EXPOSURE TO MERCURY AND ASSOCIATED MENSTRUAL DISORDERS AMONG WOMEN IN ARTISANAL AND SMALL SCALE GOLD MINING IN NYANG'HWALE DISTRICT, GEITA, TANZANIA

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MSc (Environmental and Occupational Health) Dissertation
Muhimbili University of Health and Allied Sciences
October, 2019

Muhimbili University of Health and Allied Sciences

School of Public Health and Social Sciences

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By

Shuku C. Kaishwa

A Dissertation Submitted in (Partial) Fulfilment of the Requirements for the Degree of Master of Science (Environmental and Occupational Health) of

Muhimbili University of Health and Allied Sciences
October, 2019

CERTIFICATION

The undersigned certifies that they has read and hereby recommends for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled: **"Exposure to Mercury and Associated Menstrual Disorders among Women in Artisanal and Small Scale Gold Mining in Nyang'hwale District, Geita, Tanzania'',** in (partial) fulfilment of the requirements for the degree of Master of Science (Environmental and Occupational Health) of Muhimbili University of Health and Allied Sciences.

_____

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(Supervisor)

Date: _____

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Dr. Jane Mlimbila

(Co- Supervisor)

Date: _____

DECLARATION AND COPYRIGHT

I, **Shuku Charles Kaishwa**, declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other university for similar or any other degree award.

Signature: …….. **Date:** ……...

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ACKNOWLEDGEMENT

First and foremost, I would like to thank the Almighty God for giving me life, good health, endurance and a hard working spirit since I started this study until now. I wouldn't have finished this study if he abandoned me."***Glory to God the Almighty Heaven Father''.***

I would like to convey my special thanks to my supervisors Dr. Simon Mamuya and Dr. Jane Mlimbila for their tireless supervision, guidance, insight, criticisms, and many suggestions to make this study successful. I am most grateful also to NORAD through the NORHED – programme (Norwegian Programme for Capacity Development in Higher Education and Research for Development) for financial support given to me.

I also would like to extend my sincere gratitude to Mr E.Ntiriyo, the District Environmental and Sanitation Officer (DESO) Nyang'hwale District, District Medical Officer, Village executive officers for Kasubuya, Ng'wasabuka, Ifugandi and Shibaranga, and head teachers for primary schools participated in this study for their cooperation in this study for their great support during data collection. I am highly thankful to the mining community for their voluntary participation in this study; last but not least I am grateful to Government Laboratory Chemistry of Lake zone for performing laboratory analysis, also special thanks go to my husband, my family for their support and encouragement in conducting this study.

Special thanks also go to my research assistants for the high spirit they have shown during data collection.

Last but not least, I would like to extend my sincerely gratitude to all people who have contributed to the achievement of this study. God bless you all.

DEDICATION

This dissertation is dedicated to my lovely family Mr. Yohane M. Kanjanja, Wambi Yohane Kanjanja, Atipelile Yohane Kanjanja, Emmiliana M. Kanjanja,Pendo Charles Kaishwa, Martha Charles Kaishwa, Scholastica Charles Kaishwa, Sekunda Charles Kaishwa,Yesse Charles Kaishwa, Omary Charles Kaishwa, Obed Charles Kaishwa and Eva Adamson; who motivated me to endure all challenges during the study.

Special dedication to my lovely mother Veronica Omary Mashimba for her prayers and always giving me hope and encouragements to face the challenges during the initial stage of research preparation to the end of the study.

ABSTRACT

Background: Tanzania 30-50% are women involved in mining activities, normally use mercury to recover gold from the ores. This practice may cause a wide range of health impacts including reproductive defects in reproductive hormones and an ovulation which may result to menstrual disorders in women working in artisanal and small scale gold mining.

Objective: The study aimed to assess occupational exposure to mercury and associated menstrual disorders among women working in artisanal and small scale gold mining in Nyang'hwale District, Geita, Tanzania.

Materials and methods: The study was a cross sectional study design. Simple random sampling technique was used to obtain 170 of women working in ASGM and 99 of women were primary school teachers. Data on the proportion of menstrual disorders were collected using face to face administered questionnaire and analyzed using descriptive statistics. The Chi square test and Binary logistic regression were performed for association between mercury exposure and menstrual disorders. 95% confidence Interval expressed in P = 0.05 or P<0.05, was used. CVAAS was used to analyze mercury concentration level in urine.

Results: The mean Age of the participants was 33.6 ± SD and the mean of menarche age was 15.26 ± SD. The proportion of menstrual disorders in the exposed group was significant higher than that in the non exposed group (OR 1.5; 95% CI 1.160 – 1. 876 and P= 0.001). The proportion of menstrual disorders in exposed group was (67%) and non exposed group (46%). The proportion of dysmenorrhea in the exposed group was found statistically significant higher than that in the non exposed group (OR 2.7; 95% CI 1.579 – 4.489 and P= 0.0001) and the proportion was (38%). The mean mercury levels in urine were 41.3ug/l for exposed group and 2.04ug/l for non exposed group. Out of 21 urine samples, 6 (29%) exceeded the Maximum World Health Organization (WHO) acceptable level of 50 ug/l.

Conclusion and recommendation: The findings generalized that women who are exposed to occupational mercury have higher risk to report the problems of menstrual disorders. The district council stakeholders should create awareness to mining community, that mercury used for amalgamation process to extract gold may be associated with menstrual disorders and other reproductive health defects among women working or living nearby the mining areas.

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ABBREVIATIONS

ASGM	Artisanal Small Scale Gold Mining
WHO	World Health Organization
UNEP	United Nations of Environmental Protection
PMS	Premenstrual Syndrome
NIOSH	National Institute of Occupational safety and Health
BJOG	International Journal of Obstetrics and Gynecology
NEMC	National Environmental Management Council
ATSDR	Agency for Toxic Substances and Diseases Registry
CVAAS	Cold Vapor Atomic Absorption Spectrometry
SPSS	Statistical Package for Social Sciences
OR	Odds Ratio
CL	Confidence Interval
AMDC	African Minerals Development Centre's
AMREF	African Medical and Research Foundation

DEFINITION OF TERMS

Menstruation refers the flow of blood and tissue lining the uterus through the vagina. Most sources note that flow happens for 5 days (range 2-7 days), every 28 days (range 21-35days) (e.g. Fraser, 2011).

Menstrual disorder refer to an abnormal condition in a woman menstrual cycle such as; when menstrual periods that occur less than 21 days or more than 35 days apart, missing three or more periods in row, and menstrual flow that is much heavier or lighter than usual.

The symptoms of Menstrual disorders includes; (of duration or length), hyper- or hypomenorrhoea, polymenorrhoea or oligomenorrhoea, dysmenorrhoea, amenorrhoea, menorrhagia, prolonged menses, intermenstrual bleeding (Karout et al, 2014).

Dysmenorrhea Pain (e.g. cramps) or discomfort related to menstruation, either primary (associated directly with menstruation) or secondary (related to an underlying gynecological disorder) (Medical Dictionary - The Free Dictionary, Fraser 2011).

Amenorrhea Absence menstrual periods: stops getting period for at least 3 months and is not pregnant.

Oligomenorrhea infrequent menstrual periods: Periods that occur more than 35 days apart.

Menorrhagia heavy menstrual periods: Also called excessive bleeding.

Prolonged menstrual bleeding: Bleeding that exceeds 7 days in duration on a regular basis.

Polymenorrhea: Frequent menstrual periods occurring less than 21 days apart

Hypomenorrhoea: Shortened menstrual bleeding of less than 2 days in duration

Intermenstrual bleeding: Episodes of bleeding that occur between periods, also known as spotting

Artisanal and Small-Scale Gold Mining (ASGM) refer to Small groups of people engaged in low-cost, low-tech, labor intensive excavation and processing of gold. (ILO).

Mercury (Hg) is a heavy silver liquid metal. When heated, it turns into invisible vapors. Even at room temperature, it releases toxic vapors. (UNEP, 2014).

Amalgamation refer to the process of mixing mercury with gold-containing materials, forming a mercury-gold amalgam which is then heated, vaporizing the mercury to obtain the gold. (UNEP, 2014).

CHAPTER ONE

1.1 Background Information

Artisanal and small-scale gold mining (ASGM) is undertaken by individuals or groups with limited equipment and often informally without mineral right (1). Artisanal small scale mining (ASGM) is increasingly common in many parts of the world with more than 30 million active artisanal miners in more than 55 countries (2). It is estimated that over 30% of all ASGM activity worldwide is undertaken by women but depending on the region this may be much greater (3). In Africa, ASGM workforce comprises no less than 40-50% women (4). Female miners can take part in all aspects of mining, digging, crushing, transporting, sorting, processing and trading (5). In Tanzania alone, there are an estimated 0.5 to 1.5 million informal miners, of whom 30-50% are women (2):- involved in mining activity they normally use mercury to recover gold from the ore. Again in gold smelting or amalgam they use their bare hands when handling mercury, which expose them to risk both from mercury vapour and direct contact through skin. In fact, the number of artisanal mining sites is expanding in many regions of Tanzania, particularly around Lake Victoria and in the central and southwestern regions of the country (2); Artisanal mining activities are largely concentrated in rural areas that have very little infrastructure, and the individuals undertaking informal mining generally lack education, training, management skills and essential equipment for safe mining practices (2). In mining process, mercury is used to extract gold from ore in artisanal or small scale gold mining. Approximately 40% of this mercury is lost during the initial concentration of amalgamation stages of the gold mining process and the remaining 60% is released directly into the atmosphere when the Hg amalgam is burned at the end of the purification process, exposing miners to inorganic-mercury poisoning either via the respiratory tract as vapor or through the skin by contact (6). Thus resulting into millions of miners, infants, children, women of child bearing age (potentially pregnant), and breast-feeding women, working or living in ASGM communities be at risk of mercury exposure (7). Chronic mercury exposure may seriously result to menstrual cycle disorders, arising from interference with the part of the brain which controls reproduction (hypothalamo-pituitary-gonadal axis) (19). Epidemiological

studies have shown the harmful effects of mercury vapour on the central nervous system; the excess of ovulatory troubles in a group of occupationally exposed women has been interpreted as an indirect consequence of this effect on the pituitary hypothalamic axis (8). Mercury is poorly absorbed through the skin and gastrointestinal tract by less than 1%, also is efficiently absorbed through the lung by 80% to 85% (9), the dissolved vapour remains in the blood long enough to cross the blood brain barrier where it is oxidized and eliminated only very slowly (10).Necropsy studies of occupationally exposed to mercury have found high concentrations of mercury in the pituitary, thyroid, and brain; these is evidence that mercury persists in these tissues for many years, hence the mercury that accumulates is biologically active able to interfere with endocrine or reproductive function (10). The occurrence of these hormonal problems may lead to the development of various chronic health problems, including menstrual cycle irregularities and the continually occurring over a long periods may result in early onset of menopause. (11). But the evidence shows that the women exposed to mercury are reported to have the highest prevalence of menstrual cycle disorders, compared to non mercury exposed group according to some studies done in China, Italy, and Colombia (17%, 47% and 59% respectively) (8,12,13).

In European and North American studies, it was found that over one-half of the women of reproductive age and about 30 to 90% of menstruating women report lower abdominal and lower back pain associated with the menstrual cycle due to mercury vapour exposure. (12). The findings suggest that globally there is high prevalence of menstrual disorders such as dysmenorrhea, prolonged menstrual periods, irregular periods, heavy flow periods and premenstrual syndrome (14). The World Health Organization (2008) reported that 18 million women of reproductive aged perceive their menstrual bleeding to be excessive. Such disorders have economic consequences in terms of health care costs due to the consumption of expensive hormonal drugs and laboratory tests (15). In developing countries approximately 4 to 8% of women report having menstrual periods longer than 7 to 8 days and excessive, profuse or heavy bleeding 4 to 9% and prevalence of excessive bleeding was reported to be higher, increasing from 8% to 27%.(16). Nigeria and Ethiopia also reported the prevalence of

menstrual cycle disorders among the women in reproductive age to be 19% and 46% respectively (17).

1.2 Statement of the problem

Tanzania is a country with significant mineral resources, including gold. It is estimated 0.5 to 1.5 million informal miners, of whom 30-50% are women (2), being involved in mining activity are normally using mercury to recover gold from the ores, with gold smelting or amalgam they use their bare hands when handling mercury, which expose them to risk both from mercury vapour and direct contact through skin. This practice may cause a wide range of health impacts including reproductive defects in reproductive hormone and an ovulation which may result to menstrual disorders in women working in ASGM (18). However the menstrual disorders are the most common gynecological problem among women of reproductive age. But the evidence shows that the women who are exposed to mercury reported the highest prevalence of menstrual disorders, according to some studies done in China, Italy, and Colombia (17%, 47% and 59%) respectively (8,12,13). Although the menstrual disorder is associated with psychosocial problem, life style, health status; also may be associated with mercury exposure (19).

Studies done in Tanzania on mercury exposure and associated health effects among ASGM focused on mercury intoxication and neurological symptoms, tremors, stomatitis, gingivitis memory loss, vision impairment, insomnia, emotional instability and other health symptoms (2,20,21). Despite the fact that mercury exposure has been associated with a wide range of the health effects; mercury exposure associated with menstrual disorders in women working in artisanal and small scale gold mining is not yet documented and most of studies which were done in industries or factories are from other countries. This study will cover this gap and enrich information on menstrual disorders associated to mercury exposure among women in mining area.

1.3 Rationale of the study

Findings from this study will yield useful information to Tanzanian Ministry of Health, Community Development, Gender, Elderly and Children that may help in providing clinical training to health care providers to identify menstrual disorders associated with mercury exposure and report them as part of their routine diseases report and address on coming Health policy menstrual disorders as public reproductive health problem.

The findings will help the government and other stakeholders to take intervention to achieve SDGs number 3 to ensure good health and well being for the women working in ASGM.
The study is for fulfillment of my master degree of science in Environmental and Occupational health.

Also the findings will add up to the body of knowledge of the scientific community on understanding the exposure to mercury during the gold amalgam, vaporization may affect the reproductive hormones and endocrine system which may result to alteration of the menstrual cycle.

Moreover findings from this study may be useful to the Ministry of energy and minerals in instituting the best available alternatives in gold extraction instead of mercury**.** According to National Environmental Management Council (NEMC) of Tanzania; ASGM is an urgent pollution problem that needs to be addressed and attention is needed at the political level to emphases more on the safety methods or techniques to be used in ASG mine extraction like use free mercury techniques in ASGM, in order to reduce the burden of reproductive health effect including menstrual disorders to women who are working in artisanal and small scale gold mine activities. As regard to Minamata convention on mercury article no.1 and article no.7 emphasize on establish the measures that will reduce or eliminate the uses of mercury, also according the Tanzania Mineral Policy 2009 which emphases on best practices for health, safety and environmental management in mining areas to protect the environmental mining area and human health so as to enhance the sustainability on mining activities in our country.

1.4 Main research questions

Is there association between occupational exposure to mercury and menstrual disorders among women in artisanal and small scale gold mining in Nyanghwale District?

1.5 Specific research question

1. What is the proportion of women with menstrual disorders among the women in artisanal and small scale gold mining in Nyanghwale District?
2. What is the mercury concentration in urine among the women working in artisanal small scale gold mining in Nyang'hwale District?

1.6 Main study objective

To assess association of occupational exposure to mercury and menstrual disorders among the women working in artisanal small scale gold mining in Nyang'hwale District, Geita.

1.7 Specific study objectives

1. To determine the proportion of women with menstrual disorders among the women in artisanal and small scale gold mining in Nyang'hwale District.
2. To determine the concentration of mercury level in urine among the women in artisanal and small scale gold mining in Nyang'hwale district.
3. To examine the association between mercury exposure and menstrual disorders among women in artisanal and small scale gold mining in Nyang'hwale District.

1.8 Study Hypothesis

Alternative Hypothesis

There is an association between mercury exposure and menstrual disorders among women working in ASGM.

Null Hypothesis

There is no association between mercury exposure and menstrual disorders among women working in ASGM.

1.9 Conceptual frame work

Independent Variables

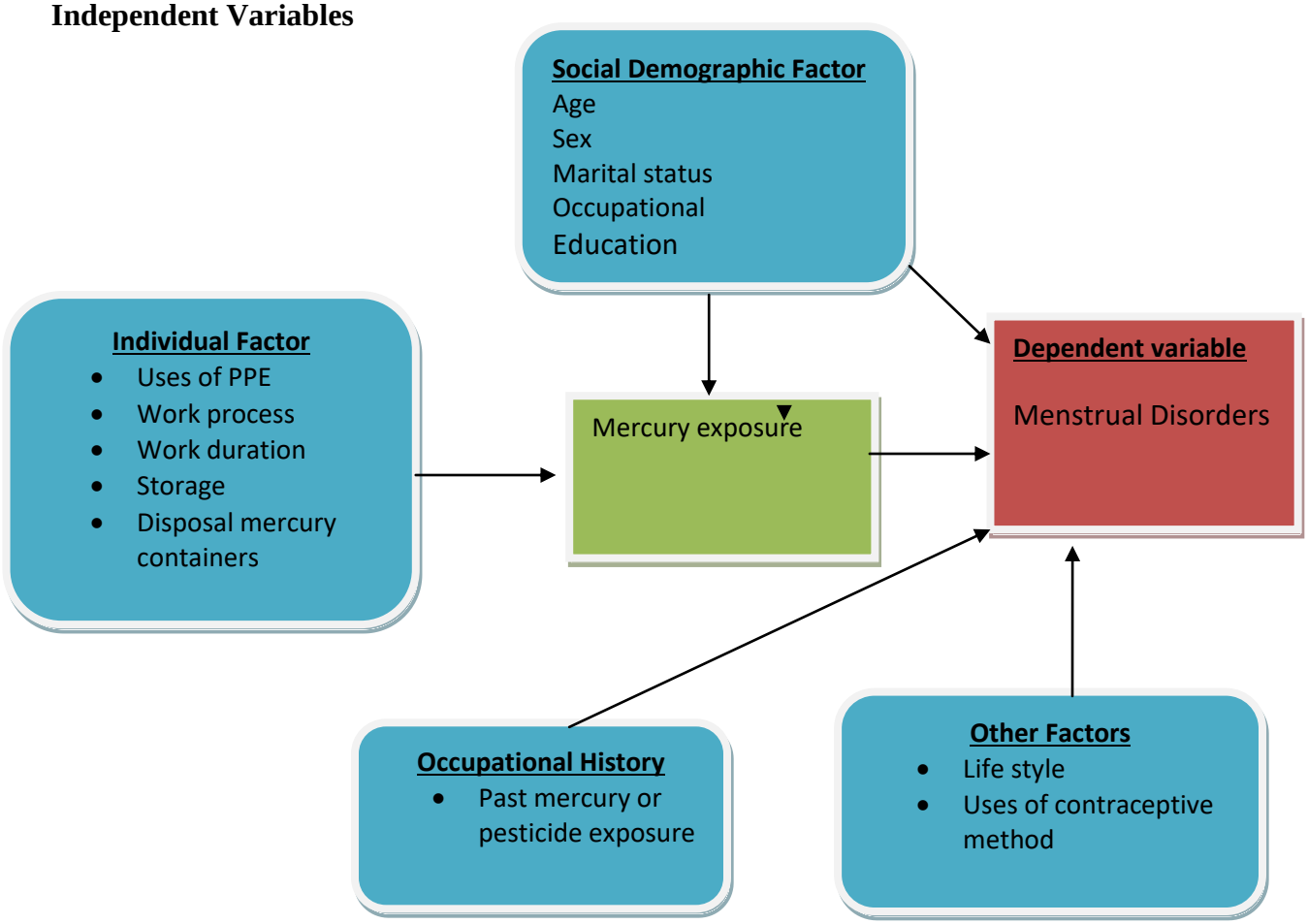


Figure 1.9.1: Conceptual frame work on mercury exposure and menstrual disorders among women working in artisanal and small scale gold mining**.**

Mercury exposure may lead to menstrual disorders among women in artisanal small gold mining. It is arising from interference with the part of the brain which controls reproductive hormones (hypothalamo-pituitary-gonadal axis). (19). Mercury vapour exposure may be attributed by individual factors such as lack of the use PPEs, working process such as forming gold amalgam and heating gold amalgam (open burning) (5), working duration, poor storage mercury in leakage and poor disposal of empty mercury containers at worksite or at home which contribute to increase of exposure to mercury hence may lead to menstrual cycle disorders (9).Other factors such as lifestyle like gaining or losing a significant amount of weight, dieting, changes in exercise routines, illness, or other disruptions in a woman's daily routine can have an impact on her menstrual cycle. Previous reproductive health problem such as uterine polyps or fibroids, Endometriosis, Pelvic inflammatory disease, also have impact on menstrual cycle. The past mercury exposure or pesticide can attribute direct to irregular menstrual cycle. Also the demographic factors such as age, sex, marital status, occupational, education level, can increase the chance of exposure to mercury and attribute to menstrual cycle disorders among the women in ASGM, like the occupational if a women is self employed or working in ASGM as a source of income to fulfill her basic needs these increase a chance of them to be exposed to mercury, marital status also contribute to the women to increase a chance of exposure to mercury if the women whose husbands are also working in ASGM; education level if the women working in ASGM who are not educated (no any education) they become more likely to be exposed to mercury because most of them lack knowledge or awareness on the effects and how to reduce or protect from the exposure compared to the women who are educated or knowledgeable, and these may lead to increase a chance of exposure to mercury hence may lead to menstrual disorders, but menarche age may have direct effect on hypothalamus-pituitary-gonadal axis and attribute to menstrual disorders. The independent variables and dependent variables were assessed by using face to face administered questionnaire which was consists semi structured questions which was adapted from Modified gynecologist questionnaire for assessing Menstrual cycle disorders (22).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1. The processes undertaken in artisanal and small scale gold mining

Artisanal and small scale gold mining is an activity undertaken by individuals or groups of people with limited equipment and often informally without mineral right (1). The activity consists of extracting gold from rocks or sediment; it can be done in several ways, depending on the type of ore deposit. In Africa, ASGM is mainly done in primary rock, which involves the following steps; Extraction whereby the gold-containing ore is extracted from the soil through digging, often in wells or gallery; crushing the ore is then crushed using rudimentary methods, such as a hammer; milling the ores is ground using a mill, in order to obtain a very fine powder; washing whereby the concentrated ores washed with the help of sluices and pans; amalgamation process whereby mercury is added to gold ores to form an amalgam (capture the gold); burning of the amalgam and gold recovery, the gold-mercury amalgam is heated so that mercury evaporates, leaving only a porous“ sponge gold” product behind (9) .

In mining process, elemental mercury is used to extract gold from ore in artisanal and small scale gold mining which is a heavy silver liquid metal, when heated it turns into invisible vapors even at room temperature and releases toxic vapors. It is estimated that, 1.32kg of mercury is released to the environment for every 1kg of gold produced (9). Approximately 40% of mercury is lost during the initial concentration of amalgamation stages of the gold mining process in which it is released in liquid form into rivers, lakes, ponds, streams etc and taken up by fish hence bio accumulates through the food chain. The remaining 60% is released directly into the atmosphere when the Hg amalgam is burned at the end of the purification process, thus exposing miners to inorganic-mercury poisoning either via the respiratory tract as vapor or through the skin by contact (6). Mercury is potentially very harmful to the environment and to the human health. Thus resulting into millions of miners, infants, children, women of child bearing age (potentially pregnant), and breast-feeding women, working or living in ASGM communities be at risk of mercury exposure (7). It is a highly dangerous toxic, in Tanzania it

has affected over 2 million men, women and children (21). Chronic mercury exposure may seriously result to menstrual cycle disorders, arising from interference with the part of the brain which controls reproduction (hypothalamo-pituitary-gonadal axis) (19).

Environmental and safety measures for reduction or elimination of mercury exposure in artisanal and small scale gold mining activities are as follows; The best measure is to eliminate the uses of mercury in ASGM by instituting the best available alternatives in gold extraction without mercury such as Gravity Concentration Methods which includes panning using water to separate heavy gold particles from other lighter particles within a medium sized pan; sluices use water to wash ore or alluvium down a series of angled platforms; shaking tables are elevated tables tilted to one side with raised ridges running horizontally down their length; spiral concentrators are specialized pans tilted on an angle with spiraled grooves, the spiral grooves in the pan lead toward the center where a hole is connected to a container to catch the ores; centrifuge is a vessel that rotates about a central point, it is used to separate material in a mixture by density (44).

Apart from the alternative methods that can be used in extracting gold without using mercury among ASGM, the mercury exposure in artisanal and small scale gold mining can be reduced by simple solutions if mercury is still in use for gold extraction (9). Such solutions are; mercury should be stored outside in a solid bottle with a tight fitting lid. Always keep a layer of water over the mercury to prevent the vapors from escaping; wear gloves if you touch the amalgam, or use a stick if possible, using a respirator with activated charcoal is the only type of respirator that will protect ASGM against mercury vapors. Normal masks or fabric are ineffective; create a designated area where the amalgam will be burned and the equipment should be left in specified area (including work clothes). The area must be well ventilated, far from the village and placed so that the prevailing winds do not bring the vapors towards the residences; use a retort adequately (the retort guide) (9).

The below figure is a summary of the processes undertaken in artisanal and small scale gold mining for extracting gold.

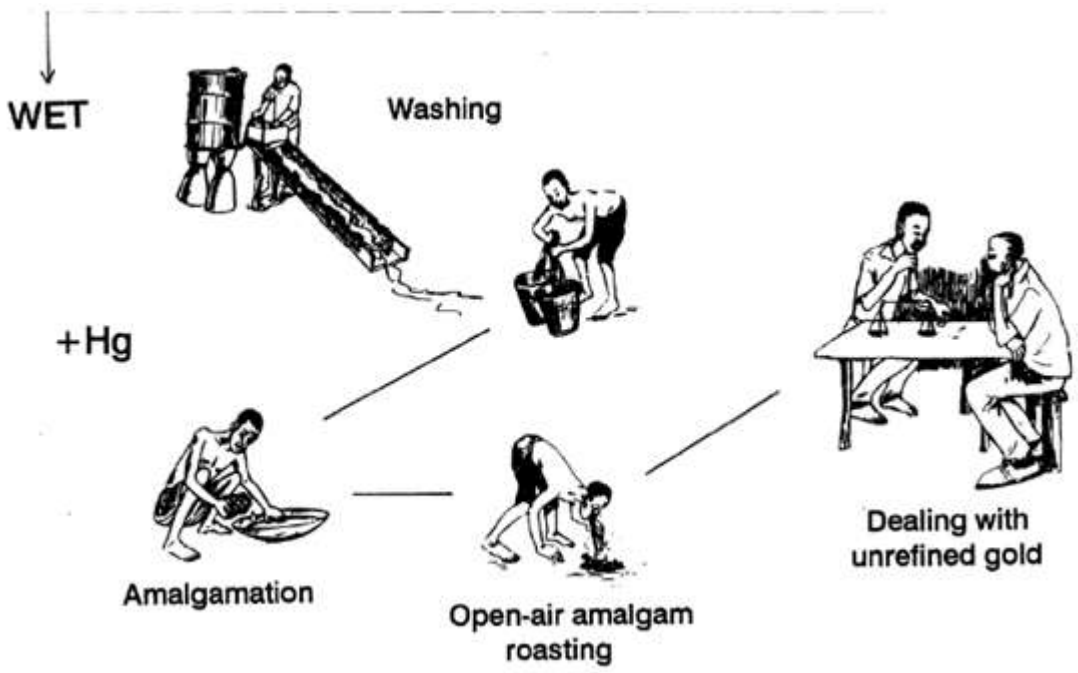


Figure 2.1.1: Generalized flow pattern of artisanal and small scale gold mining the same as what is done in Nyang'hwale District**.** ASGM involves in seven stages extraction, crushing, milling, washing, panning, Amalgamation, burning of amalgamation and gold recovery (9).

2.2. Context of Menstrual Disorders

Refer to an abnormal condition in a woman menstrual cycle such as; when menstrual periods that occur less than 21 days or more than 35 days apart, missing three or more periods in row, and menstrual flow that is much heavier or lighter than usual.

Menstrual disorder is a major symptom of an ovulation, a phenomenon that is accompanied by decreased ovarian steroid secretion and production. The most important cause of menstrual disorders is functional hypothalamic amenorrhea associated with decreased gonadotropin-releasing hormone secretion and hypothalamic–pituitary–adrenal (HPA) axis dysregulation (11). The evidence shows that, the menstrual problems are the most common gynecological complaints among the women and prevalence is highest in the 20 to 24 years old age group (17). It has been estimated 14% to 25 % of women of childbearing age suffer from irregular menstrual cycle in their lifetime (17). But chronic mercury exposure can seriously result to

menstrual disorders, arising from interference with the part of the brain which controls reproductive hormones (hypothalamo-pituitary-gonadal axis) (19).

The evidence that mercury accumulates in the brain, pituitary, and thyroid, that it disrupts ovulation in animals, and that women exposed to mercury experience abnormal menstrual cycles (23).

2.3. Prevalence of menstrual disorders

The World Health Organization (2008) reported that 18 million women of reproductive age perceive their menstrual bleeding to be excessive. Such disorders have economic consequences in terms of health care costs due to the consumption of expensive hormonal drugs and laboratory tests (24). Over one-half of the European and North American women of reproductive age about 30 to 90% of menstruating women reported to have abdominal and excessive back pain associated with the menstrual cycle due to mercury vapour exposure. Dysmenorrhea is the most reason for absenteeism from work due to it cause of prolonged abdominal pain and suffering (12). Also the menstrual disorders are the most common problem in most women of reproductive age in India, it covers 54% of all gynecological problem (25).

In developing countries is approximately 4 to 8% of women report having menstrual periods longer than 7 to 8 days and excessive, profuse or heavy bleeding 4 to 9% and prevalence of excessive bleeding was reported to be higher, was increasing from 8% to 27% (16). In Nigeria and Ethiopia also reported the prevalence of menstrual cycle disorders among the women in reproductive age 19% and 46% respectively (17).

The prevalence of menstrual disorders associated with exposure to mercury vapour among the women working with elemental mercury is found to be higher compared to the women who are not working with elemental mercury or mercury vapour. According to the study conducted in Colombia among the women in artisanal gold mining the prevalence of menstrual disorders was found to be higher by 59% of women exposed to mercury in the process of artisanal gold mining, than in the group of non-exposed women (26). This was similar to the study

conducted in China among the women working in fluorescent lamp factory, the findings also show the increase in the prevalence of abnormal menstruation among women group who were exposed to mercury vapour, the prevalence of irregular menstrual cycle was 17% (12). According to the study conducted in Italy among the women working in lamp factories, the findings shows that the women exposed to mercury vapour had a higher prevalence of disorders in menstrual cycles than those not exposed, for the prevalence of 47% (8). As regard to study on exposure to mercury and menstrual disorders most of studies were conducted in factories, but in artisanal small and scale gold mining the information is limited.

In developing countries especially in Africa countries including Tanzania the scientific data regarding mercury exposure and associated menstrual disorders is not well documented. Therefore this study was conducted to assess mercury exposure and associated menstrual cycle disorders to cover this gap of knowledge.

2.4. The menstrual disorders

Menstrual cycle disorders are includes; (of duration or length), hyper- or hypomenorrhoea, polymenorrhoea or oligomenorrhoea, dysmenorrhoea, amenorrhoea, menorrhagia, prolonged menses, intermenstrual bleeding and premenstrual syndrome (PMS) (15). Several experimental and epidemiological studies have shown the harmful effects of mercury vapour on the central nervous system; the excess of ovulatory troubles in a group of occupationally exposed women has been interpreted as an indirect consequence of this effect on the pituitary hypothalamic axis (8). When occupationally exposed to mercury vapour the most targeted organ of mercury after absorbed are brain, kidney and lungs; high concentrations of mercury is found in the pituitary, thyroid, and brain (9).That mercury persists in these tissues for many years. It is estimated that the half-life of mercury in the brain can be as long as 20 years (30).The mercury that accumulates is biologically active and therefore able to interfere with endocrine or reproductive function, that it disrupts ovulation in animals, and that women exposed to mercury experience abnormal menstrual cycles (10) such as Amenorrhea, Oligomenorrhea, hypomenorrhea, Dysmenorrhea, excessive bleeding, slight bleeding.

Amenorrhea is the absence of menstruation for 3 normal cycles, or for 6 months. Oligomenorrhea is a condition in which the menstrual cycle lasts longer than 35 days. Hypomenorrhea is a condition in which uterine bleeding may be slight in volume, short in duration (<2 days), or both. Menorrhagia is cyclic bleeding at normal intervals; namely, 5/28, which is excessive in amount (>80 ml), or at normal intervals with prolonged duration, for example 8/28. Dysmenorrhea refers to the presence of painful menses, where there is no underlying pathology that can account for the pain (31).

The findings show that women who are working with mercury compound are more likely to develop menstrual disorders (dysmenorrhea) which have been associated with chronic exposure to high concentrations of mercury vapor (30). The epidemiological studies have documented menstrual cycle abnormalities among women exposed to mercury vapor. According to the studies conducted in Europe, menstrual cycle abnormalities includes changes in bleeding patterns and cycle length among women occupationally exposed to mercury vapor (23).

So far, studies conducted in Eastern Europe, have reported abnormalities of the menstrual cycle including painful menstruation and changes in bleeding patterns and menstrual cycle duration among workers exposed to mercury (12). According to the study conducted in Colombia among the women in artisanal gold mining the findings shows that the menstruation abnormality in the last six months was reported more frequently in the group of women chronically exposed to mercury vapors (13). Dysmenorrhea is the most reason for absenteeism from work due to it cause of prolonged abdominal pain and suffering according to study conducted in China among the workers exposed to metallic mercury and menstrual period and amount of menstrual bleeding in the exposed group were higher than in the control group (12). In developing countries especially in Africa countries including Tanzania the scientific data regarding mercury exposure and associated menstrual disorders is not well documented. Therefore this study was conducted to assess mercury exposure and associated menstrual cycle disorders to cover this gap of knowledge.

2.5. The concentration level of mercury (U Hg) in urine

Elemental Hg is a silver-white liquid at room temperature. The concentration of air Hg rapidly increases as the temperature increases and after distribution in the environment easily enters to the human lungs. Exposure can occur through respiratory system and skin contact. Occupational exposure to Hg and its compounds may occur in various occupations such as amalgam makers, barometer makers, battery makers, chemical laboratory workers, chlor-alkali petrochemical workers, dentists, fluorescent lamp makers, gold and silver extractors, insecticide makers, Hg miner workers and thermometer makers (27).

The presence of mercury in urine represents long level exposure to inorganic and/or elemental mercury. Urine mercury levels are usually considered the best measure of the average exposure over the previous few months in those chronically exposed. Blood mercury measurements are less frequently used due to their invasive nature and their reflection of only recent exposure (days). Their use has been confined to acute accidental exposure (28).

Strong correlation between elemental mercury levels in inhaled air and urine levels at medium and high concentrations has been reported. The maximum urine mercury concentration set by WHO (1991) is 50 µg/g creatinine. Mercury urine levels rarely exceed 5 µg/g creatinine in persons who are not occupationally exposed to mercury (28).

In most studies, findings shows that the concentration of mercury Hg level in urine increased with the increase of exposure concentration of mercury vapour. As the study conducted in animal (rats) found that the total mercury level Hg in urine increased with the increase with exposure concentration and duration (23). The same applies to the human being who are exposed to mercury vapour; according to the four studies conducted in UK indicated a higher than average mercury level in the urine of dental personnel. Scottish dentists had mean urinary mercury levels four times higher than control individuals. A study of dental practices in Turkey detected higher urinary mercury levels in dental nurses (dental assistants) than dentists. Higher urine mercury levels in dental personnel than the control individuals were detected in Iran (29). In most the concentration of urine mercury exceed WHO standard 50ug/g creatinine to the people who are occupationally exposed to mercury. According to the

report from the study conducted in Handeni Tanzania among workers in small scale gold miner, they found that the level of mercury with a maximum of 74.7 ug/l for urine which exceeded the maximum World Health Organization (WHO) acceptable level of 50 ug/l. Miners engaged in amalgamation and burning of amalgam had higher mean mercury levels in urine 54 ug/l (21). Also the study conducted among the artisanal and small scale gold miners in Chunya Tanzania, the findings shows that the urinary mercury level was higher than the acceptable level (20).

2.6. Association between exposure to mercury and menstrual disorders

In female workers exposed to mercury vapour, menstrual disorders (dysmenorrhea) have been associated with chronic exposure to high concentrations of mercury vapor (32). According to the study conducted in China among the female exposed to mercury vapour abnormal menstruation was found higher significantly in mercury exposed workers worked in fluorescent lamp factory in China than in control group and Dysmenorrhea may be a useful biomarker for assessing female exposure to mercury occupationally (12). The mercury vapour which produced by any industrial process it found to have effect in reproductive hormones which may result in menstrual disorders and other reproductive outcome in women working with elemental mercury. Also according to the study conducted in Colombia among the women in artisanal gold mining; the findings shows that the exposure to elemental mercury during the process of gold mining was associated with a higher prevalence of menstrual cycle irregularity (13). In developing countries especially in Africa countries including Tanzania the scientific data regarding mercury exposure and associated menstrual disorders is not well documented. Therefore this study was conducted to assess mercury exposure and associated menstrual cycle disorders to cover this gap of knowledge.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study design

This study deployed descriptive cross sectional study design. The study design was used for assessing exposure to mercury and associated menstrual disorders among women in artisanal gold mining at the same point in time with limit of time without follow up.

Because of limited time for data collection which was conducted for only one month from June 2019 to July 2019.

3.2 Study area

The study was conducted in Nyang'hwale district which is one of the five districts in Geita region, Tanzania. Geita region is among regions where artisanal and small scale gold mining activities are taking place, and most of women are self employed in gold mining activities, directly exposed to elemental mercury vapour. Nyang'hwale district was selected for the study because it counts the smallest area coverage area about 1450 km^2 and lowest population 148,320 (male 73,272 and female 75,048) among 5 districts in Geita region where intensive artisanal and small scale gold mining activities are conducted and no any study on artisanal small scale mining and reproductive health problem have been conducted. It is in the rural setting to which the study designed for. The region, Geita, has been selected for the study because is one of the gold richest regions in Tanzania, processing substantial deposits, minimally exploited by large and small scale/ artisanal miners (33). The study was conducted in the women working in Artisanal small scale gold mining as exposed group and among the women working in teaching primary schools as non exposed group who were selected 5km away from the village where artisanal and small scale mining was conducted; the selection was based on simple random sampling.



Figure 3.2.1: Map of Geita region showing Nyang'hwale district located within the region.

3.3 Study population

The study population involved women of 18 – 44 years of age currently working in artisanal gold mining for at least one year proceeding the data collection day as exposed group and women working in teaching primary schools as non exposed group who were selected 5km away from the village where artisanal and small scale mining was being conducted.

3.4 Study sample

The sample size was calculated using quantitative sample estimation equation (43) .

The Sample Formulae as given by:

$N= Z^2 P (1-P)/ \varepsilon^2$

Whereas

N = Estimated Sample Size

Z = standard normal deviate of 1.96 on using 95% Confidence Level.

P = prevalence or proportional 59% on using the average prevalence of irregular menstrual cycle by the study conducted in Colombia (13).

ε = Margin of error, 0.06 on using 6%.

Thus, N = 4 x 0.59 (1 – 0.59)/0.0036.

N = 269

The total Sample was **269** participants included in the study; 99 of participants of this sample were the women teaching primary school teachers and 170 were the women working in ASGM as exposed group.

3.5 Sampling procedures and techniques applied

A mixed method was applied involving different stages. At first, twelve wards with villages where artisanal and small scale gold mining were being conducted, were selected conveniently from the list of wards obtain from the district council. The second stage, four study wards were selected purposively out of twelve wards due to availability of the villages where women were working intensively in artisanal and small scale gold mining in all mining stages. Next, one village from each ward was selected purposively due to criteria of the elements included in the study as predefined to obtain 4 villages. Then the women who were working in artisanal and small scale gold mining whose fulfill the inclusion criteria were selected using simple random sampling technique using lottery method; whereby the list of element was prepared according to the participants presence at the ASGM sites selected. Then each element were given a number individually which was written on slips of paper. The slips of paper were put into box and mixed thoroughly, then decided odds number of slips was drawn out of a box as

the participants included in the study till to obtain total number of sample size 170; and the same sampling technique was used to select non exposed group (Primary teachers) to obtain the total number of sample size 99 from 16 primary schools (34); and the response rate was 100%. The sample distribution can be seen in Table 3.5.1 and table 3.5.2 below.

Table 3.5.1: Sample size distribution for women working in mining (Exposed group N= 170)

Ward	Villages	Name of Mining Site	Participants
Nyijundu	Kasubuya	Kasubuya	35
Kaboha	Shibaranga	Shibaranga	35
Busolwa	Ifugandi	Ifugandi	31
Mwingiro	Mwasbuka	mwasabuka	69
Total			**170**

Table 3.5.2: Sample size distribution for women working in teaching primary school (non Exposed group N= 99)

Village	Primary school	Participants
Ikangala	Ikangala	07
Kanegele	Kanegele	05
Karumwa	Karumwa	09
Bupamba	Bupamba	09
Nyalubele	Nyalubele	07
Nyijundu	Nyijundu	06
Ibambila	Ibambila	05
Bumanda	Bumanda	07
Mwingiro	Mwingiro	05
Nyang'hwale	Nyang'hwale	07
Nyugwa	Nyugwa	05
Izunya	Izunya	05
Bukwimba	Bukwimba	05
Beya	Beya	05
Kitongo	Kitongo	05
Kakora	Kakora	07
Total		**99**

3.6 Eligibility Criteria

3.6.1 Inclusion criteria

The study sample involve women of 18 – 44 years of age currently working in artisanal gold mining for at least one year in amalgamation process and those who carry out other activity around the mining area , heating gold ores were included in the study. The women of 18 – 44 years of age currently working in teaching primary schools for at least one year were included as non exposed group, who were selected 5km away from the villages where ASGM was being conducted.

3.6.2 Exclusion criteria

The women who were pregnant, any type of diagnosed pelvic pathology (fibroids, pelvic inflammatory disease), and lactating mothers were excluded.

3.7 Data collection tools (instrument)

3.7.1 Face to face administered questionnaire

Face to face administered questionnaire was used for assessing objective one; Data on the proportions of menstrual disorders was collected using semi structured questions which were adapted from Modified gynecologist questionnaire for assessing Menstrual cycle disorders (22). The tools was constructed in English and translated into Swahili. The questionnaire includes questions about demographic and occupational data, history of exposure to mercury or other chemicals, history of gynecological and disease, the approximate interval of days (menstrual length) between first to next menstrual cycles (include Oligomenorrhea, Amenorrhea, Polymenorrhea, Hypomenorrhea) the average days of the menstrual bleeding, menstrual flow as slight or excessive bleeding (Menorrhagia,) than usual by assessing the approximate number of sanitary napkins used daily, prolonged menstrual bleeding, shortened menstrual bleeding, intermenstrual bleeding and on symptoms of menstrual cycle disorders the questionnaire included the questions on physical symptoms like excessive abdominal pains, severe menstrual cramps. The questionnaire was contained the questions on assessing other factors contribute to menstrual disorders like consumption of alcohol, smoking habit, post exposure to pesticide and habit of performing a physical exercises.

3.7.2 Biological monitoring of mercury in Urine

Mercury exposure in urine was used to assess objective two by testing mercury concentration level in the urine of the participants. The mercury concentration level was assessed if it was maximum acceptable level or above the maximum acceptable level according to the World Health Organization standards (28) . The analysis of urine using Flow Injection Cold Atomic absorption spectrometry (CVAAS) was conducted according to NIOSH analytical method 6009, which is a standard method of analyzing elemental/ inorganic mercury in urine (28,35). The preference in this study to use the urine to test the exposure level of mercury, is due to the fact that urine mercury U Hg reflects average of chronic exposure of the inhalation exposure to elemental mercury vapors or inorganic mercury to workers (36). Monitoring U-Hg is useful for assessing the risk of adverse effect (37); and the mercury in urine stay for 40-60 days, so the collection sample and analysis of sample can be taken at any time compared in blood stay for short time (38,39,40).

3.8 Pre testing of the data collection tool for reliability and validation

The Principal Investigator (PI) along with RAs tested the questionnaire in the study area in order to measure whether participants understood the questions. This also measured research skills for RAs and revealed if more training was needed, and enabled to assess whether the research questions generated the intended results or if adjustment was necessary before the data collection process.

3.9 Data collection procedures for Questionnaire

During the period of data collection, the researchers were introduced themselves and introduce the purpose of the study and ask for the workers to participate in the study. Workers who met the criteria and who were willing to participate were given a consent form to fill and sign. The interview was carried out at the start of the working day by using the standardized questionnaire (Modified gynecologist questionnaire for assessing menstrual cycle disorders) was used to interview the women who were working in artisanal small scale gold mining at Nyang'hwale District and women working in teaching primary schools who were selected

5km away from the villages where artisanal and small scale were being conducted. The participants were asked to complete a questionnaire while identification anonymously.



Figure 3.9.1: Principal investigator and research assistants interview the women who were working in artisanal small scale gold mining in Nyang'hwale District**.**

3.10 Procedures for urine collection and storage

After the interview was completed the participants were requested to collect the urine under the supervision of a skilled laboratory technician. First morning urine samples were collected as recommended by World Health Organization guideline for mercury analysis in urine sample (27). Because is the specimen of choice for chemical and microscopic urine testing since it is the most concentrated and more likely to detect any abnormalities. From 21 respondents who were selected by random systematic sampling strategy by skipping 12 respondents after each sampled participants.15 and 6 urine samples were collected from exposed and non exposed groups respectively. The urine sample was collected in sterile plastic containers (100 ml size) and 50ml of urine were collected and coded according to code number indicated to the questionnaire answered by the respondents, the containers were kept closed until ready for analysis. Participants were asked to open the container at the time of urine collection and close it immediately after urine collection to avoid touching inside the container or cap to avoid contamination (28). Urine samples were stored in cold box at collection site and transported to the District hospital laboratory where they were refrigerated (4^0C) until transport to Government Chemist Laboratory for analysis.



Figure 3.10.1: The women who were working in artisanal and small scale gold mining in Nyang'hwale District collecting urine samples.

3.11 Mercury Analysis in the Urine

Acidification of the urine sample was carried out by using 1% Hydrochloric acid and 1% Nitric acid which were mixed at the ratio of 3:1 respectively as a means of stabilization prior to storage in a cold condition (28). Analysis of urine was performed by Flow Injection Cold Vapour Atomic Absorption Spectrometry (CVAAS) because of its adequate sensitivity to measure mercury in urine at low ppb levels (28); The detection limit was generally about 0.2 ug/1 for a 1ml urine sample and the precision was about 5% (37). Urine samples were diluted by 1% of HCL for the purposes of preserving the urine sample. The digestion of urine was carried out using 50ml of a conical flask; whereby 2 ml of urine was mixed with 0.100 ml of 35% (w/v) nitric acid, 0.2 ml of 50% (w/v) sulfuric acid and 0.500 ml of 5% (w/v) potassium permanganate. The sample solution was allowed to stand at room temperature for 15 minutes.

After the permanganate reaction was completed, 0.4 ml of 2.5% (w/v) potassium per sulfate was added and incubate at 85–95 °C for 90 minutes and then cooled followed by adding 0.5 ml of butan-1-ol (used to control foaming) and 5% (w/v) hydroxylamine hydrochloride in 3% (w/v) sodium chloride to make a total volume up to 10.0 ml with reagent water and mix well prior to determination, then the sample solution were subjected to CVAAS for mercury determination. The mercury levels in the urine from analytical results were compared with World Health Organization (WHO) standards. Analysis was performed for three weeks by Government chemistry Laboratory Authority at Lake Zone.

3.12 Mercury analysis accuracy

The accuracy of the method for mercury determination was proved by running the standard solutions (control) of known mercury concentration. Also sample blank (reagents used during preparation) were run to determine mercury levels they contain. Mercury levels in the sample blank were deducted from the total mercury levels available in the sample to get the actual mercury levels contained in the sample.

3.13 Data Management

All filled questionnaires on the day were checked for completeness and collected by the principle investigator (PI) to check if there was any missing information before leaving the field area on daily basis. During data entry, a consecutive record of each identification number was made to avoid mixing up of data. The Principal Investigator insured that every item has been coded correctly.

3.14 Data screening and cleaning

This was done through running the all variables where categorical variable where checked by using frequency and continuous variable where checked for error and missing data by using descriptive. It helped in identifying miscoded variables, duplicates, omissions, missing data etc. Listing of selected variables was also done to identify missing information that needs to be

entered, properly coding of all variables etc. Cross checking of the appropriate questionnaire was done to insure that all missing data was entered in SPSS via data view sheet.

3.15 Data analysis

The collected data was coded and then entered into Statistical Package for Social Sciences (SPSS) for cleaning and analysis was done through descriptive statistics with frequency tabulation used, number and percentage was presented in tables.

Objective 1: **To determine the proportions of women with menstrual disorders among the women in artisanal small scale gold mining in Nyang'hwale District.**

Data were analyzed descriptively by using SPSS in order to show the frequency and the percentage of the menstrual disorders among the women who were exposed to mercury and non exposed to mercury and data presented in table.

Objective 2: To determine the concentration level of mercury in urine among the women in artisanal small scale gold mining in Nyang'hwale district.

Descriptive statistics analysis was used to give the frequency and the proportion of the exposed group and non exposed group, who were at normal level less than 5ug/l, alert level (5 – 19 ug/l), action level (20 – 49 ug/l), or above the maximum acceptable level according to WHO standard of 50ug/L, the difference in mean of mercury level between two group were determine by using Mann Whitney U test.

Objective 3: To examine the association between mercury exposure and menstrual disorders among women in artisanal small scale gold mining in Nyang'hwale District.

Multivariate logistic regression and bivariate analysis using chi square test were used to find the association between mercury exposure and menstrual disorders; P value equal to 0.05 or less ($P<0.05$) was considered statistically significant to show the association between mercury exposure and menstrual disorders among the women in ASGM.

The prevalence odds ratio (OR) which was used to measure the association between mercury exposure and menstrual disorders.

3.16 Study Variables

3.16.1 Dependent variable (Outcome variable)

Menstrual disorder is a major symptom of ovulation, a phenomenon that is accompanied by decreased ovarian steroid secretion and production (11). Refer to when menstrual periods that occur less than 21 days or more than 35 days apart, missing three or more periods in row, and menstrual flow that is much heavier or lighter than usual according to WHO. A cycle is considered clinically abnormal when the majority of cycles in the previous six months are out of range.

Menstrual disorders are characterized by the following terms

Amenorrhea is the absence of menstruation for 3 normal cycles, or for 6 months.

Oligomenorrhea is a condition in which the menstrual cycle lasts longer than 35 days.

Hypomenorrhea is a condition in which uterine bleeding may be slight in volume, short in duration (<2 days), or both.

Menorrhagia is cyclic bleeding at normal intervals; namely, 5/28, which is excessive in amount (>80 ml), or at normal intervals with prolonged duration, for example 8/28.

Dysmenorrhea refers to the presence of painful menses, where there is no underlying pathology that can account for the pain (31).

Prolonged menstrual bleeding: Bleeding that exceeds 8 days in duration on a regular basis; Polymenorrhea: Frequent menstrual periods occurring less than 21 days apart; Shortened menstrual bleeding of less than 2 days in duration (hypomenorrhea); Intermenstrual bleeding: Episodes of bleeding that occur between periods, also known as spotting.

The women were asked to recall if they have observe any variation in the length of the menstrual cycle, for less than 21 days or for more than 35 days which was considered menstrual disorders(31),also were asked to recall the menses flow days if was more than 7days, menses flow was much heavier or lighter than usual by referred the number of sanitary pad used per day.

3.16.2 Independent variables

Individual factors such as; Use of PPE, Job category, Work duration, Work process Work condition, Storage, Disposal of mercury containers which can make the workers in artisanal small scale gold mining to be direct exposed to mercury vapour (9).

Was assessed by asked the women in ASGM to recall frequency of exposure by working duration, the use of personal protective equipment during the process for those who were engaged in amalgamation, job category, storage of the chemical itself, disposal of the containers.

Demographic Factor such as; Age, Marital status, Occupational, Education, Socio economic:

i) Education was assed according to Tanzania education levels: no formal education, having a primary level education, secondary, college or higher level.
ii) Family occupational; Also was assessed based on the economic activities common in the family like farming, petty trade, small mining scale.
iii) Marital status was assessed by classified according to Tanzania marital status levels: single, married, widow, Divorced, Cohabitation.
iv) Age this was assessed by asked the participant to recall their date of birth

Background information of the health status of the individual such life style, Contraceptive Methods, Previous reproductive health problem.

i) The life style was assessed by asked the participant to recall if they have the behavior of drinking alcohol, smoking, physical exercise.

ii) The uses of contraceptive methods; was assessed by classified according to WHO as long active reversible contraception such as implant or intra uterine device (IUD), hormonal contraception method, pills or the Depo Provera injection. The participants were asked to recall for the past or currently uses the contraceptive methods either any from the above.

iii) Past occupational history; this was assessed by asked the participant to recall any previous occupational associated with mercury or pesticide exposure.

3.17 Recruitment and training of research assistants.

Three research assistants with health professional background including laboratory technician were recruited and oriented for one day on the research topic, data collection tools (questionnaire) and procedures of urine collection.

3.18 Ethical issues

Ethical clearance was requested from Muhimbili University of Health and Allied Sciences research and publication Committee for conducting this research. Also, letters to seek permission to conduct the research was sent to the Regional administrative Secretary of Geita and to the District Executive Directors of Nyang'hwale District Council (DED), District Medical Officer (DMO) provide the permission to conduct the study. Informed consent was obtained from study respondents after being informed the benefit and disadvantages of the study for those who were agreed to participate signed the consent form. And for those who were found with menstrual disorders problem, the principal investigator advised them to visit health facilities to consult the clinicians/ gynecologist so as to assist or advise them on the menstrual disorders treatment. Also the principal investigator provided health education to the participants on the exposure to mercury used for extracting gold mine my associated with menstrual disorders among the women working in ASGM, they were emphases more on the safety methods or techniques to be used in ASG mine extraction like use free mercury techniques in ASGM, in order to reduce the exposure to mercury as well as the burden of reproductive health effect including menstrual disorders.

3.19 Dissemination of the research findings

The study report will be disseminated and made available in the MUHAS library for use. The report will be disseminated and made available to the Nyang'hwale district council for use in improving the artisanal gold mine working condition and for taking preventive measures. This study will be published in mid-2020 so as to give scholars a room of knowing what was unknown before.

CHAPTER FOUR

4.0 RESULTS

4.1 Social demographic characteristics of the study participants

Table 4.1: Socio-demographic characteristics of women working as ASGM and Primary School Teachers in Nyang'hwale District (N= 269).

Variables	Overall		Exposed		Non exposed		P value
	Frequency	%	Frequency	%	Frequency	%	
Age (years) Mean (SD)	33.64 (7.476)		35 (7.868)		31.3(6.117)		
Weight(kg) Mean (SD)	65.29 (12.610)		65.3 (12.594)		65.2 (12.703)		
Marital status n (%)							
Single	70	26.0	39	22.9	31	31.3	
Married	105	39.0	50	29.4	55	55.6	
Cohabitation	27	10.0	21	12.4	6	6.1	
Divorced	45	16.7	42	24.7	3	3.0	
Widow	22	8.2	18	10.6	4	4.0	0.0001
Education level n (%)							
No education	92	34.2	92	54.1	0	0	
Primary school	72	26.8	72	42.4	0	0	
Secondary school	6	2.2	6	3.5	0	0	
Tertiary level	99	36.8	0	0	99	100	0.0001
Occupation							
Exposed group	170	63.2	170	100	0	0	
Non exposed group	99	36.8	0	0	99	100	0.0001

The study had 269 respondents who were in the age group between 18 – 44 years with mean age 34 (7.476**);** whereby the mean age of the exposed group was 35(7.868) and non exposed group 31(6.117). According to occupation, (63%) of the women working in artisanal and small scale gold mining as exposed group and (37%) were primary school teachers as non exposed group, these groups were very energetic and productive. With regard to marital status (56%) of non exposed group were married and the difference was statistical significance. Regard to education level, the majority of exposed group had no education by (54%) followed by (42%) who had primary education level, whereby **(**100%) of primary school teachers had a tertiary education level (Table 4.1).

4.2 Occupational exposure to mercury

Table 4.2: Occupational exposure to mercury among the women in ASGM and non exposed group (Primary school teachers) in Nyang'hwale District

Variables	Variable categories	Frequency	%
Work category	Amalgamation	160	59.5
	Heating gold ores	10	3.7
	Teaching	99	36.8
Not used PPE	Miners	170	63.2
Storage of Mercury	Special room	22	8.2
	Inside the house	88	32.7
	Others place	4	1.5
	Don't know	56	20.8
Disposal of empty containers	Damp site	2	0.7
	Burning around the mining site	140	52.0
	Disposal haphazardly	28	10.4

Table 4.2.1: Distribution of working duration and daily working hours among exposed and non exposed group in Nyang'hwale District

		Exposed (N= 170)		**Non exposed (N= 99)**	
Variable		**Frequency**	**%**	**Frequency**	**%**
Working duration	1 year	58	34.1	21	21.2
	2-3 years	87	51.2	20	20.2
	4-5 years	7	4.1	20	20.2
	Above 5 years	18	10.6	38	38.4
Daily working hours	Below 8 hours	51	30	50	50.5
	8 hours	13	7.3	37	37.4
	Above 8 hours	106	62.4	12	12.1

According to the work category (60%) were the women in artisanal and small scale gold mining working in section of amalgamation process. Table 4.2.1 shows distribution of work duration and working hours of study participants (51%) of the exposed group work duration was between 2-3years, and (38%) of non exposed group had been working for more than 5 years. With respect to working hours (62%) of the exposed groups were working for more than 8hours per day, while (51%) for non exposed group were working below 8 hours per day.

4.3 The proportion of menstrual disorders among women

Table 4.3: The proportion of menstrual disorders among women working in artisanal and small scale gold mining and women teaching primary schools in Nyang'hwale District.

		Exposed (N = 170)		Non exposed (N=99)	
Variable	**Indicator**	**Frequency**	**%**	**Frequency**	**%**
Menarche Age	Mean (SD)	15.33 (1.577)		15.13(1.77**)**	**(**15.26)
Interval menstrual cycle (Days)	Below 21days	24	14.1	7	7.1
	Between 21-35 Days	99	58.2	92	92.9
	Above 35 days	47	27.6	2	2
Menstrual disorders	Yes	114	67.1	45	45.5
	No	56	32.9	54	54.5
Menstrual disorders occurs for 3 months consecutively	Yes	70	41	16	16.2
	No	100	58.8	83	83
Menstrual disorders due to current job	Immediate after start the job	51	44.7	0	0
	1 year after start the job	15	13.2	0	0
	2-3 year after start the job	12	13.2	1	2.2

According to the proportion of the menstrual disorders the results on table 4.3 showed that, the mean of menarche age of the participants were 15.3; whereby 15.33 for exposed group and 15.13 for non exposed group. (67%) of the respondents among the women working in artisanal and small scale as exposed group were having menstrual disorders problem while (46%) of the women teaching in primary schools as non exposed group were having menstrual disorders problem. Also (41%) of exposed group were reported to have menstrual disorders for three months consecutively as compared to non exposed group (Table 4.3).

Table 4.3.1: The menstrual disorders among women in artisanal and small scale gold mining and women teaching primary schools in Nyang'hwale District

	Exposed (N=170)		Non exposed N=99		
Variables	**Frequency**	**%**	**Frequency**	**%**	**P -Value**
Amenorrhea	61	35.9	21	21.2	0.01
Oligomenorrhea	47	27.6	1	1	0.0001
Polymenorrhea	24	14.1	7	7.1	0.05
Dysmenorrhea	64	37.6	14	14.1	0.0001
Menorrhagia (Excessive bleeding)	52	30.6	14	14.1	0.003
Bleeding spot before and after the menstrual period	31	18.2	20	20.2	0.75
Blood spot after sexual intercourse	15	8.8	7	7.1	0.65
Slight Bleeding	3	1.8	0	0	0.001
Prolonged duration	32	18.8	7	7.1	0.001
Hypomenorrhea	15	8.8	2	2.0	0.001

Exception for bleeding spotting before and after bleeding or after sexual intercourse, proportion of women with menstrual disorders was found to be statistically significant higher in exposed group as compared to non-exposed group. Generally high proportion of exposed group experienced the menstrual disorders compared to non exposed group (Table 4.3.1).

4.4 Mercury Level in Urine

Table 4.4: Urine Mercury levels (ug/L) in selected participants N=21

		Mean (SD)	N	Mean Rank	Sum of Rank	P-value
All participants		30.06 ug/l				
Occupation	Miners	41.33 ug/l	15	14	210.00	
	Non Miners	2.04ug/l	6	3.5	21.00	<0.001

Mann Whitney U Test for difference in means between two independent groups was used

Mean mercury level in urine of the participants was (30.06µg/l), and the range was 72.883ug/l to 0.247ug/l. The mean mercury level in urine for exposed group was statistically significantly higher (41.33ug/l) compared to non exposed group (2.04 ug/l) and P = 0.0001 (Table 4.4).

Table 4.4.1: Distribution of mercury level in urine measurements in comparison to WHO standards

Levels (µg/L)	Mercury level in Urine (µg/L) Exposed N = 15		Mercury level in Urine (µg/L) non exposed N =6		Status WHO standards
	Frequency	**Percentage**	**Frequency**	**Percentage**	
Less than 5ug/l	0	0	5	83.3	Normal
5- 19 ug/l	3	20	1	16.7	Alert level
20 – 49ug/l	6	40	0	0	Action level
Greater than 50ug/l	6	40	0	0	Maximum Acceptable level

About (40%) of the miners group had mercury level above the maximum acceptable level and (40%) of them were at action level who were tested for mercury levels in urine, exceed the maximum acceptable level provided by WHO as shown in Table 4.4.1 above. Amongst the non exposed group who tested for mercury levels in urine, (83%) were at normal level (less than 5ug/l) as shown in Table 4.4.1.

4.5 Association between mercury exposure and menstrual disorders

Table 4.5: Association of mercury exposure and menstrual disorders among the women working in ASGM in Nyang'hwale District

	Exposed (N=170)		**Non exposed N=99**				
Variables	**Frequency**	**%**	**Frequency**	**%**	**P -Value**	**OR**	**95% CI**
Menstrual disorders	114	67.1	45	45.5	0.001	1.5	1.160 -1.876
Menstrual disorders for three months consecutively	70	41	16	16.2	0.0001	2.6	1.571 – 4.131

Chi square test (x^2) P< 0.05, OR is odds ratio, and 95% CI is 95% confidence interval

The results found that exposure to mercury in women working in ASGM in Nyang'hwale was more likely to be associated with menstrual disorders (OR 1.5; 95% CI 1.160 – 1. 876 and P= 0.001), and was statistically significant to menstrual disorders occurred for three months consecutively with preceding this study (OR 2.6; 95% CI 1.571 – 4.131 and P=0.0001) (Table 4.5).

Table 4.5.1: Association between mercury exposure and menstrual disorders among the women working in ASGM in Nyang'hwale District

	Exposed (N=170)		**Non exposed N=99**				
Variables	**Frequency**	**%**	**Frequency**	**%**	**P -Value**	**OR**	**95% CI**
Amenorrhea	61	35.9	21	21.2	0.01	1.7	1.101 - 2.599
Dysmenorrhea	64	37.6	14	14.1	0.0001	2.7	1.579 – 4.489
Menorrhagia	52	30.6	14	14.1	0.003	2.2	1.266 -3.695
Polymenorrhea	24	14.1	7	7.1	0.005	2.0	0.893-4.464

Chi square test (x^2); P< 0.05; OR is odds ratio, and 95% CI is 95% confidence interval

The menstrual disorders were more likely among the women who were in exposed group compared to non exposed group; and there was statistically significant association between mercury exposure and menstrual disorder; for example dysmenorrhea was more likely among women exposed to mercury (OR 2.7; 95% CI 1.579 – 4.489 of and P= 0.0001) (Table 4.5.1).

Table 4.5.2: Distribution of factors associated with the menstrual disorders among women working in ASGM and non exposed group in Nyang'hwale District.

		Exposed (N=170)		Non exposed N=99	
Variables		**Frequency**	**%**	**Frequency**	**%**
Previous exposed to pesticides		28	16.6	5	5.1
Specify job industry or area	Cotton farm	26	92.9	2	40
	Vegetable farm	2	7.1	2	40
	Others	0	0	1	20
Birth control methods current used	Calendar of the menstrual cycle	130	76.5	62	62.6
	Implant	11	6.5	15	15.2
	Depo provera injection	20	11.8	16	16.2
	Pills	6	3.5	3	3.0
	Intra uterine device (IUD)	3	1.8	3	3.0
Physical exercise		29	17.1	35	35.4
Type of physical exercise performed	Working	6	20.7	16	45.7
	Running	13	44.8	12	34.3
	Roping	2	6.9	6	17.1
	Gym	1	3.4	0	0
	Do heavy duty	7	24.1	0	0
	Ride a bicycle	0	0	1	1
Drinking alcohol		23	13.5	9	9.1
Amount of alcohol drinking per day	Half a litre	5	21.7	3	33.3
	1 litre	6	26.1	2	22.2
	2 - 3 litre	9	39.1	2	22.2
	Above 3 litre	3	13.0	0	0
Body weight loss	Yes	62	36.5	35	35.4
	No	109	64.1	64	64.6
Body weight gain	Yes	51	30	34	34.3
	No	120	70.6	65	65.7
Body weight loss	Less than 5kg	29	46.7	25	71
	5kg +	33	53.2	10	28.6
Body weight gain	Less than 5kg	40	78.4	22	64.7
	5kg +	11	21.6	12	35.3

Regarding to the factors shown on table 4.5.2; (17%) of the exposed group were reported to have previous exposure to pesticides and (93%) were exposed through cotton farming. About 35.4% of non exposed group were reported to perform physical exercises of which (46%) reported walking long distance to work place as their main type of physical exercise. Regarding to the behavior of drinking alcohol; about (14%) of exposed group were reported to drink alcohol, whereby (39%) drinking 2 -3 litre per day. As far as birth control methods, the most of exposed group (77%) reported to use calendar while non exposed group (63%) were using calendar (4.5.2).

Table 4.5.3: Logistic regression for associated factors and menstrual disorders among women working in ASGM in Nyang'hwale District

	β	SEB	Wald	P value	OR (95% Cl)
Menstrual disorders					
Modern family planning	-.246	0.285	0.748	0.4	0.782(0.44 -1.366)
Decrease BW	-.528	.310	2.899	0.09	0.590(0.321-1.083)
Increase BW	.014	.305	.002	0.9	1.014(.558-1.845)
Exposed to pesticide	-.257	.409	.394	0.5	0.773(.347-1.725)
Use alcohol	-.659	.439	2.254	0.1	0.517(.219-1.223)
Body physical exercise	-.553	.300	3.398	0.07	0.575(.320-1.036)
Working hours	.756	.594	1.619	0.003	2.129(1.256-6.816)
Amenorrhea					
Modern family planning	-.481	.288	2.777	0.1	0.618(.351-1.088)
Decrease BW	.093	.326	.082	0.8	1.098(.580-2.079)
Increase BW	-.113	.325	.121	0.7	0.893(.472-1.689)
Exposed to pesticide	-.314	.409	.590	0.4	0.730(.328-1.629)
Use alcohol	-.421	.405	1.080	0.3	0.657(.297-1.452)
Body physical exercise	.209	.316	.440	0.5	1.233(.664-2.288)
Working hours	.479	.434	1.220	0.03	1.615(1.290-3.779)
Dysmenorrhea					
Modern family planning	-.896	.331	7.307	0.007	0.408(.213-.782)
Decrease BW	-.316	.330	.917	0.4	0.729(.382-1.393)
Increase BW	-.029	.325	.008	0.9	0.972(.514-1.837)
Exposed to pesticide	-.126	.424	.088	0.8	0.882(.384-2.023)
Use alcohol	-.744	.488	2.331	0.1	0.475(.183-1.235)
Body physical exercise	-.624	.347	3.234	0.07	0.536(.272-.272)
Working hours	.468	.470	.993	0.02	1.598(1.226-4.015)
Menorrhagia					
Modern family planning	-.091	.121	.566	0.5	1.095 (.864-1.388)
Decrease BW	-.141	.341	.174	0.7	0.867(.445-1.691)
Increase BW	-.318	.354	.804	0.4	0.728(.364-1.458)
Exposed to pesticide	-.012	.438	.001	0.9	0.988(.418-2.333)
Use alcohol	-.005	.445	.000	0.9	0.995(.416-2.379)
Body physical exercise	.003	.339	.000	0.9	1.003(.516-1.950)
Working hours	-.093	.160	.338	0.6	.911(.666-1.247)

Logistic regression, OR is odds ratio, and 95% CI is 95% confidence interval

Binary logistic regression shows that the daily working hours was the most predictor for menstrual disorders**.** This result indicates that increasing working hours are more likely associated with menstrual disorders among women working in ASGM exception to menorrhagia; whereby the working hours was statistically significant associated to menstrual disorders (OR 2.13; 95% CI 1.256 - 6.816 and P= 0.003), amenorrhea (OR 1.6; 95% CI 1.290-3.779 and P = 0.03), dysmenorrhea (OR 1.6; 95% CI 1.226 - 4.015 and P= 0.02) (Table 4.5.3).

4.6 The association between mercury level in urine and menstrual disorders among women working in ASGM in Nyang'hwale District

Table 4.6: Logistic regression show the association between mercury level in urine and menstrual disorders among women working in ASGM in Nyang'hwale District

Variables	β	SE	Wald	P value	OR (CI of 95%)
Menstrual disorders					
Uses of family planning	-0.751	1.504	0.249	0.6	0.472(0.025 -9.000)
Body physical exercise	-3.905	2.441	2.560	0.1	0.020(0.000 -2.408)
Exposed to pesticide	-0.399	1.819	0.048	0.8	0.671(.019 -23.700)
BW decreases	-0.576	2.067	0.078	0.8	0.562(.01 -32.310)
BW increases	0.397	1.871	0.045	0.8	1.487(.038-58.241)
Hg level urine	1.566	.845	3.431	0.05	4.787(1.213-25.106)

Logistic regression, OR is odds ratio, and 95% CI is 95% confidence interval

The result from binary logistic regression shows that mercury level in urine was the most predictor for menstrual disorders after adjusted with other predictors as shown in table 4.6. The results indicate that the increase in mercury exposure there is an increase the probability of menstrual disorders problem. This mean that mercury in urine is statistically significant associated with menstrual disorders compared to other predictors (OR 4.787; 95% CI 1.213-25.106 and P = 0.05) (Table 4.6).

CHAPTER FIVE

5.0 DISCUSSION

This chapter presents the discussion on the main findings of this study with respect to specific objectives set and various literature review. The study comprised of 269 whereby 170 were the women working in artisanal and small scale gold mining was exposed group to mercury, 99 were women teaching primary school as comparison group (non exposed group). The study findings showed that exposure to mercury during the artisanal and small scale gold mining process seems to be associated with the menstrual disorders. To the best of scientific knowledge, this is the first study that evaluates the association of mercury exposure on aspects of reproductive health in the context of artisanal and small scale gold mining in Nyang'hwale District.

5.1 The proportion of menstrual disorders

The findings show that the proportion of menstrual disorders among the exposed group who were exposed to mercury used in the process known as amalgamation was statistical significant compared to non exposed group. The proportion of menstrual disorders among exposed group was (67%), while in non exposed group the proportion of menstrual disorders was (46%) (Table 4.3). This was consistent to the studies on mercury exposure and menstrual disorders in China, Italy and Colombia, which show that women who are exposed to mercury have the highest prevalence of menstrual disorders 17%, 47%, and 59% respectively (8,12,13). However the proportion of menstrual disorders in this study (67%) was found to be slightly higher than those in Colombia (59%). The difference may be attributed by the following factors; most of exposed group 63.2% were working above 8 hours, 51% of exposed group were working duration was 2-3 years thus may result to increase mercury dose intake due to longer duration and longer working hours, 63.2% of exposed group, non of them were using personal protective equipment to protect them from direct exposure to mercury and 32.7% of mercury was stored inside the living house, and 52% of empty containers of mercury were burned around the mining area thus may lead to increase the concentration of exposure (Table

4.2 & 4.2.1); these factors might contributed to the increase dose response relationship toward the menstrual disorders among the exposed group. Also due to fact that African women physiological have higher fat deposit in the buttocks, hips, thigh region compared to American women, Asian women and European women. Some evidence suggests that higher fat deposits was associated with menstrual cycle irregularity; hence the peripheral body fat in the hips and thigh region might also be associated with menstrual cycle function, perhaps because fat deposits in the buttocks and thighs had higher aromatase enzymes than to abdominal fat deposits that play part in the production estrogen hormone (41,42).

5.2 The menstrual disorders

In this study the menstrual disorders was found to be statistically significant higher in exposed group as compared to non-exposed group except for bleeding spot before and after the menstrual period and blood spot after sexual intercourse was found not statistically significant different between the exposed group and to the non exposed group. The proportion of dysmenorrhea was found to be statistically significant higher among the exposed group (38%) than to the non exposed group (14%) as compared to other menstrual disorders (Table 4.3.1). This findings was consistent to the study conducted in China among the women working in lump factory and exposed to metallic mercury also found the prevalence of dysmenorrhea to be higher in exposed group than that in the non exposed group compared to other menstrual disorders (12). Also the higher proportion of Polymenorrhea and oligomenorrhea were found statistical significant higher among exposed group compared to non exposed group in the study conducted in Italy among women worked in lamp factory (8).

5.3 Association between mercury exposure and menstrual disorders

The results found that exposure to mercury in women working in artisanal and small scale gold mining in Nyang'hwale District was more likely associated with menstrual disorders (OR 1.5; 95% CI 1.160 – 1. 876 and P= 0.001), and menstrual disorders occurred for three months consecutively was statistical significant higher (OR 2.6; 95% CI 1.571 – 4.131 and P=0.0001) (Table 4.5); thus means that there was statistical significant association between exposure to

mercury and menstrual disorders among women working in artisanal and small scale gold mining in Nyang'hwale Districts. The results was consistent to the study conducted in China where by proportion of abnormal menstruation was significantly higher in mercury exposed workers worked in fluorescent lamp factory in China than in control group (12). The mercury vapour which is normally produced in any industrial process it found to as an effect in reproductive hormones which may result to menstrual disorders and other reproductive outcome in women working with elemental mercury. Also according to the study conducted in Colombia among the women in artisanal gold mining; the findings shows that the exposure to elemental mercury during the process of gold mining has an association with a higher prevalence of menstrual cycle irregularity (13). The findings also was supported by the experimental study of all chemical forms of Hg administered to animals has shown that the result in disturbances in menstrual cycle and inhibition of ovulation (23). Also the study conducted on occupational exposure to mercury in female dentist in United State of America found the evidence that mercury accumulates in the brain, pituitary, and thyroid, that it disrupts ovulation in animals, and that women exposed to mercury tend to experience abnormal menstrual cycles (10). The results generalized that women who are exposed to mercury have higher risk of reporting the problem of menstrual disorders compared to non exposed women.

Regarding to menstrual disorders such as amenorrhea, dysmenorrhea and menorrhagia were found statistically significant higher among the exposed group compared to non exposed group. This results supported by the study conducted in China among the females exposed to mercury vapour found the prevalence of dysmenorrhea was significantly higher than that to the control group. The prevalence of an abnormal menstrual cycle, abnormal duration of menstrual bleeding, and abnormal of menstrual bleeding in the exposed group was higher than that in the control group (12). The menstrual disorders like dysmenorrhea was found to be statistically significant higher to mercury exposure (OR 2.7; 95% CI 1.579 – 4.489 and P= 0.0001) (Table 4.5.1), hence from the result, there is an association between exposure to mercury and the menstrual disorders. This result also was supported by the study conducted in

China among the females exposed to mercury vapour found that Dysmenorrhea may be a useful biomarker for assessing female exposure to mercury occupationally (12).

5.4 Mercury level in urine

The findings shows that the mean mercury level in the urine (30.1µg/l) (Table 4.4) was lower than that found in the study conducted in Handeni and Chunya respectively (20,21). It can be explained that the mean of mercury level in the urine were found from the lower level 0.27ug/l which was obtained from the non exposed group and the highest level was 72.883ug/l to the exposed group. This may be due to the difference in frequency of mercury used in the amalgamation process because women in mining area were not involved in amalgamation process as their daily activity. Despite the fact that, mercury use in this study area is low, there were women who were found with mercury levels exceeding the allowable levels. In this study we found that the maximum urinary mercury level of 72.883µg/l to a woman who was 44 years old used to store the mercury at home and involved in the amalgamation process for 5 years. While comparing to the study conducted in Handeni (21), the exposed miners with maximum urinary mercury levels (74.7µg/l) who had worked in extraction, amalgamation process and burning amalgam for 7 years. The exposed group in this study was found with the urine mercury levels above (World Health Organization) WHO maximum allowable levels 40% of the urine samples tested by CVAAS exceeded WHO standard; and 40% of tested sample were found to the action level (Table 4.4.1). This results is slightly similar to the study conducted in Handeni Tanga found 47.6% of the urine samples tested by CVAAS exceeded WHO standard (21).

The mean of mercury level in exposed group was statistically significant difference from the non exposed group. The results is consistence to the study conducted in Chunya which found the Urinary mercury concentrations for exposed group were higher than the referent group (20).

The result from binary logistic regression shows that mercury level in urine was the most predictor for menstrual disorders compared to the other predictors like the uses of modern family planning, body physical exercise, post exposure to pesticide, body weight increased and body weight decreased. When β value (coefficient value) is positive, OR>1 this indicates that the increase of mercury exposure is an increase for the probability of reporting menstrual disorders problem among women working in artisanal and small scale gold mining. This means that mercury in urine is statistically significant associated with menstrual disorders (OR 4.8; 95% CI 1.213-25.106 and P = 0.05) (Table 4.7). This findings is consistence to the study conducted in China among the females exposed to mercury vapour also observed a trend of increase prevalence of menstrual abnormality with the increase level of mercury exposure (12).

5.5 Limitations of the Study

i. Information bias, is one of the limitations due to the nature of the study the respondent were more likely to provide wrong information for different reasons like fear of disclosing the information. This lead to spending more time to explain clearly to them on the aims and benefits of the study. Hence it was easy for them to understand before a respondent was given the consent.

ii. Since the study was a cross sectional study design, it involved collection of information at a single point in time to assess the exposure and the outcome; it could not determine the causal-effect relationship between exposure to mercury and menstrual disorders.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The findings show that proportion of menstrual disorders among workers exposed to mercury is statistically significant higher than that in non exposed group, the proportions were as follows; (67%) for the exposed group and (46%) for non exposed group. The mean mercury level in urine for exposed group was statistically significant higher (41.33ug/l) compared to non exposed group (2.04 ug/l) and P =0.0001. In general the findings show that women working in artisanal and small scale gold mining are more likely associated with menstrual disorders (OR 1.5;1.160 – 1. 876 of 95% CI and P= 0.001).

The findings generalized that women who are exposed to occupational mercury have higher risk to report the problems on menstrual disorders.

6.2 Recommendations

i. The cohort study should be conducted in order to establish the causal effect relationship between mercury exposure and menstrual disorders, because there is still limited scientific information on mercury exposure and reproductive health effects to women occupationally exposed to mercury.

ii. The council management team including the council health management team, councilors and Nongovernmental Organizations such as AMREF and Faith Based Organizations, should prepare the rules and enforce them to artisanal small scale miners so as to ensure personal protective measures are taken in mining areas and should be used effectively in order to protect miners from direct exposure to mercury.

iii. The council management team including the council health management team, councilors and Nongovernmental organization such as AMREF and Faith Based Organizations within the councils should use the information from this study to create

awareness to mining community on mercury used for amalgamation process to extract gold which may associate with menstrual disorders and other reproductive health defects among women working in artisanal and small scale gold mining. It will help the artisanal and small scale gold miners to take precautions on the safety measures to protect themselves from direct exposure to mercury; and also it will help them to come up with alternative techniques such as free mercury techniques, instead of using mercury for amalgamation process in order to protect the environmental in mining areas as well as the health of miners and to enhance the sustainability on mining activities.

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APPENDICES

Appendix I: Questionnaire in English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF PUBLIC HEALTH SOCIAL SCIENCES

A Questionnaire for Assessing Exposure to Mercury and Associated Menstrual Disorders among Women in Artisanal Small scale Gold Mining at Nyang'hwale ,Geita – Tanzania.

DATA COLLECTION TOOLS

Name of the Ward…… Village Name …….

Name of the mining plant … …….. Name of the owner……

Name of interviewer…… Date……

Questionnaires number ……

Please, put check (√) in the last column which indicate the correct response to each question; and give the answer to the space provided in last column for the questions which need the direct answer for example, age(write the year of birth).

A: SOCIAL DEMOGRAPHIC

S/N	**Question**	**Coding classification**	**Respond**
1.	Sex: (observe)	1= Male	
		2=Female	
2.	Age or year of birth	……	
3.	Weight	……Kg	
5.	Marital status: Marriage	1=Single	
		2= Married	
		3=Cohabitation	
		4= Divorced	
		5= Window	
6.	Education Level	1= No education	
		2= Primary education	
		3= Secondary education	
		4 = Collage or higher level	
7.	What is your current occupation?	…….	
8.	What is your job category?	……..	
9.	For how long have you been in this job?	……..	
10.	How many hours do you work per day?	……	

11.	During the work process you always use personal protective equipment?	0 = No	
		1 = Yes	
12.	Where did you use to storage elementary mercury for amalgamation?	……..	
13.	Where did you use to disposal empty mercury containers?	……	

B. **DISORDER SYMPTOMS ON MENSTRUAL CYCLE**

S/N	**Question**	**Coding classification**	**Respond**
	Menstrual pattern		
14.	Age experienced the first menstrual flow (menarche)	……	
15.	What is the interval of your menstrual cycle?	…….. days	
16.	Is there any irregularity in your menstrual cycle? If YES; answer the question No. 17.	0 = No	
		1 = Yes	
17.	Did this changes of menstrual cycle start before the current occupational?	0 = No	
		1= Yes	
18.	If YES; For how long did your irregularity started after starting the current job?	……	

19.	Did your irregularity of menstrual cycle go for three months consecutively?	0= No	
		1 =Yes	
20.	If No; How many times have you had menstrual irregularities?	……..	
	Symptoms of menstrual cycle disorders.		
21.	The cycle length of your menstrual period?	1. Below 21 days	
		2. Between 21 – 27days	
		3. Between 28 - 35 days	
		4. Above 35 days	
22.	The duration of your menses flow last for?	1. 2 days	
		2. Below 2 days	
		3. Between 5-7 days	
		4. Above 7 days	
23.	Do your menses flows always last for how many days in duration?	1. 2 days	
		2. Below 2 days	
		3. Between 5-7 days	

		4. Above 7 days	
24.	Have you always experienced menstrual cycle after how many days apart from each cycle?	1. More than 35 days	
		2. Between 21 – 35 days	
		3. Below 21 days	
25.	If YES for 1 & 3; for how many times?	……	
26.	Have you ever missed menstrual flow for 3 months consecutively?	0 = No	
		1 = Yes	
27.	How many number of sanitary pad or tampon do you use per day?	1. Below 5 pads/day)	
		2. Between 5 - 7 pads/day)	
		3. Above 7 pads/day)	
28.	Does bleeding spot occur between the menstrual periods?	0 =No	
		1= Yes	
29.	Does bleeding spot occur after intercourse?	0 =No	
		1= Yes	
30.	Have you ever experienced excessive bleeding during your menstrual period?	0 =No	
		1= Yes	

31.	If YES; for how many times?	…….	
32.	What is the level of pain you experienced during your menstrual period?	1 = Excessive pain	
		2 = Normal pain	
	Birth control method history		
33.	What birth control method do you currently use?	1 = Implant	
		2 = Intra uterine device (IUD)	
		3 = Pill	
		4 = Depo provera injection	
		5 =Natural method	
	Other Symptoms		
34.	Have you had recent weight loss?	0 = No	
		1 = Yes	
35.	If YES, state the amount.	……kg	
36.	Have you had recent weight gain?	0 = No	
		1 = Yes	
37.	If YES, state the amount.	……kg	
	Past Occupational History		
38.	Have you ever worked for any other mercury exposure job?	0= No	
		1= Yes	
39.	If YES; Specify job Industry/area	……	

40.	For how long?		……..Years
41.	What perceived level of mercury has been exposed in that job?	1= mild	
		2= Moderate	
		3= High	
42.	Have you ever been exposed to pesticide or other heavy chemical in any other work?	0= No 1= Yes	
43.	If YES; Specify job Industry/area	……..	
44.	For how long exposed?	……...Years	
45.	What perceived level has been exposure in that job?	1= mild	
		2= Moderate	
		3= High	
	Other personal Habits		
46.	Do you smoke cigarette? If NO; escape all questions concerned with smoking habit.	0= No	
		1= Yes	
47.	How many cigarettes do you smoke per day?	…….	
48.	For how long have you been smoking?	……..	
49.	Do you use to drink alcohol? If NO; escape all questions concerned with alcohol drinking habit.	0= No	
		1= Yes	
50.	Amount of alcohol use per day?	……..	

51.	For how long have you been drinking alcohol?	……..	
52.	Do you perform physical exercise?	0= No	
		1= Yes	
53.	Which type of physical exercise do you perform?	……..	
54.	How often do you perform physical exercise per day? If NO; escape the question concerned with physical exercise habit.	1= Once a day	
		2 = Twice a day	
		3 = More than twice a day	

B: **Measurement of mercury concentration level in Urine**

S/No.	Code number of the urine sample	Conc. Level after analysis

Appendix II: Dodoso Ya Kiswahili

CHUO KIKUU KISHIRIKI CHA TIBA NA SAYANSI MUHIMBILI

SCHOOL OF PUBLIC HEALTH SOCIAL SCIENCES

Fomu ya kukusanyaji taarifa za mabadiliko ya hedhi kutokana na kuvuta/kugusa kemikali ya zebaki inayo tumika katika uchenjuaji wa madini ya dhahabu kwa kina mama wano jishughulisha na uchimbaji mdogo wa madini ya dhahabu katika Wilaya ya Nyang'hwale, katika Mkoani Geita, Tanzania.

Jina la Kata…… Jina la Kijiji …….

Jina la chimbo ……...……. Jina la mmiliki wa chimbo……

Jina la Mdodosaji …… Tarehe……

Namba ya Dodoso **……**

Weka vema (√) mbele ya Jibu sahihi na andika Namba au jibu sahihi kila panapohitajika.

SEHEMU A: TAARIFA ZA AWALI ZA MDODOSWAJI

S/N	**SWALI**	**CHAGUO**	**JIBU**
1.	Jinsia: (angali)	1= ME	
		2=KE	
2.	Umri	(Andika mwaka wakuzaliwa) ……..……	
3.	Uzito	……Kg	
5.	Hali ya ndoa	1=Sijao/sijaolewa	
		2= Nimeoa/nimeolewa	
		3=Naishi na mwenza	
		4= Tumetengana	
		5= Mgane/ mjane	
6.	Kiwango cha elimu	1= Sina elimu	
		2= Elimu ya msingi	
		3= Elimu ya sekondari	
		4 = Elimu ya baada ya kuhitimu sekondari (Taja)	……

7.	Kazi yako ya sasa?	(Taja)……..	
8.	Upo kitengo gani?	(Taja)…….	
9.	Umekuwa ukifanya kazi hii kwa muda?	(Taja)…….	
10	Unafanya kazi masaa mangapi kwa siku?	…… Kuanzia saa……Hadi saa……..	
11.	Wakati unapofanya kazi ya uchenjuaji unatumia vifaa vya kukukinga na zebaki (PPE) wakati wote?	0 = Hapana	
		1 = Ndiyo	
12.	Unahifadhi wapi chupa/ kopo zenye kemikali ya zebaki?	(Taja)……..	
13.	Unatupa wapi chupa/kopo tupu mara baada ya kutumia kemikali ya zebaki?	(Taja)…….	

B. DALILI ZA MABADILIKO YA MZUNGUKO WA HEDHI

Na.	**SWALI**	**CHAGUO**	**JIBU**
14.	Hedhi yako ya kwanza ulipata ulikuwa na umri gani?	(Taja)……	
15.	Hedhi yako ya kila mwezi unapata kila baada ya muda gani?	(Taja) ……. …….	
16.	Ulisha wahi kupata mabadiliko yoyote yasiyo ya kawaida katika mzunguko wako wa mwezi wa hedhi? Kama jibu ni NDIYO jibu swali na.17.	0 = Hapana	
		1 = Ndiyo	
17.	Mabadiliko hayo katika mzunguko wako wa hedhi yalianza kabla ya kuanza kazi yako ya sasa?	0 = Hapana	
		1= Ndiyo	
18.	Kama jibu ni ndiyo; Mabadiliko hayo ya hedhi yalianza muda gani baada ya kuanza kazi?	(Eleza)……	
19.	Mabadiliko hayo ya hedhi hutokea kwa miezi mitatu mfurulizo au zaidi?	0= Hapana	
		1 =Ndiyo	

20.	Kama jibu ni HAPANA; Mabadiliko ya hedhi katika mzunguko wako wa kila mwezi hutokea mara ngapi?	(eleza)……..	
21.	Mzunguko wako wa hedhi wa kila mwezi hutokea kila baada ya siku ngapi?	1. Chini ya siku 21	
		2. Kati ya siku 21 na siku 27	
		3. Kati ya siku 28 na siku 35.	
		4. Zaidi ya siku 35	
22.	Hedhi yako ya kila mwezi hudumu kwa siku ngapi?	1. Siku 2	
		2. Chini ya siku 2	
		3. Kati ya siku 5-7	
		4. Zaidi ya siku 7	

23.	Wakati wa hedhi yako ya kila mwezi mara kwa mara hudumu kwa muda wa siku ngapi?	1. Siku 2 2. Chini ya siku 2 3. Kati ya siku 5-7 4. Zaidi ya siku 7	
24.	Hedhi yako ya kila mwezi mara kwa mara unapata kila baada ya siku ngapi?	1. Zaidi ya siku 35	
		2. Kati ya siku 21-35	
		3. Chini ya siku 21.	
25.	Kama jibu ni na. 1 au 3 imetokea mara ngapi?	(Taja)……..	
26.	Ulisha wahi kukosa hedhi yako mfurulizo kwa miezi mitatu?	0 = Hapana	
		1 = Ndiyo	
27.	Wakati wa hedhi yako ya kila mwezi unatumia pedi/ Vitambaa vingapi kwa siku?	1. Chini ya 5 kwa siku	
		2. Kati ya 5 hadi 7 kwa siku	

		3. Zaidi ya 7 kwa siku.	
28.	Huwa unatokwa na matone ya damu kabla na baada ya hedhi yako ya mwezi kuisha?	0 =Hapana	
		1= Ndiyo	
29.	Huwa unatokwa na matone ya damu kila baada ya tendo la ndoa?	0 =Hapana	
		1= Ndiyo	
30.	Wakati wa hedhi yako ya mwezi, huwa unatokwa na damu nyingi kuliko kawaida?	0 =Hapana	
		1= Ndiyo	
31.	Kama jibu NDIYO; mara ngapi imetokea?	(Taja) ……..	
32.	Unapo kalibia kuanza hedhi yako ya mwezi huwa na maumivu ya aina gani?	1 = Makali sana	
		2 = Kawaida	
	Historia ya njia ya uzazi wa mpango		
33.	Ni njia gani ya uzazi wa mpango unayo tumia kwa sasa?	1 = Kijiti	
		2 = Kitanzi (IUD)	
		3 = Vidonge	
		4 = Sindano	
		5 = Asili/kawaida	

	Mabadiliko mengineyo		
34.	Hivi karibuni ulisha wahi kupungua uzito wako?	0 = Hapana	
		1 = Ndiyo	
35.	Kama jibu ni NDIYO; (Taja kiasi cha uzito uliyo pungua)	…….. kg	
36.	Hivi karibuni ulisha wahi kuongezeka uzito?	0 = Hapana	
		1 = Ndiyo	
37.	Kama jibu ni NDIYO; (Taja kiasi cha uzito uliyo ongezeka)	…….. kg	
38.	Ulishawahi kufanya kazi nyingine iliyokua inatumia kemikali ya zebaki?	0 = Hapana	
		1 = Ndiyo	
39.	Kama jibu ni NDIYO;Kazi gani? Kiwanda /Eneo	…….. ……..	
40.	Ulifanya kazi hiyo kwa muda gani?	(Taja)……	
41.	Unafikiri ulikuwa unapata kiasi gani cha kemikali ya zebaki?	1= Kidogo	
		2= Kawaida	
		3= Kikubwa	

42.	Ulishawahi kufanya kazi eneo linalo tumia viwatilifu au kemikali nyingine zaidi ya zebaki?	0 = Hapana	
		1 = Ndiyo	
43.	Kama ni NDIYO; Kazi gani? Kiwanda/Eneo	(Taja)…….. ……	
44.	Ulifanya kazi hiyo kwa muda gani?	(Taja)……...	
45.	Unafikiri ni kiasi gani cha viwatifu/kemikali ulivuta?	1= Kidogo	
		2= kawaida	
		3= Kubwa	
	Tabia zinginezo		
46.	Je, unavuta sigara? ***Kama HAPANA acha maswali yote yanayo husu sigara***	0= Hapana	
		1 = Ndiyo	
47.	Unavuta sigara ngapi kwa siku?	(Taja)…….	
48.	Una muda gani toka ulipo anza kuvuta sigara?	(Taja)……..	

49.	Unatumia pombe? ***Kama HAPANA acha maswali yote yanayo husu pombe***	0= Hapana	
		1= Ndiyo	
50.	Unakunywa pombe kiasi gani kwa siku?	(Taja)…….	
51.	Una muda gani toka ulipo anza kunywa pombe?	(Taja) …….	
52.	Huwa unafanya mazoezi ya viungo? ***Kama HAPANA acha maswali yote yanayo husu mazoezi ya viungo***	0= Hapana	
		1= Ndiyo	
53.	Ni aina gani ya mazoezi ya viungo huwa unafanya?	(Taja)…….	
54.	Unafanya mazoezi ya viungo mara ngapi kwa siku?	1= Mara moja	
		2 = Mara mbili	
		3 = Zaidi ya mara mbili	

ASANTE KWA USHIRIKIANO WAKO

B: **VIPIMO KIASI CHA KEMIKALI YA ZEBAKI KWENYE MKOJO**

S/No.	**Namba ya sampli ya mkojo**	**Kiaasi cha zebaki kwenye mkojo baada ya vipimo vya maabara**

Appendix III: Consent to Participate in Research – English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF PUBLIC HEALTH SOCIAL SCIENCES

A research on exposure to mercury and Associated Irregular Menstrual Cycle among Women in Artisanal Small scale Gold Mining at Nyang'hwale , Geita –Tanzania.

Dear Madam

You are hereby invited to participate in a study conducted by Shuku C. Kaishwa for a Masters Dissertation at Muhimbili University of Health and Allied Sciences.

Your participation in this study is entirely voluntary. You should read the information below before deciding whether or not to participate in the study. Your participation in the study will involve answering the questionnaire which contain 56 questions, also will involve taking of urine sample for assessing mercury concentration.

Purpose of the study: The purpose of this study is to assess exposure to mercury and associated Irregular Menstrual Cycle among Women in Artisanal Small scale Gold Mining at Nyang'hwale District.

Voluntary Participation: Participation in this study is voluntary and you have a right to refuse to consent. If you consent to participate, you have the right to withdraw from the study at any time if you wish to do so.

Benefits: There are no direct benefits for participating in the study. However this study will provide information on exposure to mercury and associated Irregular Menstrual Cycle among Women in Artisanal Small scale Gold Mining**.** This information will be useful to government and non-government actors to report irregular menstrual cycle on routine reporting system of the diseases and will help to find the best method or alternative for extract the gold instead of uses mercury.

Risks and discomfort: There are no risks or discomforts involved in this study.

Compensation for time: You will not receive any payment or other compensation for participation in this study. There is also no cost to you to participate in the study except your time.

Confidentiality: Your participation in this study will remain confidential and your identity will be disclosed. There will be no any link between your identity and response.

Review and approval: The review and approval of the study has been done by the Ethical committee of Muhimbili University of Health and Allied Sciences (MUHAS).

Results: The results of the study will be made available to you through a planned means of research dissemination and will be compiled in a research paper for publication as part of a partial fulfillment of a master's degree.

Consent Form: I confirm that I have read carefully, understood the information provided and consent to participate in the study.

Contact: If you ever have questions about this study, you should contact the Principal Investigator Shuku C. Kaishwa from Muhimbili University of Health and Allied Sciences, P.O. Box 65001, Dar-es-Salaam. (Tel. 0784966997/ 0754893937)

The research has been reviewed and approved by Ethical Research Committee of Muhimbili University of Health and Allied Sciences, MUHAS. Please if you have any question about your rights as a participant, you may contact.

Dr. Bruno Sunguya,

Chairman of the Senate Research and Publications Committee,
P.O Box 65001, Dar es Salaam (Tel 022-21503002-54 06, 2152489)
Dr. Simon Mamuya; MUHAS: P.O Box 65001, Dar-es Salaam.
(Tel. 0787 721 377) who is the supervisor of this research.
Dr.Jane Mlimbila; MUHAS: P.O Box 65001, Dar-es Salaam.
(Tel. 0713210174) who is the supervisor of this research.

Agreement Part

I therefore request your participation in this study;
DO YOU AGREE? YES:…… NO……. (Tick for appropriate response)
If you agree, sign below
Participants sign…….. Date…….

Investigators sign…… Date…….

Appendix IV: Ridhaa ya kushiriki kwenye utafiti - Kiswahili Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES

SCHOOL OF PUBLIC HEALTH SOCIAL SCIENCES

Utafiti kuhusu mabadiliko ya mzukuko wa hedhi kutokana na kuvuta/kugusa kemikali ya zebaki inayo tumika katika uchenjuaji wa madini ya dhahabu kwa kina mama wano jishughulisha na uchimbaji mdogo wa madini ya dhabu katika Wilaya ya Nyang'hwale, katika Mkoani Geita, Tanzania.

Mpendwa Mshiriki;
Nakukaribisha kushiriki katika utafiti unaofanywa na Bi. Shuku C. Kaishwa, mwanafunzi wa shada ya pili (udhamili) kutoka katika chuo kikuu cha afya na sayansi shirikishi Muhimbili. Kushiriki kwako katika utafiti huu ni kwa hiari unatakiwa kusoma taarifa zote katika fomu hii na kuaamua kushiriki au kutokushiriki katika utafiti huu.

Madhumuni ya utafiti: Dhumuni la utafiti huu ni kuangalia mabadiliko katika mzunguko wa hedhi kutokana na kuvuta/kugusa kemikali ya zebaki inayo tumika katika uchenjuaji wa madini ya dhahabu kwa kina mama wanao jishughulisha katika uchimbaji mdogo wa madini ya dhabu katika Wilaya ya Nyang'hwale.

Ushiriki: Ushiriki katika utafiti huu ni wa hiari na una haki ya kukataa kushiriki katika utafiti. Kama umekubali kushiriki utatakiwa kuweka sahihi yako katika fomu hii nakujibu maswali utakayokuwa unaulizwa na msahili. Pia utahitajika mkojo kwa akili ya kupima kiasi cha

kemikali ya zebaki uliyopo mwilini ili kuoanisha mabadiliko ya hedhi na kiasi cha kemikali hiyo.

Faida: Hamna faida ya moja kwa moja kwa wewe kushiriki katika utafiti huu. Ila matokeo ya utafiti huu yatasaidia kutathimin mabadiliko katika mzunguko wa hedhi kutokana na kuvuta/kugusa kemikali ya zebaki inayo tumika katika uchenjuaji wa madini ya dhahabu kwa kina mama wanao jishughulisha katika uchimbaji mdogo wa madini ya dhabu. Taarifa hizi zitasaidia serikali na wadau wengine kutambua tatizo hilo na kuingizwa katika mfumo wa utoaji wa taarifa ya magonjwa ya kila siku, pia itasaidia kubuni njia mbadala ya uchenjuaji wa dhabu kwa wachimbaji wadogo badala ya kutumia kemikali ya zebaki .

Hasara: Hakuna hasara za moja kwa moja zitakazotokana na utafiti huu.

Fidia: Hakuta kuwa na malipo yoyote kutokana na ushiriki wa utafiti huu na pia kama mshiriki hutakuwa na gharama zozote za wewe kushiriki katika utafiti huu ispokuwa muda wako tu.

Usiri: Ushiriki wako katika tafiti hii utabaki kuwa siri na taarifa zote zitakazokusanywa zitashughulikiwa kwa usiri wa hali ya juu. Jina lako halitatumika katika taarifa zozote.

Kuidhinisha utafiti: Mapitio na uidhishaji wa utafiti huu umefanywa na kamati ya maadili ya utafiti kikuu cha afya na sayansi shirikishi Muhimbili.

Matokeo: Matokeo ya utafiti huu yatapatikana kupitia uwasilishwaji katika chuo kikuu cha afya na sayansi shirikishi Muhimbili, na wadau, pia ripoti ya utafiti itawekwa kwa umma (publish) ili iweze kusaidia kutekeleza shughuli za lishe na tafiti zingine.

Fomu ya utafiti: Nakiri kwamba nimesoma maelezo yote kwa umakini na nimeelewa kila kilichoandikwa katika fomu hii.Ninaelewa kwamba ninaweza kujitoa muda wowote nitakaotaka kujitoa katika tafiti hi.

Mawasiliano kuhusiana na utafiti huu

Kama una maswali kuhusiana na utafiti huu unaweza kuwasiliana na mtafiti mkuu, Shuku C. Kaishwa kutoka chuo kikuu cha afya na sayansi shirikishi Muhimbili, S.L.P 65001, Dar es Salaam. Na. (Tel. 0784966997/ 0754893937).

Utafiti huu ulipitiwa na kukubaliwa na kamati ya mapitisho ya utafiti ya chuo kikuu cha cha afya na sayansi shirikishi Muhimbili. Iwapo una maswali kuhusu utafiti huu, unaweza kuwasiliana na **Dr.** Bruno Sunguya Mwenyekiti wa kamati ya chuo utafiti na machapisho, P.O Box 65001, Dar es Salaam (Tel 022-21503002-06, 2152489), au Dr. Simon Mamuya; MUHAS: P.O Box 65001, Dar-es Salaam. (Tel. 0787 721 377) ambaye ni msimamizi wa utafiti huu, au DR. Jane Mlimbila; MUHAS: P.O Box 65001, Dar-es Salaam. (Tel. 0713210174) ambaye ni msimamizi wa utafiti huu.

Makubaliano

Hivyo basi, unaombwa kushiriki katika utafiti huu; utauliza maswali ambayo yatahitaji kupata maelezo kutoka kwako,pia tutachukua mkojo kwa ajili ya kupima kiwango cha kemikali ya zebaki. JE WAKUBALI? NDIYO:…… HAPANA……. (Weka alama ya vema panapohusika) Endapo umekubali, tia saini hapa chini:

Saini ya mshiriki …….. Tarehe…….

Saini ya mtafiti…… Tarehe ……..

Appendix V: Ethical Clearance Letter

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

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Ref. No. DA.287/298/01A/ 31st May, 2019

Mr. Shuku C. Kaishwa
MSc. Environmental and Occupational Health
MUHAS.

RE: APPROVAL OF ETHICAL CLEARANCE FOR A STUDY TITLED: "EXPOSURE TO MERCURY AND ASSOCIATED MENSTRUAL DISORDERS AMONG WOMEN IN ARTISANAL SMALL SCALE GOLD MINING AT NYANG'HWALE DISTRICT, GEITA"

Reference is made to the above heading.

I am pleased to inform you that, the Chairman has, on behalf of the Senate, approved ethical clearance for the above-mentioned study. Hence you may proceed with the planned study.

The ethical clearance is valid for one year only, from 30th **May, 2019 to 29th May, 2020.** In case you do not complete data analysis and dissertation report writing by **29th May, 2020,** you will have to apply for renewal of ethical clearance prior to the expiry date.

Dr. Emmanuel Balandya
ACTING: DIRECTOR OF POSTGRADUATE STUDIES

cc: Director of Research and Publications
cc: Dean, School of Public Health and Social Sciences, MUHAS

Appendix VI: Introduction Letter to Nyang'hwale District

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES
OFFICE OF THE DIRECTOR OF POSTGRADUATE STUDIES

P.O. Box 65001
DAR ES SALAAM
TANZANIA
Web: www.muhas.ac.tz

Tel G/Line: +255-22-2150302/6 Ext. 1015
Direct Line: +255-22-2151378
Telefax: +255-22-2150465
E-mail: dpgs@muhas.ac.tz

Ref. No. HD/MUH/T.342/2017

31st May, 2019

District Executive Director
Nyang'hwale District
P.O. Box 352
GEITA.

Re: INTRODUCTION LETTER

The bearer of this letter Ms. Shuku Charles Kaishwa is a student at Muhimbili University of Health and Allied Sciences (MUHAS) pursuing MSc. Environmental and Occupational Health.

As part of her studies she intends to do a study titled: "***Exposure to mercury and assocaited menstrual disorders among women in artisanal small scale Gold Mining at Nyang'hwale District, Geita".***

The research has been approved by the Chairman of University Senate.

Kindly provide her the necessary assistance to facilitate the conduct of her research.

We thank you for your cooperation.

Ms. Sharifa Kamby
For: DIRECTOR, POSTGRADUATE STUDIES

cc: Dean, School of Public Health and Social Sciences.

Appendix VII: Approval Letter from Nyang'hwale District

JAMHURI YA MUUNGANO WA TANZANIA
OFISI YA RAIS
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

HALMASHAURI YA WILAYA YA NYANG'HWALE
(Barua zote zipelekwe kwa Mkurugenzi Mtendaji Wilaya)

Simu: +255-28252003
Fax: +255 -28252061S.L.P. 352
Baruapepe dednghl@yahoo.com

Ofisi ya Mganga Mkuu (W)
Nyang'hwale

Kumb: Na.CA/128/53/90

19/6/2019

SHUKU CHARLES KAISHWA
CHUO KIKUU CHA MUHIMBILI
S.L.P 65001
DAR-ES-SALAAM

YAH: KUKUBALIWA OMBI LA KUFANYA UTAFITI (RESEARCH)

Tafadhali husikana somo hapo juu,

Rejea barua inayoandikwa kutoka chuoni kwako na Dean of school of Public and sciences ya tarehe 31 May 2019, yenye Kub Na HD/MUH/T.342/2017 Inayohusiana na kujakufanya utafiti katika Halmashauri hii, unaohusian ana ***Exposure to Mercury and associated menstrual disorders among women in artisanal small Gold Mining at Nyang,hwale District, Geita".***

Ombi lako **limekubalika,** Utafanya utafiti kuanzia tarehe **20/6/2019** hadi **22/7/2019,** hata hivyo ofisi yangu inakutaka ulete nakala ya mrejesho wa utafiti wako mara tu umalizapo kufanya utafiti wako.

Nakutakia kazi njema.

Wako,

RENATUS IHOYELO
KNY MGANGA MKUU WILAYA
NYANG'HWALE

Afisa Def - Nyang'hwale.

MGANGA MKUU WA WILAYA
NYANG'HWALE