Risk Factors for Low Birth Weight in a Socio-Economically Disadvantaged Population: Parity, Marital Status, Ethnicity and Cigarette Smoking
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Risk factors for low birth weight in a socio-economically disadvantaged population: Parity, marital status, ethnicity and cigarette smoking

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Abstract. Low birth weight (LBW) is a public health problem, because it is associated with increased risk of morbidity and mortality. The principal aim of this study was to assess risk factors for LBW in a large multi-ethnic and socio-economically disadvantaged population. Data from 3242 mothers, who attended the Well Baby Clinic (Southwestern Sydney, Australia) for the first time, were analysed in relation to their demographic characteristics and socio-economic indices. The overall birthweight was 3377 ± 577 g (mean ± SD). In multiple linear regression analysis, smoking during pregnancy, marital status, parity, and country of birth were independently associated with birth weight. According to this analysis, lower birth weight was associated with mothers who had smoked during pregnancy (by 215.2 ± 18.6 g), who were single (46.9 ± 21 g), and of Asian background (108.5 ± 38.2 g). However, higher parity was associated with significantly higher birth weight. The presence of each factor was coded as 1 and the absence, 0. A 'risk score' was then derived by summing up the individual scores. When birth weight was classified as 'low birth weight' (defined as those with birth weight being less than 2500 g) or normal birth weight, the overall prevalence of LBW was 1.9%. Each unit increase in the risk score was associated with a 1.9-fold (95% confidence interval: 1.5–2.6) increase in the risk of LBW. These data suggest that apart from marital status, ethnicity and parity, maternal smoking is the single most important preventable risk factors for LBW.

Key words: Ethnicity, Low birth weight, Marital status, Parity, Smoking during pregnancy, Socio-economic status

Abbreviations: LBW = low birth weight; MINET = maternal and infant network; SEIFA = Socio-economic Index For Area; WBC = Well Baby Clinic

Introduction

Low birth weight (LBW) is a challenging public health problem. Its high priority stems from the fact that it is the major predictor of infant mortality in developed countries and that it contributes substantially to the overall burden of childhood handicap. Scientifically, in spite of advances in the medical science of pregnancy and delivery, the proportion of LBW births has changed little in the world during the past 30 years.

The deleterious effect of smoking on health has been well recognised and well documented. In mothers, smoking during pregnancy not only affects the physical condition and fitness of the mothers, but also adversely influences the wellbeing and growth of their children. Between 11 and 35% of LBW could be attributed to maternal smoking [1]. However, one of the most important confounding factors in the relationship between smoking and health outcomes such as LBW is the socio-economic status (SES) of study subjects. The prevalence of smoking appears to exhibit a clear social class gradient in most developed countries with the lowest income mothers smoking the most and the highest income mothers smoking the least [2]. Therefore, to elucidate the maternal smoking–LBW relationship, it is necessary to consider socio-economic factors.

It has been noted previously that Asian infants were more likely to be born with LBW or preterm than were Caucasian infants [3, 4], and the ethnic-related differences were not wholly explained by ethnic differences in the occurrence of various medical conditions, in the prevalence of smoking or by demographic characteristics and other lifestyle differences. Most of past studies, nevertheless, have focussed on Caucasian populations, and few studies have attempted to directly compare the effects of maternal smoking among ethnic populations.

In an attempt to address the gap in knowledge, the present study was designed to examine various socio-economic factors and maternal lifestyle factors in the prediction of the risk of LBW in a multi-ethnic population in Sydney, Australia.

Study design and method

Study design

The study was designed as a population-based, epidemiological study, and was part of the mother and infant network (MINET) initiative [5]. The MINET project was initiated in South Western Sydney in November 1995. The primary aim of this project was to identify needs and hence to provide better quality of patient care to mothers and infants, who were most at risk of adverse health outcomes. The South Western Sydney consists of seven local government areas with a population of 700,000. Approximately 34.4% of the population was born in non-English speaking countries, with the majority from Vietnam (5.2% of the total South Western Sydney population), Lebanon (2.1%), Italy (1.9%), and China (1.2%). In terms of socio-economic consideration, South Western Sydney is regarded as a socially disadvantaged region, as it experiences higher unemployment rate, lower income, and lower level of education than other areas in Australia.

Subjects

As part of routine check-up after discharge from the birthing unit, mothers are required to make periodic visit to the Well Baby Clinic (WBC), a community health centre. However, in reality, between 80 and 90% of pregnant women visited the clinic. The median age of newborn infants, at the time their mothers attended the WBC for the first time, was 2 weeks. Data reported here were obtained between January 1996 and February 1998, during which, 3242 mothers attended the WBC.

Data collection and measurements

After obtaining informed consent, subjects were interviewed by a nurse co-ordinator, who administered a structured questionnaire for anthropometric variables (height, weight), lifestyle factors. For each subject, the following data were collected: country of birth, age, years of education, employment status, marital status, parity, gravidity, and prenatal care factors. Subjects were asked whether they had smoked cigarettes during pregnancy. The number of cigarettes smoked per day was grouped into three categories: 1–4, 5–10 or 10 or more.

Suburb of residence at the time of giving birth was also recorded for each mother. The suburb was then mapped and linked with the 1996 Australian Bureau of Statistic Census Data to obtain socio-economic information. This process was done by using a geographical information system (Geoloc and MapInfo). SES was assessed by the Socio-economic Index For Area (SEIFA) index, in which methods of development and verification have been described elsewhere [6]. There were five SEIFA indices available (e.g., rural socio-economic advantage; urban socio-economic advantage; socio-economic disadvantage; economic resources; and occupation and education index). In this study, the economic resources and education indices were used in the analysis. The economic resources index was derived from data concerning income and expenditure of families, home ownership, dwelling size, and ownership of cars. The education index was designed to reflect the educational and occupational structure of communities. In either index, areas with high scores reflect a better SES.

Birth weight was extracted from hospitals' discharge summary within the Southwestern Sydney Area Health Service. Preterm delivery was defined as delivery occurring at 37 or fewer weeks of gestation. LBW infants were defined as those with birth weight of less than 2500 g at birth but were not preterm delivery.

Data analysis

Statistical analyses were undertaken to identify for independent predictors of birth weight (as a continuous variable), and risk factors for LBW (as a dichotomous outcome). Multiple linear regression analysis, with stepwise and backward elimination algorithms, were used to identify potential predictors of birth weight. Estimation of the regression model parameters for the 'final model' was based on the least squares method. Statistical significance of these parameters was considered if $p < 0.05$ level. Verification of model assumptions such as normally independent distribution of errors and homogeneity of variances, was assessed by analysis of residuals.

To determine the association between risk factors and LBW, the logistic regression model was used to model the probability of LBW in relation to the risk factors. Univariate association of various 'risk factors' (e.g. age, parity, gravidity, ethnicity, marital status, etc.) was evaluated individually by the univariate logistic regression model. Separate interaction terms to detect relationships between age and each of the factors were included in the model to examine whether advanced age and the presence of a particular risk factor had a significant impact on the probability of LBW.

For the logistic regression model, to assess the predictive value of various factors, the area under the receiver-operating characteristic (ROC) curves [7] was calculated. The ROC curve evaluates the ability of the score to discriminate LBW infants from those with normal birth weight. The area under the ROC curve, formed by the plot of the pairs of false-positive and true-positive probabilities at all possible score values, should be greater than 0.5 (the value expected if the model was not better than chance fluctuation). The discriminatory powers of different models was compared by using the approach described by Hanley and McNeil [8]. Attributable risk was calculated as p (OR – 1)/[p (OR – 1) + 1], where p is the proportion of subjects having a given risk factor and OR is the odds ratio, estimated from the logistic regression model.

In this formulation, attributable risk is the proportion by which the incidence rate of fracture in the population would be eliminated if a risk factor (measured by p) was eliminated. All database management and statistical analyses were performed by means of the SAS Statistical Analysis System [9].

Results

Characteristics of study subjects

Between January 1996 and February 1998, data from 3242 mothers who gave birth in the Area Health Service were collected; of these, 38.6% were first-time mothers. The average maternal age of the entire sample was 27.9 ± 5.4 (mean ± SD). In the sample, 5.6% of mothers was less than 20 years old, and 1.8% was more than 40 years old. The majority (65%) of mothers were married; 14% were reported as single mothers, and 21% as being lived with partners. Eighty percent of the mothers were of Caucasian background, other groups were of Asian (5%), Middle Eastern (2%) and Pacific Islander background (2.5%). A large proportion (64%) of mothers had educational level of high school or less, technical college (21%) and university education (13.3%). In terms of SES, 35.4% of mothers lived in suburbs with the lowest SEIFA quintile, 33.4% lived in suburbs with the second quintile of the SEIFA, and 3.2% lived the highest-quintile suburbs.

Married mothers were, on the average, older than non-married mothers (29.4 ± 4.7 vs. 25.1 ± 5.5 years, $p < 0.0001$); 15% of non-married mothers aged less than 20 years old compared with 0.5% among the married mothers. Asian mothers were significantly older (31.1 ± 4.9 years) than mothers of Middle Eastern background (29.7 ± 5.4 years), Pacific Islanders (28.3 ± 5.3 years) and Caucasian (27.5 ± 5.3 years).

In this sample of mothers, the overall prevalence of smoking during pregnancy was 31.6 ± 0.8% (proportion ± SE). Smoking mothers were significantly younger ($p < 0.001$), had higher parity, and lower educational attainment than non-smoking mothers. As a result, the prevalence of smoking was inversely related to age, such that older age was associated with lower prevalence of smoking mothers. More than 50% of young mothers (< 20 years old) were smokers. The prevalence was highest among single (56%), which was significantly higher than among married mothers (20%). Asian mothers were the least likely to smoke during pregnancy (prevalence of 3.4 ± 1.5%), compared with Caucasian mothers (36.4 ± 0.9%) and other ethnic groups (18.9 ± 1.8%) (Table 1).

Lower educational attainment was associated with higher prevalence of smoking during pregnancy, as 39.6 ± 1.3% of mothers with high school education were smokers, which was significantly higher ($p < 0.001$) than among mothers with technical college (30.7 ± 2.2%) and university education (13 ± 2.0%). The prevalence of smoking during pregnancy increased almost linearly with socioeconomic indicator. In suburbs with the lowest quintile of socioeconomic index, the prevalence was 40.4 ± 1.5%; this proportion progressively reduced to 16.8 ± 3.7% in suburbs with the highest SEIFA index (Table 2). Similar trend was also observed with educational index.

Determinants of birth weight

For the entire sample, the average birth weight was 3377 ± 577 g (mean ± SD). The relationship between maternal age and birth weight was quadratic, in which, young mothers aged less than 20 years and more than 40 years had significantly lower birth weight than those aged between 20 and 40 years. Birth weight in smoking mothers was 218.8 g (95% CI: 176–261 g) lower than non-smoking mothers. Moreover, the difference increased proportionally with the intake of cigarettes (Figure 1). Birth weight among infants whose mothers were of Caucasian or Pacific Islander background was significantly higher than those whose mothers were Asian. In addition, babies of married, multi-parous and better educated (technical college and university) mothers had significantly higher than those of single, high school or primary school, and first-time mothers, respectively (Table 3).

When all factors were considered in a multiple linear regression model, the following mothers' characteristics were found to be significant determinants of birth weight: smoking during pregnancy, marital status, country of birth and parity. In addition to the four factors, gestational age and sex of the baby were also significant predictors of birth weight. These six factors accounted for 44% of the total variance of birth weight. After simultaneous adjustment for these factors, smoking mothers were associated with a 215 ± 19 g lower birth weight than non-smokers. Furthermore, birth weight among Asian was 109 ± 38 g lower than non-Asian mothers. Mothers with two or more children tended to have babies with higher birthweights. However, birthweight of children among single mothers was significantly lower (by 47 ± 21 g) than among married mothers. Furthermore, female babies had

Table 1. Characteristics of study subjects

	Smokers	Non-smokers	Prevalence of smoking[a]
Mother's age			
< 20	190(9.1)	85(4.0)	51.4 ± 3.8
20–29	611(61.4)	1150(53.5)	34.7 ± 1.1
30–39	278(27.9)	873(40.6)	24.2 ± 1.3
40+	16(1.6)	41(1.9)	28.1 ± 6.0
Marital status			
Married	429(42.7)	1629(76.1)	20.8 ± 0.9
Single	250(24.9)	193(9.0)	56.4 ± 2.4
Living with partners	325(32.7)	318(14.9)	50.5 ± 2.0
Race			
Caucasian	939(90.5)	1642(75.0)	36.4 ± 0.9
Asian	15(0.5)	143(6.5)	3.4 ± 1.5
Middle Eastern	114(1.4)	51(2.3)	21.5 ± 5.1
Pacific Islanders	113(1.3)	67(3.1)	16.3 ± 4.1
African and others	167(6.5)	286(13.1)	18.9 ± 1.2
Parity			
1	366(36.2)	840(39.9)	30.3 ± 1.3
2–3	508(50.3)	1091(51.8)	31.8 ± 1.2
⩾4	136(3.5)	176(8.3)	43.6 ± 2.8
Maternal care			
Antenatal care	451(69.3)	743(55.5)	37.8 ± 1.4
Obstetricians	95(14.6)	427(31.9)	18.2 ± 1.7
Shared care	91(14.0)	155(11.6)	37.0 ± 3.1
Others	114(2.2)	14(1.1)	50.0 ± 9.4
Education			
Primary education	2(0.3)	6(0.4)	25.0 ± 15.3
High school	512(74.1)	813(58.9)	38.6 ± 1.3
Technical college	131(19.0)	296(21.5)	30.7 ± 2.2
University	36(5.2)	241(17.5)	13.0 ± 2.0
Others	10(1.5)	24(1.7)	29.4 ± 7.8

Numbers in brackets are percentage of total for each characteristic. Due to rounding, some percentages may not add up to exactly 100%.
[a] Prevalence is expressed in percent ± standard error for each characteristic.

Table 2. Prevalence of smoking by suburbs' socio-economic status

	Smokers	Non-smokers	Prevalence of smoking[a]
Quintile of economic status			
1 (lowest)	454(44.5)	670(31.0)	40.4 ± 1.5
2	335(32.9)	728(33.7)	31.5 ± 1.4
3	128(12.6)	366(16.9)	25.9 ± 2.0
4	85(8.3)	314(14.5)	21.3 ± 2.0
5 (highest)	17(1.7)	84(3.9)	16.8 ± 3.7
Quintile of educational status			
1 (lowest)	457(44.8)	669(30.9)	40.6 ± 1.5
2	256(25.2)	487(22.5)	34.5 ± 1.7
3	228(22.4)	738(34.1)	23.6 ± 1.4
4	74(7.3)	229(10.6)	24.4 ± 2.5
5 (highest)	4(0.4)	39(1.8)	9.3 ± 4.4

Numbers in brackets are percentage of total for each characteristic. Due to rounding, some percentages may not add up to exactly 100%.
[a] Prevalence is expressed in percent ± standard error for each characteristic.

significantly lower birth weight (by 186 ± 17 g) than male babies (Table 4).

Based on the four 'risk factors', a risk score was constructed by summing their individual values (with

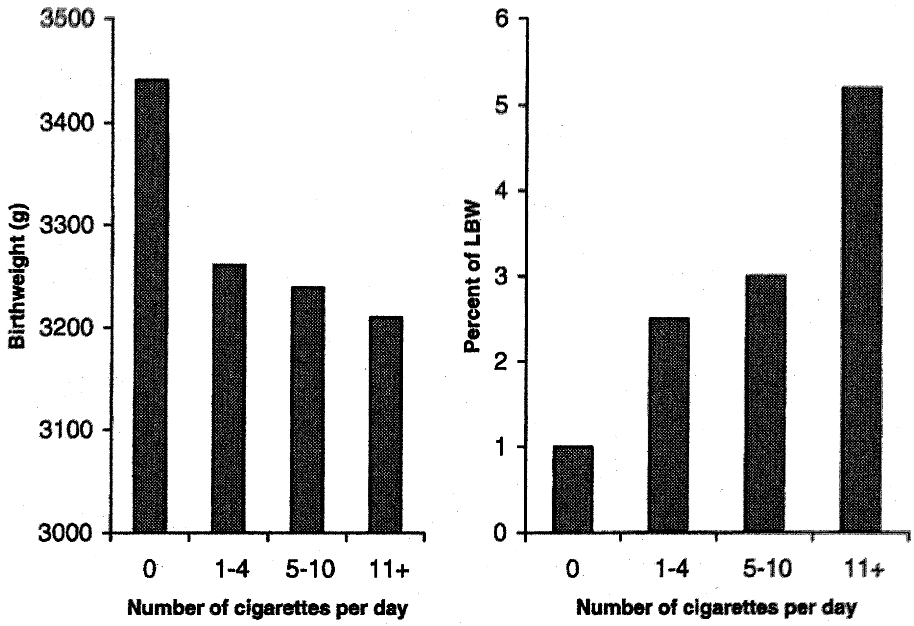

Figure 1. Relationship between cigarette intake during pregnancy and birth weight (left panel) and prevalence of LBW (right panel).

Table 3. Effects of smoking on birth weight in relation to characteristics of mothers

	Birth weight (g)		
	Smokers	Non-smokers	Differences[a] (95% CI)
Overall mean	3227 ± 591	3446 ± 557	219 (176, 261)
Mother's age			
<20	3281 ± 558	3312 ± 558	32 (−136, 200)[b]
20–29	3234 ± 592	3449 ± 533	215 (160, 270)[b]
30–39	3214 ± 608	3469 ± 581	255 (175, 335)[b]
40+	3111 ± 554	3339 ± 563	228 (−105, 560)
Marital status			
Married	3268 ± 596	3459 ± 535	190 (130, 249)[b]
Single	3181 ± 578	3383 ± 610	202 (89, 314)[b]
Living with partners	3212 ± 599	3407 ± 620	195 (100, 290)[b]
Race			
Caucasian	3234 ± 585	3480 ± 566	246 (199, 292)[b]
Asian	3022 ± 449	3308 ± 493	286 (−119, 691)
Middle Eastern	3021 ± 549	3304 ± 531	283 (−70, 636)
Pacific Islanders	3130 ± 719	3424 ± 616	294 (−130, 718)
African and others	3193 ± 682	3354 ± 498	160 (10, 311)[b]
Parity			
1	3183 ± 561	3371 ± 531	189 (121, 256)[b]
2–3	3242 ± 578	3509 ± 569	267 (206, 327)[b]
⩾4	3263 ± 694	3430 ± 580	167 (24, 311)[b]
Educational level			
Primary	3309 ± 603	3810 ± 509	500 (−675, 1677)
High school	3236 ± 583	3453 ± 592	217 (151, 283)[b]
Technical college	3334 ± 570	3443 ± 594	109 (−14, 234)
University	3267 ± 568	3449 ± 454	181 (14, 349)[b]
Others	3148 ± 672	3570 ± 503	421 (2, 841)[b]

Birth weight is expressed in mean ± standard deviation; statistical significant difference between smokers and non-smokers is tested for each level of risk factors.

[a] Difference between smoker and non-smoker in term of mean and 95% confidence interval.

[b] Significant difference between smokers and non-smokers at $p < 0.01$.

Table 4. Independent determinants of birthweight: results of multiple linear regression analysis

Predictor variable	Unit	Regression coefficient ± SE[a]	p-Value
Gestational age	+1 week	195.7 ± 4.7	<0.001
Baby's sex	Female	−185.5 ± 17.1	<0.001
Smoking during pregnancy	Yes	−215.2 ± 18.6	<0.001
Marital status	Single	−46.9 ± 21.4	0.002
Country of birth	Asia	−108.5 ± 38.2	0.005
Parity	+1 child	121.9 ± 17.6	<0.001

Coefficient of determination (R^2) of the model was 0.44.

lower values representing low risk; and higher values, high risk). The overall median risk score was 5, with minimal and maximal risk score being 2 and 9, respectively. As expected, higher risk score was progressively associated with lower birth weight and increased prevalence of LBW (Figure 2). By simple regression analysis, each unit increase in the risk score was associated with a 132 ± 12 g reduction in birth weight.

Predictors of risk of low birth weight

The overall prevalence of LBW was 1.9 ± 0.2%. As with birth weight, the prevalence was highest among mothers aged >40 years (3.5 ± 2.4%), followed by teenager mothers (2.9 ± 1.3%). Single or lived-with-partner mothers also had a significantly higher prevalence of LBW (3.1 ± 0.7%) compared to married mothers (1.3 ± 0.3%). However, there were no significant differences in the prevalence of LBW among ethnic groups. Eight-three percent of mothers with LBW had high school education, and the prevalence of LBW in this group was 2.3 ± 0.4%, which was significantly higher than mothers with college (0.9 ± 0.4%) or university education (0.7 ± 0.5%).

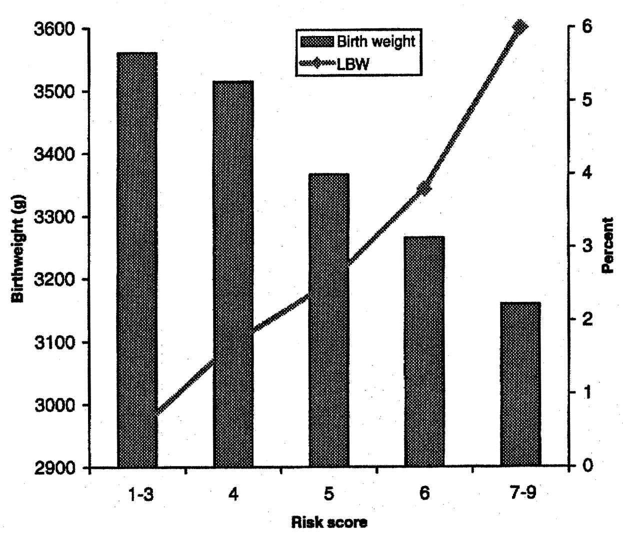

Figure 2. Relationship between 'risk score' (combined scores of smoking, marital status, parity, and ethnicity) and birth weight (shown in solid bar and the left y-axis) and prevalence of LBW (shown in solid line and the right y-axis). A higher risk score was associated with lower birth weight and higher risk of LBW.

When the factors were considered individually in the logistic regression model, advancing age, intake of cigarettes, being single mothers, and living in suburbs with lower socio-economic index was each associated with increased risk of LBW (Table 5). Among the significant risk factors, smoking during pregnancy appeared to exert the strongest effect (odds ratio: 4.1; 95% CI: 2.4–6.9). When all factors were considered simultaneously in a multiple logistic regression model, the risk score (which combined the additive effects of smoking during pregnancy, marital status, country of birth, and parity) was the significant predictor of LBW risk. Each unit increase in the risk score was associated with a 1.9-fold (95% CI: 1.5–2.6) increase in the risk of LBW. The area under the operator characteristics (ROC) curve for this model was 0.68.

Discussion

LBW is a public health problem, because it is a major predictor of perinatal mortality, and is associated with a higher incidence of childhood health problems [10, 11]. There is strong evidence indicating that maternal smoking during pregnancy is associated with reduced LBW. However, smoking mothers are often of low SES, disadvantaged ethnic groups, and young age, which are also risk factors for LBW; it is not clear whether the association between LBW and maternal smoking is confounded by these demographic and socio-economic factors. By using data from a primary care surveillance system, the present study demonstrated that apart from maternal smoking, other factors such as marital status, mother's country of birth, and parity were also significant predictors of the risk LBW.

In this study, the average difference in birth weight between smokers and non-smokers was 219 g, which is comparable to previous studies in which smoking during pregnancy was associated with lower birth weight by between 150 and 200 g [12, 13]. Furthermore, the present data also showed that negative effect of smoking on birth weight was somewhat

Table 5. Predictors of LBW risk: univariate analysis

Predictor variable	Unit	Odds ratio (95% CI)[a]	AUC ± SE ROC curve
Age	+5 years	1.1 (0.9–1.2)	0.54 ± 0.04
Parity	+1	1.0 (0.0–1.2)	0.51 ± 0.04
Intake of cigarettes[b]	1	**1.7 (1.4–2.1)**	0.68 ± 0.03
Smoking during pregnancy	Yes	**4.1 (2.4–6.9)**	0.68 ± 0.03
Marital status	Single	1.6 (0.8–3.0)	0.53 ± 0.05
Country of birth	Asia	1.3 (0.3–4.1)	0.52 ± 0.04
Economic quintile	+1	0.9 (0.7–1.1)	0.55 ± 0.04
Educational quintile	+1	0.9 (0.7–1.1)	0.54 ± 0.04

AUC = area under the receiver operating characteristic curve.
[a] Values are odds ratio and 95% confidence interval. Statistical significance at $p < 0.05$ level is indicated in bold-faced figures.
[b] Intake of cigarettes was coded as follows: 1 = 1–4 cigarettes per day; 2 = 5–10 cigarettes per day; and 3 = 11 or more cigarettes per day.

proportional to the amount of cigarettes smoked, with the higher the number of cigarettes smoked being associated with the lower birth weight. This observation is also consistent with previous finding, in which a maternal cigarette intake of between 1 and 14 cigarettes per day was associated with a difference of 140 g in birth weight [14, 15]. In this sample, 49% of the prevalence of LBW could be attributable to maternal smoking, making it one of the major preventable risk factors for LBW.

It is not entirely clear about the mechanisms of association between cigarette smoking and birth weight; however, it could be hypothesised that the association is mediated by gestational age (SGA) and preterm birth. LBW is principally due to preterm birth and/or low for gestational age. Cigarette smoking is associated with an increase in both the incidence of SGA [16], and to a lesser extent, preterm birth [17–19], and placenta previa [20]. On the other hand, it is possible that smoking may affect birth weight via its effect on the decrease in maternal estrogen levels [21]. It is known that maternal weight gain during pregnancy was substantially reduced in smokers [22], and low maternal weight gain during pregnancy is associated with LBW. Thus, it is possible that the relationship between birth weight and smoking is also mediated via maternal weight gain during pregnancy.

The present study also indicates that apart from cigarette smoking, marital status, ethnicity and parity were also important independent predictors of LBW. Marital status, which has previously been shown to be associated with birth weight in previous studies [23, 24], may serve as a marker for the 'wantedness' of the child, the economic status of the mother, and the social support that the mother has, all of which are factors that may influence the health of the mother and infant. Although the relationship appeared to vary by maternal age and race, the association of unmarried status with LBW was strongest for Caucasian mothers over 20 years of age.

In this study, birth weight of Asian babies was approximately 109 g lower than those of non-Asian babies. However, the prevalence of LBW among Asian babies was not significantly lower than non-Asian babies. This suggests that the distribution of birth weight in the Asian babies was shifted down with a narrower range. It is not clear why infants of Asian mothers were more likely as Caucasian infants to be born with LBWs. The aetiology of racial disparities in infant mortality and LBW is probably multi-factorial in nature and is not completely explained by differences in demographics, tobacco intake, or medical illnesses. It could also be hypothesized that the difference is due to genetic influences, or due to the LBW and height of Asian mothers; however, the present study has no such data to confirm this hypothesis.

As observed in this study, higher parity was associated with higher birth weight. Although there is no clear biological explanation of the relationship between parity and birth weight, our finding is consistent with the literature [25, 26]. One possible explanation for this relationship is that mothers who had given birth to LBW infants were more likely to subsequently deliver LBW babies. Indeed, previous study has shown that the risk of delivering a LBW is 2.75 times greater for women with one or more previous LBW infants than women with no history of LBW deliveries [2]. If this hypothesis is true, it is reasonable to suggest that the effect of parity on LBW represent in part, a genetic influence.

LBW and infant mortality are closely related to socio-economic disadvantage. Indeed, virtually all of the indicators of parents' social status (e.g. occupation, educational attainment, income level, and marital status) which are associated with infant mortality exert their effects by altering the birth weight distribution. It has been argued that the relationship is due to malnutrition: poor women might have lower caloric intake, which impairs fetal growth and results in LBW. However, because caloric restriction (as contrasted to other forms of malnutrition) is not widespread in Australia, this hypothesis would appear to explain little of the social gradient of LBW in Australia. A more likely mediator is smoking during pregnancy, because smoking exhibits a clear social class gradient in most developed countries with the poorest mothers smoking the most. It can also be hypothesized that economic disadvantage may be a marker of high levels of stress and negative life events that are associated with being poor. In addition, stress and negative life events are associated with health behaviors such as smoking. Social support may act as a moderator or as a buffer from the untoward effects of stressful life experiences and emotional dysfunction. Thus, SES and ethnicity are markers of complex linkages among environmental factors, psychological states, and physiological factors, which may lead to LBW or preterm delivery.

Regardless of the mechanisms involved, the findings of this study, together with previous reports, indicate that almost 50% of LBW could be avoided if smoking during pregnancy were eliminated. It seems, therefore, the primary prevention of LBW should be focussed on this single modifiable risk factor. Furthermore, it seems possible to identify 'at risk' mothers for intervention by using simple score as shown in this study. This score may be used for secondary prevention involves the early identification of women likely to have LBW children. Secondary prevention studies with women without identifiable risk factors have been more encouraging and suggest that universal education about preterm labour for women and health care providers with associated supportive hospital policies may be effective in reducing preterm birth. However, the traditional medical model is not sufficient on its own to prevent LBW, because of the uncertain and multiple aetiologies. The reduction of LBW rates will only be accomplished through community-wide programs with creative partnerships among health service providers and the community. A variety of strategies including relevant policy initiatives, creating smoke free environments, and reorienting the health care system will be needed.

The present findings must be interpreted in the context of a number of strengths and potential limitations. The study was based on a large sample size with a virtually complete denominator; thus, fine differences could reliably detected which otherwise was not possible with smaller and detached studies. Despite this strength, the data were collected retrospectively, therefore, causal inferences cannot be made. Furthermore, the data on cigarette intake, marital status, ethnicity, education, parity, etc. were based on recall or self-report, some misclassification or biases may have been present in the analysis. It is possible that differences in lifestyle or nutritional status between smoking mothers and non-smoking mothers may explain our findings. The proportion of Caucasians in the study sample (80%) was significantly higher than in the general population (66%), and this difference could have effect on the comparison and estimation of the prevalence of LBW among ethnic groups. Finally, the data were collected from a large region considered to be at some social and economic disadvantage, therefore, any generalisability of the present results is limited.

In summary, these data suggested that, apart from maternal cigarette smoking, marital status, ethnicity and parity were also independent determinants of birth weight. The results also underscore the idea that it is possible to reduce the incidence of low birth weight if the health, well-being, resources, and prenatal care of the disadvantaged women in this area could be more widely distributed and if improvements in education, employment, and child care opportunities could be realised.

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