Adult Functional Outcome of Those Born Small for Gestational Age

Twenty-six–Year Follow-up of the 1970 British Birth Cohort

Richard S. Strauss, MD

Context Although studies have documented cognitive impairment in children who were born small for gestational age (SGA), other studies have not demonstrated differences in IQ or other cognitive scores. The need exists for long-term studies of such children to assess functional outcomes not measurable with standardized testing.

Objective To determine the long-term functional outcome of SGA infants.

Design Prospective cohort study.

Setting and Participants A total of 14 189 full-term infants born in the United Kingdom on April 5 through 11, 1970, were studied as part of the 1970 British Birth Cohort; 1064 were SGA (birth weight less than the fifth percentile for age at term). Follow-up at 5, 10, 16, and 26 years was 93%, 80%, 72%, and 53%, respectively.

Main Outcome Measures School performance and achievement, assessed at 5, 10, and 16 years; and years of education, occupational status, income, marital status, life satisfaction, disability, and height, assessed at 26 years, comparing persons born SGA with those who were not.

Results At 5, 10, and 16 years of age, those born SGA demonstrated small but significant deficits in academic achievement. In addition, teachers were less likely to rate those born SGA in the top 15th percentile of the class at 16 years (13% vs 20%; $P<.01$) and more likely to recommend special education (4.9% vs 2.3%; $P<.01$) compared with those born at normal birth weight (NBW). At age 26 years, adults who were SGA did not demonstrate any differences in years of education, employment, hours of work per week, marital status, or satisfaction with life. However, adults who were SGA were less likely to have professional or managerial jobs (8.7% vs 16.4%; $P<.01$) and reported significantly lower levels of weekly income (mean [SD], 185 [91] vs 206 [102] £; $P<.01$) than adults who were NBW. Adults who were SGA also reported significant height deficits compared with those who were NBW (mean [SD] *z* score, –0.55 [0.98] vs 0.08 [1.02]; $P<.001$). Similar results were also obtained after adjusting for social class, sex, region of birth, and the presence of fetal or neonatal distress.

Conclusions In this cohort, adults who were born SGA had significant differences in academic achievement and professional attainment compared with adults who were NBW. However, there were no long-term social or emotional consequences of being SGA: these adults were as likely to be employed, married, and satisfied with life.

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The long-term effects of fetal growth retardation on intellectual and educational outcome remain controversial. Those born small for gestational age (SGA) may demonstrate developmental delays in childhood,[1-4] although other studies have not substantiated these findings.[5-9] Even when cognitive impairments have been identified, these deficits are typically quite small. Unfortunately, because of study design and difficulty in long-term tracking of patients, the vast majority of outcome studies follow up children who were SGA to mid-childhood. In adolescence, Westwood and colleagues[5] found no significant differences in IQ between those children who were SGA and those who were normal birth weight (NBW); however, only 33 (28%) of the original 118 children were located. Similarly, Stein et al,[10] Douglas and Gear,[11] and Nilsen et al[12] also found no cognitive deficits among those aged 18 to 19 years who were SGA; however, relatively few adolescents were studied and follow-up rates were low. In contrast, Paz et al[13] reported that boys who were SGA had lower levels of educational attainment and adolescent girls who were SGA had lower IQ scores than those who were NBW.

Gross measurements of cognitive function such as IQ often do not detect other learning difficulties. Studies of school performance in children who were SGA document poorer performance despite normal intelligence.[14,15] Fitzhardinge and Steven[14] reported that approximately one half of children who were SGA had academic difficulties despite normal IQ testing scores. Rubin

Author Affiliation: Department of Pediatrics, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson School of Medicine, New Brunswick.
Corresponding Author: Richard S. Strauss, MD, Division of Pediatric Gastroenterology and Nutrition, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School, 1 Robert Wood Johnson Pl, CN-19, New Brunswick, NJ 08903-0019 (e-mail: strausrs@rwja.umdnj.edu).

and colleagues[16] reported that those who were SGA were more than twice as likely to repeat a grade and 4 times more likely to be placed in special classes compared with those who were not. Low and colleagues[2] have also shown that children who were born SGA were twice as likely to have minor learning deficits compared with those who were NBW.

Psychometric testing and cognitive testing provide little insight into the long-term functional outcomes of those who were SGA. Mitchell[17] has emphasized that current perinatal research needs to focus on long-term educational and social dysfunction. In addition, a recent consensus statement by the International Dietary Energy Consultative Group and International Union of Nutritional Sciences on intrauterine growth retardation recommended that attempts should be made to study the long-term social, emotional, and economic implications of intrauterine growth retardation including educational attainment, occupation, income, and work productivity.[18] To address the long-term functional outcomes of full-term infants born SGA, data from the 1970 British Birth Cohort were studied. Demographic data at birth also allowed for adjustment for socioeconomic factors influencing long-term outcome.

METHODS

Sample

Data from the 1970 British Birth Cohort Study were initially used to provide insight into the patterns of obstetrical and neonatal care in the United Kingdom. The study has been subsequently used to describe the health, social welfare, and emotional development of those children into adulthood. Comprehensive sweeps of all locatable participants were performed at ages 5, 10, 16, and 26 years. Evaluators at the follow-up sweeps were unaware of the participant's perinatal history.

Information was collected on infants born in the United Kingdom from April 5 through 11, 1970. Overall catchment was estimated at 95% to 98% of all births. Birth weight, gestational age, and congenital abnormalities were recorded at birth by the midwife or physician who delivered the neonate. Fetal or neonatal distress was defined by the presence of fetal bradycardia (heart rate <120/min), fetal tachycardia (heart rate >160/min), neonatal resuscitation (endotracheal tube or cardiac massage), respiratory distress, seizures, cyanosis, or hypoglycemia (blood glucose level ≤2.2 mmol/L [40 mg/dL]). Social class was categorized according to the Hope-Goldthorpe scale.[19] Gestational dating was calculated from the last menstrual period. More than 86% of mothers received their first prenatal visit prior to the 3rd trimester, and 98.6% of infants were singletons. Since developmental outcomes of children with congenital abnormalities may differ substantially from the rest of the population, 600 (3.6%) of these infants were excluded from analysis. Also excluded were 811 preterm infants (5.8%) (gestational age ≤36 weeks). Since 618 (3.6%) of those born in Northern Ireland were not followed up at 16 and 26 years, they are excluded from analysis. There were 14 189 full-term infants studied, of which 1064 were born SGA. Small for gestational age was defined as a birth weight of less than the fifth percentile for age at term. Birth weight for gestational age percentiles were calculated from British reference standards.[20,21] Birth and demographic characteristics of the sample are shown in Table 1.

Table 1. Demographic Characteristics of Cohort, British Birth Cohort, 1970-1996*

Characteristics	Normal Weight (n = 13 125)	Small for Gestational Age (n = 1064)	*P* Value
Birth weight, mean (SD), g	3416 (434)	2436 (391)	<.001
Gestational age, mean (SD), wk	40.1 (1.9)	40.3 (2.2)	<.001
Girls†	49	49	.91
English or European†	97.5	94.5	<.001
Parental occupation			
Either parent professional	24	15	<.001
At least 1 parent skilled	62	63	
Both parents manual, unskilled, or unemployed	15	22	
Mother's marital status single	5.8	10.0	<.001
Mother's age ≤18 y	5.5	7.5	<.01
Fetal or neonatal distress‡	6.7	12.7	<.001
Neonatal deaths, No. (%)	21 (0.2)	13 (1.1)	<.001
Congenital abnormalities§	2.0	4.5	<.001

*Data presented as percentage unless otherwise indicated. Normal weight indicates birth weight was in at least the fifth percentile; small for gestational age, less than the fifth percentile.
†Ethnicity first assessed at 10-year follow-up (n = 11 315).
‡Fetal or neonatal distress includes any of the following disorders: fetal bradycardia or tachycardia, oxygen requirement, neonatal resuscitation, seizures, cyanosis, or hypoglycemia at birth. Fetal bradycardia is defined as a heart rate of less than 120/min; fetal tachycardia, heart rate of at least 160/min; and hypoglycemia, blood glucose level of 2.2 mmol/L (40 mg/dL) or less.
§Infants with congenital abnormalities were excluded from all other analyses (n = 314). The number of those born at normal weight is 13 389; and small for gestational age, 1114.

Follow-up Rates

Follow-up rates at 5, 10, and 16 years were 93%, 80%, and 72%, respectively. At age 5 years , standardized testing included the Copy Design Test,[22] the English Picture Vocabulary Test,[23] the Human Figure Drawing Test,[24] and the Profile Test.[25] Head circumference was also measured to the nearest centimeter at the 5-year visit. Reading, spelling, and vocabulary tests were administered at 10 years. Vocabulary tests, spelling tests, and questionnaires about social and emotional attitudes were administered at 16 years. Each student's teacher was also asked to complete a questionnaire concerning each participant's academic achievements or difficulties. In addition, the community medical officer or school nurse filled out a comprehensive medical evaluation.

Questionnaires were mailed to all cohort members for whom an address was available for the 26-year follow-up. Overall, data were available on 7470 adults (52.6% of eligible cohort). Years of education, occupation, income, marital status, level of disability, and self-reported height were assessed by the 26-year questionnaire. Previous studies in adults have reported correlations between actual and reported heights typically range between 0.96 and 0.99.[26,27] Self-reported height was converted to *z* scores using the ANTHRO anthropometry software (Centers for Disease Control and Prevention, Atlanta, Ga). Income and occupation were reported by more than 90% of adults who classified themselves as full-time or part-time workers. Occupation was coded using Computer-Assisted Standard Occupational Coding (Institute of Employment Research, University of Warwick, Warwick, England). Income and occupation were not reported for adults who classified themselves as being unemployed (4.3%), full-time students (2.6%), disabled (1.7%), or in full-time family care (7.9%). Temporary disability and long-term disability were assessed by self-report as part of the employment questionnaire.

Using a 1-to-9 scale with 9 being completely dissatisfied, participants were asked "How satisfied are you with how life turned out?" Although single-item assessments of "satisfaction with life" are not ideal, they are generally considered valid and reliable as a brief measure of global well-being.[28] In this study, the satisfaction-with-life score correlated independently with employment status, marital status, standard of living rating, malaise or anxiety, and the presence of chronic medical conditions (ie, depression, digestive problems, back pain). In addition, participants were asked to rate their standard of living compared with others of the same age (Likert scale, 1-5).

Statistics

Data were analyzed using the SPSS-X program (SPSS Inc, Chicago, Ill). Differences in proportions were compared with χ^2 tests. Differences in continuous variables were determined by independent *t* tests. Statistical significance of Likert scale variables were assessed using the Mann-Whitney test. Twenty-six–year outcome data were adjusted for sex, social class, region of birth, and neonatal distress using hierarchical multivariate regression analysis. Parental social class and region of birth were coded as binary dummy variables for the analyses. Data for 26-year height were also adjusted for self-reported maternal and paternal height. Odds ratios with 95% confidence intervals (CIs) were calculated using logistic regression. Interactions between SGA and small head size and social class were calculated using 2-way analysis of variance for continuous outcomes and logistic regression for dichotomous outcomes. Goodness-of-fit for logistic regression models was calculated according to the methods of Hosmer and Lemeshow.

RESULTS

School-Year Comparisons

Children who were born SGA demonstrated significant deficits in a wide range of standardized testing from the ages of 5 to 16 years (TABLE 2). However, these deficits were typically small, ranging from 0.13 to 0.37 SDs. Other scores such as the 10-year reading score and the 16-year spelling and word recognition score were not significantly different between the 2 groups. Similar results were also obtained after correcting for parental social class and region of birth.

At age 10 years, teachers rated the general knowledge and academic achievement of children who were SGA as significantly lower than those who were not (Table 2). Similarly, teachers were less likely to rate those who were SGA in the top 15th percentile of the class. Adolescents who were SGA also received significantly lower math grades than those who were not. In addition, those who were SGA were significantly more likely to have been enrolled in special education compared with adolescents who were NBW (4.9% vs 2.3%, respectively; $P<.01$). However, there was no difference in gross neurological abnormalities between adolescents who were NBW and those who were not (1.0% vs 1.4%, respectively; $P = .45$).

Social and emotional development was similar between both groups, with each reporting similar numbers of friends both in and out of school, levels of family stability and happiness, personality traits, and interests in leisure activities, such as going to friends' homes, playing musical instruments, reading, going to movies, or dancing (Table 2). However, as expected, adolescents who were SGA were more likely to report difficulties at school than those who were NBW.

Twenty-six–Year Outcomes

After adjusting for confounding factors, there were no differences in years of education or hours of work performed weekly between groups (TABLE 3). However, those who were SGA were significantly less likely to have professional or managerial occupations (8.7% vs 16.4%; $P<.001$) and were significantly more likely to work as unskilled, semiskilled, or manual laborers than those who were NBW (34.3% vs 27.8%; $P<.001$), resulting in their reporting a significantly lower income than those who were NBW. These differences persisted after adjusting for sex, social class, and region of birth. The 2 groups, however, experienced no significant differences in marital status, satisfaction with life, and perception of standard of living.

Adults who were SGA also demonstrated significant height deficits compared with those who were NBW (Table 3). Overall, 25% of men who were SGA had a height of less than 168 cm compared with 10% of those who were NBW($P<.001$). Similarly, 24% of women who were SGA were no taller than 157 cm compared with 9% of those who were not ($P<.001$).

The interaction between childhood head growth and SGA on long-term outcome was also assessed (TABLE 4). Those who were SGA were substantially more likely to have a small head size at age 5 years than those who were NBW (odds ratio [OR], 2.7; 95% CI, 2.3-3.2; $P<.001$). Both head size at age 5 years and being SGA at birth were significant independent predictors of occupation and income with 17% of those born NBW and with a normal head size becoming professionals or managers compared with 3% of those born SGA with a small head size (OR, 5.96; 95% CI, 1.9-18.8; $P<.01$). Similarly, 28% of the former group became manual, semiskilled, or unskilled laborers compared with 38% of those in the latter group (OR, 0.6; 95% CI, 0.4-0.96; $P<.05$). However, neither head size at age 5 years nor SGA was associated with differences in satisfaction with life (Table 4).

The interaction between social class and SGA on long-term outcome was also assessed (TABLE 5). Being born SGA remained a significant predictor of long-term professional and economic attainment independent of social class. Even in families with at least 1 professional parent, those who were SGA were

Table 2. Academic and Emotional Outcomes of Those Born Small for Gestational Age (SGA) vs Those Born at Normal Weight at Age 5, 10, and 16 Years, British Birth Cohort, 1970-1996*

Variables	Normal Weight	SGA	*P* Value
5-Year Outcomes			
Standardized testing score			
Copy design, 2-8	4.8 (1.9) [n = 10 436]	4.1 (2.0) [n = 798]	<.001
Profile test, 1-13†	7.0 (4.0) [n = 10 025]	6.5 (3.9) [n = 750]	<.01
Human figure drawing, 5-16	10.5 (3.1) [n = 10 271]	9.8 (3.3) [n = 775]	<.001
English Picture Vocabulary Test, 14-60†	37.7 (13.1) [n = 9834]	32.4 (13.6) [n = 743]	<.001
10-Year Outcomes			
Standardized testing score			
Reading, 71-95†	85.5 (8.9) [n = 7074]	85.6 (9.1) [n = 541]	.76
Spelling, 30-96†	70.2 (20.3) [n = 9480]	66.3 (21.0) [n = 703]	<.001
Vocabulary, 3973†	56.7 (10.1) [n = 9706]	54.3 (9.7) [n = 720]	<.001
Teacher's assessment, No. (%)			
General knowledge			
Above average or well informed	9409 (31)	698 (21)	<.001
Below average or extremely limited	9409 (26)	698 (35)	<.001
16-Year Outcomes			
Standardized testing score			
Spelling and word recognition, 54-94†	82.4 (11.6) [n = 4396]	82.0 (10.1) [n = 303]	.52
Vocabulary, 29-83†	56.7 (16.3) [n = 4491]	52.3 (17.0) [n = 316]	<.001
Teacher's assessment, No. (%)			
Math grade levels			
Highest	2642 (28)	191 (16)	<.001
Lowest	2642 (17)	191 (29)	<.001
Academic ability, 15th percentile			
Top	2826 (20)	208 (13)	<.01
Bottom	2826 (4)	208 (10)	<.001
Social and emotional development compared with others, 1-5 scale			
Family stability	3.7 (1.1) [n = 4290]	3.6 (1.1) [n = 301]	.67
Happiness	3.5 (0.9) [n = 4186]	3.4 (1.0) [n = 291]	.32
No. of good friends	3.4 (0.9) [n = 4259]	3.4 (1.0) [n = 294]	.93
No. of close friends at school	5.6 (2.9) [n = 4753]	5.5 (2.9) [n = 327]	.59
No. of close friends out of school	4.9 (3.2) [n = 4666]	4.8 (3.2) [n = 314]	.56
Think self a worthless person, No. (%)	4333 (33.9)	303 (34.0)	.96

Self-description at Age 16 Years

	Normal Weight				SGA				
Qualities	Very Much, %	Somewhat, %	Not at All, %	No. of Respondents	Very Much, %	Somewhat, %	Not at All, %	No. of Respondents	*P* Value
Friendly	58	41	1	4348	58	41	1	302	.67
Popular	29	65	6	4343	29	65	6	302	.99
Angry	7	48	45	4306	6	52	43	294	.49
Shy	15	48	38	4290	16	48	37	303	.78
Loving	48	50	3	4343	51	48	2	301	.42
Not good at school	6	34	60	4269	8	41	51	295	<.05

*Data are presented as mean (SD) unless otherwise indicated. Normal weight indicates birth weight in at least the fifth percentile; SGA, less than the fifth percentile.
†Data represent 5th through 95th percentiles of scores.

less than 50% as likely to become professionals or managers compared with those who were NBW (OR, 0.41; 95% CI, 0.17-0.98; $P<.05$). Nevertheless, the deficits in professional and economic attainment due to SGA were relatively small compared with the impact of parental social class. In addition, social class was associated with long-term differences in satisfaction with life, while SGA was not.

Finally, fetal or neonatal distress did not account for substantial differences in income, professional attainment, or prevalence of unskilled occupations among those who were SGA. There was also no substantial difference in income, professional attainment, and prevalence of unskilled occupations in those who were SGA whose mothers smoked during pregnancy and those who did not smoke during pregnancy.

Assessment of Bias

The 26-year follow-up data were available on 8163 children (52.6%). Both NBW and SGA children with missing data at age 26 years had similar birth size as those children with follow-up data (TABLE 6). Similarly, both groups with missing data had similar head size at age 5 years as those children with follow-up data. In contrast, substantial differences existed in parental occupa-

Table 3. Twenty-six–Year Functional Outcome of Those Born Small for Gestational Age vs Those Born at Normal Weight, British Birth Cohort, 1970-1996*

Variable	Normal Weight		Small for Gestational Age		Crude Estimate of Difference (95% Confidence Interval)	Adjusted Crude Estimate of Difference (95% Confidence Interval)†
	Outcome (n = 6981)	Response Rate, %	Outcome (n = 489)	Response Rate, %		
Age left school, y	18.4 (3.0)	95	17.8 (2.8)	93	−0.6 (−0.9 to −0.3)‖	−0.3 (−0.5 to 0.01)
Unemployed, %	4.1	99	4.8	99	0.7 (−1.1 to 2.6)	0.6 (−1.2 to 2.4)
No. of hours worked per week	40.5 (10.9)	98	40.1 (12.3)	99	−0.4 (−1.6 to 0.7)	−0.5 (−1.5 to 0.5)
Professional or managerial, %‡	16.4	92	8.7	90	−7.7 (−11.7 to −3.6)‖	−6.1 (−10.1 to −2.1)¶
Manual, semiskilled, or unskilled, %§	27.8	92	34.3	90	6.5 (1.6 to 11.5)¶	5.0 (0.02 to 9.8)#
Weekly income, £ (£ = US $1.60)	206 (102)	90	185 (91)	89	−21 (−10 to −32)‖	−16 (−5 to −26)¶
Married, %	34	99	36	99	2 (−2 to 6)	0 (−4 to 5)
Satisfaction with life, 1-9 scale	6.9 (1.8)	90	6.8 (1.7)	90	−0.1 (−0.3 to 0.02)	−0.1 (−0.3 to 0.1)
Consider standard of living is better than others, %	52	99	52	99	0 (−5 to 4)	0 (−4 to 6)
Seizures between ages 16-26 y, %	1.7	100	1.6	99	−0.1 (−1.3 to 1.1)	0.2 (−1.4 to 1.0)
Height, *z* score	0.08 (1.02)	82	−0.55 (0.98)	89	−0.63 (−0.73 to −0.53)‖	−0.39 (−0.47 to −0.30)‖
Long-term or short-term sickness or disability, %	1.4	99	2.7	99	1.3 (0.2 to 2.5)#	1.1 (0.01 to 2.3)#

*Data are presented as mean (SD) unless otherwise indicated. Response rates (ie, hours per week, income and occupation) were calculated for full- and part-time workers. Normal weight indicates birth weight in at least the fifth percentile; small for gestational age, less than the fifth percentile.
†Results adjusted for maternal social class, paternal social class, region of birth, sex, and fetal or neonatal distress. Height *z* score adjusted for maternal height and paternal height (n = 5602).
‡Goldthorpe Social Class I (1980 classification).[19]
§Goldthorpe Social Class IV, VIIa, and VIIb (1980 classification).[19]
‖$P<.001$.
¶$P<.01$.
#$P<.05$.

Table 4. Interaction Between Being Born Small for Gestational Age (SGA) vs Being Born at Normal Weight and Head Size at Age 5 Years, British Birth Cohort, 1970-1996*

	Head Circumference				Main Effects		SGA × Small Head Circumference *P* Value‡
	Normal Birth Weight		SGA				
	Small†	Normal	Small†	Normal	SGA	Small Head Circumference	
Professional or managerial, No. (%)	702 (12)	3895 (17)	92 (3)	193 (10)	<.001	<.001	.17
Manual, semiskilled, or unskilled, No. (%)	702 (27)	3895 (28)	92 (38)	193 (34)	<.01	.98	.47
Weekly income, mean (SD), £ (£ = US $1.60)	180 (86) [n = 673]	211 (104) [n = 3832]	168 (81) [n = 95]	189 (95) [n = 187]	<.003	<.001	.46
Satisfaction with life, mean (SD), scale 1-9	6.8 (1.9) [n = 845]	6.9 (1.8) [n = 4495]	6.7 (1.7) [n = 124]	6.8 (1.7) [n = 251]	.16	.08	.38
How standard of living compares with others, No. (%)	956 (49)	4970 (54)	144 (54)	273 (52)	.91	<.01	.31

*Normal weight indicates birth weight in at least the fifth percentile; small gestational age, less than the fifth percentile.
†Head size less than the 10th percentile.
‡Lack of interaction implies that the effects of being born SGA were not significantly different at small and normal head circumference. Nonsignificant variables were removed with backward elimination.

tion and test scores at years 5 and 10 and in teacher assessment at year 16 between both groups with and without follow-up data. However, the pattern of dropout was similar in all groups, suggesting similar degrees of bias. After adjusting for differences in social class, region, and test scores, there was no significant difference in the rate of follow-up between those who were SGA and those who were NBW (*P* = .87).

COMMENT

These results demonstrate that those born SGA have increased academic difficulties persisting into adolescence. As young adults, those born SGA also have deficits in professional and economic attainment. However, measures of social and emotional outcome in mid-adolescence and early adulthood were normal in those born SGA. Therefore, previous studies that have focused on developmental and neurological outcomes of children who were SGA do not present a complete picture of the long-term consequences. Solely focusing on neurodevelopmental testing ignores the social and emotional outcome of adolescents and adults who were SGA, which appears to be excellent.

This study also shows that long-term professional and economic disadvantage occurs in persons who were SGA with both normal and abnormal head growth. Previous studies have documented that preterm very low-birth-weight infants with subnormal head size at age 8 months have a substantially worse outcome than preterm infants with normal head size at age 8 months.[29] Similarly, in this study, those born SGA who had a small head size had substantially lower rates of professional attainment and a trend toward lower income than those born SGA and who had a normal head size at age 5 years. However, poor head growth alone did not explain the deficits observed in adults who were SGA in as much as significant professional and economic deficits were also

Table 5. Interaction Between Being Born Small for Gestational Age (SGA), Normal Weight, and Social Class, British Birth Cohort, 1970-1996*

	Normal Birth Weight			SGA			Main Effects		
	≥1 Parent Professional	≥1 Parent Skilled	Both Parents Unskilled or Unemployed	≥1 Parent Professional	≥1 Parent Skilled	Both Parents Unskilled or Unemployed	SGA	Parental Occupation	SGA × Parental Occupation *P* Value†
Professional or managerial, No. (%)	1348 (25)	3136 (15)	537 (8)	50 (12)	214 (9)	47 (4)	<.002	<.001	.75†
Manual, semiskilled, or unskilled, No. (%)	1348 (17)	3136 (29)	537 (46)	50 (22)	214 (32)	47 (51)	.016	<.001	.40†
Weekly income, mean (SD), £ (£ = US $1.60)	225 (106) [n = 1317]	203 (100) [n = 3079]	175 (92) [n = 514]	204 (120) [n = 46]	181 (81) [n = 214]	177 (112) [n = 51]	<.002	<.001	.30†
Satisfaction with life, mean (SD), scale 1-9	7.1 (1.7) [n = 1556]	6.9 (1.8) [n = 3645]	6.6 (1.9) [n = 679]	6.9 (1.5) [n = 57]	6.8 (1.7) [n = 270]	6.2 (1.8) [n = 76]	.17	<.001	.12†
How standard of living compares with others, No. (%)	1687 (60)	4032 (51)	769 (44)	63 (52)	299 (53)	85 (42)	.87	<.001	.40†

*Normal weight indicates birth weight in at least the fifth percentile; SGA, less than the fifth percentile.
†Lack of interaction implies that the effects of being born SGA were not significantly different at low, medium, and high parental social class. Nonsignificant variables were removed with backward elimination.

Table 6. Comparison of Those Born Small for Gestational Age (SGA) vs Those Born at Normal Weight With and Without Follow-up Data, British Birth Cohort, 1970-1996*

	Normal Birth Weight			SGA			
Variable	Missing	Follow-up	*P* Value	Missing	Follow-up	*P* Value	Interaction SGA × Normal Birth Weight, *P* Value
Birth weight, g	3410 (436)	3422 (431)	.10	2427 (418)	2448 (356)	.35	.70
Both parents professional, managerial or skilled, No. (%)†	6144 (29.0)	6981 (37.0)	<.001	575 (27.0)	489 (35.0)	<.01	.92
Region of birth London, England, No. (%)	6144 (13.7)	6981 (11.0)	<.001	575 (13.2)	489 (10.6)	.09	.88
5-Year Follow-up and Scores							
Head circumference, cm	51.9 (1.8)	51.9 (1.9)	.44	50.9 (2.0)	51.0 (1.9)	.55	.77
English Picture Vocabulary Test	35.9 (13.3)	39.1 (12.8)	<.001	30.0 (13.7)	34.5 (13.1)	<.001	.20
Copy design	4.5 (1.9)	5.1 (1.9)	<.001	3.0 (2.0)	3.8 (2.0)	<.001	.68
10-Year Scores							
Spelling	66.7 (21.5)	72.6 (19.0)	<.001	63.3 (20.3)	68.9 (21.3)	<.001	.84
Vocabulary	55.1 (10.1)	57.8 (10.0)	<.001	53.0 (9.6)	55.5 (9.7)	<.001	.76
Reading	85.7 (9.6)	85.4 (8.4)	<.001	85.5 (9.7)	85.7 (8.5)	.001	.49

*All data are presented as mean (SD) unless otherwise indicated. Similar patterns of follow-up were also present for 16-year scores and 16-year teacher's assessment. Normal weight indicates birth weight in at least the fifth percentile; SGA, less than the fifth percentile.
†Goldthorpe Social Class I, II, IIIM, and IIINM (1970 Classification).[21]

observed in SGA children with normal head size at age 5 years.

The powerful effects of environmental factors on long-term professional and economic attainment are also demonstrated by this study. Adults who were SGA with professional parents achieved significantly better professional and economic outcomes than those whose parents were semiskilled, manual, or unskilled workers. However, even in professional families, adults who were SGA demonstrated significantly lower long-term professional and economic achievement profiles compared with those who were NBW. Nevertheless, the achievement deficits were small in comparison with the effects of family environment. Other studies have also documented that socioeconomic factors are strongly related to the developmental outcome of high-risk infants.[9,30] Since those born SGA reared in poorer environments demonstrate significantly lower professional attainment and income than those reared in more stimulating environments, this study supports the use of early intervention programs such as Head Start for children who were SGA infants born to disadvantaged families. Previous studies suggest that early intervention significantly enhances cognitive outcome in low socioeconomic preterm and term infants.[31,32]

Substantial long-term height deficits in children who were SGA were also observed. Those who were SGA are approximately one half of an SD shorter than those who were NBW. This deficit corresponds to approximately 5.08 cm (2 in) in adults. Similar degrees of growth retardation have been previously described in young adults who were SGA by Paz et al.[33] In addition, Strauss and Dietz[34] have shown that those who were preterm SGA infants remain approximately one half of an SD smaller than those who despite being born preterm were an appropriate gestational age, and those who were born full term but were SGA infants were also approximately one half of an SD shorter than their normal-weight siblings.[7]

Levels of life satisfaction were normal in those who were SGA. Satisfaction with life provides a subjective assessment of a person's quality of life incorporating personal values and expectations. As such, satisfaction with life is only loosely correlated with income, education, age, and social class.[35] Satisfaction with life has been studied in adults with disabilities,[36] spinal cord injury,[37] breast cancer,[38] and chronic renal failure.[39] Across medical conditions, satisfaction with life is related to a combination of perceived disability, social support, and social contacts. Since adults who were SGA did not have significantly increased prevalence of gross neurological findings or disabilities, and they demonstrated normal social skills, marital rates, and friendships, it is not surprising that they report a normal satisfaction with life. Similar results have been reported with very low-birth-weight infants by McCormick et al.[40] Saigal et al[41] have also shown that the majority of adolescents who had extremely low birth weight demonstrate similar ratings of their overall health status compared with control adolescents, despite lower cognitive, sensory, and self-care scores.

Bias due to sample attrition is always a cause for concern in long-term follow-up studies. In this study, sample attrition was approximately 50% at 26 years. To characterize nonresponders, 2 separate telephone surveys were conducted. Follow-up telephone calls to selected nonresponders suggested that wrong address, vacation, and failure to receive a questionnaire were the primary reasons for nonresponse. Less than 10% of nonresponders refused to participate in the study. Nevertheless, study dropout certainly raises the possibility of biased results. Comparison of birth characteristics and 5-year, 10-year, 16-year test scores and teacher evaluations reveal a similar pattern of dropout in those who were NBW and SGA. In addition, a similar pattern of economic and professional deficits was observed in adults who were SGA from professional families for whom the dropout rate was less than 40%. Previous studies on the characteristics of patients lost to follow-up in longitudinal studies have revealed conflicting results. Data from the National Collaborative Perinatal Project suggest that the level of neurological deficits was similar in patients lost to follow-up but later tracked down compared with the rest of the population.[42] However, data from Tin and colleagues[43] of high-risk, premature infants demonstrate that the rate of disability in the study population was 11%, but if the study was confined to easy-to-trace families, the reported disability rate would have been only 7%. The pattern of dropout in this study also suggests that the deficit in economic and professional attainment of SGA adults may have been underestimated.

Even though some SGA infants may simply be genetically small and not "growth retarded," birth-weight cutoffs are generally used to establish groups of infants who are considered "at risk." In this study, SGA was defined as a birth weight less than the fifth percentile. Other authors have defined SGA as a birth weight less than the 10th percentile or the 3rd percentile (2 SDs) for gestational age or less than 80% to 90% of average birth weight for gestational age, and birth weight less than 2500 g. Although older studies have most commonly used the 10th percentile cutoff to define SGA, recent evidence suggests that only the smallest infants (≤3rd percentile) demonstrate increased neonatal mortality or morbidity, although actual birth weight percentile values were not provided.[44] In addition, these analyses with SGA defined as a full-term birth, weight less than 2500 g revealed similar results for all outcomes.

Finally, by focusing on professional attainment, income, and satisfaction with life, this study presents nonconventional measures of mental and social development. Previous studies of persons who were SGA have predominantly focused on gross neurological abnormalities or cognitive testing such as IQ scores. However, recent psychological theory continues to point to limitations in standardized intelligence tests in predicting long-term success at college or employment.[45] This study clearly indicates that many infants with birth weights less than the fifth percentile have mild, but significant, degrees of functional impairment. Every effort, therefore, should be made in early and middle childhood to provide children who were SGA with an enriched environment to minimize the long-term negative effects.

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