Chapter 3:

Prevalence and Predictors of Risk Behaviors and Practices for Lead Exposure during the First Trimester of Pregnancy in the Central District, Botswana.

3.1 Abstract

Objectives: Lifestyle, environmental and cultural behaviours of pregnant women have been associated with lead exposure and elevated blood-lead levels (PbB). This study determines the prevalence and predictors of health risk behaviours and practices for prenatal exposure to lead in the Central District of Botswana. The study further looks at socioeconomic and demographic factors influential to such behaviours during the first trimester of pregnancy.

Methods: Interviews were conducted among 142 pregnant women (73% participation rate) attending antenatal care in hospitals and clinics in the study areas.

Results: Ingestion of non-food items was the most commonly practiced risk behaviour (86%) followed by the use of brake fluid oils, torch batteries, light brown shoe polish and traditional cosmetic clays (*letsoku)*) for skin treatment (74%). Alcohol consumption, tobacco and traditional medicines use were practiced by 31%, 8% and 11% of participants, respectively. Multiple risk behaviours (two or more risk behaviours) were practiced by 62% of women. Overall, age, employment and parity were significant predictors of whether a woman would engage in a risky behaviour or not.

Conclusion: These findings highlight the importance of monitoring and surveillance of behaviors and practices of pregnant women in order to understand potential prenatal exposure sources of lead. Inclusion of these behaviors in the Botswana Obstetrics Record booklet is recommended to allow midwives, obstetricians, gynecologists and family physicians to manage the risk behaviors and prevent potential adverse pregnancy outcomes. Development of awareness materials for pregnant women on the potential negative impacts of these habits and practices is recommended.

Key words: Risk behaviours, prevalence, pregnant women, lead exposure, Central District, Botswana

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3.2 Introduction

Lifestyle, cultural, environmental and other behaviors of pregnant women such as pica, the use of certain cosmetics, traditional remedies, alcohol and tobacco use have been identified as potential exposure sources for lead exposure during pregnancy.[1-3] Prenatal exposure to lead is increasingly becoming an issue of concern due to severity of lead toxicity even at very low concentrations. In addition, substantial fetal lead exposure can occur during pregnancy because of the ability of lead to transfer across the blood placenta barrier. Furthermore, during some health episodes, mobilization of maternal skeletal lead stores can occur thereby increasing fetal exposure.[4,5] Another concern is that the fetal nervous system is extremely sensitive to neurotoxins including lead.[6]

Exposure to lead during pregnancy is influenced not only by the health status of the pregnant women, but also by environmental, occupational and behavioural factors. Pregnant women may have additional sources of lead exposure which often involve habits or practices such as pica - an intentional ingestion of non-food items, very common in pregnant women. Shannon (2003) and Klitzman *et al*. (2002) have reported that severe lead poisoning resulting in blood-lead (PbB) levels equal to or exceeding 45µg/dL in pregnant women are more likely to occur due to intentional pica.[7,8] In these studies, most pregnant women with elevated PbB levels ingested soil, clay or pottery (known as geophagia) with very few cases of ingested paint chips. According to Shannon (2003) home renovation and the use of crushed bone meal (usually considered animal feed) were additional sources of lead exposure.[7] Lifestyle habits such as alcohol consumption, tobacco and traditional medicine use have been linked to lead and present yet additional exposure sources of lead poisoning during pregnancy. Alcohol has been reported to increase the absorption of lead in the gastrointestinal tract.[9,10] Acetaldehyde formed from alcohol may inhibit δ-aminolaevulinic dehydratase.[11] Severe lead poisoning has also been reported as a result of lead contaminated traditional/folk remedies.[12] Smoking of cigarettes is estimated to increase PbB by 0.33 µg/l for every cigarette smoked.[10]

Attention on lead and pregnancy is motivated by reports that pregnancy accelerates the release of lead stored in the woman's bones and therefore raise not only

circulating maternal PbB, but also PbB of the umbilical cord at term as well as raise postpartum PbB of the mother.[13,14] Heavy metals, including lead have been shown to cross the barrier of the placenta and transported to the fetus during pregnancy.[15] Bone lead is believed to follow the same kinetic pathway as calcium and therefore presents a potential source of lead for the fetus.[16] Miller (1983), has concluded in his study that kinetic studies during pregnancy must take into account the complex relationship between the mother, the fetus and the placenta.[17] Investigations further show that physiological factors may modulate the movement of lead from maternal bone to the growing fetus. Total lead exposure as well as the rate of lead exposure is reported to influence the concentration and location of maternal compartment, which in turn has an effect on the bioavailability and mobilization of lead into the placenta and fetus.[18]

Lead exposure plays a major role in the epidemiology of spontaneous abortion,[19] and hypertension.[20] It is vascular active and causes elevations in both systolic and diastolic blood pressure. Elevations in maternal blood pressure during pregnancy is a cause of concern for the mother and is a known risk factor for adverse pregnancy outcomes, particularly in the form of retarded foetal growth that is in itself a risk factor for adverse developmental effects.[21,22]

Botswana is a landlocked, semi-arid country with an approximate area of 582 000 km^2 and has a population of 2,024,904.[23] It is located in the center of Southern Africa, bordered to the north by Zambia, to the northwest by Namibia, to the northeast by Zimbabwe and to the east and southeast by South Africa. The study area, Serowe Palapye, is located 22° 44' 53" S and 26° 47' 15" E in the Central Administrative District of Botswana with a total population of 180,500.[23] It is home to the only coal mine in Botswana, the Morupule Colliery, which supplies a coal-fired Murupule Power Station of the Botswana Power Corporation.

Published data on lead levels in air, blood, soil or water as well as paint used in Botswana is limited. A few published studies could however be sourced that focused on lead in soils and in blood. These studies were conducted in Gaborone (the capital City of Botswana) and in Palapye. Gaborone soils had lead levels as high as 222mg/kg compared to rural soils.[24] Zhai *et al.* (2009) further assessed the

distribution of heavy metals including lead near Palapye in the Serowe Palapye District and found lower lead values compared to Gaborone.[25] In terms of blood lead levels, the only study published in Botswana is that by Mbongwe *et al.* (2010) assessing PbB in children aged 1-6 years.[26] In this study 31% of children had PbB levels ≥10µg/dL with 5% of all study children having PbB levels ≥20µg/Dl.[26] In terms of behaviors and practices likely to expose the population to lead, there are currently no published studies in Botswana.

The goal of this study is to determine the prevalence of behaviors and practices among pregnant women that may contribute to exposure to lead. Specifically, this study determines the baseline characteristics of pregnant women and predicts prevalence rates and socioeconomic and demographic correlates of risk behaviors, separately and in combination during the first trimester of pregnancy in subjects residing in the Central District of Botswana (figure 3.1).

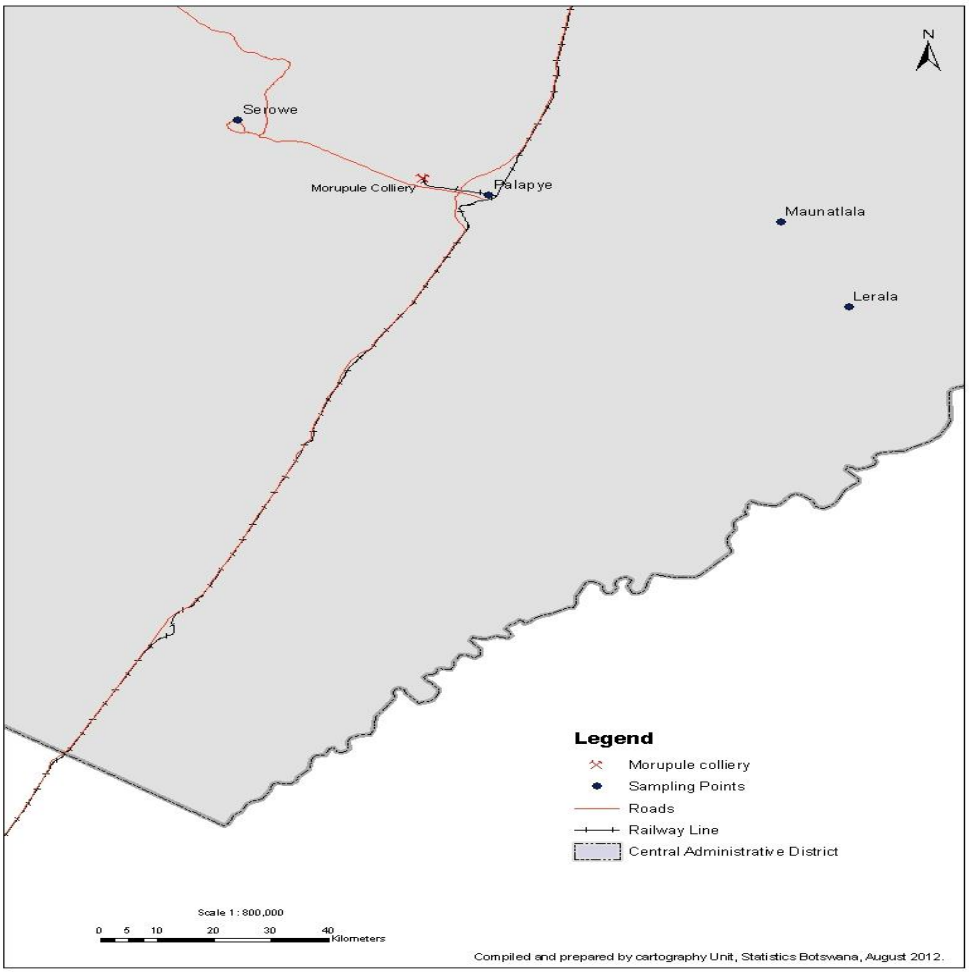

Figure 3.1 Sampling Locations, Central District

3.3 Methods

3.3.1 Study area and population

The eligible target population in this study was pregnant women aged 18 to 49 years attending antenatal clinic services at any public clinic or hospital in the Serowe/Palapye District. While the reproductive age is 15 to 49 years, for ethical requirements in Botswana and the University of Pretoria informed consent could only be given by persons 18 and above. Specifically the women were recruited from Serowe, Palapye, Maunatlala and Lerala villages. Serowe is the largest of the villages with a population about 52,000,[23] a typical major village in Botswana with minimal industrial activity but moderate traffic volume. Palapye is a moderately industrial major village (equated to a town due to the extent of industrial activity). Palapye population is approximately 37,000,[23] and is located about 5-7 kilometres from Morupule coal mine and the Morupule Power Station, with a major railway station and a major highway passing through the village from Gaborone to Francistown. Major villages are designated in terms of infrastructural developments, population size as well availability of services. Maunatlala and Lerala with populations 4,552,[23] and 687, [23] respectively, represent a typical small, rural villages in Botswana with no industrial activities and extremely minimal traffic volume.

3.3.2 Participation, recruitment and informed consent

All pregnant women registering for prenatal clinic between September 2009 and February 2010 who were between 0 and 12 weeks of pregnancy were invited to take part in the study. All eligible women were issued a letter containing a statement of consent and a leaflet describing the study and its protocols. Of the 200 women deemed eligible, 17 were not reached. Informed consent was given by 147 women, however out of these 5 women were below the age of 18 and therefore excluded from the study, making eligible women 195 instead of 200. Overall participation rate was therefore 73%.

3.3.3 Research Instrument

Validated risk assessment questionnaires were administered after the consent forms were signed by study participants. Prior to the interviews, the questionnaire was pretested and validated in a workshop attended by research experts from the

University of Botswana and Pretoria, statisticians as well as members of the Ministry of Health Research Ethics Committee (see appendix 8). Individual interviews were conducted by eight trained interviewers who recorded data directly into the questionnaires. Any additional information was recorded in a notebook to elaborate certain behaviours and practices. Interviews were conducted in a reasonably quiet location to ensure privacy but in close proximity to the queue so that participants retained their positions in the queue. All interviews were conducted in Setswana. Information was collected on the behaviours and practices of pregnant women in relation to lead hazards. Participants were asked about their personal habits during the first trimester of pregnancy such as alcohol consumption, tobacco use and traditional medicine and whether they have pica behaviour. In terms of practices, women were asked what substances they use to treat skin or other health related problems during pregnancy.

3.3.4 Alcohol and tobacco use

Women were asked on the number of alcoholic drinks they consume every day. Alcohol consumption was then estimated by a modification of the methods suggested by Miller *et al.* (1991), to calculate standard drink units.[27] For each type of alcoholic drink (beer, wine, spirits, etc.), respondents reported their usual quantity and frequency of intake. Average daily volume (AVD) scores were then calculated for those who were specific on the number of drinks taken daily. Only alcohol users included in this study were those who had quit after becoming pregnant provided they quit between 8 and 10 weeks after their last menstrual period.[28] AVDs were not calculated for binge drinkers and for traditional brews. Participants were also asked whether they currently use tobacco products and to state the type of tobacco they were using.

3.3.5 Pica behaviour

Women were asked to indicate if they currently ingested non-food items. The women were further asked to indicate the type of non-food items that they ingest from a list provided as well as any other not listed in the questionnaire.

3.3.6 Unconventional skin disease treatments and complexion solutions

Study participants were specifically asked about the use of traditional cosmetic clays (*letsoku*), dry cell batteries and brake fluid. Women were further asked to state the specific use of such products. It is traditional practice for women to use *letsoku* for skin smoothing purposes. The use of used brake fluid oil has also been observed in the general public for treatment of skin related problems as well as dry cell batteries. The dry cell battery would normally be crushed and the powdery content of it mixed with petroleum jelly and applied in the skin, particularly for ringworm treatment. These practices have not been studied in pregnant women and their impact on health.

3.3.7 Data Analysis

Data was "double punched" using a Microsoft Excel software package, and subsequently transferred to STATA 11.0 statistical programme using Stattransfer. Bivariate analysis was used to test associations between risk behaviours and practices during pregnancy and socio-demographic variables (Chi-square statistics). Logistic regression analysis was then conducted to examine the multivariate relationships between the socio-demographic variables and each risk behaviour or practice. This method of analysis was chosen because it provides an interpretable linear model for a categorical dependent variable. Additionally, logistic regression allows for testing of significance of a given predictor whilst controlling for all other predictors in the model.[29] Each behaviour or practice was coded as a dichotomous variable with those women having engaged in behaviour coded as 1 and those who did not engage in the behaviour or practice (abstainers) coded as zero. Dummy variable coding was used for categorical independent variables with the references category chosen to represent the lowest expected risk behaviour. The assumption of linear relationships between each risk behaviour and independent variables was examined using the -2 log-likelihood chi-square statistic, and where applicable the final models were re-estimated using the correct scale of the variables. Normalized sample weights were used in the analysis of the data. The sampling weight is the inverse of the probability of selection, which is represented by the proportion of the actual number of respondents in each age category among the total targeted population in that same age category. Sample weights assigned to each respondent were divided by the mean sample weight to adjust for differing sampling probabilities. This procedure has the

effect of reweighting the sample to approximate the population distribution, while maintaining the study sample size as the total number of observations used in the analysis.

3.4 Ethical Approval

This study obtained unconditional ethical approval from the Research Ethics Committee, Faculty of Health Sciences, University of Pretoria, South Africa (reference 110/2009, appendices 1 & 2) and endorsement by the Ministry of Health Research and Ethics Committee, Gaborone, Botswana in 2009.

3.5 Results

3.5.1 Socioeconomic and demographic characteristics of study population

Table 3.1 shows the socio-demographic characteristics of pregnant women enrolled in the study.

Table 3.1
Socio-demographic Characteristics of the Study Population

Age (years)	**Number**	**Percent (%)**
≤19	13	(9.2)
20-24	49	(34.5)
25-29	32	(22.5)
30-34	28	(19.7)
35+	20	(14.1)
Employment		
Employed	61	(43.3)
Unemployed	80	(56.7)
Educational Status (in Years)		
Primary Education (1-7 Years)	19	(13.4)
Secondary Education (8-12 years)	92	(64.8)
Post-Secondary(13+years)	31	(21.8)
Income adequacy		
Lowest (P 0.00-P3000)	132	(93.6)
Lower Middle (P3001-6000)	7	(5)
Middle (P6001-9000)	1	(0.7)
Upper Middle (P9001-12000)	1	(0.7)
Parity		
Primipara	54	(38)
Multipara	88	(62)
Location		
Serowe (major village)	66	(46.5)
Palapye (major village)	48	(33.8)
Maunatlala (small village)	14	(9.9)
Lerala (small village)	14	(9.9)
Recruitment Facility type		
Hospital	104	(73.2)
Clinic	38	(26.8)

Note: One subject had missing values for employment and income variable

The income reported in this study indicates the total monthly household income as reported by the respondents. At the time of data collection 10 categories were created ranging from BWP <1 500 to BWP >9 500. However, upon analysis data was pooled into four groupings (Table 3.5.1). Since these were self-reported, there is a possibility that most of the respondents withheld the information. In this study, we define employment as having a paid salary at the end of each month.

Of the participants, 9% were found to be under the age of 20 years, with more than half (57%) being aged 20-29 years and 34% being above the age of 30 years. The majority of the women (89%) were not married. The low prevalence of marriage cut across all the study areas, however the majority of the unmarried (63%) was aged between 18-29 years and came from Maunatlala (100%) and Lerala (92.8%), both of which are small villages. About 57% of the women were unemployed in spite of more than 75% attaining secondary education level (matric) with 92% of the women falling in the lowest income adequacy group. Multiple parity was prevalent in 62% of the women overall, but more prevalent in Maunatlala (78%) and Lerala villages (92%) compared to Serowe and Palapye which both had 56% of multiparous women. The majority of the women were recruited from clinics (73%).

3.5.2 Prevalence and level of risk behavior

Table 3.2 shows prevalence of pica behavior. It is apparent that a substantial proportion of women overall reported ingesting non-food items (86%, n=142) which encompass a habitual ingestion of a variety of surface soils, crushed pottery and clays.

Table 3.2
Prevalence of Pica Behaviour By Age During the First Trimester of Pregnancy

	% ΣSoil Pica*		% Matches Pica		% Pencil Pica		% Paint Chips Pica		% Bone meal Pica		% Chalk Pica	
	No	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
Age (Years)												
≤19	38.5	61.5	92.3	7.7	100	-	100	-	100	-	100	-
20-24	51	49	91.8	8.2	89.8	10.2	98	2.0	98	2.0	98	2.0
25-29	43.8	56.2	75	25	81.2	18.8	96.9	3.1	100	-	100	-
30-34	21.4	78.6	92.9	7.1	96.4	3.6	96.4	3.6	100	-	100	-
≥35	70	30	80	20	90	10	90	10	100	-	100	-
Overall %	45.1	54.9	86.6	13.4	90.1	9.9	96.5	3.5	99.3	0.7	99.3	0.7

***Chi-square test, p< 0.05**

(ΣSoils), unused matches heads, chewing pencil, ingesting paint chips from both furniture and peeling walls, bone meal and chalk The most frequently ingested item at the time of the study was soils about (55%) referred to as the sum of all soils (ΣS) in this paper. The ΣS ingested included termite mounds (n=56:39%), soils from pits and other surfaces (n=49:35%), river clay (n=16:11%) and crushed traditional clay pot (n=3:2.1%). Habitual soil ingestion was followed by habitual ingestion of unused matchstick heads and pencil chewing. Crushed bone meal, chalk and paint chips were the least ingested. Figure 3.2 characterizes ΣS by type and use by age. Women aged 30-34 years consumed more soil than all other age groups. Soil pica was less prevalent in the over 35 years age group.

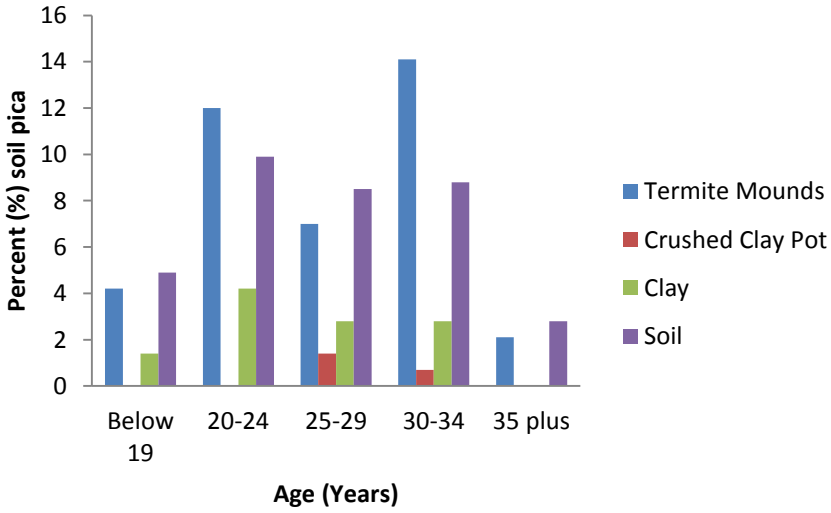

Figure 3.2 Characterization of ∑S Pica by type and Age (n=142)

Table 3.3 shows that 31% of women reported consuming alcohol. Out of these women, over 90% reported consuming alcohol 8-12 weeks before finding out they were pregnant (8 weeks: 53.5%; 12 weeks: 40.8%). Almost three quarters of the women had fewer than two drinks per week on average. Binge drinking was more prevalent among younger women while heavy drinking was observed in older women. Relatively fewer women (8%) reported using tobacco products. Out of the women only 2 smoked cigarettes whilst the rest used smokeless tobacco (snuff). Traditional medicines use was reported by 11% of women and was more prevalent in women aged 30 years and above.

Table 3.3
Prevalence of Alcohol, Tobacco and Folk Remedies Use By Age During the First Trimester of Pregnancy

	%Alcohol Use*¶					%Tobacco Use		% Traditional Medicine Use	
	None	Light (AVD 0.01-0.39)	Moderate (AVD 0.40-0.89)	Heavy (AVD 0.90+)	Binge	None	Yes	None	Yes
Age (Years)									
≤19	46.2	15.4	15.4	-	23.1	100	-	92.3	7.7
20-24	57.1	20.4	2.0	2.0	18.4	93.9	6.1	93.9	6.1
25-29	40.6	31.2	6.2	-	21.9	84.4	15.6	87.5	12.5
30-34	50	28.6	7.1	3.6	10.7	96.4	3.6	89.3	10.7
≥35	60	-	10	20	10	90	10	75	25
Overall %	51	21	6.3	4.2	16.9	92.3	7.7	88.7	11.3

***Average Daily volume (ADV):**0.01-0.39: equivalent to ≤ 2 drinks per week; 0.4-0.89: equivalent to 3-6 drinks per week; 0.90+: equivalent to ≥ 7 drinks per week. A standard drink is defined as 340ml can of beer(3.5% alcohol) or 105 ml wine (12% alcohol) or 30ml distilled spirits(43% alcohol)[27]
¶Chi-square test, p< 0.05

Table 3.4 shows unconventional skin practices among pregnant women. Used brake fluid oil was unanimously used treatment of psoriasis (referred to as *madi* or blood) by the women) and was prevalent in 30% of pregnant women overall. Approximately 20% of these women also reported using brake fluid for wound treatment and ringworm. Compared with younger women, older women (30 years and above) were more likely to use brake fluid. About 8% of women used torch battery contents for treatment of ring worm specifically. This practice was more prevalent in younger women than older women (above 34 years).

Table 3.4
Prevalence of Unconventional Skin Treatment Solutions By Age During the First Trimester of Pregnancy

	% Brake fluid Use For Treatment of Psoriasis		%Torch Battery Use for Ringworm Treatment		% *Letsoku* (Clay powder) Use for Vanishing		% Shoe Polish Use for Skin Vanishing	
	No	Yes	No	Yes	No	Yes	No	Yes
Age (Years)								
≤19	69.2	30.8	92.3	7.7	92.3	7.7	84.6	15.4
20-24	81.6	18.4	87.8	12.2	87.8	12.2	75.5	24.5
25-29	71.9	28.1	93.8	6.2	78.1	21.9	87.5	12.5
30-34	53.6	46.4	96.4	3.6	75	25	92.9	7.1
≥35	60	40	95	5	75	25	75	25
Overall %	**69.7**	**30.3**	**92.3**	**7.7**	**81.7**	**18.3**	**82.4**	**17.6**

Letsoku, was used for different purposes including cosmetic use and was reported overall by 18% of women. All of the women said they used *letsoku* as a facial powder with 60% and 20% using it for skin acne treatment (or skin smoothing) and for treatment of stomach ache respectively. Light brown shoe polish was also reported by 18% of women for skin smoothing and vanishing. The use of *Letsoku* was more prevalent in women aged >30 years whilst light-brown shoe polish cut across all age groups with a higher prevalence among the older (≥ 35) and the age 20-24 years category. The prevalence of each risk behavior did not vary with age with the exception of ΣS pica (p=0.01) and alcohol consumption (p=0.03). ΣS pica by age had a somewhat U-shape distribution being more likely among the less than 19 years and the 30-34 years age groups. However when termite mounds ingestion was compared with all other soils separately, termite mounds alone had a stronger association with age (p=0.001) with the age group 30-34 years more likely to ingest termite mounds than most of other age groups. Compared with older women, younger women (below 34 years) were more likely to drink alcohol; however older women (35 plus years) tended to drink more heavily.

Figure 3.3 shows the distribution of risk behaviours by location. A significant difference in the prevalence of risk behaviour by locations was observed (Chi square test, p<0.05).

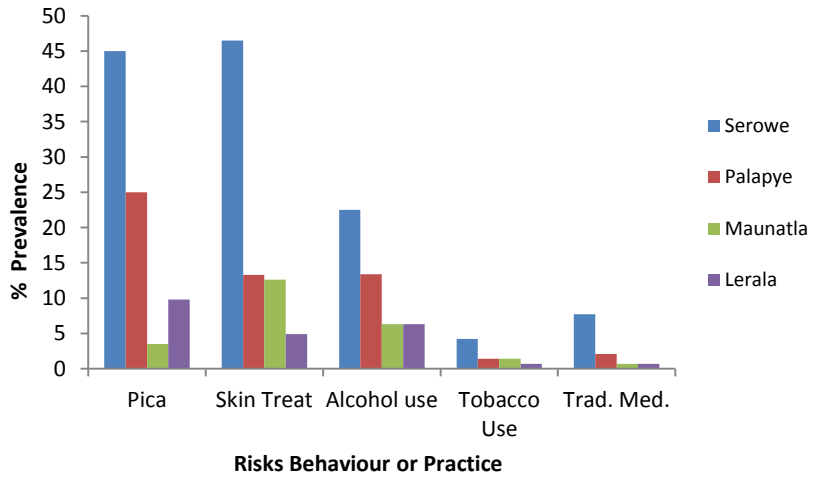

Figure 3.3: Percent Prevalence of Risk Behaviour/ Practice by Location (n=142)

Pica, skin treatment interventions and alcohol consumption were more prevalent in the major villages (Serowe and Palapye) compared to smaller villages (Maunatlala and Lerala). Tobacco use and traditional medicines were reported in all areas, but slightly higher in Serowe.

3.5.3 Socio-demographic correlates of risk behavior

Table 3.5 shows that age was an important predictor of the ingestion of non-food items such as soil, matches, brake fluid and folk remedies. Those at ages 30-34 were at a significantly higher risk of engaging in geophagy (ingestion of soils) than other age groups ($p<0.01$).

Table 3.5
Significant Socio-demographic Predictors of Risk Behaviors During the First Trimester of Pregnancy

	ΣSoils Pica OR(95%CI)	Pica Matchsticks OR(95%CI)	Pica Pencil Lead	Brake fluid	Folk Remedies
Age (Years)					0.62(0.39,0.98)**
18-19		22.70(1.2,458.04)**		1.00 Reference	
20-24		15.0(1.7,29.96)**		0.23(0.05,1.01)**	
25-29					
30-34	0.12(0.03,0.54)***				
≥35	1.00 Reference	1.00 Reference			
Employment					
Employed					1.00 Reference
Unemployed					0.25(0.07,0.99)**
Parity					
Primipara		1.00 Reference	1.00 Reference		
Multipara		0.16(0.04,0.66)**	0.17(0.04,0.77)**		

*****p<0.01; **p<0.05;**
OR=Odd Ratio; CI = Confidence interval

Additionally, the odds of predicting correctly who eats soils improved by 64% (1.64 – 1) (OR 1.64;CI:50,5.40) if one knew respondents marital status and 46% (1.46–1) if one knew respondents income categories. Younger women aged 18-24 and multiparous women were at a significantly higher risk for ingesting matches than older and primiparous women respectively. Multiparous women were at a greater risk of ingesting pencil ($p<0.05$) than primiparous women. Age was positively associated with pencil ingestion.

3.5.4 Unconventional skin treatment solutions

No significant differences were observed among the predictor variables for unconventional skin treatment products ($\chi^2 = 6.20, df = 6, N = 142, \rho > 0.05$). The odds ratio which suggest that the odds of predicting correctly who uses all the skin products improve by 29% (1.29 – 1) if one knew respondents age whilst it was 19% (1.19 -1) and 20% (1.99 -1) if one knew respondents marital status and level of education respectively. Women aged 20-24 years were at a higher risk of using brake fluid (OR=0.23: p<0.05).

3.5.5 Traditional medicines use

The use of traditional medicines or folk remedies was predicted by all the six predictor variables when considered together (χ = 9.609, df = 3, N= 142, ρ < 0.05). However employment and age were significantly better predictors of traditional medicine use. Women who were unemployed were at a significantly higher risk of using folk remedies than those who were employed (p<0.05).

3.5.6 Alcohol consumption and tobacco use

Alcohol consumption and tobacco use were positively associated with all the six predictor variables (p>0.05).

3.5.7 Multiple risk behaviours

Table 3.6 presents the proportions of women engaging in each possible combination of risk behaviours. About a quarter (26.7%) of the respondents reported two risk behaviours with alcohol and soil pica as the most common combination (8.5%). About 35% of the women engaged in three or more risk behaviours with no specific common risk behaviour combinations but rather varied alcohol and soil pica combinations.

Table 3.6
Multiple Risk Behavior During the First Trimester

	No.	%
One Risk Behavior (n=39; 27.5%)		
Pica Soils	13	9.2
Alcohol use	9	6.3
Brake fluid use	6	4.2
Letsoku application	3	2.1
Two Risk Behaviors (n=38; 26.8%)		
Alcohol use and soil pica	12	8.5
Alcohol use and matchstick pica	3	2.1
Alcohol use and tobacco use	1	0.7
Alcohol use and pencil lead pica	1	0.7
Alcohol use and torch battery contents application	1	0.7
Alcohol use and shoe polish application	1	0.7
Alcohol use and paint chip pica	1	0.7
Brake fluid and torch battery contents application	2	1.4
Brake fluid and shoe polish applications	2	1.4
Brake fluid and pencil lead pica	1	0.7
Brake fluid and matchstick pica	1	0.7
Matchstick and pencil lead pica	1	0.7
Shoe polish and *Letsoku* applications	1	0.7
Soil pica and brake fluid application	8	5.6
Soil pica and matchstick pica	2	1.4
Three Risk Behaviors (n=28;19.7%)		
Alcohol use, soil pica and brake fluid application	4	2.8
Alcohol use, soil pica and shoe polish application	4	2.8
Alcohol use, soil pica and *letsoku* application	4	2.8
alcohol use, soil pica and tobacco use	1	0.7
Alcohol use, soil pica and torch battery contents application	1	0.7
Alcohol use, soil and paint chips pica	1	0.7
Alcohol use, tobacco use and chalk pica	1	0.7
Alcohol use, shoe polish and *letsoku* applications	2	1.4
Alcohol use, *letsoku* and brake fluid application	1	0.7
Soil pica, brake fluid and *letsoku* application	3	2.1
Soil pica, shoe polish and torch battery contents application	1	0.7
Soil pica brake fluid and torch batteries contents application	1	0.7
Soil pica, shoe polish and brake fluid application	1	0.7
Soil pica, pencil pica and brake fluid application	1	0.7
Bone meal pica, torch battery contents and brake fluid application	1	0.7
Tobacco use, alcohol and brake fluid application	1	0.7
Four and above risk factors (n=22;15.5%)		
Alcohol use, shoe polish, *letsoku* and brake fluid application	1	0.7
Alcohol use, soil pica, torch batteries *Letsoku* and brake fluid application	1	0.7
Alcohol use, soil pica, pencil lead pica, torch batteries and brake fluid applications	1	0.7
Alcohol use, soil pica, *letsoku* and brake fluid application	2	1.4
Alcohol use, soil pica, matchstick pica, shoe polish, *letsoku* and brake fluid application	1	0.7
Alcohol use, soil pica, matchstick pica, *letsoku* and brake fluid application	1	0.7
Alcohol use soil pica, matchstick pica, pencil lead pica *letsoku* and brake fluid application	1	0.7
Alcohol use, soil pica, match stick pica, pencil lead pica and *Letsoku* application	1	0.7
Alcohol use , soil pica, shoe polish, *letsoku* and brake fluid applications	2	1.4
Alcohol use, soil pica, tobacco use letsoku and shoe polish application	1	0.7
Alcohol use, soil pica, tobacco use *letsoku* and chalk pica	1	0.7
Alcohol use, soil pica, tobacco use, paint chips pica, matchstick pica, pencil lead pica, shoe polish and torch battery content applications	1	0.7
Alcohol use, matchstick and pencil lead pica, shoe polish and *letsoku* application	1	0.7
Alcohol use, tobacco use, matchstick, paint chips and pencil lead pica	1	0.7
Alcohol use, tobacco use, matchstick and pencil lead pica, shoe polish and brake fluid application	1	0.7
Soil pica, matchstick pica, pencil lead pica, *letsoku*, shoe polish and torch battery contents applications	1	0.7
Soil pica, matchstick pica, pencil lead pica *letsoku* and brake fluid application	1	0.7
Soil pica, matchstick, pencil lead pica and *letsoku* application	1	0.7
Soil pica, bone meal pica, paint chip pica and brake fluid application	2	1.4
Soil pica, recreational drugs, shoe polish and *letsoku* applications	1	0.7
Abstainer from all risk factors	**15**	**10.6**

Employment was a better predictor of two or more risk behaviours than all other predictor variables (OR=1.43: CI=0.66,2.86). Not being married and being

multiparous were 1.5 times (OR=1.52:CI=0.45,4.74) and 1.3 times (OR=1.34:CI=0.53,3.35) as likely as women who were married or primiparous respectively to engage in two or more risk behaviours or practices.

3.6 Discussion:

This study has identified health risk behaviors among pregnant women in the Central District of Botswana during the first trimester of pregnancy. Pregnant women engage in behaviors such as pica, skin application of auto oils and other substances with a potential to expose them to lead and other hazardous substances. Socio-demographic factors such as age, employment and multigravida have an influence on pregnant women engaging in risky lead exposure behaviors during the first trimester of pregnancy.

3.6.1 Ingestion of Non-food items as a potential source of lead poisoning among pregnant women

Pica is described as the craving and subsequent purposive consumption of non-food substances for more than one month. Among the most prominent forms of pica in this study is geophagia, the intentional ingestion of earths or soils.[30] While this practice is prominent in countries of the African region, it has been observed in other regions as well as in nationalities which have immigrated to the developed countries.[8,31] Observations of women ingesting surface soil, particularly from anthills, have been noted in urban areas as well in Botswana and this is consistent with studies elsewhere. [32] In a related New York study women were likely to purchase such soils from areas where they were reared that was brought by visiting relatives. [33] In Kenya, more than half of pregnant women practice geophagy.[34] Our results show a similar pattern where approximately, 55% of women ingested different types of soils ranging from clays to termite mounds during their first trimester of pregnancy. Ingestion of paint was less of a problem and this is consistent with Shannon's findings where she reports more women engaging in geophagia compared to paint ingestion.[7] Soil and dust have been identified as dominant pathways for human lead exposure and that these pose a greater risk than lead-based paint to children who engage in hand-to-mouth and pica behavior.[35] In a literature review of 25 years, Shannon (2003) identified pregnant women who experienced severe lead poisoning as a result of ingestion of soil, clay or

pottery.[7] Reported adverse health effects as a result of geophagia during pregnancy include hypokalemic quadriparesis as well as death.[7,36] It is more concerning that pregnant women in this study have engaged in other forms of pica such sucking heads of match sticks, chewing pencil (likely to be painted with lead containing paint), ingesting paint chips from peeling wall paints and furniture paint, bone-meal and chalk. While paint-chips, chalk and bone-meal ingestion during pregnancy have been reported by other studies.[37-39] Studies of women chewing pencil have not been reported. This type of practice has generally been reported in children ingesting pencil paint that contains lead. [40] A study carried out in South Africa by Okonkwo (2004) identified pencils painted with lead paint.[41] Pencil chewing as a pica habit by pregnant women in this study therefore presents a potential lead exposure source. Ingestion of matches by pregnant women has been reported in other studies, however, these were burnt matches women habitually ingested.[39] In this study, pregnant women sucked the heads of unused matches. While it is not established if such a practice can predispose women to lead exposure, matches has previously contained lead pyrophorus from roasted lead tartrate and the modern matches has a variety of chemicals which may present harm if ingested such as ammonium phosphate, borax, paraffin, potassium chlorate, sulphur, zinc oxide, glass powder and many other substances.[42]

3.6.2 Use of nonconventional skin treatment solutions

Used brake fluid was reported to treat psoriasis, ringworm and applied on wounds including open wounds. Car lubricants, known to contain lead and its derivatives such as lead naphthenate were used. [43,44] Lead has been determined from various used and unused oils ranging from 4.6 to 928ppm lead.[43] Such oils include gear oils, brake washing oil, lockhead brake oils, tyre cleaners and many other used motor oils. In their study, among autoworkers, Claussen and Rastogi (1977) concluded that inadequate protection of workers might allow organic lead to be taken up by the body through direct skin contact.[43] Cutaneous application of lead naphthenate solution has been found to produce chronic lead toxicity in rats.[45] This therefore places women who apply oils such as brake on their skin, including on open wounds, at a much greater risk for lead exposure. It is not understood why women engage in using car lubricants for treatment of skin infections of conditions. However lubricants containing lead naphthenate have been used elsewhere for cleaning hands in auto

workshops for their apparent effectiveness in removing carbon particles due to their apparent detergent content.[45] Of major concern is that in studies of auto workers who used car oils for cleaning hands, high blood-lead levels have been observed (mean 57.4µg/dL) yet the workers were not aware of the risks from such practices.[45] In other non-human studies car oils have been identified as an important cause of lead toxicity for cattle in countries such as Australia where cattle drank it. [46] Auto oils are also used in South Africa as an acaricide even though there has been no report of lead poisoning as a result of such practice by small scale farmers.[47] This study reveals that while the use of brake fluid is prevalent in all age groups, women aged 20-24 years are at a significantly higher risk of using brake fluid compared to other women. These women may not be aware of the hazards presented by using brake fluid and exposure at such a young age might present lifelong lead exposure source for them and generations to come.

Light brown shoe polish was used as a "cosmetic" for smoothing and vanishing skin. This is a new phenomenon identified by this study. Shoe polish contains high concentrations of solvents and the solvents contained in shoe polish, just like lead, cause adverse effects on the central nervous system which may result with brain damage.[48,49] Other effects of solvents from shoe polish similar to those caused by lead found in animal studies include anemia and embryo-toxic effects such as significant reduction in fetus weight.[50] While solvents in shoe polish may not be a direct exposure source of lead in pregnancy, the solvent concentrations in it need to be taken into consideration as potentially powerful confounding factors in lead studies.

The prevalence of torch batteries used for the treatment of ringworm and other skin conditions was low (8%) compared to that of brake fluid (30%) and shoe polish (18%), but it is yet another new finding by this study. While it is not known how these women identified torch batteries as a treatment option for ringworm and found it effective, it is suspected that its effectiveness stems from the high zinc content in dry cell batteries. Studies that have characterized dry cell batteries have found large amounts zinc in dry cell batteries. In one study the total amount of zinc per AA alkaline household battery was 3418 mg.[51] The same study however reported total lead in one battery to be 1.2 mg.[51] Even though lead concentrations in dry cell

batteries are reported in trace amounts and the levels may even fall within the recommended standards, the application of contents of dry cell batteries on skin cannot be ignored because dry cell batteries contain other hazardous substances such as arsenic, cadmium and mercury. [51,52] On the other hand one may also argue that the standards were not set with the application of dry cell battery contents on human skin. This practice therefore, may still pose yet another new exposure source for lead not only for pregnant women, but for children and other adults who have been observed using dry cell batteries for treatment of ringworm in Botswana. This argument is supported by a body of literature which confirms that there is no threshold for lead toxicity. [21,22]

The use of clays as cosmetic and medicinal products (known as *letsoku* in Botswana) has extensively been studied in many parts of Africa including Botswana.[53,54] They are well known for their cleansing, sunscreen and body beautification properties due to their high mineral content.[55] However, heavy metals including lead have been detected in these clays.[56] In this study, women use *letsoku* for beautifying purposes (as a facial powder and acne treatment) but they also reported using it for treatment of stomach-ache. These practices therefore create another exposure source for lead in pregnant women through skin or the gastrointestinal tract particularly that some of the clays have been found to be acidic.[53-56]

3.6.3 Alcohol and tobacco use

In humans, the intake of about 1 drink/day or more has consistently been shown to be associated with a large number of adverse pregnancy outcomes.[57] A number of population based studies have also identified lifestyle factors such as smoking and alcohol consumption as potential avoidable sources of lead exposure.[58] Cigarettes contain varying amounts of lead and a person who smokes 20 cigarettes a day has been estimated to inhale an approximate amount of 1-5µg of lead daily.[59] Maternal drinking and smoking during pregnancy and prenatal exposure to low doses of lead have been associated with reduced gestational age and weight at birth. A dose response relationship was found between cigarette smoking and alcohol consumption of mothers and cord blood lead levels. An average increase of about 15% (0.013µmol/litre) in cord blood lead levels was estimated for every 10 cigarettes

smoked per day.[60] Mean blood lead levels in babies whose mothers did not smoke during pregnancy but who drank alcohol moderately was 17% higher than those of non-smoking mothers who abstained from alcohol intake.[60] Rhainds and Levallois concluded that the lifestyle of pregnant women play an important role in the prenatal lead exposure of newborns.[60] While the majority of women used smokeless tobacco in this study, it is noted that such a practice is a potential confounder for lead exposure, as it has been associated with poor birth outcomes such as stillbirth.

3.6.4 Traditional medicine

Traditional medicine was used for different purposes which ranged from pain relief to blood cleansing by pregnant women in this study. The greatest concern with the use of traditional medications during pregnancy is that such medications may be contaminated with heavy metals including lead.[61] The Centers for Disease Control (2004) has reported severe lead poisoning as a result of traditional medications use??resulting with detrimental health effects such as brain damage.[12] Adverse pregnancy outcomes such as lead poisoned infants, encephalopathy, ante-partum hemorrhage, and elevated cord blood lead levels have been reported as a result of the use of traditional remedies.[3] The use of traditional medications and lack of monitoring thereof during pregnancy have serious implications on the health of pregnant women and the expected infants. This practice by pregnant women, require not only strict control measures but public awareness among health care providers and the public.

3.6.5 Predictors of risk behaviours:

In terms of predictors of risky behaviours, age, employment and parity were significant predictors of whether a woman would engage in a risky behaviour or not. Pregnant women aged 30-34 years were at a significantly higher risk of geophagy than all the other age groups. Multiparours women were at a significantly higher risk of engaging in pencil and matchstick pica than all other women. In this study, this has implications on women living in rural areas (small villages) who had the highest number of children compared to women in larger, semi-urban villages. Studies are not conclusive on predisposing factors in terms of geophagy and socioeconomic status. However, this study has similarities with that carried out in Kenya in terms of age as a

predictor of geophagy.[62] Even though the differences were not statistically different, Luoba and others (2004) also found unemployment and education as predictors of geophagy among pregnant women.[62] The findings of this study are also generally similar in many respects with studies that concluded that pica of any sort is not limited to socioeconomic background.[30,34] Predictor factors for traditional medicines were limited to employment. Unemployed women were at a significantly higher risk of using traditional medicines than those employed. The use of brake fluid was significantly predicted by age with the 20-25 years age category at a significantly higher risk to use brake fluid than other age groups. Interestingly, though not significant, employment and marital status were better predictors of two or more risk behaviors than all other predictor variables.

3.7 Limitations

The sample size of this study was not entirely representative of all pregnant women in Botswana but was heterogeneous in terms of demographic characteristics as well as risk behaviours. For this reason, the findings can be applied to many districts and therefore make findings of this study relevant to other settings.

Another limitation of this study is that respondents felt that the questionnaire was too long and the additional waiting to receive the services compounded this. It is the view of the author that some of the critical behaviour were under reported. The behaviours that are normally observed in these communities, for example, tobacco use do not generally reflect the actual observations with regard to snuff used by many women.

Alcohol use in this study did not take account of traditional brews, which are common in villages (major and small). This may therefore have an effect on the number of women who used traditional brews.

The majority of the women were reluctant to reveal their income. The author therefore feels income was under reported.

3.8 Conclusions and policy implications

The results of this study have brought out important lifestyle, environmental and cultural behaviors of pregnant women in the Central District of Botswana. Most importantly, these findings have been observed in other parts of Botswana including urban areas. These behaviors and practices have a potential to adversely affect pregnant women and their expected infants. While the current Botswana Obstetric Record booklet, [63] lists alcohol and smoking as risk factors for adverse effects during pregnancy, it is however silent on the behaviors reported in this study such as pica, the use of traditional medications, and hazardous skin treatment interventions such as auto oils, torch batteries, shoe polish and traditional clay cosmetics. This study highlights the need to enquire whether pregnant women engage in these practices during history taking and report these in the obstetrics record booklet. Most importantly this study highlights the need for obstetricians, gynecologists and family practitioners or physicians to be sensitized on these habits and practices through workshops to enable them to analyze the prevalence of the risk behaviors and practices within their communities; identify risk factors for such behaviors and practices, assess potential adverse effects on pregnancy outcomes and develop interventions to manage the risk behaviors and practices. Education and awareness of pregnant women on the potential negative impacts of these habits and practices is recommended.

Finally, the inclusion of these risk behaviors and practices on the Botswana Obstetric Record booklet is recommended. This will allow family physicians, gynecologists and obstetricians to be aware of the potential risks to lead and other hazardous substances. This will enable timely behavior risk management and the interventions such as education and awareness. Such an inclusion will also allow continuous screening of pregnant women for risky lead exposure behaviors during antenatal visits as this will provide a more systematic and a less expensive way of establishing the epidemiological status of such behaviors and practices. Additionally baseline lead exposure studies are recommended to establish if there is a link between these habits and lead exposure in Botswana.

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