



Appendix 11: Lead Screening and Assessment Guideline for Health Workers, Policy Brief for Decision Makers and an Awareness leaflet on Lead Exposure for Pregnant and Lactating Women

CLINICAL ASSESSMENT TOOL FOR SCREENING LEAD EXPOSURE DURING PREGNANCY AND AFTER DELIVERY

Guidelines For Health Professionals 2012



This guideline provides information on lead, its sources, health effects and primary prevention strategies to educate, assess risks and confounders for lead exposure, provide counseling and care during pregnancy and follow-up after delivery.

The guideline is informed by current research and has been adapted to complement the information in the Botswana Obstetrics Record to be able to assess lead exposure risks along with other pregnancy risks.

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Part I: Introduction

Lead is a poison that affects many systems and functions in the human body including the neurologic, hematologic, gastrointestinal, cardiovascular and renal systems. It has a wide variety of uses in industries and at the household level.

The general uses of lead include:

- Batteries Production
- Ammunition Production
- Metal products (sheet lead, solder, brass and bronze products)
- Ceramic glazes
- Paint additive
- Medical equipment (radiation shields for protection against X-rays, ultra sound machines, surgical equipment)
- Scientific equipment (circuit boards for computers and other electronics)
- Military equipment (jet turbine engines)
- Fuel

Lead may also be found in household items such as mini plastic blinds, ceramic tiles, pottery plates, crystal glass and even in sweets and children's toys. Other practices which involve the uses of lead or lead containing products in the context of Botswana include

backyard repair shops and battery repairs, commonly observed in lower income families.

Car lubricants from backyard repair shops may contain lead naphthenate, an additive which is also used in wood preservative; insecticides; paint and varnish drier. Gear oil is one of the lubricants also known to contain high levels of lead. Lead is often used to mend Cast Iron pots and metal dishes in rural areas. This may expose family members and pregnant women.

How is the general public exposed to lead?

Lead exposure occurs when lead dust or fumes are inhaled, or when lead is ingested through contaminated hands, food, water, cigarettes or clothing. When lead enters the body, the respiratory and digestive systems, it is released to the blood and distributed throughout the body.

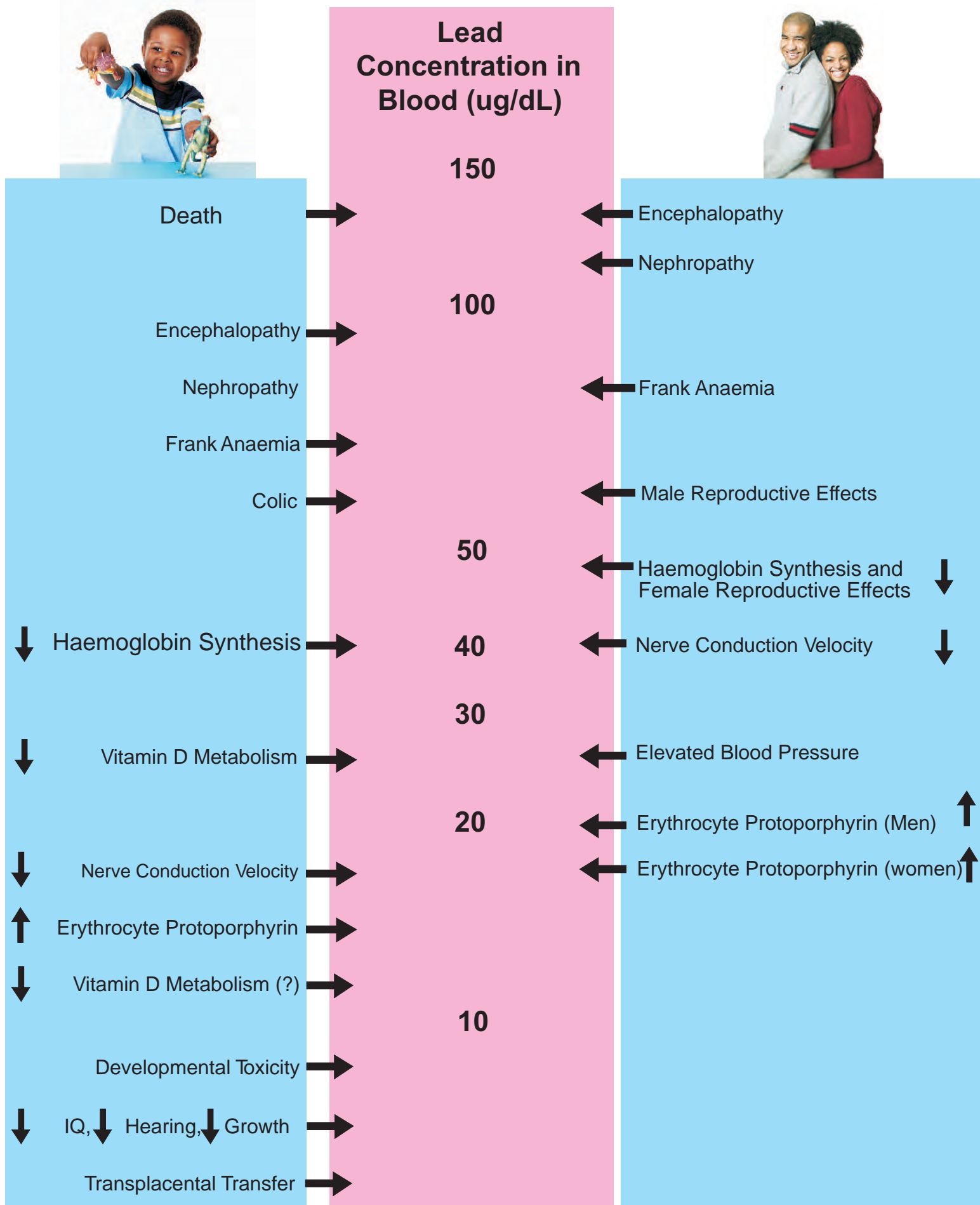
More than 90% of the total body burden of lead is accumulated in the bones, where it is stored and released later in life during times of stress. Lead in bones may be released into the blood, re-exposing organ systems long after the original exposure.

Part II: Health effects of lead

Lead can affect anybody, but children under five years of age are at greater risk because they tend to put their hands or other objects into their mouths; they absorb more ingested lead than adults; and their brains are still at a developing stage so they are more sensitive to the effects of lead.

Exposure to low doses of lead in children may persistently and irreversibly affect their neurological development. The US Centers for Disease Control and Prevention (CDC) defines an elevated concentration of lead in the blood as $10\mu\text{g}/\text{dL}$. However, there is evidence that some health effects can occur below this level and no level of lead in blood has been found to be safe (Diagram 1).

Diagram 1: Blood lead levels associated with adverse health effects in children and adults



Please Note: the sign ↓ = decrease and ↑ = an increase.

Source: Adapted from ATSDR, 1992

Lead exposure has been associated with multiple health effects ranging from death to impaired cognitive behaviour. The following are some of the examples of the adverse effects of lead:

- **Damage to brain and nervous system**
- **Developmental effects**
- **Gastrointestinal effects**
- **Behaviour and learning problems in children**
- **Anaemia**
- **Slow growth**
- **Damages to kidney and immune system**
- **Reproductive health problems**

Signs and symptoms of lead poisoning

Lead poisoning can be hard to detect — because even people who seem healthy can have high levels of lead in blood. Signs and symptoms usually don't appear until dangerous amounts have accumulated. The following are some of the known lead poisoning symptoms:

- **headaches**
- **muscle and joint weakness or pain**
- **excessive tiredness or lethargy**
- **behavioural problems or irritability**
- **difficulty concentrating**
- **loss of appetite**
- **metallic taste in the mouth**
- **abdominal pain, nausea or vomiting**
- **constipation**

Part III: Why are pregnant women of major importance in lead poisoning and prevention?

Even though children are particularly susceptible to lead poisoning, pregnant women are now recognized as a vulnerable group to lead exposure and lead poisoning because they often behave in similar ways as children such as ingesting

non-food items.

For example many pregnant women have been reported to have cravings for soils, chalk, and other non-food items. Additionally, the body's demand for calcium increases during pregnancy to support fetal bone development, which might release lead that was stored in bone.

Pregnancy and lactation can therefore accelerate the release of lead that was stored in bone during childhood to circulate in the blood stream. Once lead is in the blood stream, it passes through the placenta into the baby and into the baby's developing bones and other organs.

The following are some of the adverse effects of lead exposure for the mother and child:

- **increased risk of hypertension in pregnant women**
- **increased risk of miscarriage**
- **decreased IQ scores in babies born to lead poisoned mothers**
- **impaired neurobehavioral development in children born to mothers exposed to lead**
- **deficits in academic and cognitive skills in children and adolescents later in life**

Part IV: Basis for developing lead exposure screening and prevention guideline during pregnancy and after delivery

Evidence building:

In light of recent research which highlight the negative effects of prenatal lead exposure even at very low levels on maternal and infant health and the consequent life-long impacts on population health, a research was carried out in the Central Administrative District of Botswana to assess potential environmental sources of lead exposure during pregnancy, assess the behaviours and practices of women likely to influence lead exposure and finally assess blood lead levels at each stage of pregnancy and after delivery.

The Central Administrative District was chosen due to the existence a coal mine and a coal fired Power Station in the district. The study therefore compared results from an area in the vicinity of the mine (Palapye), a major village further away from the mining area and Power Station (Serowe) and two small villages with minimal industrial activity and traffic volume (Maunatlala and Lerala).

The purpose of the study was:

- a) To assess blood lead exposure levels during pregnancy
- b) To assess environmental lead levels in soils and water
- c) To assess behaviors of pregnant women that could potentially expose them to lead
- d) To use the information obtained from the study to develop lead exposure screening and prevention guideline for health workers, develop an awareness leaflet for pregnant women and a policy brief to disseminate the research result directly to decision makers in Botswana.

The following is a summary of the results:

- **Environmental Sources of lead exposure:** Soil lead concentrations were lower than the set international soil lead levels, however lead concentrations in drinking water by far exceeded permissible World Health Organization (WHO) drinking water-quality standards and therefore present a potential exposure source for pregnant women. Mean lead concentrations in water in Palapye, Serowe and small villages were 0.32 ppm, 0.25 ppm and 0.12 ppm respectively in excess of the WHO drinking water quality permissible lead concentration of 0.01ppm.
- **Behaviours and practices of pregnant women:** The study found that 83% out of a total of 142 pregnant women ingested non-food items such as soil (55%), pencil (10%), match sticks (13%), paint (4%), chalk and bone meal both accounting for 2% of the women. Pregnant women also engaged in unfamiliar practices such as the application of brake fluid (20%), torch batteries (8%) for “treatment” of psoriasis, ringworm and wounds. Light-brown shoe polish and traditional cosmetic clays were used by (18%) of women each for beautification purposes (vanishing and improving skin complexion). A substantial number of pregnant women in the study area engaged in alcohol consumption (31%), tobacco use (8%) and traditional medicines use (11%). Multiple risk behaviors (two or more risk behaviors) were practiced by 62% of women. Overall, age, employment and parity were significant predictors of whether a woman would engage in a risky behavior or not during the first trimester of pregnancy. The following is a summary of the implications for these behaviours based on current research elsewhere:

- **Eating soil (known as geophagia):** Severe lead poisoning from the ingestion of soil has been reported by many studies resulting with detrimental health effects for maternal and child health.
- **Eating other non food substances:** eating paint chips from furniture and walls, matchsticks, crushed bone meal, chalk and chewing pencil may cause lead poisoning. Some paints have lead therefore eating paint chips and chewing pencil (which is painted) can expose pregnant women to lead.
- **Applying brake fluid, torch battery contents on skin:** Brake fluid and other car oils contain lead and other heavy metals and studies have found high blood lead levels in people who apply brake fluid to their skin. Some torch batteries contain not only lead but other harmful chemicals to the health of the baby and the mother such as mercury, cadmium and arsenic.
- **Application of letsoku (red, yellow and brown clay) to skin:** Some pregnant women use letsoku for beautifying themselves by applying it on their skin. Other women have reported using letsoku to treat stomachaches. These clays have been tested and contain lead and other heavy metals which may be absorbed through the skin and the gastrointestinal tract and therefore expose women to lead.
- **Drinking alcohol and smoking:** Alcohol consumption during pregnancy may increase the absorption of lead and tobacco smoke contains lead. 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. Alcohol consumption and tobacco use are therefore potential confounders for lead exposure. Some homemade alcohol brews may be processed in lead based containers such as PVC material and therefore lead may leach into the brew and expose the women who consume such brews.
- **Traditional and other remedies:** Some women use traditional and other remedies from other countries. These may contain lead as they are extracted from different soils or processed in containers which may be contaminated by lead. Studies globally have shown that traditional medications cause severe lead poisoning in pregnancy.
- **Light-brown shoe polish:** 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. 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. The solvent concentrations in shoe polish may therefore be potentially confounding factors for lead exposure.
- **Blood lead levels:** Concentrations of lead in the blood of pregnant women in the Central District were lower than the US Centers for disease Control and Prevention (CDC) action level of 10µg/dL (mean blood lead levels 2.34µg/dL, range 0.5-12.90µg/dL). Out of 137 women who donated blood 6% had blood lead levels greater or equal to 5µg/dL. A significant increase in blood lead levels was observed between the first and third trimester of pregnancy. Mean blood lead levels (\pm SEM) for the first, second and third trimesters were 1.96(\pm 0.14)µg/dL, 2.49(\pm 0.17) µg/dL, 2.66 \pm 0.19) µg/dL respectively. The highest concentrations of lead in blood were observed in women from Lerala and Maunatlala, the smallest rural villages located further away from any pollution sources when compared to major villages being Serowe and Palapye. It was concluded that the increase in blood lead levels in small villages

was more a function of the socioeconomic status of women in Lerala and Maunatlala villages who were poorer, had more children, ingested soil and had poorer dietary habits compared to women from major villages. Additionally, these factors had an influence on blood lead levels which significantly increased at each stage of pregnancy, therefore reflecting past lead exposure from bone stores in women of lower socio economic status, with poorer dietary intake of iron and calcium rich foods. It is also important to note that even though these women were prescribed iron and calcium supplements at Government clinics, they did not utilize them as instructed, reflecting poor awareness on the importance of a good dietary intake of such supplements during pregnancy.

Low blood lead levels in pregnant women, should we be concerned?

The results of the study just presented showed very low blood lead levels. Should we be concerned? The answer is yes we should. While the US CDC has set $10\mu\text{g}/\text{dL}$ as an action level for lead poisoning, recent research suggests that there is no safe level of lead and that the current action level should be reduced to $2\mu\text{g}/\text{dL}$. Prenatal lead exposure has been linked to adverse neurodevelopment effects with mean blood lead levels as low as $1\text{--}2\mu\text{g}/\text{dL}$.

Furthermore, not only does research support the existence of adverse effects at levels lower than $10\mu\text{g}/\text{dL}$, but that the rate of decline in intelligence quotient (IQ) scores for example, might be greater at levels below $10\mu\text{g}/\text{dL}$ than it is at levels above $10\mu\text{g}/\text{dL}$. It is further important to note that even though cognitive outcomes have historically been the focus of most studies,

higher lead exposures have been linked to psychosocial disorders such as attention deficit hyperactivity disorder (ADHD) and aggression or even delinquency. In such high dose lead levels, chelation therapy has been used and a major concern raised by researchers is that chelation will not prevent or reverse neurodevelopmental deficits. (Please refer to Annexure 1 for further reading)

The evidence just presented by these studies emphasizes primary prevention of exposure as the best hope for mitigating the impacts of lead exposure. It is on this basis therefore that these lead exposure screening and prevention guidelines for health workers are prepared. It is further recognized that, the guidelines on their own will not make a difference.

It is therefore necessary to continue research and surveillance of lead exposure sources as new lead exposure sources keep emerging. It is also necessary to continuously inform the health workers to fully appreciate their roles as agents of change in lead prevention, and finally, it is critical that pregnant women, along with the general public be made aware of lead exposure sources, how to prevent exposures and maintain a healthy personal and environmental health.

Part V: Screening and prevention guidelines for lead exposure during pregnancy and after delivery:

The diagnosis of lead poisoning is challenging due to its vague symptoms. Only in high dose lead poisoning, symptoms such as severe abdominal pain, irritability, decreased consciousness, motor, and sensory deficits can enough diagnostic suspicion of lead toxicity be raised.

Chronic low dose exposure may manifest with non-specific gastrointestinal distur-

bances, subtle neurologic and subclinical cognitive deficits. In the majority of lead poisoning cases, the simple removal of the lead sources has proved sufficient coupled with a good iron, calcium and vitamin C-rich diet and good environmental lead prevention strategies.

Primary prevention of lead poisoning

It is better to prevent lead poisoning from happening in the first place than to treat lead poisoning after it has occurred. These screening guidelines (refer to diagram 2) are aimed at preventing lead exposure from occurring and thus decrease the number of pregnant women who may suffer from lead poisoning through:

- Increased education and awareness on lead poisoning and how it can be prevented
- Identification of lead exposure risks and confounders;
- Counselling and care of women who may be exposed to lead;
- Follow up of pregnant women through the entire pregnancy and after delivery to eliminate potential lead exposure sources.

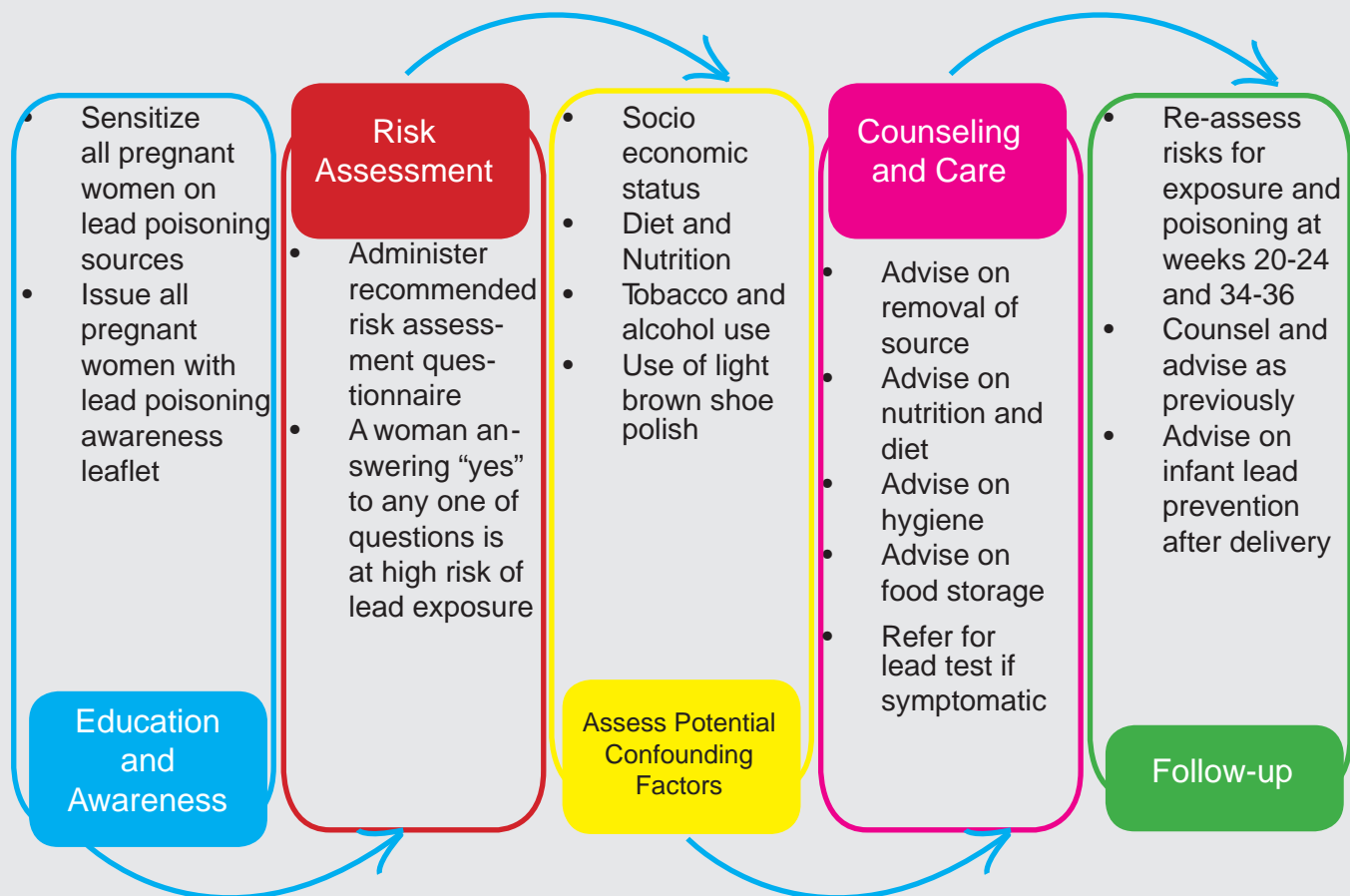


Diagram 2: The primary prevention of lead poisoning approach to mitigate lead exposure during and after pregnancy

Education and awareness:

- All Pregnant women should be issued with the lead awareness leaflet when they register for prenatal clinic at the initial visit during the first trimester of pregnancy. Key educational messages should focus on:

- Avoiding eating non-food items such as soil, matches, pencil, bone-meal, chalk, paint chips, and so forth;
- Avoiding to use unregulated traditional and other medicines from other countries which may contain lead;
- Avoiding applying brake-fluid, and torch battery contents, letsoku or any other products likely to expose them to lead;
- Not to purchase any herbal products that they are not sure of as they may contain lead, but to consult the health professionals for advice and treatment;
- Avoiding to use hot water directly from the tap for cooking and drinking;
- Reading the labels of all products to check if they contain lead;
- Practicing good hygiene and hand washing such as damp dusting instead of feather dusting;
- Being aware of environmental factors such as water, fuel used for

cooking and lead emitting practices such as backyard mechanics, home renovation, and waste management sites that may expose them to lead.

- Education and awareness of supplements prescribed at clinics should be reinforced, for women to take as prescribed

Risk assessment

All pregnant women should be asked the following questions upon their first prenatal registration. The reported practices should be incorporated in their obstetric record along with other pregnancy risks for follow up purposes. Answering yes to any of the questions is an indication that the woman is at risk of lead exposure:

1. Do you sometimes have a craving to eat soil, matches, pencil, paint, bone meal, chalk or anything that is non-food?
2. Do you use letsoku for vanishing or for any other purposes?
3. Do you sometimes use brake fluid (new or old) or torch battery contents for treatment of psoriasis, ringworm or wounds?
4. Do you use traditional medicine produced locally or remedies from other countries sold in

informal or formal markets? (see Box 1)

5. Is your job lead-related? (see Box 2)
6. Do you engage in hobbies or activities likely to expose you to lead? (see Box 3)
7. Is your water from a public standpipe?

Assessment of potential confounding factors:

a) Social status: poorer, unemployed women are at a higher risk of lead exposure due to poor diets, and lead contaminated environments such as backyard car repair workshops, living closer to waste management facilities which would have contaminated soils, and living in dusty environments.

b) Alcohol and tobacco use: see Part IV

c) Use of light brown shoe polish- see Part IV

Counselling and Care

Any woman who has answered yes to any of the risk assessment questions is at risk of lead exposure and possible poisoning and should receive counselling and guidance on how to avoid exposure sources.

The following is a guide to facilitate proper counseling and care of pregnant women:

Source/behavior or Practice

Investigate

Action

Pica behaviour

- Establish the item ingested
- Establish where it is obtained from
- Establish history (how long it has been practiced)

- Provide counseling and advise woman immediately to stop the behaviour
- Record the behavior on the Obstetric Record(MH022/ rev.97) under “other risks” for follow up
- Test for low iron in blood
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead. (see Box 4)

Cosmetics and traditional or other self prescribed remedies

- Establish the source of the remedy
- Establish the reason for the use of reported remedy or cosmetic
- Investigate the condition being treated with the remedy

- Provide appropriate counseling, treatment and care for the condition reported
- Record the behavior on the Obstetric Record(MH022/ rev.97) under “other risks” for follow up
- Advise on cosmetics and remedies (traditional and non-traditional) that may contain lead (see Box 1)
- Test for low iron
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Use of brake-fluid, torch batteries and so forth.

- Establish item used
- Establish condition being treated
- Establish preparation of item before use and mixtures used
- Provide appropriate treatment
- Advise the woman to stop the usage of the product immediately
- Advise on the health impacts of the practice
- Record the behavior on the Obstetric Record(MH022/ rev.97) under “other risks” for follow up
- Test for low iron
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Alcohol consumption and tobacco use

- Establish the type of alcohol used (formal or traditional brews)
- Establish type of tobacco used (snuff or smoking, cigarettes or roll-your-own)
- Establish history of behavior and family members involved in the habit likely to affect the health of the pregnant woman (e.g. cigarette smoking)
- Advise the woman to stop the usage of the product
- Offer advise to other family members likely to affect the pregnant woman. This might require a home visit
- Advise on the health impacts of the practice
- Record the behavior on the Obstetric Record(MH022/ rev.97) under “other risks” for follow up
- Test for low iron
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Use of light-brown shoe polish

- Establish purpose of use
- Establish history of use
- Offer advice on immediate stoppage of product
- Advise on health effects of solvents in shoe polish and effects on pregnancy
- Test for low iron
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Hygiene and home environment

- Establish if home is paved or has lawn
- Establish indoor and outdoor cleaning practices (if cleaning routine follows damp dusting or feather dusting, etc)
- Establish Hand-washing practices
- If home surroundings are not paved or have a lawn advise dampening the ground before sweeping
- Advise damp dusting in the house as opposed to feather dusting
- Advise on regular hand washing before preparation of meals and eating
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Environmental factors
(water source, fuel
source)

- Reestablish the type of water source
 - Establish type of plumbing
 - Establish heating and cooking source
 - Establish renovation status
- Advise woman to run water from standpipe or tap for at least one minute first thing in the morning or if the water has been standing in the tap for a few hours.
 - Advise woman not to use hot water for cooking, drinking and mixing formulas directly from the tap. Lead leaches more from hot water if plumbing is lead based
 - If heating source is wood, advise woman not to use treated wood as it may contain lead
 - Advise women to avoid staying in the house during renovations to avoid dust from paint and other materials that may contain lead
 - Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Lead related occupations and hobbies

- If the pregnant woman is employed, establish the if the job is not lead related
- Establish if the woman has lead related hobbies
- See Box 2&3 for lead related jobs and hobbies
- If the job is lead related, offer advice on hygiene such as regular hand-washing, not taking work clothes home, informing the employer of her pregnancy and to avoid lead exposure.
- Test for low iron
- Offer advice on diet and nutrition – Iron, calcium and vitamin C rich diet reduces absorption of lead (see Box 4).

Follow up

1) All women should be followed up during subsequent visits at weeks 20-24, 34-36 and six weeks after delivery to establish if the behavior, practices and environmental factors identified above are still continuing or have been stopped. If the practices have not been stopped appropriate advice and counseling should be continued.

2) Education after delivery:

a. All steps must be taken to advise women after delivery to prevent lead poisoning of the infant:

b. Where the baby is not breastfed and infant formula used, women must be advised to boil tap water and not to use hot water directly from the tap. All tap water should be run for at least one minute if it has been standing for a while:

c. The baby should be fed with foods that are rich in iron to lower their lead risk:

d. Mothers must be advised to purchase lead-free infant toys and hands must be washed often.

Part VI: Lead exposure sources _examples

- **Letsoku - A traditional clay cosmetic for vanishing and skin conditioning**
- **kohl surma - a black powder used as an eye cosmetic and sometimes an umbilical stump remedy**
- **Azarcon - bright orange powder often used to treat gastrointestinal upset stomach - ach**
- **BaliGoli: Around, fat bean dissolved in "gripe water" for treatment of stomach ache**
- **Greta: Yellow-Orange powder used to treat digestive problems**

Box 1: Examples of cosmetics and remedies found to contain lead



- Use of paints containing lead
- Home renovation
- Recycling and metal scrap yards or working in waste disposal sites
- Glass recycling, stained glass and glass manufacturing
- Manufacturing or installation of plumbing components
- Pottery making
- Battery manufacturing and repair
- Production and use of chemical preparations
- Firing range work
- Car repair shops

Box 2: Examples of lead related occupations



- Scraping, sanding and burning of paint containing lead on woodwork, walls and other household structures
- Handling electronics with lead solder
- Glass blowing with leaded solder
- Making pottery and ceramic utensils with lead glazes and paints
- Scrap metal collection and processing
- Painting
- Mending three legged cast iron pots and metal dishes with lead solder

Box 3: Examples of hobbies, activities that may cause lead exposure



Part VII. Diet and nutrition guide

Lead is more easily absorbed on an empty stomach. In order to reduce lead absorption, pregnant women should be advised to eat regular meals and eat more frequently. Dietary deficiencies in iron, calcium, and vitamin C may make pregnant women more vulnerable to lead exposure. Diets rich in iron discourage absorption of lead. Calcium is known to compete with lead and can inhibit its absorption. Vitamin C is important to facilitate increased excretion of lead by the kidneys. Where women are prescribed iron, calcium and vitamin C supplements as is the current Government policy, this must be accompanied by proper education and counselling to promote compliance on regular intake of such supplements alongside good eating habits.

Box 4: Dietary Sources of Iron, Calcium and Vitamin C

Sources of iron

Meat: lean beef, veal, ham, pork, chicken, lamb

Fish: clams, mussels, oysters, tuna, cod, sardines

Eggs

Liver

Cereal: iron fortified cereals, wheat germ

Fruits: dried fruits (apricots, raisins, prunes, dates)

Vegetables: spinach, collard greens, lentils, peas, beans, peanut butter

Sources of calcium

Fish: sardines, anchovies, shrimp, trout, cod, mackerel, tuna, salmon, crab, lobster

Milk, ice cream, yoghurt, cheese

Vegetables: cabbage, collard, broccoli, spinach

Fruits: oranges, pineapples, raisins, fortified orange juice

Sources of vitamin C

Fruits: grapefruit, oranges, cantaloupe, strawberries, juices, wild berries, moretlwa, morula, mmopudu, mogorogowana

Vegetables: broccoli, green peppers, greens

Annexure 1: Additional Reading

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Environmental Lead Exposure During Pregnancy and After Delivery

Introduction

Lead is a persistent heavy metal that is toxic to humans and the environment. Due to such persistence lead is detected in water and soils even in the most remote parts of the world. The negative effects of lead are known globally and as a result countries around the world have developed lead exposure prevention policies and legislation to protect public and environmental health.

Health Effects of Lead

Lead exposure has been associated with multiple health effects ranging from death to impaired cognitive behaviour. Lead can affect anybody, but children are at a greater risk because they tend to put their hands or other objects in their mouths, additionally because their organs are not fully developed, the effects of lead on them are more devastating.

Even though children are particularly susceptible to lead poisoning, pregnant women are now recognized as a vulnerable group to lead exposure and lead poisoning because they often behave in similar ways as children such as ingesting non-food items.

Many pregnant women have been reported to have cravings for soils, chalk, and other non-food items.¹ More than 90% of lead is accumulated in bones where it is stored and released later in life during times of stress such as pregnancy.² Pregnant women therefore have additional lead from bone during pregnancy, which is released with calcium to support the unborn baby's bone development.

Once lead is in the blood stream, it passes through the placenta into the baby's developing bones and other organs and may cause increased spontaneous abortions, and low birth weight,³ decreased intelligence quotient (IQ) in babies,⁴ deficits in academic and cognitive skills in children⁵ and hypertension⁶ and anaemia in pregnant women.¹

Sources of Lead Exposure Pathways for Pregnant Women

There is an increased recognition that lead contaminated soils are an exposure source to humans. Soil can enter the human body through

inhalation, eating soil and through skin lesions.^{1,7,8} Another important pathway for lead exposure is water. Water lead levels can vary from dwelling to dwelling due to the variations in plumbing configurations as well as social factors.⁹ Water is also relatively efficiently absorbed by the body compared to other sources. Recent research further estimated that water, both in its direct form and indirectly through adsorption contributes on average to at least 10% of lead in food.¹⁰

International Guidelines for Lead Exposure

The developed world has long recognised lead as a toxin and has put in place guidelines for monitoring lead exposure particularly in children and pregnant women. The US Centers for Disease Control has for example set blood lead levels at 10µg/dL or higher as an action level to prevent lead poisoning.¹¹ Current research suggests that there is no safe level of lead and that the current action level should be reduced to 2µg/dL.⁵

Exposure of infants during pregnancy has been linked to adverse neurodevelopment effects with mean blood lead levels as low as 1-2µg/dL.⁵ It is further important to note that even though cognitive outcomes have historically been the focus of most studies, higher lead exposures have been linked to psychosocial disorders such as attention deficit hyperactivity disorder (ADHD) and aggression or even delinquency. The World Health Organisation (WHO) has also set a water lead levels standard of 0.01 ppm¹² to prevent lead exposure and potential lead poisoning.

Lead Studies in Botswana

The following studies have been carried out in Botswana:

In 2012 a study was carried out in pregnant women from four villages in the Central District of Botswana (current study). Blood samples were collected during the first, second and third trimesters of pregnancy from 137 women. The mean blood lead levels were 2.34 µg/dL.

The highest mean blood levels were in women from Lerala village in all trimesters of pregnancy compared to other villages (3.33 µg/dL, 3.78 µg/dL and 3.84 µg/dL during the first, second and third trimesters respectively). The highest

blood lead level was 13 µg/dL (detected from a woman from Lerala during the third trimester).

Poorer women living in small rural villages had significantly higher blood lead levels. In the same study water lead levels were tested and showed that the levels were 19 times higher than the permissible concentrations set by WHO.

The habits of pregnant women have also been studied from the Central District to establish women potentially exposed to lead. Out of a group of 142 pregnant women, more than 80% ate non-food items and out of these more than 50% ate soil (diolo). More than 30% of the women also applied lead containing substances such as brake fluid and torch batteries to treat conditions such as ringworm and psoriasis.¹³

In 2010 a study was carried out among children in the city of Gaborone. Out of a total of 220 children aged 1-6 years, 31% had blood lead levels equal to or greater than 10 µg/dL and of these children 5% had blood lead levels equal to or above 20 µg/dL.¹⁴

Conclusion

Prenatal exposure to lead is increasingly becoming an issue of concern due to several reasons. Among these is concern that substantial foetal lead exposure can occur from mobilization of maternal skeletal lead stores, which can in turn persist for many years after external lead exposure has declined. Another concern is that the foetal nervous system is extremely sensitive to neurotoxins.

Few studies have been conducted in Botswana on lead exposure and poisoning. However the studies reported above indicate that more pregnant women and children could be exposed to lead. The need for primary prevention of lead exposure in these vulnerable groups can therefore not be over emphasized. This is in light of emerging evidence that lower lead levels can cause adverse health effects on women and children than previously thought.

Policy Recommendations/ Options

Surveillance of Lead Levels in Water

Botswana currently has set water standards that are in line with the WHO water quality standards; however, lead is not currently tested in water. There is need for water to be tested regularly to prevent adverse health effects caused by lead in population health.

Regulation on Lead Containing Plumbing Materials

There is an urgent need for Botswana to consider regulating materials containing lead for plumbing purposes. The high levels of lead in the Central District could be attributed to lead solder which is not regulated in Botswana. It is also important that other water parameters such as pH need to be monitored in order to reduce lead leaching accelerated by water that is highly acidic.

Inclusion of Lead Related Risk Behaviour Screening Questions in The Obstetric Record

It is recommended that the Botswana Government should include behaviors and practices such as pica, the use of brake fluid and other harmful practices in the obstetric record as women register for the first time in order to identify lead related risk behaviours and provide proper counselling, care and follow up in subsequent trimesters.

Education and Awareness

Education, awareness, counselling and care of pregnant women who engage in soil pica and other non-food items should be intensified and these behaviours incorporated in the current obstetric record when pregnant women register for the first time at prenatal clinics. This should be preceded by intensive training of health workers on lead exposure and its adverse health effects. It is further recommended that lead exposure and poisoning training be incorporated in the curriculum of midwives.

Research and Surveillance

A national lead surveillance programme should be implemented in Botswana to identify the key sources, mechanisms of exposure and ingestion of other risk factors for lead exposure during pregnancy and lactation. The survey should incorporate environmental sources of lead exposure as well as behaviours that could potentially expose different population groups. For example brake fluid use, and torch battery use seem to be accepted by communities as treatment options for skin problems. Communities in rural and low income areas could also still be mending cooking pots and utensils with lead solder. These and many other practices need further investigation.

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**DID YOU KNOW THAT LEAD IS A
POISON?
IF YOU ARE PREGNANT OR
LACTATING, READ THIS LEAFLET TO
KEEP YOU AND YOUR BABY SAFE**

WHAT IS LEAD?

It is a persistent heavy metal that is harmful to humans & the environment. Lead may also occur naturally in rocks and soil. It is used also to join water pipes and other metallic products. Lead is also found in many household and industrial products such as torch and car batteries and is used in car lubricants such as brake fluid and gearbox oil. Decorated plates (pottery) may also contain lead. In Botswana some people also use it to mend leaking cast iron cooking pots (the three legged pot) and metal dishes. Some people also use it to join the rods used for pot stands (matshego) in villages.

It may also be found in dinkgwana (clay-based pots) used to store water in villages.

WHAT IS LEAD POISONING?

Lead poisoning is a medical condition caused by increased levels of lead in the body. Lead in the body can cause permanent damage to the brain and other organs. Children are most at risk for the damage caused by lead poisoning. But, a pregnant woman who has lead in her body may expose her baby by passing the

lead to the expected baby. Symptoms include abdominal pain, confusion, headache, anaemia, irritability and it may even cause seizures, coma and death when the levels are very high.

WHY SHOULD I BE WORRIED ABOUT LEAD?

Lead exposure can cause:

- High blood pressure in a pregnant woman
- Babies born too soon or too small
- Miscarriage and stillbirth
- Lower IQ in children
- Learning and behavior problems in children
- Slow growth in children
- Poor hearing in children

HOW CAN I BE EXPOSED TO LEAD?

We breathe lead in the air and dust. People who eat soil and ant-hills are also exposed to lead. We may also be exposed to lead from water pipes where lead solder (material used to join pipes) has been used. In Botswana pregnant women also use brake fluid and other car oils and torch batteries to 'treat' skin problems such as psoriasis and ringworm.

Lead and other heavy metals in these products may be absorbed through the skin when you use them and circulate in your blood making you sick.

If a pregnant woman has been exposed to lead as a child, her body may store the lead in her bones and teeth. If the pregnant woman's

diet does not contain enough calcium, the body may substitute lead in her bones for the calcium that the baby needs.

HOW CAN MY UNBORN BABY BE EXPOSED TO LEAD?

- A pregnant woman can breathe in or swallow lead. This passes from her to the baby.
- The lead can enter the mother's bloodstream.
- Lead in the mother's womb passes through the placenta and can get into the baby's bones, brain, and other organs.
- If a pregnant woman was exposed to lead in the past, before becoming pregnant, this can also cause problems for the unborn baby. This lead can be stored in her bones for many years and then be released during pregnancy

HOW CAN I PREVENT LEAD EXPOSURE?

Lead poisoning can be devastating, but it is preventable. If you follow these messages you and your baby will be safe.

DOs

1. Eat foods rich in calcium, iron, and vitamin C: These will protect you and your unborn baby.
- Calcium is in milk, yoghurt, cheese, and green leafy vegetables like spinach.
 - Iron is in lean red meat, beans, cereals, and green leafy vegetables like spinach.

- Vitamin C is in oranges, green and red peppers, broccoli, tomatoes, moretwa, morula, mmupudu, mogorogorwane and juices.
 - Be careful when eating sweets, spices, and other foods that have been brought into the Botswana from other countries, especially if they appear to be non-commercial products.
2. Store food properly. Some food containers may contain lead. It is important to store and serve your food properly.
 - Avoid using or storing food in imported lead-glazed ceramic pottery or any pottery produced locally if you are not sure it may contain lead.
 - Avoid using brass containers or utensils to cook, serve, or store food.
 - Avoid using leaded crystal to serve or store drinks.
 - Do not use dishes that are chipped or cracked.
 3. Use only cold water directly from the tap for cooking and drinking: Run water for 30 to 60 seconds the first thing in the morning or during any part of the day especially if you haven't used your water for a few hours. Hot water will make lead in pipes dissolve in water.
 4. Encourage members of your family working in lead related jobs to shower at work: If a member of your family works in an industry with high lead exposure, he or she can

bring lead dust home on his or her clothes, hair, shoes and skin, passing the dust to others in the family. Their clothes should also be washed separately.

5. Read the labels on anything that you buy: check if the product contains lead.

DON'Ts

- Do not eating soil or chew pencil, matches, peeling paint chips from furniture or walls and chalk. If you have cravings for any of these, contact your health care provider so that they may help you.
- Do not apply brake fluid or any other car oil to your skin; it contains lead and other chemicals that can harm you and your child. If you have a skin disease please consult your health care provider, they will give you treatment for that condition. Also do not use used car oil to condition your floors because you will carry lead in your shoes and crawling babies will be exposed from their hands.
- Do not use torch batteries for treatment of ringworm. Torch batteries contain lead , mercury, arsenic and other chemicals that may affect you and your unborn baby.
- Do not apply letsoku on your skin or drink it if you have stomach ache. Some letsoku that is sold on the market (dimausu) contain lead that can be absorbed through

your skin and your gastrointestinal tract.

- Do not apply shoe polish on your skin. It has the same effects as lead and may cause brain damage and anaemia. You may also give birth to a small baby.
- Do not use traditional medicine mixtures, especially those sold out in dimausu (informal markets). Consult your health professional if you have any condition to treat.
- Do not smoke cigarettes or drink alcohol during pregnancy. Snuff tobacco is also not safe.

If you have any questions, consult your nearest local clinic. They will provide you with more information