



# Maternal risk exposure during pregnancy and infant birth weight



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## ABSTRACT

**Background:** Birth weight is an important determinant of an infant's immediate and future health.

**Aim:** This study examined associations between selected maternal psychosocial and environmental risk factors during pregnancy and subsequent infant birth weight, utilising data from the South African Birth to Twenty Plus (Bt20+) birth cohort study.

**Subjects:** Exposure to nine maternal risks were assessed in 1228 women who completed an antenatal questionnaire and whose infants were delivered within a seven-week period.

**Outcome measures:** The outcome of interest was infant birth weight. Birth weight z-scores (BWZ) were calculated using the World Health Organization Child Growth Standards. Bivariate analyses and multiple regression models were used to identify significant risk factors.

**Results:** The mean infant birth weight was 3139 g (SD 486 g), with a significant advantage in mean birth weight for male infants of 73 g ( $p = 0.008$ ). Being unsure or not wanting the pregnancy was associated with a ~156 g reduction in infant birth weight ( $\beta = -0.32$ ; 95% CI  $-0.51$ ;  $-0.14$ ). Tobacco use during pregnancy was also negatively associated with BWZ ( $\beta = -0.32$ ; 95% CI  $-0.59$ ;  $-0.05$ ). Exposure to both significant risk factors (tobacco use and pregnancy wantedness) was associated with cumulative reductions in birth weight, particularly among boys.

**Conclusions:** This study reinforces the importance of risks related to maternal attitudes and behaviours during pregnancy, namely unwanted pregnancy and tobacco use, which significantly lowered birth weight. Both identified risks are amenable to public health policy and programme intervention.

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## 1. Introduction

Birth weight is well-established as a determinant of an infant's immediate and future health, influencing infant and adult morbidity and mortality [1,2]. Low birth weight (birth weight < 2500 g) results from complex interactions between a range of individual, psychosocial and environmental factors. The link between low birth weight and stressful life events immediately preceding or during pregnancy is well-established [3,4]. Psychosocial factors, such as prenatal stress or poor social support, are postulated to impact on birth outcomes via biological (neuroendocrine, immune or vascular) mechanisms [5]. Health behaviours, such as inadequate maternal nutrition and substance use, are also known to increase risk of low birth weight through similar mechanisms [6].

Birth weight itself may affect an individual's risk for positive and negative short- and long-term health outcomes. Increases in birth

weight are related to increased years of schooling, decreased risk of grade failure and reduced likelihood of short adult stature [7]. Risk for chronic diseases in later life, such as adult-onset diabetes, among others, increases continuously as birth weight decreases, even for infants born within the normal birth-weight range [8]. Thus, it is important to consider the full continuum of birth weight and not only categorisations of birth weight (such as low birth weight) in epidemiological research.

The relationship between maternal risk exposure and infant birth weight has mostly been studied in high income countries and by categorising birth weight, rather than using it as a continuous variable [9]. This study aimed to address these gaps by identifying the associations between selected maternal psychosocial and environmental risk factors assessed during pregnancy and subsequent infant birth weight in a large, urban prospective South African cohort.

## 2. Methods

### 2.1. Data and study population

Data for this study were drawn from the Birth to Twenty Plus (Bt20+) study, a longitudinal birth cohort study, initiated in 1990 in

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the greater Johannesburg metropolitan area, South Africa [10]. Pregnant women deemed likely to deliver within a specified period were recruited through public health antenatal facilities and all singletons born within a 7-week period in 1990 were enrolled. The study prospectively follows 3273 children and their families throughout the Gauteng province. The enrolment methods, attrition, and profile of the Bt20+ cohort have been well described elsewhere [10,11]. Black children comprised the major race group in the study sample (78.5%), followed by Coloured/mixed race (11.7%), White (6.7%) and Indian (3.5%) children. These groupings refer to the *apartheid* system of population group classification and continues to be used as a measure for redressing past inequities. It is the largest and longest running study of child and adolescent health and development in Africa, tracking outcomes in several domains, i.e. physical, educational, social and psychological. The study spans South Africa's transition from *apartheid* to democracy and adopts a life course approach [10].

The full Bt20+ sample comprises 3273 singleton births. In our analysis we use data from the antenatal period ( $n = 1595$ ) and delivery reports. A total of 1228 women had complete data for all exposure variables (measured prenatally) and had infants who were delivered within the greater Johannesburg metropolitan area over the specified 7-week period, between April and June of 1990. These 1228 mother-infant pairs comprised the analytical sample for this study.

## 2.2. Measures

### 2.2.1. Individual risk exposures

Maternal demographic, and psychosocial, risk exposure was explored using a verbal questionnaire administered to mothers by trained, multilingual interviewers during the third trimester of pregnancy. Infant outcomes were collected immediately after birth.

Nine maternal psychosocial and environmental risk factors were assessed: 1) maternal education; 2) maternal age at birth; 3) marital status; 4) pregnancy wantedness; 5) alcohol use during pregnancy; 6) tobacco use (cigarettes, snuff or chewing tobacco) during pregnancy; 7) crowding in the home (>3 people per room used for sleeping); 8) maternal prenatal stress; and 9) household socio-economic status (SES).

Household SES was categorised based on an asset index derived from a listing of household assets (home ownership, electricity, television, car, fridge, washing machine and telephone). Use of a household asset indicator as a proxy measurement for SES has been validated in developing country contexts [12]. Asset scores were generated through an additive index, by attributing a score of 1 to assets present in the household and a score of 0 to unavailable assets. Asset scores were then grouped into tertiles, i.e. 1 (poorest) to 3 (wealthiest) for analysis; these groupings were relative to the study sample.

For prenatal stress, sixteen stressors were surveyed at interview during pregnancy, with yes/no responses indicating the presence or absence of each. Scores were summed across all sixteen responses to yield an overall stress score. The scale had reasonable internal consistency ( $\alpha = 0.64$ ). As stress scores were not normally distributed, participants with the top 15% of scores were considered to be high scorers, in congruence with previous studies [13]. The closest cut-off point to yield the top 15% was a score of 4. Thus, scores of 4 or more were taken as indicative of high levels of stress.

In addition, demographic variables such as ethnicity and sex of the child were also collected (Table 1).

### 2.2.2. Control variables

In addition to the nine risk factors, maternal parity, maternal height and gestational age were adjusted for as possible covariates. Maternal height (in cm) was measured using standardized techniques [14]. Gestational age was obtained from medical records and estimated based on the mother's report of her last menstrual period.

**Table 1**  
Descriptive statistics and differences in mean birth weight for study sample.

Variable	N (%) / mean $\pm$ SD	Mean birth weight (g)	p-Value
<i>Demographic variables</i>			
Child sex			
Male	639 (52)	3174	0.008**
Female	589 (48)	3101	
Ethnicity			
Black	940 (76.6)	3162	0.109
White	87 (7.1)	3225	
Coloured	132 (10.8)	3077	
Indian	69 (5.6)	2826	
<i>Explanatory variables</i>			
Smoked cigarettes during pregnancy			
No	1133 (93.0)	3151	0.013*
Yes	85 (7.0)	3015	
Snuff use during pregnancy			
No	1031 (91.2)	3154	0.398
Yes	99 (8.8)	3112	
Chewed tobacco during pregnancy			
No	1116 (99.4)	3150	0.726
Yes	7 (0.6)	3086	
Tobacco use in pregnancy (any)			
No	1037 (84.9)	3153	0.028*
Yes	184 (15.1)	3067	
Drank alcohol during pregnancy			
No	1066 (88.5)	3143	0.444
Yes	138 (11.5)	3109	
Pregnancy wantedness			
Yes	512 (42.8)	3187	0.004**
No/unsure	685 (57.2)	3104	
Marital status			
Married	497 (40.5)	3156	0.627
Living together	22 (1.8)	3013	
Separated/divorced/widowed	20 (1.6)	3223	
Single	689 (56.1)	3128	
Maternal education			
$\leq$ Grade 7	171 (14.0)	3187	0.686
Grades 8–10	478 (39.1)	3129	
Grades 11–12	371 (30.3)	3120	
Post school training	203 (16.6)	3157	
Prenatal stress			
Scores < 4	1048 (85.3)	3140	0.774
Scores $\geq$ 4	180 (14.7)	3129	
Maternal age at birth	26.2 $\pm$ 5.7		
<20 years	145 (11.8)	3016	0.681
20–35 years	974 (79.3)	3156	
$\geq$ 35 years	109 (8.9)	3153	
Crowding			
$\leq$ 3 people/room	770 (62.8)	3159	0.064
>3 people/room	456 (37.2)	3106	
Household assets			
0	45 (3.7)	3128	0.044*
1	100 (8.1)	3169	
2	145 (11.8)	3154	
3	198 (16.1)	3117	
4	281 (22.9)	3131	
5	212 (17.3)	3130	
6	147 (12.0)	3189	
7	100 (8.1)	3100	
<i>Control variables</i>			
Gestational age (weeks)	38.2 $\pm$ 1.6		
Parity	2.2 $\pm$ 1.3		
Maternal height (cm)	159.5 $\pm$ 6.3		
<i>Outcome variables</i>			
Birth weight (g)	3139 $\pm$ 486		

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

### 2.2.3. Outcome measure

The outcome variable was birth weight. Electronic weighing scales were used to weigh the infant. Reliability was confirmed by test-retest

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