. Radloff LS. The CES-D scale: a self-reported depression scale for research in the general population. Applied Psychological Measurement 1977;1:385–401.
7. Vrijkotte TG. Working condition and birth weight in a multi-cultural cohort: the ABCD-study. Eur J Epidemiol 2006;21(suppl 1):38 (abstr).
8. Karasek R, Brisson C, Kawakami N, Houtman I, Bongers P, Amick B. The Job Content Questionnaire (JCQ): an instrument for internationally comparative assessments of psychosocial job characteristics. J Occup Health Psychol 1998;3:322–55.
9. Allison PD. Multiple imputation: basics. In: Allison PD. Missing data. Thousand Oaks, CA: Sage Publications, 2001:27–41.
10. Doornbos JP, Nordbeck HJ, van Enk AE, Muller AS, Treffers PE. Differential birthweights and the clinical relevance of birthweight standards in a multiethnic society. Int J Gynaecol Obstet 1991;34:319–24.
11. Verkerk PH, Zaadstra BM, Reerink JD, Herngreen WP, Verloove-Vanhorick SP. Social class, ethnicity and other risk factors for small for gestational age and preterm delivery in The Netherlands. Eur J Obstet Gynecol Reprod Biol 1994;53:129–34.
12. Drooger JC, Troe JW, Borsboom GJ, et al. Ethnic differences in prenatal growth and the association with maternal and fetal characteristics. Ultrasound Obstet Gynecol 2005;26:115–22.
13. van der Wal MF, Uitenbroek DG, van Buuren S. Geboortegewicht van Amsterdamse kinderen naar etnische afkomst (Birthweight of children in Amsterdam by ethnic origin). TSG Tijdschrift voor Gezondheidswetenschappen 2000;78:15–20 (in Dutch).
14. Wilcox M, Gardosi J, Mongelli M, Ray C, Johnson I. Birth weight from pregnancies dated by ultrasonography in a multicultural British population. BMJ 1993;307:588–91.
15. Shiono PH, Rauh VA, Park M, Lederman SA, Zuskar D. Ethnic differences in birthweight: the role of lifestyle and other factors. Am J Public Health 1997;87:787–93.
16. Blair EM, Liu Y, de Klerk NH, Lawrence DM. Optimal fetal growth for the Caucasian singleton and assessment of appropriateness of fetal growth: an analysis of a total population perinatal database. BMC Pediatr 2005;5:13.
17. Catalano PM, Ehrenberg HM. The short- and long-term implications of maternal obesity on the mother and her offspring. BJOG 2006;113:1126–33.

18. Rosenberg TJ, Garbers S, Lipkind H, Chiasson MA. Maternal obesity and diabetes as risk factors for adverse pregnancy outcomes: differences among 4 racial/ethnic groups. Am J Public Health 2005;95:1545–51.
19. Fang J, Madhavan S, Alderman MH. The influence of maternal hypertension on low birth weight: differences among ethnic populations. Ethn Dis 1999;9:369–76.
20. Lumey LH, Stein AD. Offspring birth weights after maternal intrauterine undernutrition: a comparison within sibships. Am J Epidemiol 1997;146:810–9.
21. Ramakrishnan U, Manjrekar R, Rivera J, Gonzáles-Cossío T, Martorell R. Micronutrients and pregnancy outcome: a review of the literature. Nutr Res 1999;19:103–59.
22. Burchinal MR, Roberts JE, Hooper S, Zeisel SA. Cumulative risk and early cognitive development: a comparison of statistical risk models. Dev Psychol 2000;36:793–807.
23. van den Oord EJ. Ethnic differences in birth weight: maternal effects emerge from an analysis involving mixed-race US couples. Ethn Dis 2006;16:706–11.
24. Vangen S, Stoltenberg C, Skjaerven R, Magnus P, Harris JR, Stray-Pedersen B. The heavier the better? Birthweight and perinatal mortality in different ethnic groups. Int J Epidemiol 2002; 31:654–60.
25. Wilcox AJ, Russell IT. Birthweight and perinatal mortality: II. On weight-specific mortality. Int J Epidemiol 1983;12:319–25.
26. Graafmans WC, Richardus JH, Borsboom GJ, et al. Birth weight and perinatal mortality: a comparison of "optimal" birth weight in seven Western European countries. Epidemiology 2002;13:569–74.
27. Harding S, Rosato MG, Cruickshank JK. Lack of change in birthweights of infants by generational status among Indian, Pakistani, Bangladeshi, Black Caribbean, and Black African mothers in a British cohort study. Int J Epidemiol 2004;33:1279–85.
28. Draper ES, Abrams KR, Clarke M. Fall in birth weight of third generation Asian infants. BMJ 1995;311:876.
29. Margetts BM, Mohd Yusof S, Al Dallal Z, Jackson AA. Persistence of lower birth weight in second generation South Asian babies born in the United Kingdom. J Epidemiol Community Health 2002;56:684–7.
30. David RJ, Collins RW. Differing birth weight among infants of U.S.-born blacks, African-born blacks, and U.S.-born whites. New Engl J Med 1997;337:1209–14.
31. Amante A, Borgiani P, Gimelfarb A, Gloria-Bottini F. Interethnic variability in birth weight and genetic background: a study of placental alkaline phosphatase. Am J Phys Anthropol 1996;101:449–53.
32. Dunger DB, Petry CJ, Ong KK. Genetic variations and normal fetal growth. Horm Res 2006;65(suppl 3):34–40.
33. Foster HW, Wu L, Bracken MB, Semenya K, Thomas J, Thomas J. Intergenerational effects of high socioeconomic status on low birthweight and preterm birth in African Americans. J Natl Med Assoc 2000;92:213–21.
34. Frank R. What to make of it? The (Re)emergence of a biological conceptualization of race in health disparities research. Soc Sci Med 2007;64:1977–83.
35. van Zee W, Hylkema C, eds. Kerncijfers Amsterdam 2004 (Key figures Amsterdam 2004). Amsterdam: Stadsdrukkerij Amsterdam, 2004 (in Dutch).
36. Tromp M, van Eijsden M, Ravelli AC, Bonsel GJ. Anonymous non-response analysis in the ABCD-cohort study enabled by probabilistic record linkage (submitted 2007).