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Article title: Approaches to assessing the role of household socio-economic status on child anthropometric measures in urban South Africa

Abbreviated title: Ways to assess the role of SES on child health

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ABSTRACT

Objectives: To compare the variance explained in anthropometric outcomes when using individual measures of socio-economic status (SES) versus different approaches to creating SES indices within the urban African context. To examine the influence of SES measured during infancy on child anthropometric outcomes at 7/8 years in urban South Africa.

Experimental design: Data from the 1990 Birth-to-Twenty cohort study set in Johannesburg-Soweto, South Africa, were used (n=888). Linear regression models were used to investigate the association between SES (individual and index measures) during infancy and anthropometric measures at age 7/8 years, controlling for sex, age, and population group.

Principal observations: Both individual and index measures of SES explained similar proportions of the variance for each anthropometric outcome. SES measured during infancy influenced weight more than height at age 7/8 years in Johannesburg-Soweto. Positive associations were found between SES and the anthropometric measures - ownership of a car, telephone, and having an inside flush toilet were the most significant SES variables.

Conclusions: The similarities observed in the variance explained relating to the anthropometric outcomes suggest that researchers who want to adjust for SES in analyses could use an SES index to make statistical models more parsimonious. However, using such indices loses information relating to the specific socio-economic factors that are important for explaining child anthropometrics. If the purpose of the research is to make policy

recommendations for the improvement of child growth, individual SES variables would provide more specific information to target interventions.

INTRODUCTION

Socio-economic status (SES) is known to be associated with a variety of health outcomes including child growth (Barker et al., 2001; Fuhrer et al., 2002; Griffiths et al., 2008; Jones et al., 2008; Teranishi et al., 2000). The potential for social or economic interventions to impact on a wide range of health outcomes makes health inequality research a priority area. Such research and interventions require adequate measures of SES.

Childhood SES has been associated with health outcomes in later life (Beebe-Dimmer et al., 2004; Blane et al., 1996; Davey-Smith et al., 1998; Hardy et al., 2000; Power et al., 2005; Wamala et al., 2001). Some of these associations may be mediated through differences in size at birth and childhood fat/lean composition across SES groups. Some studies show that birth weight and infantile weight gain are positively associated with greater lean mass deposition in childhood, whereas weight gain in early (Sachdev et al., 2005; Wells et al., 2005) and late childhood (Wells et al., 2005) is associated with increased adult adiposity. Other studies have shown birth weight and weight gain in the first year to be risk factors for obesity at seven years (Reilly et al., 2005). Clearly, early life SES can affect growth, through weight gain for example.

SES measures are often included in studies either as *“a primary focus variable or as an important control variable”* (Bollen et al., 2001:1). However, the choice of SES measures depends on the ability to collect good quality data (Falkingham and Namazie, 2002). Ownership of assets and dwelling characteristics are often used as proxies for long-term income. However, these measures only capture the economic component of SES, meaning that other measures, such as education, and marital status are often used to capture the social dimension. Socio-economic status is indeed a complex multidimensional concept that is difficult to define and measure like many social variables. For example, when using Factor Analysis (FA) to explore definitions of urbanicity in the Philippines, McDade and Adair (2001:55) highlighted the difficulty of adequately capturing urban versus rural environments and the need for a finer level of detail.

Because it is difficult to define and measure, researchers within the field of human biology have operationalized SES in a variety of ways. For example, multiple individual measures of SES have been incorporated into studies of children’s nutritional status (e.g. King and Mascie-Taylor, 2002). Also, SES indices such as composite wealth indices of consumer durables have been used in addition to social measures such as maternal education (e.g. Huntsman and White, 2007). Indices of household condition have also been considered along with individual measures (e.g. Som et al., 2007), as well as indices encompassing many different dimensions of SES incorporating parental occupation, education, income, housing, as well as area characteristics (e.g. Freitas et al., 2007). Finally, indices based on the local market price of consumer durables and livestock have been used (e.g. Pawloski and Kitsantas, 2008), and more sophisticated indices based on data reduction techniques such as Principal Component Analysis (PCA) (e.g. Oyhenart et al., 2008).

The methodological aim of this paper was therefore to compare the results obtained using a variety of different approaches to incorporate SES variables into regression analyses of child anthropometric outcomes in urban South Africa. The intention was to be able to make recommendations about the use of SES measures and indices in studies of child anthropometric outcomes that are applicable within a dynamic urbanizing environment. The empirical aim of the paper was to examine the influence of SES measured during infancy on child anthropometric outcomes in later childhood, at age 7/8 years in urban South Africa. These two aims are important, and challenging to investigate in a rapidly transitioning urban environment such as Johannesburg due to the huge socio-economic inequalities (May, 2000).

METHODS

Data

Data from the 1990 Birth-to-Twenty (Bt20) cohort set in Johannesburg-Soweto, South Africa, were used. The study enrolled all singleton children born in Johannesburg-Soweto during a seven week period in 1990 who remained resident for six months (a description of the study can be found in Richter et al., 2007). These analyses use data combined from the antenatal, delivery, six months, one year, and two year data collection points (infancy) as well as data collected at 7/8 years. All caregivers provided written informed consent and ethical approval was obtained from the University of the Witwatersrand Committee for Research on Human Subjects.

Body mass index (BMI), height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ) were chosen as the health outcomes of interest because they are commonly used indicators of child health and development and reflect both long-term and current nutritional status (McMurray, 1996). The ANTHRO 1999 software version 1.02 (Atlanta, USA) was used to calculate HAZ, WAZ, and WHZ based on the 1978 National Center for Health Statistics/Center for Disease Control (CDC)/World Health Organization growth references. Weight and height at 7/8 years were assessed by two trained observers (one male and one female) using standard techniques (Lohman et al., 1991).

The 12 binary SES measures of interest were whether or not the children had a number of consumer durables in the home during infancy (television, car, refrigerator, washing machine, and telephone); whether the caregiver was married/cohabiting; whether the caregiver had Grade 11-12 or higher education (Grade 12 being completed High School); whether the child was born in a private hospital; whether the child lived in a house/flat/cottage; whether the family had an indoor water source, inside flush toilet, and electricity. These measures were chosen as they included both economic and social support dimensions of SES as well as facilities.

The household SES measures were caregiver assessed using a questionnaire based on the Demographic and Health Survey (DHS) tool, which is widely used in developing countries. The Bt20 SES questionnaire was piloted with 30 caregivers who were not enrolled in the cohort to ensure understanding of concepts, an optimal layout of the questionnaire, and appropriate translation. Caregivers reported the population group of the child as recorded on the birth notification slip that was based on official ethnic definitions being used by the Department of Home Affairs in South Africa in 1990, being Black (African decent), Colored (mixed ancestry), White (European origin), and Indian (from South East Asia) (Richter et al., 2007:1).

Methods

Linear regression models were used to investigate the association between SES during infancy and anthropometric measures at age 7/8 years, that is, prior to puberty, thus avoiding the potential confounder of pubertal status. Inclusion criteria were complete data for BMI, HAZ, WAZ, WHZ at 7/8 years, and sex, age, population group, and birth weight data as well as the 12 SES measures of interest during infancy (n=888). The Statistical Package for the Social Sciences (SPSS) version 14.0 (Chicago, USA) was used for the analyses.

Several SES indices were created for comparison based on the five principal strategies summarized by Falkingham and Namazie (2002). First, an additive index was created, being the sum of the 12 binary variables. Second, an index was created based on a subjective ranking by a member of the 1990

Bt20 data collection team of the 12 variables in order of importance. A third approach to weighting is to attach a monetary value to each of the items but this proved too difficult in the 1990 South African context, particularly for the social support variables. Instead, a simpler approach was to weight the SES variables depending on the frequency of households not having each measure, similar to the method used by Morris et al. (2000) and Howe et al. (2008), thus giving relative importance to each SES measure within the context of the sample.

Next, indices were created using PCA and FA data reduction techniques as described by Manly (2005). Principal Component Analysis was used to create three data driven indices with Eigen values over 1.0 (variances of the principal components (PCs) (Townend, 2004)) from the 12 SES measures. The true PC scores were calculated by multiplying the three PC scores by the square root of the corresponding Eigen value. The loadings for the data driven PCA are shown in Table 1.

[Table 1 about here]

As some of the groupings were not intuitive (also found by Houweling et al. (2003)), more *theoretically* driven PCAs were also performed, where the consumer durables were forced to group together (having a television, car, refrigerator, washing machine, and telephone) to create one PC score (Eigen Value = 2.24), the social support measures were made to group together (caregiver's marital status and education) to produce a second PC score

(Eigen Value = 1.05), and the facility variables were also put together (type of hospital, dwelling type, water source, toilet type, and electricity) to construct a third PC score (Eigen Value = 1.91). The loadings for the theory driven PCA are shown in Table 2.

[Table 2 about here]

A data driven FA was also used to create three factor scores from the 12 SES measures using Varimax rotation and Principal Axis Factoring as the extraction method. The same theoretically driven groupings were also used with FA as were employed for PCA. The loadings for the data and theory driven FA are shown in Tables 3 and 4. All indices were measured on a continuous scale but they were measured on different scales so it must be noted that some indices had more/less power to detect differences in SES.

[Tables 3 and 4 about here]

Linear regression was used to model the four anthropometric outcomes at age 7/8 years (BMI, HAZ, WAZ, and WHZ), controlling for sex, age, and population group of the child. Each of the individual SES variables was included separately as an explanatory variable in each of the regression models. Subsequently all of the individual SES variables were included together, and finally only those SES variables that were significantly associated ($p<0.05$) with the outcomes prior to including other SES measures. Assessment of co-linearity between the SES measures entered into the regression models together revealed no concerns (tolerance of >0.05). Each of the SES indices was then used in turn as the explanatory variable in separate regression models with each of the outcomes. The performance of the models was assessed using the adjusted R^2.

RESULTS

Table 5 presents the characteristics of the analysis sample. Mean HAZ, WAZ, and WHZ were all below the reference median, and mean BMI was 15.83 kg/m^2. The under-representation of Whites in the sample when compared to the South African urban population has been documented elsewhere (Richter et al., 2007:2) but makes little difference when comparing the use of different SES measures as the sample is *consistent* for all comparisons.

[Table 5 about here]

Of the consumer durables measured in the study, the lowest proportion of households owned a washing machine while the highest proportion owned a television or refrigerator. Just over a third of children’s caregivers were married or cohabiting and 43.2% had at least Grade 11-12 education. Only 10.5% of children were born in a private hospital and just over one third of households had an inside flush toilet. In contrast, household electricity supply was nearly universal.

Table 6 presents the coefficients, standard errors, and significance levels for the models comparing the influence of SES on the anthropometric measures. Ownership of a car, telephone, and having an inside flush toilet were all individually positively associated with BMI, WAZ and WHZ. Being born in a private hospital was also positively associated with WAZ and having a television was positively associated with BMI and WHZ. None of the 12 SES measures were significantly associated with HAZ. When all 12 measures of SES were entered into the same regression models, none were significantly associated with any anthropometric measures. This remained the case when only those SES measures that were found to be independently significantly associated with each of the outcome measures were included.

[Table 6 about here]

When comparing the other indices, Table 6 shows that they were significantly positively associated with all of the anthropometric measures except for the FA indices and the theory driven PCA index on HAZ. The first PC score from the data driven PCA was positively associated with all of the outcomes, whereas it was the second factor score from the data driven FA that was significantly associated with all of the outcomes apart from HAZ. It was the consumer durable indices from the theoretical PCA and FA that were significantly positively associated with BMI, WAZ, and WHZ.

In general, only a small proportion of the variance was explained by each of the models (not shown) and there was little difference in the values of the adjusted R^2 for each model. Indeed, 4% of the variance was explained by each of the models for HAZ, regardless of which measure of SES/index was included in the model. The models explained 3-4% of the variance for BMI, 7-8% for WAZ, and 5-6% for WHZ.

DISCUSSION

Methodological findings

The small proportion of the variance explained by the models was expected as there were likely to be many unobserved variables associated with the anthropometric outcomes such as genetic and unmeasured environmental factors (McMurray, 1996). Although McMurray (1996) controlled for a number of other factors in her paper on cross-sectional anthropometry, the author reported an adjusted R^2 of 12% for HAZ and 9% for WAZ. In general, a higher proportion of the variance in the data tends to be explained by biological variables as opposed to social ones, probably because social variables are more difficult to measure and have more noise associated with them. Indeed, Sahn and Stifel (2003:480) note that *"models of nutritional outcomes are rarely estimated for their predictive capabilities"* but instead to interpret the parameter estimates and significance levels.

The models in this study showed no consistent difference in the proportion of the variance explained or in the direction of the significant associations when different measures/indices of SES were used. As there was no real difference in the performance of the models, the use of individual measures of SES versus the use of indices probably depends on whether one is interested in *adjusting* for SES in an analysis where other variables are of principal interest, or if SES is the main focus.

Indices to adjust for SES

An index may be useful when *adjusting* for SES in small samples to make statistical models more parsimonious and to allow power to detect significant associations for variables of more substantive interest. For example, in studies of the role of the fetal environment or early life biological predictors on growth in late childhood, there is clearly a need to adjust for environmental variations so the adjusted phenotype is closer to the genotypic expression (Gluckman et al., 2007), and SES is an important component in defining the environment. Such studies need to have a measure of SES to *adjust* out important factors in the external environment but they are not necessarily interested in understanding the nuances of the role of the different components of SES on the outcome. The findings here suggest that a simple additive index accounts for a similar proportion of the variance in child anthropometric outcomes compared to more sophisticated PCA or FA indices.

Despite similar adjusted R^2 values across all of the models, the predicted values showed there was evidence that the data driven FA distinguished the effect of SES the most. For example, the average BMI of a Black boy in households of the lowest and highest SES for all of the SES measures was predicted from the different regression equations setting age at its mean value (8.25 years) (not shown). These predictions showed that a household with the minimum SES data driven FA index ranked between the 25th and 50th

percentile according to the CDC 2000 BMI reference charts and those with the maximum ranked close to the 75th percentile (National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion, 2000).

Others such as Filmer and Pritchett (2001) and Sahn and Stifel (2003) have previously recommended the use of indices derived from PCA or FA. However, it could be argued that PCA and FA are inappropriate techniques to use for categorical data when many measures of SES are of a binary nature (e.g. asset ownership) because the notion of correlation does not make sense. For example, Chatfield and Collins (1980:58) note that although there are no distributional assumptions for the original variables, *"more meaning can generally be given to the components in the case where the observations are assumed to be multivariate normal"*.

Our findings have also shown the importance of constructing SES indices which measure the different *dimensions* of SES. For example, distinguishing economic from social support aspects of SES rather than using one individual index. Findings from this research have shown that the economic (consumer durables) dimension of SES was particularly important for child nutritional status. Fotso and Kuate-Defo (2005) in their analyses of socio-economic inequalities in child malnutrition and morbidity using DHS data from five African countries used an economic index, a social index, and a community index, but found that the importance of each dimension differed by country, suggesting that SES may be context specific. Durkin et al. (1994:1296) found that housing conditions and wealth were the two important dimensions of SES in Bangladesh and Pakistan and argued for the use of multiple measures of SES to increase reliability and the chance of identifying important dimensions of SES.

Individual measures to investigate SES as the primary focus

If researchers are interested in SES as the primary focus of the analysis, and if there are no problems of co-linearity between SES variables, then using individual measures of SES allows the identification of specific aspects of SES that are important for child growth. However, no SES measures were significantly associated with the outcomes when the SES measures were entered into the models together, the preferred method asserted by Montgomery et al. (2000) who found this method to have the most explanatory power compared to an additive index, and dummy variables for the additive index. We observed no problems of multicolinearity in the model using all of the individual variables, which is a reason many authors have advocated using indices rather than individual measures. The potential danger of putting these individual factors into a model together is that we would have concluded that SES was not significantly associated with the anthropometric measures if this approach had solely been followed in this paper. The lack of significance of the individual SES measures entered simultaneously in the model could potentially be a statistical power issue created by the inclusion of additional parameters into the model as individual factors were found significant when entered independently. This finding highlights the importance of looking at the variables individually as well as in combination.

Finally, and importantly, examining individual measures of SES has the added advantage of identifying potential areas to prioritize when targeting policies. For instance, these data suggest that improving sanitation in the form of inside flush toilets may be important for improving BMI, WAZ, and WHZ of Johannesburg-Soweto born children as opposed to targeting policies aimed at advocating children being born into households where the mother is married/cohabiting. Identification of these specific policy recommendations would not have been possible using an index.

Empirical findings

Empirically, two key findings emerged from these analyses. Firstly, SES was more consistently significantly associated with weight rather than height. Height is regarded as an indicator of chronic situations whereas weight is regarded as being more eco-sensitive and thus more responsive to the proximal environment in terms of nutrition and health (Bogin, 2003). Nevertheless, the extent to which environmental factors are associated with size for age is influenced by study design, variation in the background, nutritional, and health care environment, as well as many other factors.

A second factor that may explain the weaker association between SES and HAZ could be the low proportion of stunting observed in this sample (approximately 8%). Where the majority of children are growing in height adequately, the SES environment is less likely to affect the height of children than genetic factors. In contrast, SES may become more important in environments where a large proportion of children are stunted. For instance, an association between parental education and HAZ was found in Papua New Guinea when more than half of the children in the sample were stunted (King and Mascie-Taylor, 2002).

Thirdly, the association with weight over height could also be context specific and be related to the nutrition transition (Popkin, 2001) as well as the local environment influencing physical activity patterns. For example, weight may be more influenced by SES in a transitioning society when behaviors start emerging such as using energy saving devices, eating junk food, and staying in to watch television when it may not be safe to play outside.

Finally, the associations found could also be influenced by the measures of SES used in this study, that is, due to specificity of the measures, for example, whether the SES measures adequately assess the SES environment into which the child was born. Indeed, other researchers have shown that the choice of measure or measures can influence associations between SES and child health (Houweling et al., 2003). However, this paper has gone some way to address this by examining several anthropometric outcomes and several measures/indices of SES. Nevertheless, there are likely to be unobservable and unmeasured individual, household, and community factors that influenced child growth, particularly with the vast amount of political change in Johannesburg at that time. It is important to note that different factors are likely to be important across ages, critical periods of growth, as well as across contexts.

The second key empirical finding to emerge from these analyses was that positive associations were found between SES during infancy and the anthropometric outcomes at 7/8 years. It therefore appears that body size at age 7/8 years is sensitive to the SES environment measured several years earlier, during infancy. Other researchers have observed an association between socio-economic measures at birth and health outcomes later in life (Beebe-Dimmer et al., 2004; Blane et al., 1996; Davey-Smith et al., 1998; Hardy et al., 2000; Power et al., 2005; Wamala et al., 2001). However, these associations have more commonly been observed in societies with less transitioning economies.

Although we measure SES at infancy and use this as an indicator of the early life SES environment, the likelihood is that for a number of children in the cohort, even with the political transition experienced in the 1990s in South Africa, their relative SES position within the cohort would not have changed by 7/8 years. Therefore, the association that we observe between SES at infancy and BMI/WAZ/WHZ at 7/8 years could be explained through both current and historical SES environmental impacts on the child's weight. We are unable to separate the relative contribution of SES at infancy and 7/8 years because although SES data were collected at 7/8 years, they were not available to use at the time of analysis. It is therefore not possible to say whether the infancy SES measure is identifying a true risk of the early life

SES environment or whether the SES measure taken during infancy is simply a good proxy for the SES environment at 7/8 years, and highlights the effect of contemporary SES on growth. Indeed, we have found previously that current SES later in childhood is a better predictor for some measures of body composition than SES measured during infancy (Griffiths et al., 2008; Norris et al., 2008).

CONCLUSION

Methodologically, this paper found that the measures and indices of SES performed similarly. Researchers who want to adjust for SES in an analysis could use an SES index to make statistical models more parsimonious. However, using such indices loses information relating to the specific socio-economic factors that are most important for explaining child anthropometrics. If the purpose of the research is to make policy recommendations for the improvement of child growth, the individual SES variables would provide more specific information to target interventions. However, researchers including more parameters into their statistical models need to ensure that the statistical power exists to support the additional parameters. It is therefore important for human biologists to consider how they incorporate and operationalize SES in studies of child anthropometrics.

Empirically, this paper found that SES measured during infancy influences weight more than height at age 7/8 years in Johannesburg-Soweto. This therefore highlights the potential importance of the early socio-economic environment for weight at 7/8 years in this transitioning urban environment, suggesting that policies to improve the early socio-economic environment may also have longer-term impacts. Furthermore, positive associations were found between SES and the anthropometric measures. Economic policies such as improving sanitation for example, may be more influential than social policies in improving anthropometric outcomes in this urban South African setting.

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TABLES

Table 1: Component matrix for the data driven principal component analysis

	Principal component 1	Principal component 2	Principal component 3
Has television	0.54	0.40	-
Has car	0.62	-	-0.26
Has refrigerator	0.60	0.43	-
Has washing machine	0.62	-0.23	-
Has telephone	0.57	0.34	-0.24
Caregiver married/cohabiting	0.34	-0.55	-0.34
Caregiver has Grade 11/12+ education	0.37	0.21	-
Born in private hospital	0.60	-0.39	-
Lives in house/flat/cottage	0.27	0.46	0.48
Has indoor water source	0.58	-0.21	0.61
Has inside flush toilet	0.64	-0.37	0.46
Has electricity	0.23	0.41	-
% of variance	26.86	13.04	9.59

Principal component analysis was used to create three data driven indices with Eigen values over 1.0 from the 12 socio-economic measures.

Table 2: Component matrix for the theory driven principal component analysis

	Consumer durable component	Social support component	Facility component
Has television	0.67	-	-
Has car	0.65	-	-
Has refrigerator	0.72	-	-
Has washing machine	0.59	-	-
Has telephone	0.71	-	-
Caregiver married/cohabiting	-	0.72	-
Caregiver has Grade 11/12+ education	-	0.72	-
Born in private hospital	-	-	0.62
Lives in house/flat/cottage	-	-	0.31
Has indoor water source	-	-	0.83
Has inside flush toilet	-	-	0.85
Has electricity	-	-	-
% of variance	44.88	52.35	38.25

Consumer durables were forced to group together (having a television, car, refrigerator, washing machine and telephone) to create one principal component (PC) score, the social support measures were made to group together (caregiver's marital status and education) to produce a second PC score, and the facility variables were also put together (type of hospital, dwelling type, water source, toilet type and electricity) to construct a third PC score.

Table 3: Rotated factor matrix for the data driven factor analysis

	Factor 1	Factor 2	Factor 3
Has television	0.56	-	-
Has car	0.34	0.45	-
Has refrigerator	0.66	-	-
Has washing machine	0.24	0.52	-
Has telephone	0.55	0.21	-
Caregiver married/cohabiting	-	0.55	-
Caregiver has Grade 11/12+ education	0.29	-	-
Born in private hospital	-	0.59	0.22
Lives in house/flat/cottage	0.34	-	-
Has indoor water source	-	-	0.74
Has inside flush toilet	-	0.37	0.73
Has electricity	0.29	-	-
% of variance	13.15	11.62	10.12

A data driven factor analysis was used to create three factor scores from the 12 SES measures using Varimax rotation with Principal Axis Factoring extraction method.

Table 4: Factor matrix for theory driven factor analysis

	Consumer durable factor	Social support factor	Facility factor
Has television	0.56	-	-
Has car	0.53	-	-
Has refrigerator	0.64	-	-
Has washing machine	0.45	-	-
Has telephone	0.61	-	-
Caregiver married/cohabiting	-	0.22	-
Caregiver has Grade 11/12+ education	-	0.22	-
Born in private hospital	-	-	0.41
Lives in house/flat/cottage	-	-	-
Has indoor water source	-	-	0.72
Has inside flush toilet	-	-	0.85
Has electricity	-	-	-
% of variance	44.88	52.35	38.25

The five consumer durables (ownership of television, car, refrigerator, washing machine and telephone) were grouped together to produce one factor, the two social support factors (caregiver's marital status and education) to create another and the five facility variables (type of hospital, dwelling type, water source, toilet type and electricity) to create a final factor score.

Table 5: Characteristics of sample (n=888)

	%	Mean	Standard deviation
Anthropometric outcome variables at 7/8 years			
Body mass index (kg/m^2)	-	15.83	1.86
Height-for-age z-score	-	-0.66	0.98
Weight-for-age z-score	-	-0.48	0.97
Weight-for-height z-score	-	-0.03	1.03
Demographic characteristics			
Sex			
Boy	50.60	-	-
Girl	49.40	-	-
Age at measurement during year 7/8 data collection phase (years)		8.25	0.34
Population group			
White	2.00	-	-
Black	82.00	-	-
Colored	12.20	-	-
Indian	3.80	-	-
Socio-economic characteristics at infancy			
Consumer durables			
Has television	76.40	-	-
Has car	30.20	-	-
Has refrigerator	74.20	-	-
Has washing machine	17.50	-	-
Has telephone	55.60	-	-
Social support measures			
Caregiver married/cohabiting	35.70	-	-
Caregiver has Grade 11/12+ education	43.20	-	-
Facilities			
Born in private hospital	10.50	-	-
Lives in house/flat/cottage	84.20	-	-
Has indoor water source	57.40	-	-
Has inside flush toilet	35.10	-	-
Has electricity	95.80	-	-

Table 6: Linear regression coefficients, standard errors and significance levels comparing the associations between the socio-economic status (SES) variables/indices and body mass index (BMI; kg/m^2), height-for-age z-score (HAZ), weight-for-age z-score (WAZ), and weight-for-height z-score (WHZ)

Model		BMI	HAZ	WAZ	WHZ
1.	**SES variables separately**				
a)	Has television	0.32* (0.15)	0.06 (0.08)	0.14 (0.08)	0.17* (0.08)
b)	Has car	0.36* (0.14)	0.12 (0.08)	0.21** (0.07)	0.21** (0.08)
c)	Has refrigerator	0.17 (0.14)	0.06 (0.08)	0.10 (0.07)	0.11 (0.08)
d)	Has washing machine	0.20 (0.18)	0.05 (0.10)	0.12 (0.09)	0.15 (0.10)
e)	Has telephone	0.28* (0.13)	0.12 (0.07)	0.17** (0.06)	0.15* (0.07)
f)	Caregiver married/cohabiting	0.12 (0.14)	0.04 (0.07)	0.06 (0.07)	0.04 (0.08)
g)	Caregiver has Grade 11/12+ education	0.17 (0.13)	0.002 (0.07)	0.06 (0.07)	0.09 (0.07)
h)	Born in private hospital	0.30 (0.24)	0.23 (0.13)	0.26* (0.12)	0.19 (0.13)
i)	Lives in house/flat/cottage	-0.14 (0.17)	0.05 (0.09)	-0.01 (0.09)	-0.06 (0.09)
j)	Has indoor water source	0.19 (0.14)	0.11 (0.07)	0.12 (0.07)	0.06 (0.07)
k)	Has inside flush toilet	0.35* (0.15)	0.11 (0.08)	0.18* (0.08)	0.16* (0.08)
l)	Has electricity	-0.02 (0.31)	0.28 (0.16)	0.15 (0.16)	-0.05 (0.17)
2.	**Regression model - all SES variables entered together**	NS	NS	NS	NS
3.	**Regression model - only independently significant SES variables entered**	NS	N/A	NS	NS
4.	**Additive index (equal weights)**	0.08** (0.03)	0.03* (0.01)	0.05** (0.01)	0.04** (0.02)
5.	**Index based on subjective ranking**	0.01* (0.004)	0.004* (0.002)	0.01** (0.002)	0.01* (0.002)
6.	**Index based on frequency of not having measures**	0.17** (0.05)	0.06* (0.03)	0.10*** (0.03)	0.09** (0.03)
7.	**Principal component analysis indices - data driven**	0.13** (0.04) (PC1)	0.05* (0.02) (PC1)	0.08*** (0.02) (PC1)	0.07** (0.02) (PC1)
8.	**Principal component analysis indices - theory driven**	0.10* (0.05) (CD)	NS	0.05* (0.02) (CD)	0.06* (0.03) (CD)
9.	**Factor analysis indices - data driven**	0.24* (0.10) (F2)	NS	0.13** (0.05) (F2)	0.13* (0.05) (F2)
10.	**Factor analysis indices - theory driven**	0.17* (0.08) (CD)	NS	0.10* (0.04) (CD)	0.11* (0.05) (CD)

Model 1 a-l added each SES variable into the models separately.
Model 2 included all 12 SES variables together.
Model 3 included only the SES variables which were found significant in Models 1 a-l.
Model 4 included an additive SES index adding together the SES variables present for each case.
Model 5 included a subjective SES index based on a ranking of the SES variables for the 1990 context by a member of the 1990 data collection team.

Model 6 included an index weighted by the overall frequency of not having each SES variable in the sample.
Model 7 included three continuous indices (PC1, 2 and 3) created from principal component analysis (PCA) on all the 12 SES variables. Only PC1 was significantly associated with the outcomes.
Model 8 included three continuous indices created from PCA on the consumer durables (CD), the social support variables and the facilities. Only CD was significantly associated with the outcomes.
Model 9 included three continuous indices of factor scores (F1, 2 and 3) created from factor analysis (FA) on all the 12 SES variables. Only F2 was significantly associated with the outcomes.
Model 10 included three continuous indices of factor scores created from FA on the consumer durables (CD), the social support variables, and the facilities. Only CD was significantly associated with the outcomes.
Each model controlled for sex, age and population group.
***p<0.001 **p<0.01 *p<0.05.
Standard errors provided in brackets.
NS = not significant N/A = not applicable (n=888).