

CHAPTER 3: METHODOLOGY

3.1 STUDY DESIGN

The study is a matched case-control study conducted in the rural Chris Hani District in the Eastern Cape, South Africa, from May to November 2010.

3.2 STUDY POPULATION

The participants were mothers of the black South African race group whose deliveries took place at one of the three public hospitals (the Frontier, Glen Grey and Cala Hospitals) in the rural Chris Hani District of the Eastern Cape. This selection was based on the availability of matching participants of the same socio-economic status and age and taking into consideration the significant association between socio-economic status and race in South Africa.⁴⁹

3.3 STUDY SUBJECTS

3.3.1 Case

A case was defined as a mother who delivered a newborn through normal delivery and whose baby at the time of delivery weighed <2.5 kg, as recorded in the medical records at the hospital concerned.

3.3.2 Control

A control was defined as a mother who delivered a newborn through normal delivery and whose baby at the time of delivery weighed ≥ 2.5 kg.

Control mothers were matched with cases by age, and socio-economic status. Age matching was done in five-year band and the level of educational attainment was used as proxy measure for socio-economic status, as these are known to influence both dental care and low birth weight delivery.⁵⁰⁻⁵¹

3.3.3 Sample size determination

In line with a prior study by Cruz et al.,⁸ the sample size determinant was based on the assumption of a periodontal disease prevalence of 15% among normal weight delivery⁴¹ and a prevalence (30%) about double (that is $OR=2.3$)⁶ among women with low birth weight deliveries. Considering the rarity of low birth weight ($<10\%$), in order to ensure sampling efficiency and adequate statistical power, two controls were recruited for each case. It was calculated that for a 5% significance level and 80% power, at a non-disease to disease ratio of two to one, 300 participants (200 controls and 100 cases) were required. However, in order to accommodate possible incomplete or missing responses, an additional 10% of the required sample was targeted, resulting in an eventual sample size of 348 (229 controls and 119 cases).

3.3.4 Exclusion criteria

Mothers who presented with cardiac disease, diabetes, HIV and/or AIDS or who were on antibiotic prophylaxis were excluded. The exclusion criteria were applied by the attending nursing Sister-in-charge without the knowledge of the

researcher. This exclusion was done primarily in the interests of the patient's safety, but also to eliminate a potential source of bias in the interpretation of the study results.

3.4 DATA COLLECTION

Data were collected using a structured questionnaire and measuring the subjects' periodontal status. These data collection methods are discussed in more detail below.

3.4.1 Structured questionnaire

Candidates were approached and the study was explained to them. They were asked to give written consent to participate. After each study participant had given her informed consent, she was invited to complete a self-administered pre-validated structured questionnaire adapted from those used in prior studies reported in previous published papers.^{8,51,52} The questionnaire was translated into Xhosa and back-translated into English to ensure consistency of meaning.

The information elicited by the questionnaire included socio-demographic data on each participant's employment status, area of residence and educational level; oral health care practices; current and previous gestational history; and health risk behaviour (such as active and passive smoking and alcohol use). The living conditions of the mothers were expressed as crowding (inhabitants per room), which was derived from responses to questions on how many rooms were present in the household and how many people resided in a respondent's household. Information was also requested on the frequency of antenatal visits and any experience of obstetric complications such as pre-eclampsia and

antepartum haemorrhage during pregnancy or any maternal characteristics such as parity and gravidity that may be a risk for the delivery of low birth weight babies.

The data related to the newborn weight were collected from the newborn's medical card. A newborn is usually weighed within an hour after delivery (in other words, before postnatal weight loss occurs). A trained maternity nurse completed a separate section of the questionnaire which requires information from the participant's maternity record, including the weight of the newborn. The clinical examination form was a stand-alone form that carried only a matching study number assigned to each participant by the attending nurse who recruited the participants from the ward. This was done to ensure that the oral examiner was blinded to the birth outcome status of the participating mothers and to ensure the confidentiality of other records in the mother's file.

3.4.2 Measurement of periodontal status

After each consenting participant had completed the self-administered questionnaire, she was invited to participate in a clinical oral examination. This was typically done two to four days after delivery. Systematic oral examination was carried out in the hospital's dental consulting room by a trained dentist who examined the patients who were referred to him from the maternity ward with an examination form.

Periodontal status was recorded using the WHO's Community Periodontal Index (CPI).^{53,54} Calibrated periodontal probes (Williams probes) were used. The examiner was blinded to the newborn's weight, as the participants only

reported to the dentist's room with a numbered examination form. The nursing sister that assisted during the self-administration of the questionnaire assigned a number to each questionnaire and the accompanying examination form, but only sent the participant to the dentist with the detached examination form without the correspondingly numbered completed questionnaire.

3.4.3 Criteria for the diagnosis of periodontal disease

During the dental examination, the sulcus/pocket probing depth, presence or absence of any calculus deposit, and gum bleeding on probing were recorded. The relevant codes were used in line with the WHO survey methods for the CPI.⁵⁴ This involved recording the periodontal status of six index teeth, namely teeth 11,16/17, 26/27, 31, 36/37, and 46/47. The presence and extent of any sign of gingival overgrowth were also recorded. Index teeth with gingival overgrowth were not recorded. Similar to the definition used by Cruz et al.,⁸ mothers who presented with at least four indexed teeth with one or more sites showing a probing depth ≥ 4 mm (in other words, with CPI codes 3 or 4) without gingival overgrowth were considered to have periodontitis. Those who showed signs of bleeding on probing only were considered to have gingivitis. Anyone with either periodontitis or gingivitis was considered to have periodontal disease.

3.5 QUALITY ASSURANCE

The universal infection control protocol was employed throughout the study. In particular, in order to ensure effective sterility, a hypochlorite solution was used to disinfect the examining probes before autoclave sterilization.

The clinical examiner was trained by an experienced periodontist using a series of standardized procedures and one-on-one tutorials in the periodontal clinic at the University of Pretoria. The study examiner was calibrated against the experienced periodontist examiner, and the level of agreement with this examiner was determined using kappa statistics. Training was continuous until the clinical examiner reached at least a kappa of 0.70 with the specialist examiner.

In order to limit the problem of inter-examiner variation, only one examiner examined all 348 study participants in this study. In order to determine intra-examiner reliability, 10% of the participants in this study were randomly recalled for a duplicate examination (intra-examiner reliability; kappa=0.95).

3.6 DATA ANALYSIS

The analysis procedures included a series of stratified analyses, followed by conditional logistic regression. To describe the study sample, the distributions of the principal independent variable (periodontal disease) and all the covariables considered were explored.

Group differences were tested using the Chi-square (or Fischer's exact test when the expected cell count was <5) and the t-test for categorical variables and for continuous variables respectively. All statistical tests were two-tailed and the level of significance was set at $p < 0.05$.

The confounding effect of potential covariates which had previously been identified in the literature and which were significantly associated with periodontal disease in the bivariate analysis were controlled for in a logistic

regression model using backward stepwise procedures. Adjusted odds ratios (ORs) with their 95% CI were calculated to estimate effect sizes.

To measure potential dose-response relation, periodontal disease was further divided to moderate (four teeth with a (PD) ≥ 4 mm) and severe periodontal disease (more than four teeth with PD ≥ 4 mm). To test the role of preterm delivery as a potential mediator of the effect of periodontal disease, gestational period was entered into the regression model last and any changes in the effect size of periodontal status were noted.

All data analyses were conducted using V.10 statistical software.

3.7 ETHICAL CONSIDERATIONS

The questionnaire survey was anonymous and information was kept confidential. Permission to conduct the study was obtained from the managements of the respective hospitals.

Only individuals who provided written informed consent were included in the study.

The study protocol was further subjected to review and was approved by the School of Dentistry Research Committee University of Pretoria, as well as the Research Ethics Committee of Faculty of Health Sciences of the University of Pretoria (Approval Number: S147/2010).

3.7.1 Benefits for participants

All the study participants who needed treatment were referred for treatment, which consisted of plaque control instructions and supra- and subgingival scaling and polishing. They were also all informed of how to care for their teeth and those of their baby.

3.7.2 Potential risk

In general, the probing could cause some discomfort. However, the oral examination protocol used was similar to that of any oral examination the participants would in any case have been subjected to in the course of routine dental care, thus no particular risk was posed by participating in this study.

CHAPTER 4: RESULTS

4.1 SOCIO-ECONOMIC STATUS OF THE STUDIED POPULATION

There was no difference between the education levels of the cases and controls. Of the study participants, among the cases, the proportions of those in the case group were as follows: those who had less than a high school education made up 47.5% (n=57), those with a high school education made up 35.8% (n=43), and those with a post-high school education made up 16.7% (n=20). These figures were not statistically significantly different from those of the control group (p=0.78) (see Table 1).

The number of unemployed case participants, however, was significantly higher than the number of unemployed controls. Of the mothers in the case group, 38.3% (n=46) were unemployed, compared to 23.7% (n=54) of the control group (see Table 1).

4.2 OBSTETRIC RISK FACTORS AND MATERNAL CHARACTERISTICS OF CASES AND CONTROLS

As Table 1 shows, of the study respondents, 34.5% (n=119) were cases, while 65.5% (n=229) were controls. Compared to the controls, the cases were significantly more likely to have been diagnosed with at least one known obstetric risk factor for a low birth weight baby (1.3% vs 6.8%; p=0.01). The

most common obstetric problem reported during pregnancy was pre-eclampsia (45.5%), followed by antepartum haemorrhage (27.7%). Compared to the controls, the cases had a significantly lower gestational age (39.7 weeks vs 36.7 weeks; <0.01) (see Table 2). There were no statistically significant differences in marital status (see Table 1) or age, or the living conditions (crowding) of the participants in the two groups (see Table 2). Compared to those in the control group, a greater proportion of mothers in the case group reported three or fewer antenatal care visits (79.8vs 68%; $p=0.02$) (see Table 1).

4.3 TOBACCO USE AND ALCOHOL INTAKE DURING PREGNANCY

As compared to the controls, the cases tended to be more likely to have been exposed to second-hand smoke during pregnancy (21.9% vs 36.7%; $p=0.01$) and were more likely to report drinking at least one glass of alcohol on five or more days per week during pregnancy (10.8% vs 4.0%; $p=0.03$).

Although compared to the controls, the cases were significantly more likely to report exposure to second-hand smoke, no statistically significant difference was found between the two groups with regard to current smoking, current snuff use and smoking during pregnancy (see Table 1).

4.4 ORAL HEALTH BEHAVIOURS AND ORAL HEALTH OF THE STUDIED POPULATION

Compared to the controls, the cases were no more likely to rate their oral health as poor (22.5% vs 21.5%; $p=0.83$). Those categorized as cases, compared to controls, were not only more likely to report frequent bleeding gums when

brushing, but were also more likely to be diagnosed with periodontitis (37.9% vs 9.2%; $p=0.001$).

No significantly different dental visit patterns were observed between the cases and the controls during the period of pregnancy or in general. Only 14.2% of the cases and 15.8% of the controls reported a visit to a dental clinic during pregnancy. Notably, 85.3% of the study participants had never visited a dentist before (see Figure 3).

Although the proportion of mothers in the case group who reported brushing at least once daily was higher than that proportion in the control group, the frequency of bleeding gums while brushing was more common among the cases than among the controls (16.0% vs 7.4%; $p=0.02$) (see Table 1).

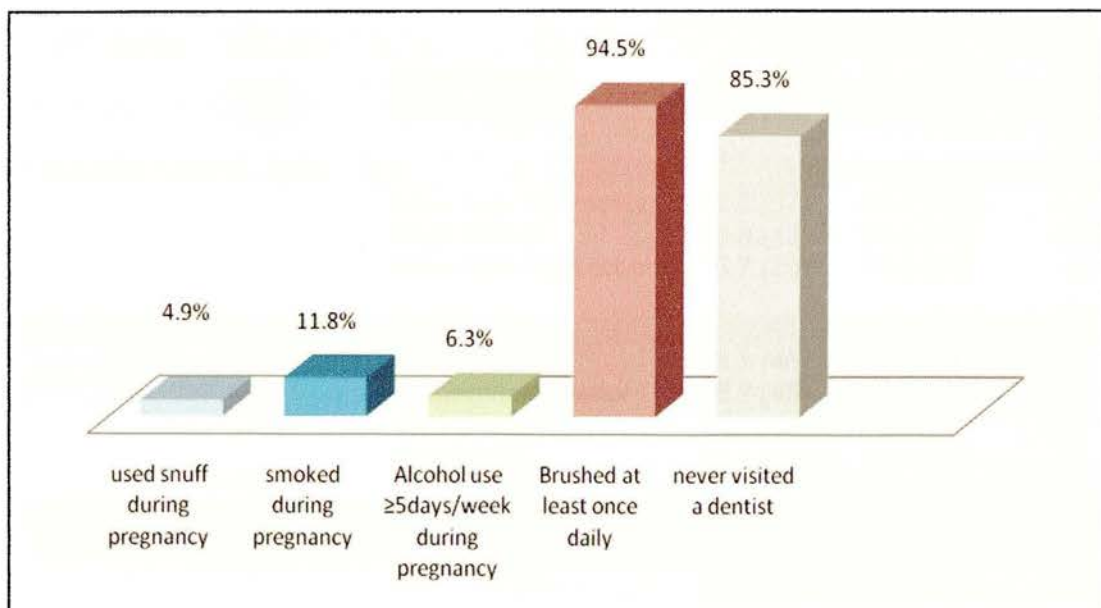


Figure 3: Distribution of oral health-related risk behaviour among the study population

4.5 UTILIZATION OF DENTAL SERVICES AMONG PREGNANT WOMEN

Only 14.7% (n=51) of the study participants had ever visited a dentist before. Of those who had ever visited a dentist, most (82.4%) had visited one mostly only when in pain (symptomatic visits). Those who reported past dental visits tended to be employed, but were significantly more likely to have reported that they were currently smoking, and/or that they frequently had bleeding gums on brushing and to present with a periodontal pocket of ≥ 4 mm on more than three teeth at the time of the oral examination (see Table 3). Other factors associated with past dental visits are displayed in Table 3.

Table 1: Socio-demographic, obstetric and behavioural characteristics of control and case mothers

Characteristics	Category	Cases %(n)	Controls %(n)	p-value
Marital status				0.20
	Never married	66.7 (80)	73.3 (167)	
	Ever married	33.3 (40)	26.8 (61)	
Education level				0.78
	Less than high school	47.5 (57)	45.6 (104)	
	High school	35.8 (43)	39.5 (90)	
	More than high school	16.7 (20)	14.9 (34)	
Employment status				<0.001
	Unemployed	38.3 (46)	23.7 (54)	
	Student/housewife/ on a grant	38.3 (46)	58.3 (133)	
	Employed	23.3 (28)	18.0 (41)	
Obstetric complications during pregnancy				0.01
	No	93.2 (110)	98.7(226)	
	Yes	12.6 (15)	2.6 (6)	
Number of antenatal visits				0.02
	≤ 3 visits	79.7 (94)	68.1 (156)	
	> 3 visits	6.8 (8)	1.3 (3)	
Parity (previous children)				0.24
	None	18.3 (22)	16.7 (38)	
	1-3 children	72.5 (87)	78.5 (179)	

Characteristics	Category	Cases %(n)	Controls %(n)	p-value
Smoking during pregnancy 0.49				
	No	87.5 (105)	89.9 (205)	
	Yes	12.5 (15)	10.1 (23)	
Exposure to second-hand smoking 0.01				
	No exposure	63.3 (76)	78.1 (178)	
	Exposure at home or at work	30.8 (37)	20.2 (46)	
	Exposure at home and at work	5.8 (7)	1.8 (4)	
Alcohol use frequency in pregnancy 0.03				
	None	70.6 (84)	72.9 (167)	
	1-4 days per week	18.5 (22)	23.1 (53)	
	≥ 5 days per week	10.9 (13)	3.9 (9)	
Reason for past dental visits 0.39				
	Never visited a dentist	83.3 (100)	86.4 (197)	
	Symptomatic	12.5 (15)	11.8 (27)	
	Preventive	4.2 (5)	1.8 (4)	
Dental visits in pregnancy 0.75				
	Never	85.8 (103)	84.2 (192)	
	0-26 weeks	11.7 (14)	14.0 (32)	
	≥ 26 weeks	2.5 (3)	1.8 (4)	
Frequency of tooth-brushing 0.02				
	Non-daily	1.7 (2)	7.5 (17)	
	At least once daily	98.3 (118)	92.5 (211)	
Gum bleeding on brushing 0.01				
	Never/rarely	84.0 (100)	92.6 (212)	
	Very often/always	16.0 (19)	7.4 (17)	
Periodontal status <0.001				
	≤ 3 teeth with a periodontal pocket of ≥4 mm	62.2 (74)	90.8 (208)	
	4 teeth with a periodontal pocket of ≥ 4 mm	24.4 (29)	7.0 (16)	
	5 to 6 teeth with a periodontal pocket of ≥ 4 mm	13.5 (16)	2.2 (5)	

Table 2: Mothers' socio-demographic and pregnancy outcome characteristics, comparing cases with controls

Characteristics	Cases: Mean (SD)	Controls: Mean (SD)	p-value
Age of mother (years)	25.3 (4.9)	24.6 (3.7)	0.17
Baby weight (kg)	2.0 (0.4)	3.3 (0.5)	<0.001
Baby height (cm)	42.1 (5.7)	48.7 (4.2)	<0.001
Gestational age (weeks)	36.7 (3.6)	39.7 (2.3)	<0.001
Crowding	0.7 (0.8)	0.6 (0.2)	0.07

Table 3: Oral health-related behaviour and the use of dental services among the study population

Characteristics		Ever visited dentist % (n)	p-value
Pregnancy-related factors			
Obstetric problem	No	14.6 (49)	0.67
	Yes	18.2 (3)	
Frequency of antenatal visits	< 3 times	13.6 (34)	0.35
	>3 times	17.5 (17)	
Parity	None	5.1 (3)	0.04
	1-3 children	16.2 (43)	
	>3 children	21.7 (5)	
Socio-demographics			
Marital status	Never	13.4 (33)	0.29
	Ever married	17.8 (18)	
Educational level	<High school	10.6 (17)	0.13
	High school	18.8 (25)	
	> High school	16.7 (9)	
Employment	Unemployed	9.0 (9)	0.06
	Employed	16.9 (42)	
Residential	Urban	17.8 (16)	0.03
	Rural	13.6 (35)	

Characteristics		Ever visited dentist % (n)	p-value
Oral health-related factor	Self-reported gum bleeding		0.02
		Never/rare	13.1 (41)
		Very often/always	44.4 (4)
	Self-rated oral health		0.05
		Very good/good	17.1 (13)
		Very poor/poor/don't know	14.0 (38)
	Frequency of tooth brushing		0.25
		Once or less daily	13.0 (29)
		Twice or more daily	17.6 (22)
	Current smoking		0.04
		No	13.4 (42)
		Yes	26.5 (9)
	Current snuff use		0.13
		No	14.2 (48)
	Yes	33.3 (3)	
Exposure to second-hand smoking in pregnancy		0.01	
	Exposure	11.8 (30)	
	No exposure	22.3 (21)	
Alcohol use during pregnancy		0.00	
	None	10.8 (27)	
	<weekly	26.7 (20)	
	>weekly	18.2 (4)	
Periodontal disease		0.04	
	≤ 3 teeth with a periodontal pocket of ≥4 mm	12.8 (36)	
	More than 3 teeth with a periodontal pocket of ≥4 mm	22.7 (15)	

4.6 CONDITIONAL LOGISTIC REGRESSION MODEL PREDICTING LOW BIRTH WEIGHT

After controlling for potential confounders and other known risk factors for low birth weight, mothers presenting with a probing depth of ≥ 4 mm on four teeth (OR=4.12; 95% CI =1.78-9.50) or more than four indexed teeth (OR=4.91; 95% CI:1.52-15.81) were significantly more likely to have low birth weight babies, compared to mothers with three teeth or fewer with periodontal pockets. These effects were stronger before controlling for gestational age, with ORs of 5.33 and 7.47 respectively. Obstetric complications also became non-significant after controlling for gestational age.

The mothers who consumed alcohol on five or more days weekly during pregnancy were four times more likely to have low birth weight babies than those who did not drink at all (see Table 3, above). Low birth weight was also significantly more common among those who were unemployed and those who reported fewer than three antenatal visits. It was also observed that compared to those with no known obstetric risk factors, mothers with any obstetric risk factors were more likely to have children with a low birth weight (OR 3.98; 95% CI: 1.29-12.27).

Table 4: Final logistic regression model of factors associated with low birth weight

Characteristics	Odds ratio	95% CI
Periodontal status		
≤ 3 teeth with a periodontal pocket of ≥4 mm	1.0	
4 teeth with a periodontal pocket of ≥4 mm	4.12	1.78 - 9.50
5 to 6 teeth with a periodontal pocket of ≥4 mm	4.91	1.52 - 15.81
Alcohol use in pregnancy		
None	1.0	
1-4 days per week	0.93	0.44 - 1.97
≥5 days per week	6.51	2.15 - 19.75
Employment status		
Employed/Student/housewife/ on a grant	1.0	
Unemployed/no grants	2.75	1.44 - 5.27
Frequency of antenatal visits		
≤ 3 times	1.0	
> 3 times	0.31	0.14 - 0.65
Self-reported gum bleeding		
Never/rarely	1.0	
Very often/always	3.61	1.39 - 9.37
Gestational age (per week increase)	0.67	0.58 - 0.76
Model R ² = 0.32		