ENVIRONMENTAL AND OCCUPATIONAL EXPOSURE TO MERCURY IN A SMALL SCALE GOLD MINING COMMUNITY IN HANDENI, TANZANIA

By

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences, a dissertation entitled ***Environmental and Occupational Exposure to Mercury in a Small Scale Gold Mining community in Handeni, Tanzania*** in fulfillment of the requirements for the degree of Master of Science in Applied Epidemiology of Muhimbili University of Health and Allied Sciences.

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DECLARATION

I, **Elida Wilfred Macha**, 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 a similar or any other degree award.

Signature……. Date……..

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ABBREVIATIONS

ASGM	**Artisanal Gold Mining**
Au-Hg	**Gold and Mercury combination**
BoT	**Bank of Tanzania**
CNS	**Central Nervous System**
ICP- OES	**Inductively Coupled Plasma Optical Emission Spectrometer**
ID	**Identification**
IRB	**Institutional Review Board**
MeHg	**Methyl Mercury**
MUHAS	**Muhimbili University of Health and Allied Sciences**
NEMC	**National Environmental Management Council**
ng/ml	**Nanogram Per Milliliter**
Ppm	**Parts Per Million**
WHO	**World Health Organization**
µg /g	**Microgram Per Gram**
µg /l	**Microgram Per Liter**

ABSTRACT

Background: Mercury is a highly dangerous neuro-toxicant, affecting over 2 million people in Tanzania. High exposures in artisanal gold mining have significant health and environmental impacts. Burning of mercury amalgamate is of great concern as it emits mercury directly to the atmosphere affecting miners and nearby residents. We assessed environmental and occupational exposure to mercury in miners and their families from Handeni District, north-east Tanzania.

Objectives: We aimed to determine mercury exposure levels among miners and their families by testing urine, blood and hair, as well as determining the relationship between exposure biomarker and signs and symptoms of mercury intoxication. We also aimed to determine the concentration of mercury in water and vegetables, in the areas surrounding the gold mining community. Moreover, we aimed to assess the health effects of mercury exposure on miners and their families

Methods: A cross sectional descriptive study was conducted among 292 miners and their families. Interviews and medical examinations were conducted on all participants. A sample of 30 participants with history of mercury use, provided hair, urine and blood, residential ground water and vegetable samples for mercury analysis by Inductively Coupled Plasma Optical Emission Spectrometry. Data analysis was done using Epi-Info.

Results: We enrolled 292 participants with a mean age of 31.8 years.. The mean mercury levels in urine and blood from selected participants were 46.3µg/L and 14.5µg/L respectively. Out of 21 urine samples, 10 (47.6%) exceeded the maximum acceptable level of 50 µg/L provided by the World Health Organization (WHO). Additionally, out of 25 blood samples, 13 (52%) exceeded the WHO normal range of 5- 10µg/L. All hair samples were below the detection limit of 0.01ppm. Miners engaged in amalgamation and burning of amalgam had higher mean mercury levels in urine (53.7µg/L, p=0.02) and blood (27.6µg/L, p= 0.6). Mercury levels in groundwater were below Tanzanian standards of 1µg/L. Tremor of the eyelid (30%) was significantly higher ($p<0.005$) in miners than non-miners. Other signs recorded on examination of miners were blue line in gums (34%), blue coloured ring in periphery of iris (11%), dysmetria (9%), gingivitis (7%), intention tremor (5%), decreased mental labial reflex (5%) and decreased Babinski reflex (5%)

Conclusion and recommendation: High mercury concentrations in urine and blood were found in mining community of Handeni District. Miners, who are known to have a high occupational exposure, have higher mercury concentrations than non-miners. In addition; signs of mercury intoxication were also identified in miners. Immediate efforts should be directed into reducing occupational and residential exposures to mercury in communities near gold mines. Larger studies should be carried out to better characterize exposures found while control measures are implemented

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1.0 INTRODUCTION

1.1 Small scale Gold Mining- Global situation

Exposure to heavy metal among small-scale artisanal gold mining communities is of global health concern. It is estimated that, 10 to 15 million people worldwide are directly involved in small-scale gold mining. Among them 4.5 million are women and 600,000 are children mostly from poor families. An additional 100 million people are estimated to rely upon the sector for income(1)(2). Due to rising price of gold, and privatization there has been an increased practice of small-scale gold mining which account for about 20 to 30% of the world's gold output (3).

1.2 Small scale Gold mining in developing countries

Artisanal and small-scale mining has been highly practised in developing countries. It is estimated that, over 30 developing countries, practice small scale gold mining in which about 13 million people are directly involved while 80 to 100 million people depends on the sector for their livelihood. About 153000 women and children are involved in small scale gold mining in developing countries. Women's participation in ASM involves not only mining but also the supply of food, drink, tools and equipment, as well as sexual services(4)

1.3 Small scale Gold mining in Sub Saharan Africa

According to the ILO Global report of 2002, it is estimated that, about 1,040,000 people are involved in small scale gold mining within Southern African countries. Amongst them, 25% are women (South Africa: <5%;Tanzania 25%; Zimbabwe > 50%). Most of the women are found at the very bottom end of the sector's hierarchy, doing subordinate work. Main countries for small-scale mining activities are Tanzania (550,000 miners) and Zimbabwe (> 350,000 miners). Small-scale mining is a fast rising sector. The number of small-scale miners in Zimbabwe has been growing exponentially. It is likely that, small-scale mining activities in Zimbabwe will triple within the next 10 years. The situation in other countries within sub-Saharan Africa might follow a similar pattern(4).

1.4 Small scale Gold Mining- Tanzania situation

Tanzania is currently Africa's third largest gold producing country after South Africa and Ghana. According to Bank of Tanzania (BoT), gold exports value rose from $906.5 million in September 2009 to $1.5 billion in the same month in 2010. Export volume of gold has also increased from 31.0 tonnes in 2009 to 36.8 tonnes in 2010. Tanzanian mining industry contributed about 3.7% of GDP in 2007. Medium and small scale mining has been significant contributors to the national economy by complimenting income that would have been derived from other seasonal activities like agriculture. It has also provided employment for majority of Tanzanians hence reducing poverty(5)

1.5 Mercury release in Artisanal Gold Mining

Artisanal gold mining is one of the major sources of mercury release into the environment in developing countries, despite the fact that, only a quarter of the world's total gold supply comes from these sources. It is estimated that, 1.32kg of mercury is released to the environment for every 1kg of gold produced. About 40% of this is released during initial stages of concentration and amalgamation 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 remained 60% is released during burning of amalgam (6).

Mercury is potentially very harmful to the environment and human health. It is a highly dangerous neuro-toxicant known, affecting over 2 million men, women and children in Tanzania. High exposures in small scale gold mining have significant health, environmental and economic impacts.

Artisanal gold miners combine mercury with gold-laden silt to form a hardened amalgam with most of gold metal from the silt. They use their bare hands when handling mercury, which expose them to risk both from vapour and direct contact through skin. The amalgam is being burned in the open air, within the home or in processing areas. Open air burning of mercury amalgamate is of great concern as it emits mercury directly to the atmosphere. In heating process mercury evaporates, and is inhaled by the miners, their immediate family (including their children) and the surrounding community. It can also be deposited in homes, food preparation areas, soils and local water bodies in which it is transformed by bacteria to MeHg, a dangerous neuro-toxicant that accumulates through food chain. Mercury vapour affects not only local residents in mining but can affect even those not residing in mining

because of its transportability characteristics. In many developing countries, gold decomposition takes place in the home through the use of kitchen stove or in small huts adjacent to processing sites(1)

Apart from inhalation, gaseous can be deposited in homes, food preparation areas, soils and local water bodies in which it is transformed by bacteria to MeHg, a dangerous neuro-toxicant that accumulates through food chain. Mining communities that depend on fish as their primary food source may be particularly susceptible to ingestion of dangerous levels of MeHg(1).

Small scale gold mining community may be exposed to mercury in any of its forms (i.e. Methylmercury, elemental mercury and other mercury compounds) through inhalation of mercury vapour, direct contact with mercury, eating of fish and/or other products contaminated with mercury. Human exposures through inhalation, direct contact and dietary exposures are extremely high. The Rwamasanga study in Tanzania found that, miners involved in burning amalgam had the highest mercury exposures in blood, hair and urine(7)

1.6 Assessment of mercury exposure

The best method to assess Hg exposure in humans is to collect bodily specimens, most commonly hair, blood and urine. Urine is the most reliable indicator of inhaled Hg vapour, which may emanate from Au-Hg amalgamation, while hair samples are good indicators of Total Hg that has been consumed in food or absorbed through skin. Blood is the good indicator of long term exposures to small amounts of mercury in any of its forms(8).

1.6 Mercury in hair, fish and urine

1.6.1 Mercury in hair and fish

Few studies have been carried out in Tanzania, it was found that, fishermen around Lake Victoria had high methylmercury in their hair than gold miners(9). They exceeded the temporal safety standards for head hair mercury level (50 ppm). The lowest hair mercury levels were found in the Nungwe Bay fishing village population and it has been consistent with the low mercury content of fish consumed by the inhabitants of the Nungwe Bay (9).From a study done in Rwamagasa Geita district, many of the fish samples exceed safety guidelines of 0.5mg MeHg/kg provided by WHO and a recommended limit of 0.2mg/kg for vulnerable groups which includes frequent fish consumers, pregnant women, and children under 15 yrs old (10).

1.6.2 Mercury in urine

In Rwamasanga, significant higher urinary mercury levels (mean: 241 ng/ml) has been observed in artisanal gold miners frequently exposed to Hg compared to population not in mining occupation. The lowest urinary mercury levels were found in the Nungwe Bay fishing village population. (9)

1.7 Factors determining mercury health effects

Several factors determine how severe are health effects brought about by mercury toxicity. It includes the chemical form of mercury; the dose received; the age of the person exposed (the fetus is the most susceptible); the duration of exposure; the route of exposure (i.e. inhalation, ingestion and dermal contact) and the health of the person exposed.

1.8 Effects of mercury exposure

1.8.1 Health effects

Continuous exposure to mercury can intoxicate miners and surrounding population and can be associated with various health effects. Mercury intoxication was diagnosed in 24% of the amalgam burners from Rwamagasa (7). Studies done around lake Victoria has found some of the participants in the exposed group presenting with symptoms of mercury intoxication(9) This in turn contributes towards worsening quality of life and increasing poverty

Low dose mercury toxicity may affect nervous, motor, renal, cardiovascular, immune and reproductive systems. In nervous system it may cause adults memory loss, deficit in attention, increased fatigue, hearing and vision impairment, sensory disturbance, ataxia, hypoesthesia, subclinical finger tremor and late talking in children (11). In motor system it may cause adults disruption of fine motor function, decreased muscular strength, increased tiredness and late walking in children (12).Decreased performance in areas of motor function and memory has been reported among children exposed to apparently safe mercury levels with maternal hair concentrations at 10–20 microgram/g (13).

It also cause increased plasma creatinine level in renal system and alters normal cardiovascular homoeostasis in the cardiovascular system. It decreases overall immunity of the body; multiple sclerosis, autoimmune thyroiditis or atopic eczema. There has been decreased rate of fertility in males and females. If conception occurs, there is low chance of pregnancy survival as many suffer abortions and still births. If the pregnancy survives to its full age and birth occurs, the offspring will suffer abnormalities

1.8.2 Environmental effects

Environmental mercury exposures cause destruction of productive natural resources. Mercury containing tailings when damped into the soil or nearby water body, they contaminate soil, rivers, ponds etc which become persistent for many years. It builds up in the food supply chain (soil, crops, sediments, water and fish) and permanently ruins the natural habitat. A survey in North Mara found high mercury concentration in water in the mining areas(14). In Rwamasanga and Lake Victoria, fish sampled from the market had significant mercury levels of concern

Due to increasing price of gold, impacts due to mercury use may continue without policy and management attention. According to National Environmental Management Council (NEMC) of Tanzania, ASGM is an urgent pollution problem that needs to be addressed. Urgent attention and action is needed at the political level. This can be achieved once we understand mercury levels accumulated in humans and environment in the mining community and health effects experienced so far

Some studies on mercury exposure in Tanzania have been conducted in north-west areas of the country including areas surrounding Lake Victoria. However, north east areas like Handeni, mercury exposures to the mining community and the environment has not been documented. The current study will be addressing this knowledge gap

Small-scale gold mining is widely practiced in Handeni District especially in Magambazi Hill, Kwadijava and Kilimamzinga villages. Like other artisanal gold miners, they use mercury to recover gold from the ore but the extent of mercury contamination to the local environment, area residents and miners themselves remained to be established

The study aimed at determining mercury exposure levels among miners and their families by testing urine, blood and hair as well as assessing the health effects of mercury exposure to miners and their families. We also aimed at determining the association between exposure biomarker and signs and symptoms of mercury intoxication and also determining mean mercury concentrations in water and vegetables in areas surrounding the mining community

2.0 LITERATURE REVIEW

2.1 Mercury Bioaccumulation and Toxic effects

2.1.1 Mercury bioaccumulation

Mercury cycle in the environment indicate that mercury bio concentrates as methylmercury more than a million fold in the aquatic food chain(15). It has shown significant biomagnifications across the food web particularly aquatic(16)and its concentration increase with increase in body mass. Methylmercury is one of the few metals known to bio magnify through food webs and it is this process that leads to elevated and sometimes toxic concentrations in fish(17), especially those that are piscivorous. Aqueous concentrations of MeHg bio concentrates in lower trophic levels through methylation done by bacteria at the bottom sediments and then biomagnified up through the foodweb(18). Piscivorous fish has been showing highest Hg concentrations and terrestrial herbivores has the lowest(19)(20)(21). Piscivorous birds in arctic tundra were found to contain high mercury concentrations especially on the liver and kidney while breast muscles had the lowest(22). Beaver mammal species in Ontario had highest mercury concentration in their fur/hair. Mink as a top trophic level carnivore found in Canada, had Total Hg levels in fur/hair 40 times higher than those in brain(22)

2.1.2 Toxic effects

2.1.2.1 Acute toxicity of inorganic mercury

Methyl mercury can affect growth, development and reproduction in aquatic ecosystems. Exposure to acute concentrations of inorganic Hg can cause neuro-toxic effects like loss of equilibrium, inactivity, respiratory distress, and ultimately death to exposed fish for 24–96 h An exposure to 100 mg/L for one day decreases oxygen consumption in gill, liver, and muscle of carp by up to 60% . It also cause increased mucus production on both gills and skin, hemorrhage, hyperplasia, edema, congestion of liver blood vessels, damage to kidney tubules and necrosis of brain tissues. It can interfere with superficial sensory organs and mask environmental signals critical for finding prey, avoiding predation, and reproduction (18)

2.1.2.2 Chronic toxicity of inorganic mercury

It affects reproduction by impairing gonad growth in exposed fish. Within the gonads sperm and eggs development is delayed or arrested after mercury exposure(18). It also affects fish and birds growth which may leads to impairment of digestion absorption of essential nutrient and emaciation (22). Gill tissues and chloride cells responsible for osmoregulation can also be affected after prolonged exposure to low level mercury. Its neuro-toxic ability affects both the central nervous system and peripheral sensory organs of fish (18)

2.1.2.3 Effects of methyl mercury

It passes the blood-brain barrier, which can cause brain lesions, degeneration of neurons and can be lethargic

2.2 Reports on small scale mining community exposure to mercury

From a study done among children in Indonesia and Zimbabwe it was found that in all three biomonitors (urine, blood, and hair), mercury concentrations were significantly higher in the exposed group (just living in mining area, those living while working in mining) than in the control group (living in area with no mining activities). Maximum mercury concentrations for children working with mercury were as high as 941 μg/l, 667 μg/g creatinine for urine, 100 μg/l for blood, and 53 μg/g for hair indicating very high mercury intoxication as compared to thresholds. Children that were exposed by living in mining area without being envolved in mining activities showed statistically significant higher levels [71 μg/l, 56 μg/g creatinine for urine, 12 μg/l for blood, 4 μg/g for hair] than the control group(23)

A study done around Lake Victoria, among Gold miners, 36% of the Artisanal gold miners had high mercury levels in urine above the WHO limit (24). It was stressed that, in this area, Hg vapour exposure is much more important than MeHg ingestion with fish.

Another study done around Lake Victoria, found significant high mercury levels among gold miners, one fisherman and three women. The three women were found to have used toilet soap containing considerable amounts of mercury for several years. The ratio of methylmercury to total mercury was low suggesting direct exposure to inorganic mercury and not through diet(25)

2.3 Measurement of mercury in different media

2.3.1 Sediments

Study conducted on Tapajo´ s River, found that, mercury concentration in sediments was 200 times more than in mercury dissolved in water. It was found that, the main source of mercury concentration to these sediments was from soil erosion and drainage(18) from mining areas and not from burning amalgam(26)(27). River sediments near contaminated Rwamasanga mine in Lake Victoria has shown significant high concentrations and has been associated with mine tailings(28)

2.3.2 Plants

Plants that were grown in cinnabar mining, spain had critical mercury levels, particularly those that were grown in soils with higher elemental mercury concentrations(29). Lichen (Parmelia lichen) has been proved to be an effective bio-indicator of mercury contamination in the atmosphere due to amalgamation processes. Highest mercury concentrations in lichens have been observed in Magusu mine, lake Victoria close to amalgamation sites(28)

2.3.3 Soil

Soils in close environments to smelting plants and mining sites have been reported to have very high mercury concentrations(29)(22)

2.3.4 Beauty creams

In Lake Victoria, females who used beauty creams with high mercury concentrations caused the estimated total mercury in their body to exceed WHO recommendations(27).another study done in Lake Victoria Kenya found that, all subjects with high mercury levels in their hair, used toilet soaps containing mercury(30)

2.3.5 Birds

Different studies have demonstrated significantly high mercury levels in sea birds with highest concentration in feathers and albumen(31)

2.3.6 Fish

From a study done in Philippines on abandoned mines, environmental assessment revealed that, Fish samples analysed had total mercury and methylmercury levels far above threshold set by Republic of Philippines (0.5μg/g and 0.3μg/g). (32)(33). The methyl mercury concentration in fish is the result of biomagnifications and varies between different species. This is influenced by species habitat (e.g species that obtain their food on bottom sediments), position in tropic chain, feeding habits, migrational characteristics and dispersion of the contaminant once it reaches the water body. From a study done in Colombia, South America, specie with highest methylmercury level was *Triportheus magdalenae* (188-1084 μg /kg wet wt) during dry season. This species feeds on bottom sediments(34)

2.3.7 Water

In phillipines, surface water were found to have mercury levels above the threshold(32). A water surveys in Northern Tanzania goldfields has found elevated mercury concentrations only in areas with small-scale gold mining activities (14)

2.4 Symptoms and signs of exposure to mercury

From the Philippines study, The symptoms that were significantly higher in the burdened groups were ataxia and coordination problems (dysdiadochokinesia). There was a significant increase in the frequency of pathological results in the reflex status (ankle jerk, biceps brachii, quadriceps) in exposed groups. Bluish discoloration of gums and excessive salivation, as reported by the participants, were additional symptoms of chronic mercury intoxication in the exposed areas (23)

A Rwamasaga study in Geita district, participants subjectively reported to get tired easily, have problems with speech and have less appetite. They felt sadder, have problems with tremor at work and have problems with their memory. They had more frequent excessive salivation especially the subgroup of workers with the highest exposure to mercury. This is due to the smelting of the amalgam as it is an exposure hazard. Upon medical examination, participants were found to have certain symptoms that were statistically significant. These were ataxia of gait, tremor of the eyelid, finger-nose tremor, sensory disturbances and two tendon reflexes (Achilles tendon reflex and biceps tendon reflex). These symptoms are

typical signs of a damaged central and peripheral nervous system as a result of chronic mercury exposure (7).

A study around Lake Victoria examined 118 gold miners working around the Lake and found that, subjective symptoms reported were: trembling, headache, numbness of extremities, disturbance in taste, chest pain, dyspnea, cough and sputum, palpitation, disturbance in smell, pain in limb extremities, sleepiness, vertigo and dizziness. Objectively, it was found that miners had gingivitis, sensory disturbances and tremors, decrease in tendon reflex, neurasthenia, night blindness and hyperreflexia(25).

3.0 PROBLEM STATEMENT

Mercury is potentially very harmful to the environment and human health. It is a highly dangerous neuro-toxicant known, affecting over 2 million people in Tanzania. High exposures in small scale gold mining have significant health, environmental and economic impacts. ASGM use mercury to recover gold from the ore with gold smelting or amalgam being burned in the open air, within the home or in processing areas. They use their bare hands when handling mercury, which expose them to risk both from vapour and direct contact through skin. Open air burning of mercury amalgamate is of great concern as it emits mercury directly to the atmosphere. Mercury vapour affects not only local residents in mining but can affect even those not residing in mining because of its transportability characteristics. Human exposures through inhalation, direct contact and dietary exposures are extremely high. The Rwamasanga study in Tanzania found that, miners involved in burning amalgam had the highest mercury exposures in blood, hair and urine(7)

High mercury exposures can affect human health by impairing the CNS leading into severe neurologic problems like ataxia, tremor and other coordination disorders. Studies done around lake Victoria and Rwamasanga in Geita has found some of the participants in the exposed group presenting with symptoms of mercury intoxication(7)(9) This in turn contributes towards worsening quality of life and increasing poverty

Environmental mercury exposures cause destruction of productive natural resources. Mercury containing tailings when damped in to the soil or nearby water body, they contaminate soil, rivers, and ponds etc which become persistent for many years. It builds up in the food supply chain (soil, crops, sediments, water and fish) and permanently ruins the natural habitat. A survey in North Mara found high mercury concentration in water in the mining areas(14). In Rwamasanga and Lake Victoria, fish sampled from the market had significant mercury levels of concern. Despite the fact that, mercury exposures have been documented in North West (Lake Victoria zone), exposure levels in north east areas like Handeni has not been documented. This study will address this gap

Small-scale gold mining is widely practiced in Handeni District especially in Magambazi Hill. Like other artisanal gold miners, they use mercury to recover gold from the ore but the extent of mercury contamination to the local environment, area residents and miners themselves remain to be established.

3.1 Research questions

What is the mean mercury level in hair, blood and urine among Handeni miners and their families?

What is the mean mercury level available in water and vegetables?

What health effects are experienced by Handeni miners and their families as a result of exposure to mercury?

4.0 RATIONALE

Due to increasing price of gold, impacts due to mercury use may continue without policy and management attention. According to National Environmental Management Council (NEMC) of Tanzania, ASGM is an urgent pollution problem that needs to be addressed. Urgent attention and action is needed at the political level. This can be achieved once we understand mercury levels accumulated in humans and environment in the mining community like Handeni and health effects experienced so far. It will help in enforcing existing policies regulating artisanal gold mining, informing decision makers, referring participants with high mercury exposure levels together signs and symptoms of mercury intoxication to health care facilities for further examination and treatment. It will yield useful information to Tanzanian Ministry of Health that may help in providing clinical training to health care providers to identify mercury diseases and report them as part of their routing in assessing mercury exposure. It may be of help to the Ministry of energy and minerals in instituting best available alternatives in gold extraction instead of mercury

5.0 OBJECTIVES

5.1 Broad objective

To assess environmental and occupational exposure to mercury in a small scale gold mining community in Handeni District.

5.2 Specific objectives

1. To determine mercury exposure levels among small scale gold miners and their families by testing urine, blood and hair
2. To determine the relationship between exposure biomarker and signs and symptoms of mercury intoxication among small scale gold miners and their families in Handeni district
3. To determine the concentration of mercury in water and vegetables, in the areas surrounding the gold mining community in Handeni district.
4. To assess the health effects of mercury exposure on the artisanal gold miners and their families in Handeni district.

6.0 METHODOLOGY

6.1 Study Area

The study was carried out in Handeni district which is one of the eight districts of Tanga Region in Tanzania. It is bordered to the west by the Kilindi District, to the north by the Korogwe District, to the east by the Pangani District, and to the south by the Pwani Region.

Fig 1: Map of Handeni showing its neighbouring districts

In Handeni, small scale gold mining is widely practiced in Magambazi Hill, Kwadijava and Kilimamzinga villages. The sites and its surroundings have very high gold potential for the district and have been attracting big number of small scale gold miners.

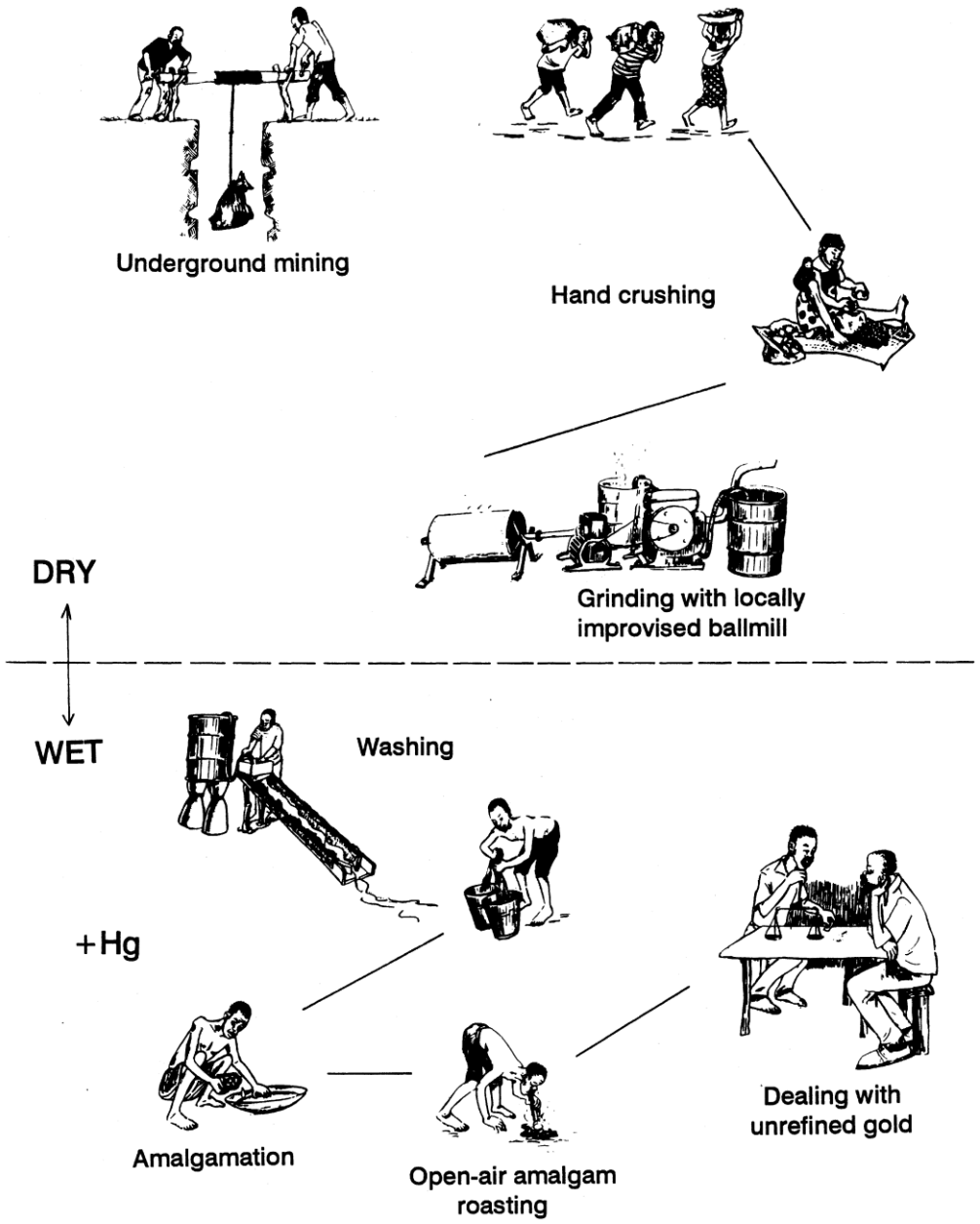

Fig 2: Generalized flow pattern of small scale gold mining in Handeni:(14)

6.2 Study design

This was a descriptive cross sectional study for small scale gold mining community in Handeni District held from November 2012 to January 2013

6.3 Study population

The study involved the population of miners and residents not involved in mining but residing in a mining area

Inclusion criteria was miners and non-miners aged 18 years and above who had resided in Magambazi Hill or Kwadijava or Kilimamzinga and within 3km catchment area for at least 1 year. This is because, mercury vapour emitted from gold mines and gold shops is transported not more than 3 km, as it is at a relatively low temperature and controlled by lower, local wind currents (14)

6.4 Sample size and sampling method

The following formula was used for calculating sample size

$$n = \frac{z^2 p (100-p)}{\varepsilon^2}$$

Assumptions made:

z= z-score, at 95% confidence interval is 1.96=2

p= expected proportion of miners with mercury intoxication -24%(7)

e= margin of error that was allowed = 5%

$$n = \frac{(1.96)^2 * 24(100-24)}{5^2} = 292$$

Minimum sample size was 292 people. 16% of this sample size was interviewed from community residents not involved in mining and was decided conveniently

Systematic sampling method was used. Miners sampling frame was obtained from the mining group chairman. Miner's family members were picked randomly upon availability

6.6 Specimen collection

6.6.1 Hair

Hair samples of approximately 10mg (20 strands) and 1cm long was cut from close to the occipital area of the scalp with stainless steel scissors at the hair root. The root ends were affixed to adhesive tape for easy identification. Hair samples were stored in polyethylene bags at room temperature until transport to Government Chemist Laboratory for analysis(35)

6.6.2 Urine

Urine samples (50mls) were collected in sterilized polyethylene bottles early morning and preserved with 1% Hydrochloric acid. In the field, samples were stored in cold boxes and transported to the district hospital laboratory where they were refrigerated (4^0C) until transport to Government Chemist Laboratory for analysis(35).

6.6.3 Water

Water samples were collected from 2 wells, 1 Canteen and 1residental area (50m from amalgam burning site) in Magambazi, 2 wells in Kwadijava and 2 wells in Kilimamzinga.. About 100ml were collected in Teflon bottles and preserved with small amount of1% HCL acid and stored in cold boxes. They were transported to a district lab refrigerator where they were stored frozen (0 to −5°C) until transport to GCL for analysis. Collection date, location and position relative to contamination source were documented(35).

6.6.4 Vegetables

Vegetables (maranthus) consumed by the local population were collected from Nyasa village (supply vegetables to Magambazi hill residents) and Kwadijava.. All vegetable samples were stored in cold boxes and transported to the district laboratory where they were refrigerated until transport to GCL for analysis(35).

6.6.5 Blood

5mls of blood was collected from a vein into EDTA tubes and stored into a cold box. The samples were then transported into District laboratory where they were centrifuged at 3,000 rpm for 10 minutes to separate the red blood cells from plasma and kept frozen (0 to -5^{o}C) until transport into GCL for analysis (35)

6.7 Mercury Analysis

Preparation of 1 % aqua regia

1% Hydrochloric acid and 1% Nitric acid were mixed at the ratio of 3;1 respectively

6.7.1 Blood and Urine

To 1 ml of the sample 9mls of 1% aqua regia was added, well shaken then left for a 5minutes. They were then subjected to ICP OES for the metal determination.

6.7.2 Hair and Vegetables.

A known weight of the sample was placed into a kjelder tube where 10mls of aqua regia was added and subjected to digestion using Kjelder digestion machine at a temperature of 150 ^{o}C for two hours. The digested samples were left to cool and then filtered into 100mls volumetric flask and then filled with distilled water to the mark. The samples were then subjected to ICP – OES for the metal determination (35)

6.7.3 Water

The water samples had no any sample pre-treatment. They were subjected direct to the ICP – OES for metal determination(7)

6.7.4 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.

6.8 Data collection tools and collection technique

Data was collected using standardised questionnaire. The questionnaires had both closed ended and open ended questions.

6.9 Variables

6.9.1 Independent variables

- Demographics: gender, age, education level, nutritional status, occupation, marital status
- Work exposure: working in mining, direct contact with mercury, working in burning amalgam, burning amalgam at home, keeping mining work clothes at home, years of work with mercury
- Diet: eating vegetables and drinking water

- neurological disorders, working with gasoline and/ or kerosene, handling of insecticides, pesticides, use of alcohol, use cosmetics like creams and soaps, got accident,

6.9.2 Dependent variables

- Mercury exposure levels in hair, urine, blood, vegetables and water
- Clinical signs: gingivitis, discolouration of gums, eye condition, ataxia, tremor, memory disturbances, dexterity and coordination

6.10 Medical examinations

Medical examinations were done by three experienced physicians from Handeni district hospital who were knowledgeable on mercury intoxication. They performed health assessment to all participants to check for symptoms and signs of mercury intoxication

6.11 Neuropsychological tests

6.11.1 Memory test: This tests short-term memory

Memory test involved testing for the ability to keep short term memory. It required participants to repeat each column of numbers given. The longest series that was correctly repeated was scored (a lower score was better than a high one)(1).

6.11.2 Matchbox test*:* This test assesses participant's neuro motor functions. It checks coordination, tremor and concentration. Twenty matches were put on a table, half on each side of an open matchbox, approximately 15 cm away. Participants were asked to use left and right hand alternatively to fill the matches in to the matchbox. Length of time taken to put all matches into the box was noted (the shorter the better)(1).

6.11.3 Pencil tapping test: This also tests tremor and coordination. Participant had to sit at a table and place the elbows on the table. He/she was asked to dot as many points as possible on a piece of paper with a pencil. The number of points dotted within 10 seconds was (the more the better)(1).

6.11.4 Frostig score: It tests tremor and visual-motoric capacity. Participant was asked to draw a line from one symbol to the other. Symbols gradually become more difficult as they

were decreased in size. Touching the lines or interrupting the drawing means no points. The total points were counted (the more the better)(1).

6.12 Data management

Monitoring of data collected was done by the principal investigator each day after return from the field. It was done by cross checking of each questionnaire to insure it is properly and completely filled. 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.

6.13 Data cleaning

This was done through running the frequencies of all variables. It helped in identifying miscoded variables, duplicates, omissions, 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 to insure that all missing information is entered was made.

6.14 Data analysis

Data was analysed by using Epi- Info version 3.5.3. and Microsoft Excel for drawing the graphs. Statistical tests performed were chi square test for trend, Fishers exact test for difference in proportion of health effects among miners and non-miners when expected value of the cell was less than 5, Chi square test for difference in proportion of health effects among miners and non-miners when expected value of the cell was greater than 5, Student t-test for difference in means for psychological tests between miners and non-miners and Krustal wallis test small sample size with continuous variables

6.15 Ethical considerations

Ethical clearance was sought from Muhimbili University of Health and Allied Sciences (MUHAS) Institutional Review Board. Consultation with the district authorities as well as ward and village authorities was made to obtain permit for carrying out the study. Respondents were informed about the purpose of the study, data to be collected and their voluntary participation. Those who agreed to participate signed a letter of informed consent

prior to inclusion in the study. Confidentiality of information and freedom to withdraw from the study anytime was stipulated.

The remaining hair and urine was disposed according to laboratory regulations for disposal of specimens

6.16 Limitations

The instrument used for mercury determination (ICP- OES) could not detect mercury levels below 10ppb.

Many males had their hair cut making it difficult to get enough amount of hair from an individual

Vegetable samples from Kilimamzinga village were not collected because they were out of season

Reducing the miners sample size by 16% to include the non miners may reduce the study power

7. 0 RESULTS

7.1 Social demographic characteristics of the study population

Table 1: Socio-demographic characteristics of the selected participants in Handeni mining community

Variable	Variable Categories	*Frequencies*	*%*
Sex	Male	249	85.3
	Female	43	14.7
Age	Mean (SD),	31.8 (8.3)	
	18-30 years	135	46.2
	31-40 years	116	39.7
	41-50 years	32	11
	>50 years	9	3.1
Education	None	56	19.2
	Primary complete	210	71.9
	Secondary	21	7.2
	Tertiary	5	1.7
Occupation	Miners	245	83.9
	Non- miners	47	16.1

We were able to enrol 292 participants of which majority (84%) were miners. As expected, there were more males (85.3%) than females. Kilimamzinga mining village contributed 42.8% of sample size. Majority (86%) of the participants were young people (i.e. < 40 years).

7.2 Mercury exposure levels in the mining community

For all (30) hair samples tested, only 2 samples had mercury levels above the detection limit which is 0.01ppm. In 5 of 25 blood samples, the mercury levels were below the detection limit. In 2 of 21 urine samples the mercury levels were below the detection limit. For statistical purposes, all mercury levels below the detection limit were equated 0.

7.2.1 Mercury levels in Urine

Table 2: Biological samples results; Urine (µg/L) N=21

		Mean (SD)	Range	P-value
All participants		46.3(18)	0-74.7	NA
Sex	Male	45.6(19)	0-74.7	0.2
	Female	51(10)	44-58	
Occupation	Miners	45.5(19)	0-74.7	0.09
	Non-miners	27.2(18)	7.6-44	
Type of mining activity	Extraction	44.4	34-54.7	1
	Amalgamation and Burning amalgam	**53.7(17)**	**45-62**	***0.02***

NA means Not Applicable. Krustal Wallis test for difference in means between two groups was used because of small sample size

Mean mercury level in urine (53.7µg/L, $p<0.02$) for miners involved in amalgamation and burning of amalgam was significantly higher as compared to miners doing extraction

Table 3: Mercury level in urine in comparison to WHO standards

WHO standards(µg/L)	Mercury level in Urine (µg/L) in Handeni N=21	
	Frequency	Percentage (%)
Normal level (< 5)	2	9.5
Alert level (5-19)	0	0
Action level (20-49)	9	42.9
Maximum acceptable level (>50)	**10**	**47.6**

About 48% of the participants, who tested for mercury levels in urine, exceed the maximum acceptable level provided by WHO as shown in Table 3 above. Amongst them 60% (i.e. 6 out of 10) were from amalgam burners and 1 female 39 years old, who had been using skin lightening cream ‘‘Carrolight’’ which is known to contain mercury.

7.2.2 Mercury level in blood

Table 4: Biological samples results; Blood (µg/L) N=25

Variable type		Mean (SD)	Range	P-value
All participants		14.5(15)	0-56.7	
Sex	Male	13.9(14)	0-56.7	0.9
	Female	20.7(29)	0-41.3	
Occupation	Miners	13.3(14)	0-56.7	0.4
	Non-miners	22.7(21)	0-41.3	
Type of mining activity	Extraction	24(0)	24	0.3
	Amalgamation and Burning amalgam	27.6(27)	2.7-56.7	0.6

Miners that were involved in amalgamation and burning amalgam had higher mean mercury level of 27.6µg/L as compared to those involved in extraction however the results were not statistically significant.

Table 5: Comparison of mercury level in blood with WHO standards

WHO standards(µg/L)	Mercury level in blood (µg/L) in Handeni N=25	
	Frequency	Percentage (%)
Normal level (< 10)	12	48%
Maximum acceptable level (>10)	**13**	**52%**

About 52% of all participants tested for mercury levels in their blood had mercury levels exceeding the maximum acceptable level provided by WHO

7.2.3 Mercury levels in Hair

We tested 30 participants for mercury levels in their head hair. All participants had mercury levels below the detection limit of the machine which was 0.01 ppm with an exception of 2 participants who had head hair mercury levels of 6.3µg/g and 8.3µg/g respectively. These levels exceed the normal range provided by WHO (1991b) of 1 to 2µg/g of hair.

7.3 Mercury concentrations in water and vegetables

7.3.1 Mercury concentrations in water

We tested 10 water samples from magambazi (4 samples), Kwadijava (2 samples), Kilimamzinga (2 samples) and Ubungo village (2 samples). It was found that, the mean mercury level in water samples was 0.6µg/L in Magambazi, 0.4µg/L in Kwadijava, 0.58µg/L in Kilimamzinga and 0.37µg/L in Ubungo. The obtained mercury levels in water does not exceed Tanzanian water quality standard which states, mercury concentration in drinking water should not exceed 1 µg/L. However all WHO standard of 0.1µg/L

7.3.2 Mercury concentrations in vegetables

We tested 2 vegetable samples (maranthus) from Kwadijava (1 sample) and Ubungo (1 sample) Mercury concentration in vegetables was 0.09µg/g and 0.1µg/g from Kwadijava and Ubungo village respectively.

7.4 Health effects of mercury exposure on the mining community

Table 6: Symptoms of mercury intoxication for miners and non-miners in Handeni

	Non-miners (N=47)		Miners (N=245)		
Symptoms	*frequencies*	*%*	*frequencies*	*%*	P-value
Tremor	1	2.1	8	3.3	0.5
Poor memory	1	2.1	12	4.9	0.35
Difficult in finding words	1	2.1	3	1.2	0.5
Changes in mood	1	2.1	2	0.8	0.4
Hallucinations	1	2.1	3	1.2	0.5
Low or non-existent libido	**1**	**2.1**	**25**	**10.2**	**0.05**

Low or none existed libido was found to be significantly higher in miners as compared to non-miners as shown in Table 6

Table 7: Signs of mercury intoxication for miners and non-miners in Handeni

Signs	**Non – miners (N= 47)**		**Miners(N= 245)**		**P-value**
	frequency	%	frequency	%	
Signs of gingivitis	4	8.5	16	6.5	0.4
Signs of ataxia	1	2.1	7	2.9	0.62
Bluish colouration in gums	12	25.5	83	33.9	0.26
Bluish coloured iris ring	2	4.3	26	10.6	0.14
Tremor, finger to nose	1	2.1	13	5.3	0.31
Tremor, eyelid	**4**	**8.5**	**73**	**29.8**	**0.002**
Dysmetria	2	4.3	23	9.4	0.19
Reflex, mentolabial	1	2.1	12	4.9	0.35
Reflex, ankle jerk	0	0	6	2.4	0.35
Reflex, babinski	1	2.1	12	4.9	0.35
Reflex, Hoffman	1	2.1	0	0	0.16

Tremor of the eyelid was found to be significantly higher in miners with p= 0.02 as compared to non-miners. Generally, high proportion of miners experienced signs for mercury intoxication as compared to non-miners although they were not significant as shown in Table 7

7.5 The relationship between exposure biomaker and signs of mercury intoxication

7.5.1 Signs of mercury intoxication and mercury levels in Urine

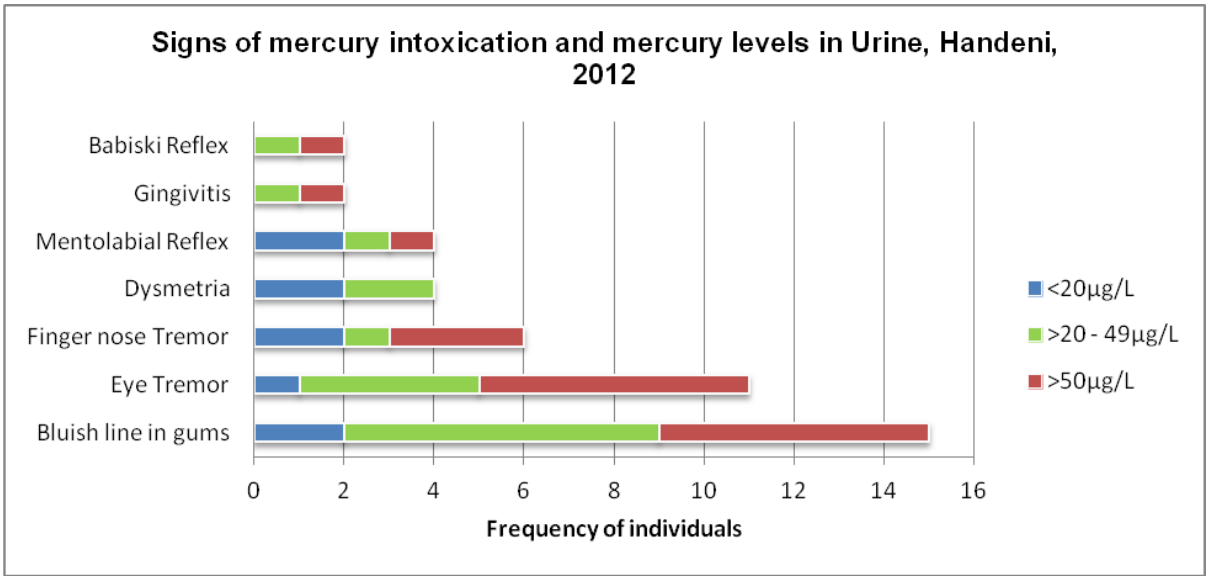

Figure 3: Relationship between signs of mercury intoxication and mercury levels in the urine

Figure 3 above shows that, majority of the participants with signs of mercury intoxication had mercury levels in their urine above 20µg/L which is the level for observation of mild subclinical symptoms of mercury intoxication

7.5.2 Signs of mercury intoxication and mercury level in blood

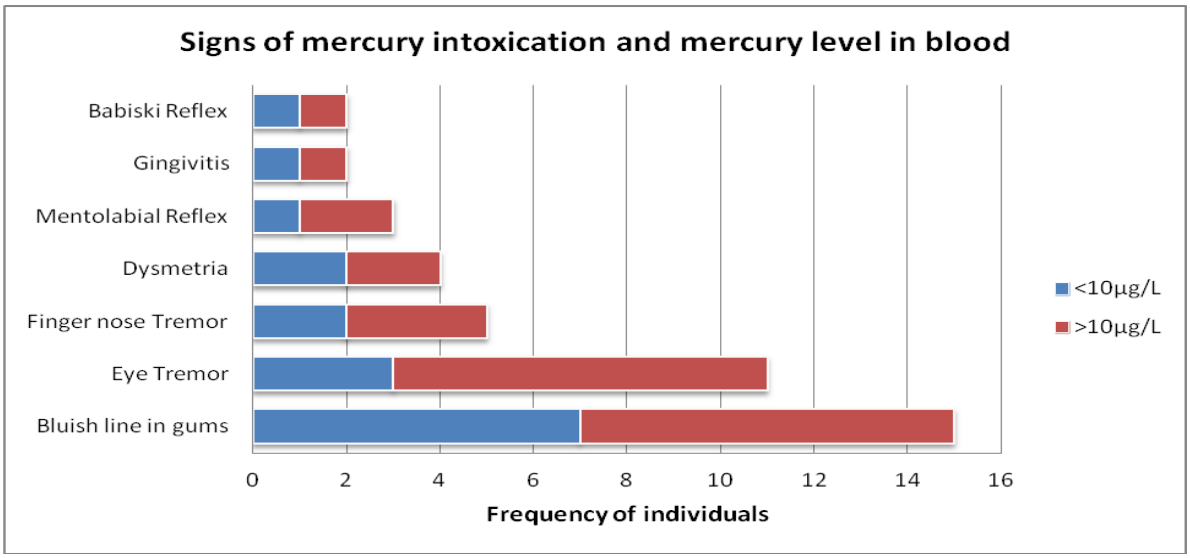

Figure 4: Relationship between signs of mercury intoxication and mercury levels in the blood

More than 50% of participants with signs of mercury intoxication had blood mercury levels that exceed WHO maximum acceptable level of 10µg/L as shown in figure 4 above

7.6 Neuro-psychological tests results

Table 8: Neuropsychological tests results for miners and non-miners

	Memory test		**Matchbox test (seconds)**		**Pencil tapping test (dots)**		**Frosting test (points**	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Miners (N=245)	2.4(1.5)	0-4	24(6.8)	14-56	55(9)	23-79	5.96(2.8)	1-17
Non miners (N=47)	2.6(1.6)	0-4	19(4.6)	13-40	57(7)	31-75	6.3(2.4)	1-14
P- value	0.26		**<0.00001**		0.22		0.46	

Student t-test was used to calculate the P-values

As shown in table 8 above, for matchbox tests, miners performed significantly less successfully with mean time of 24 seconds used to fill the matches into the matchbox as compared to non-miners who had the mean time of 19 seconds. Matchbox test checks participant's neuromotor functions. It is an indicator for coordination problem, tremor and concentration

7.6.1 Matchbox test and mercury in urine

In matchbox test, the score of 1 indicates good performers (i.e used 16-20 seconds to fill the matches in the matchbox) while the score of 2 indicates poor performers (i.e. used 21 seconds or more).

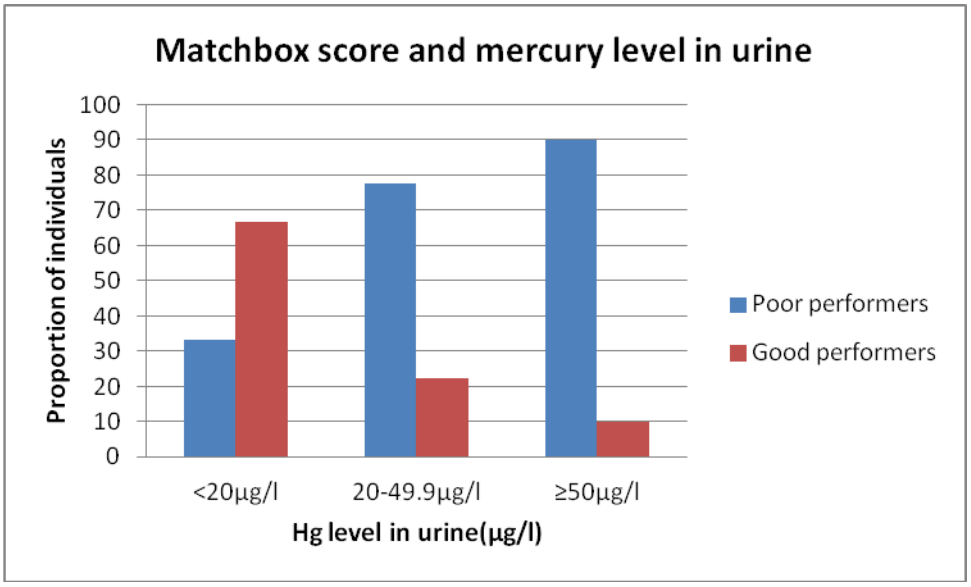

Figure 5: Relationship between mercury levels in urine and matchbox test scores among study population in Handeni

The proportion of individuals performing poorly increases with mercury levels in urine as shown in figure 5

7.6.2 Matchbox test and mercury in blood

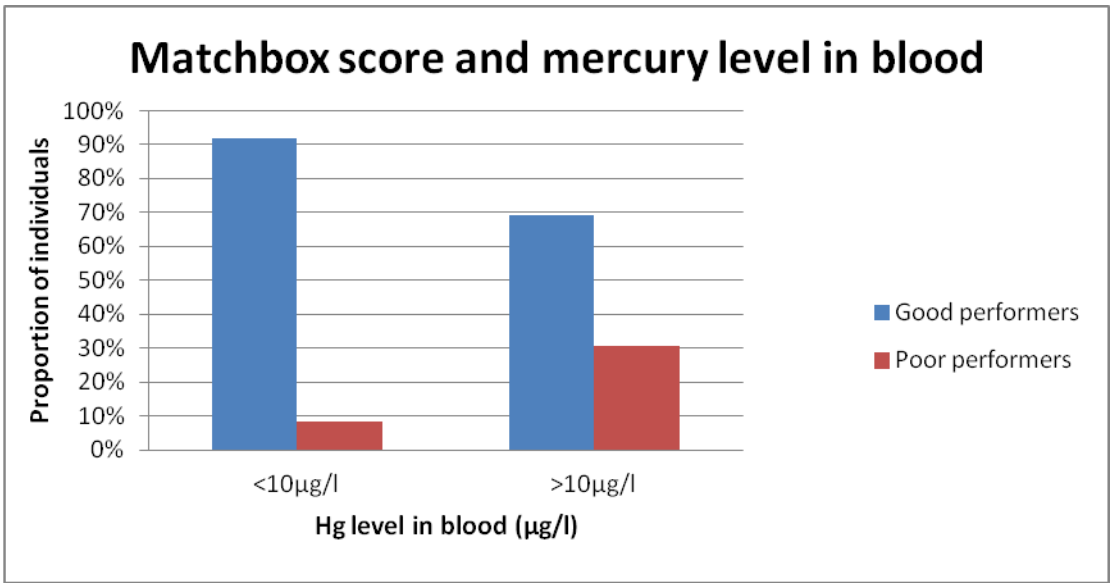

Figure 6: Relationship between mercury levels in blood and matchbox test scores among study population in Handeni

The proportion of individuals performing poorly increases with mercury levels in blood as shown in figure 6 while the proportion of good performers decrease with increased concentrations of mercury in blood

8.0 DISCUSSION

The study assessed environmental and occupational exposure to mercury among miners and their families in Handeni. Our findings show that the mean mercury level in urine (46.3µg/L) was higher than those found in Rwamasanga although the later have adjusted for creatinine level. Yet, our findings are still lower compared to those found in Lake Victoria Gold Fields in which the mean mercury level in urine was 241µg/L. It may be explained by difference in frequency of mercury use in amalgamation and burning amalgam between Handeni and Lake Victoria Gold fields. In Lake Victoria, it has been reported that, a miner can burn amalgam up to ten times a day(14) while in this study a miner can burn amalgam only once or twice a week. If Handeni miner can burn amalgam ten times a day like in Lake Victoria, mercury exposure levels could have been as high as 463µg/L. Despite the fact that, gold production and mercury use in this study area is low, there were people found with mercury levels exceeding the allowable levels. In this study we found maximum urinary mercury level of 74.6µg/L in a 56 years old male who has been storing mercury at home and involved himself in extraction, amalgamation and burning amalgam for 7 years. When compared to lake Victoria(14) and Mwanza study(27), the exposed miners with maximum urinary mercury levels (241 µg/L) had worked in burning amalgam for 9 and 6 years respectively. Our study found that, miners that were involved in amalgamation and burning amalgam had higher mean urinary mercury levels. This is consistent with the study done in Rwamasanga village(7), lake Victoria gold fields in Northern Tanzania(14) of which amalgam burners had urine mercury levels above WHO maximum allowable levels

About half of the urine samples tested by ICP-OES exceeded the WHO maximum allowable level. It was found that, those exceeding the maximum levels, involved a non-occupational exposed female, 39 years old, who has been using banned skin lightening cream ‘‘Carrolight’’ which is known to contain mercury. Habitual use of officially banned skin lightening soaps, creams and hair curling cosmetics has been found to contribute to high mercury levels in female in the Lake Victoria in which the levels were as high as 48.2µg/L to 416µg/L(25)(14). In Kisumu Kenya, females with habitual use of toilet soaps containing mercury were also found to have high mercury concentration(>36.1µg/L)(30)

The mean mercury level in blood exceeded the maximum level of 10µg/L provided by WHO ranging from < 0.01µg/L to 56.7µg/L. The maximum level was found in a 47 years old male residing in Magambazi and involved in amalgamation and burning of amalgam and storing

Hg at home for 10 years. Amalgamation and amalgam burners had higher mean mercury level in their blood compared to others. Some miners (10 out of 25) were found to exceed the maximum level of 10µg/L as also shown in a Philippines study where 12 out of 43 miners exceeded the WHO maximum level (33). Mercury levels in blood are lower compared to urine because of high mercury excretion rate in the urine. Additionaly, low dietary exposure may play a role to low blood levels.

Majority of the hair samples were below detection limit of 0.01ppm. This is consistent with low mercury concentrations found in the samples of water and vegetables in these areas. The result concurs with the study in Lake Victoria in which mercury levels in hair were very small(14). On the other hand a study done in some mines around Lake Victoria found high mercury levels in hair even exceeding WHO limit of 50µg/g. The levels being higher than the findings in this study might be attributed to eating fish and shellfish contaminated with mercury(25). Also rapid excretion of mercury through urine can be the cause for its very low or unavailability in hair.

The mean mercury levels in water samples were found to be below Tanzanian water quality standard which states, mercury concentration in drinking water should not exceed 1 µg/L. This is consistent with the results of the lake Victoria (36), Rwamasanga village(10),and abandoned mines in Philippines(33) in which drinking water did not exceed Tanzanian standards as well as Philipines national standards. However, the levels were lower compared to this study. This may be because of the close proximity of the mining area relative to the water source which may influence deposition of mercury vapours to these sources.

Mercury concentration in vegetables was 0.09µg/g from Kwadijava and 0.1µg/g from Ubungo village. Vegetables tested in Rwamasanga(10) had mercury concentration below the detection limit of 0.004µg/g in which mercury concentration in the soil where the vegetables are grown was (0.6µg/g). The concentrations obtained in this study are higher than those of similar study in Rwamasanga. This may be explained in two ways, mercury concentration in the soil where vegetables are grown may be high , or the mercury levels obtained may be the result of mercury vapour deposition on amaranthus plants

Miners in Handeni were found to experience signs and symptoms of mercury intoxication more as compared to non miners. This was also found in the Rwamasanga study of which the miners had many signs of mercury intoxication as compared to non-miners and the control

group in Katoro. Tremor of the eyelid was significantly higher in miners than non-miners ($p<0.05$) due to high mercury exposure in miners as compared to non-miners. Other signs found was bluish line in gums, bluish coloured iris ring, dysmetria, gingivitis, finger nose tremor, signs of ataxia, decreased mental labial, babinski reflex and ankle jerk reflex although the results were not statistically significant.. Amongst the signs found in this study, were also found in Rwamasanga like ataxia of gait, tremor of the eyelid and finger-nose tremor(7). Likewise on Lake Victoria study, miners were experiencing gingivitis, tremor and decreased ankle jeck reflex as also found in this study.(25).

It was also observed that, among those with signs of mercury intoxication, more than 50% had mercury concentration in their blood and urine exceeding WHO recommendations of 20µg/L for urine and 10µg/L for blood, above which mild subclinical symptoms of mercury intoxication can be observed. This is consistent with what was found in Philipines study in which those who had high mercury levels in their blood were found to have signs of mercury intoxication mostly tremors(33)

Miners performed significantly less successfully in matchbox test. This is might be caused by high mercury exposure levels in their urine and blood. This was evidenced by majority of those having high mercury concentration in their urine and blood, performing poorly in this test. This was also found in Rwamasanga, in which the higher exposed group performed less successfully compared to the less exposed group(7)

9.0 CONCLUSION

Occupational exposure to mercury vapour through amalgamation and burning of amalgam is high in Handeni since mercury levels found in urine and blood of miners and their families were high. On the other hand, exposures in amaranths vegetables were low.

10.0 RECOMMENDATION

A bigger analytical study needs to be carried out in the study area to establish the association between mercury levels in human biological samples and the health effects observed

Major efforts should be directed into reducing exposure to mercury vapour through instituting the best alternative available

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QUESTIONNAIRE FOR DETERMINING ENVIRONMENTAL AND OCCUPATIONAL EXPOSURE TO MERCURY IN A SMALL-SCALE GOLD MINING COMMUNITY IN HANDENI DISTRICT, TANZANIA

Name: _____

I hereby declare that I want to take part in this study. I will be questioned about my living circumstances and health problems related to mercury. I will be medically examined including neurologically. Urine, and a small amount of hair will be taken. The principal investigator will inform me after the laboratory analysis about my personal results and I allow my results to be used in a form where my name cannot be identified. The assessment is done respecting the "Recommendation for Conduct of Clinical Research" (World Health Organization Declaration of Helsinki).

1. Personal Data

Participant ID Number: _____

Date of interview: _____

Name of the interviewer: _____

Interviewee Name: _____

Gender: 1. Female 2. Male

Village: _____

Telephone for contact: mobile/landline _____

Date of Birth: _____ Age: _____ (years)

Education level 1. None 2. Primary complete 3. Secondary 4. Tertiary

Marital status: 1. Married 2. Not married 3. Widowed

Occupation: 1. Miner 2.Farmer 3. Office Job 4.Business 5.Student

Body Weight _____kg

Height _____ m

2. Work Exposure history

What type of mining activity are you involved in?

1. Extraction 2. Amalgamation 3.Burning of amalgam 4. Other, specify.....

Where do you live?

- ☐ Near a mining operation
- ☐ Near a gold shop?
- ☐ Other, specify

For how long have you lived in the above mentioned area?_____ Years

Have you ever worked in a mining area?

1. No 2. Yes

If yes, for how long? _____year(s)

2.6 Have you ever used mercury in your activities?

1. No 2. Yes

2.7 What type of activity

1. Mining 2. Dental filling 3. Mercury transportation 4. Mercury selling 5. Other, specify

2.8 If yes, for how long _____ years

2.9 Have you ever worked in burning amalgam?

1. No 2.Yes

2.10 If yes, for how long _____ years

2.11. Which method do you use to burn amalgam?

- ☐ Burning in open pans
- ☐ Burning in fume hoods
- ☐ Others: Specify_____

2.12 Have you ever burned amalgam at home?

1. No 2. Yes

2.13 Have any of your family member burned amalgam at home?

1.No 2.Yes

2.14 Have you ever stored mercury at home?

1.No 2.Yes

2.15 Have any of your family member stored mercury at home

1.No 2.Yes

2.16 Where do you keep your mining work clothes

1.At home 2. At work(mining site) 3. Other, mention_____

2.17 Have any of your family member kept mining work clothes at home?

1.No 2.Yes

2.18 Have you ever been involved in washing mining work clothes

1. No 2. Yes

Symptoms of mercury intoxication:

Have you ever experienced the following symptoms

- ☐ Convulsion
- ☐ Paralysis
- ☐ Tremor
- ☐ Difficulties in breathing
- ☐ Poor memory
- ☐ Difficult in finding words
- ☐ Inability to concentrate
- ☐ Difficult in multitasking
- ☐ Changes in mood
- ☐ Hallucinations
- ☐ Persistent death wish

☐ Low or non-existent libido

☐ Frequent urination

☐ None of the above

Have you ever had the following neurological problems?(Tick where appropriate)

☐ Epilepsy

☐ Stroke

☐ Parkinsons

☐ Mental disorder

☐ None of the above

3.3 Have you ever handled the following regularly?

☐ gasoline _____ years

☐ kerosene _____ years

☐ pesticides _____ years

3.4 Do you drink alcohol?

1.No 2.Yes

3.5 If yes, how many drinks per day?

1. Less than 2 drinks
2. 2 to 5 drinks
3. 6 to 10 drinks
4. more than 10 drinks

3.6 Have you ever used the following?

☐ Skin whitening soaps

☐ Skin lightening creams

3.7 Have you ever involved in any accidents?

1. No 2. Yes

3.8 what type of Injury did you experience?_____

3.9 If yes, did you experience the following?

- ☐ Lost consciousness for more than one hour
- ☐ Lost body part (e.g. limb)

3.10 When did this happen? _____ (days or weeks or months or years) ago

4. Diet Issues

4.7 Name the place where you obtain drinking water: _____

4.8 Do you consume vegetables?

1. Never
2. At least once a month
3. At least once a week
4. At least once a day

4.9 Please mention where the vegetables you eat come from?

_____

5. Clinical-Neurological Examination (Done by Medical Doctor)

Mouth and teeth conditions

5.1 Signs of gingivitis:

1. No 2. Yes

5.2 Bluish discoloration of the gums:

1. No 2. Slight 3. Yes, obvious

5.3 How many teeth with dental fillings (Amalgam):

1. None 2. One or more

5.4 Examination of the eyes:

1. No changes 2. Bluish-coloured iris ring 3. Kayser-Fleischer ring

Walking

5.5 Signs of ataxia

1. Absent 2. Moderate (ataxia visible in normal walking)

3. Marked (unable to walk without support) 4. Severe (bedridden)

Standing

5.6 Tremor - finger to nose test

1. None
2. Slight
3. Severe

5.7 Dysmetria - finger to nose test

1. Normal
2. Moderate
3. Severe

5.8 Tremor – eye lid

1. None
2. Slight
3. Marked

Lying

5.9 Mentolabial reflex

1. Negative 2. Positive

5.10 Babinski reflex

1. Negative 2. Positive

5.11 Hoffmann reflex

1. Negative 2. Positive

5.12 Ankle jerk tendon reflex,

1. Normal 2. Hyporeflexia 3. Slight hyperreflexia

4. No reflex 5. Very brisk or reflex zone enlarged or clonus

7. Specific (Neuropsychological) Tests

Memory disturbances

Forward digit span test: Repeat each column of numbers. Score the longest series correctly repeated

Obtained	Score	Test
	4	6-4-3-9
	4	7-2-8-6
	3	4-2-7-3-1
	3	7-5-8-3-6
	2	6-1-9-4-7-3
	2	3-9-2-4-8-7
	1	5-9-1-7-4-2-3
	1	4-1-7-9-3-8-6
	0	5-8-1-9-2-6-4-7
	0	3-8-2-9-5-1-7-4

7.1 Memory test score: _____ Score 2 for total score in the table above = 0, Score 1 for total score = 1 to 2, Score 0 for total score >3

7.2 **Registration of 3 words**: Tell the patient to memorize 3 words, for example: Fish, Ball and Tree. After 5 to 10 minutes, ask the patient to repeat the words you told him. After 5 to 10 min. do the same.

1. Registered all 3

2. Registered just 2

3. Registered just 1

4. Registered none

7.3 **Testing attention**: Ask the patient to respond to your command and to do something in 3 steps: For example: Grab a piece of paper, fold it in half and put it on the floor.

1. Correct action

2. Incorrect action

Dexterity and coordination

6.4 **Match Box Test**: Put 20 matches on a table, half of each on one side of an open matchbox, approx. 15 cm away. Take the time until all matches are put into the box. Use left and right hand alternatively.

_____ seconds Matchbox test score: _____

2 = 21 seconds or more, 1 = 16-20 seconds, 0 = 0-15 seconds

6.6 **Finger Tapping Test** : Sitting at a table. Elbows should be placed on the table. Try to draw as many points as possible on a piece of paper with a pencil. Count the amount of points within 10 seconds.

Score: _____

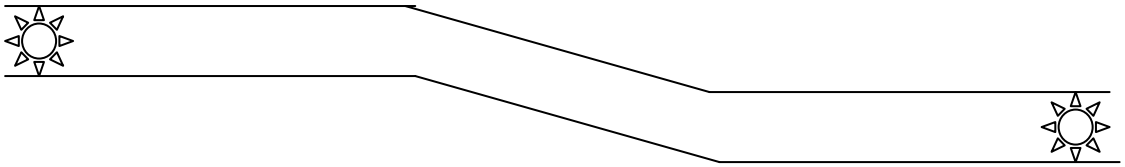
Tapping test score: 2 = 0-53 dots, 1= 54-64 dots, 0 = 65 or more dots

6.8 **Frosting score**: Draw a line from one symbol to the other. Do not touch the borders. Please try to stay within the lines.

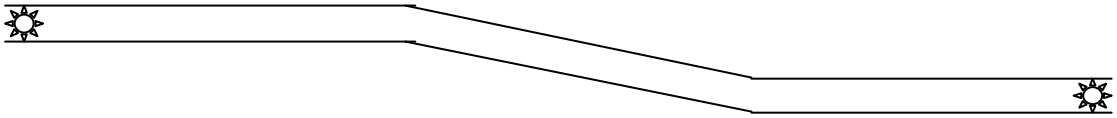
Point..... 0=good, 1= bad, 2=very bad

Point..... 0=good, 1= bad, 2=very bad

Point..... 0=good, 1= bad, 2=very bad



Point..... 0=good, 1= bad, 2=very bad



Point..... 0=good, 1= bad, 2=very bad

Total frosting score: _____ Frosting test score: 2 = 0-9 points, 1 = 10-12 points, 0 = 13-14 points

8.0 Laboratory investigation

8.1 Was lab specimen taken?

1. No 2. Yes

8.2 If yes, what specimen was taken?

☐ Urine

☐ Hair

8.3 What is the mercury level in urine? .....

8.4 What is the mercury level in hair ? .....

DODOSO KUHUSU TAHMINI YA MFIDUO WA KEMIKALI YA ZEBAKI KWENYE MAZINGIRA NA KWA WACHIMBAJI WADOGO WA DHAHABU WILAYANI HANDENI,TANZANIA.

Mimi_____ nimekubali kuwa sehemu ya huu utafiti. Nitaulizwa maswali kuhusu maisha yangu na athari za kemikali ya Zebaki kwenye afya yangu. Nitafanyiwa uchunguzi wa kiafya kuhusu madhara ya Zebaki kwenye mfumo wa fahamu. Mkojo na kiasi kidogo cha nywele vitachukuliwa. Mtafiti mkuu atanifahamisha majibu yangu yote ya vipimo vya maabara na ninarusuhu majibu yangu kutumika kwa namna ambayo jina langu halitajulikana. Tathmini hii inaheshimu mapendekezo ya ufanyaji wa tafiti zimhusuzo binadamu (Shirika la afya duniani, tamko la Helsinki)

1. **Taarifa binafsi**

1.1 Namba ya utambulisho wa mshiriki_____

1.2 Jina la baba_____

1.3 Jina lako _____

1.4 Jinsia 1. Mwanamke 2. Mwanaume

1.5 Tarehe ya kuzaliwa_____ Umri: (Miaka) _____

1.6 Kiwango cha elimu

1. Sijasoma 2.Msingi 3. Secondari 4. Elimu ya juu

1.7 Kipimo cha uzito _____kg

1.8 Kipimo cha urefu _____m

1.9 Anuani yako _____

1.10 Namba ya simu _____

1.11 Tarehe ya mahojiano _____

1.12 Jina la mhoji _____

2. Work exposure history

2.1 Kazi yako

1. Mchimba madini 2. Mkulima 3. Kazi ya ofisini

4. Mfanyabiashara 5. Mwanafunzi 6. Sina kazi

kazi nyingine, Taja _____

2.2 Unaishi wapi

☐ karibu na shughuli za uchimbaji

☐ Karibu na duka la dhahabu

☐ Nyingine , taja _____

2.3 Umeishi kwenye eneo tajwa hapo juu kwa muda gani? Miaka _____

2.4 Umewahi kufanya kazi kwenye machimbo ya dhahabu?

1. Hapana 2. Ndio

2.5 Kama ndio, kwa muda gani? Miaka _____

2.6 Umewahi kufanya kazi mgodini kwa kushika Zebaki moja kwa moja?

1. Hapana 2. Ndio

2.7 Kama ndio, kwa muda gani? Miaka _____

2.8 Umewahi kufanya kazi ya kuchoma mchanganyiko wa Zebaki na dhahabu

1. Hapana 2. Ndio

2.9 Kama ndio, kwa muda gani? Miaka _____

2.10 Kama ndio, ulitumia njia gani?

☐ Kuchoma kwanye sufuria zilizo wazi

☐ kuchoma kwenye dohani

☐ Nyingine, taja_____

2.11 Umewahi kuchoma mchanganyiko wa dhahabu na Zebaki nyumbani?

1. Hapana 2. Ndio

2.12 Kuna mtu kwenye familia yako amewahi kuchoma mchanganyiko wa dhahabu na Zebaki nyumbani?

1. Hapana 2. Ndio

2.13 Umewahi kuhifadhi Zebaki nyumbani?

1. Hapana 2. Ndio

2.14 Kuna mtu kwenye familia yako amewahi kuhifadhi Zebaki nyumbani?

1. Hapana 2. Ndio

2.15 Nguo unazofanyia kazi mgodini unazihifadhi wapi?

1. Nyumbani 2. Mgodini 3. Nyingine , taja _____

2.16 Kuna mtu kwenye familia yako amewahi kuhifadhi nguo anazofanyia kazi mgodini nyumbani?

1. Hapana 2. Ndio

2.17 Kwa miaka mingapi umefanya kazi mgodini kwa kutumia Zebaki ?

1. Sijawahi kufanya kazi kwa kutumia Zebaki

2. Miaka _____

3. Taarifa nyingine

3.1 Umewahi kuugua magonjwa yafuatayo?

☐ Kifafa

☐ kiharusi

☐ ugonjwa wa kutetemeka (parkinsons)

☐ magonjwa ya akili

3.2 Umewahi kutumia vitu vifuatanyo mara kwa mara?

☐ Mafuta ya petroli au dizeli

☐ Mafuta ya taa

☐ Dawa ya kupulizia kuua wadudu

3.3 Umetumia mafuta ya petrol au dizeli kwa mda gani? Miaka_____

3.4 Umetumia mafuta ya taa kwa mda gani? Miaka_____

3.5 Umetumia dawa ya kupulizia kuua wadudu kwa mda gani? Miaka_____

3.6 Unavuta sigara?

1. Hapana 2. Ndio

3.7 Kama ndio, sigara ngapi kwa siku?

1. Chini ya 2
2. 2 mpaka 10
3. 10 mpaka 20
4. Zaidi ya 20

3.8 Una kunywa pombe?

1. Hapana 2. Ndio

3.9 Kama ndio, unakunywa kiasi gani?

1. Chini ya chupa 2
2. Chupa 2 mpaka 5
3. Chupa 6 mpaka 10
4. Zaidi ya chupa 10

3.10 Umewahi kutumia vitu vifuatavyo?

☐ Sabuni ya kukufanya uwe mweupe

☐ Krimu ya kukufanya uwe mweupe

3.11 Umewahi kupata ajali?

1. Hapana 2. Ndio

3.12 Kama ndio, ulipata yafuatayo?

☐ Kupoteza fahamu zaidi ya saa moja

☐ kupoteza kiungo cha mwili

3.13 Ulipata ajali lini? Siku/mwezi/miaka _____ iliyopita

4. Taarifa za chakula

4.1 Unakula samaki mara ngapi?

☐Sili kabisa

☐Angalao mara moja kwa mwezi

☐Angalao mara moja kwa wiki

☐Angalao mara moja kwa siku

4.2 Taja majina ya samaki unazokula mara kwa mara_____
_____

4.3 Unafahamu samaki unaokula wanavuliwa wapi?

1.Hapana 2. Ndio

4.4 Kama ndio, taja sehemu zinakovuliwa?_____

4.5 Umewahi kutembelea sehemu samaki unazokula zinakovuliwa?

1. Hapana 2. Ndio

4.6 Kama ndio, rangi ya maji ikoje?

1. Rangi ya coca cola 2. Rangi ya blue bahari

4.7 Maji unayokunywa unayachota wapi? _____

4.8 Unakula mboga za majani?

1. Hapana

2.Angalao mara moja kwa mwezi

3. Angalao mara moja kwa wiki

4. Angalao mara moja kwa siku

4.9 M boga hizo zinalimwa wapi?_____

5. Uchunguzi wa kidaktari (sehemu hii haijatafsiriwa kwa sababu itajazwa na daktari)

CONSENT FORM

Study Title: **Assessment of environmental and occupational exposure to mercury in a small-scale gold mining community in Handeni district, Tanzania**

Principal investigator: Elida Wilfred

1.Investigator's Statement:

You have the option to take part in this study. The goal of this form is to give you information about what would happen in the study if you choose to take part and to help you decide if you want to be in the study.

2. What you should know about this study:

- This form explains what would happen if you join this research study.
- Please read it carefully. Take as much time as you need.
- Please ask the research team questions about anything that is not clear.
- You can ask questions about the study any time.
- If you say 'Yes' now, you can still change your mind later.
- You can quit the study at anytime.
- Participation in the study is voluntary. You would not lose benefits or be penalized if you decide not to take part in the study or decide to quit the study later.

3. What is the goal of this study?

We are doing research about environmental and occupational exposures to mercury and its associated effects. Mercury is a highly toxic chemical known to human. Its exposure can cause effects to the environment and human health..

The goal of any research study is to try to answer these 3 questions:

- What is the mean mercury level in hair, blood and urine among Handeni miners and their families?

- What is the mean mercury level available in water and vegetables?
- What health effects are experienced by Handeni miners and their families as a result of exposure to mercury

You have the option to take part in this research study because you either work in gold mining or live in the same family with the gold miner

4. How many people will take part in the study?

We think that about 292 people will take part in this research study in **Handeni district**

5. If I agree to join this study, what is expected from me?

Once you consent to participate in the study, you will be given an appointment for interview and collection of hair, blood and urine sample for laboratory mercury analysis. The interview will take place near your place of work or residence. The laboratory tests and the questions we ask during the interview will help us to determine if you have been exposed to mercury and if you have signs of mercury intoxication.

Explanation of Research samples or Procedures:

The samples that would be collected include:

- A urine sample: About (50mls) will be collected in paper cups early morning
- A hair sample: About 20 strands, 1cm long will be cut from close to the occipital area of the scalp with stainless steel scissors at the hair root
- A blood sample of about 5mls will be drawn from your vein using sterile syringe
- These samples will be transported to Dar es salaam for mercury analysis
- Once the results of the individual are known, they will be communicated to him/her directly
- An interview will be conducted by one of our research assistants
- The results of the individual will not be shared with other participants.

6. How long would I be in the study?

If you choose to participate, you will be in the study for only this two visits. First visit will be for interview, blood and hair collection. Second visit will be next day morning for urine collection.

7. What are the potential harms or risks if I join this study?

You will not be given any medication or treatments during this study.

Giving hair for research tests
You will have a portion of your hair cut causing uneven hair distribution in your head.

Giving your blood
You will feel some pain from the needle prick when blood is drawn from your vein

Interview
The questionnaire includes some questions that might seem sensitive or personal. You might feel uncomfortable answering some questions on the questionnaire. You can skip any questions you do not want to answer.

Confidentiality
All research assistants are trained in protecting confidentiality. However, there is the risk of loss of confidentiality even with these safeguards.

8. What are the potential benefits if I join this study?

Potential Benefits for You:

We do not expect this study to benefit you immediately. After all analyses, you may benefit by learning which practices and actions will reduce your likelihood of getting sick. In addition, you will know your health status with regard to mercury exposure and take actions immediately

Potential Benefits for Others:

We hope to use information we get from this study to benefit others in the future. This would include an understanding of high mercury exposures because of mercury use in gold mining, and health effects experienced by the exposed. From this information, we can then change our practices or provide some assistance to reduce the exposure

9. What other options do I have?

If you choose not to be in this study, there are no other options. Your lack of participation will not affect you in any way.

10. How would you keep my information confidential?

If you take part, we will make every effort to keep your information confidential.

We will store all of your research records in locked cabinets and secure computer files. We will not put your name on any research data. Instead, we will label your information with a study number.

If results of this research are published, we would not use information that identifies you.

We would only use your information for research. These are some reasons that we may need to share the information you give us with others:

- If it is required by law.
- If we think, you or someone else could be harmed.
- If ethical review committee wants to make sure the research is done safely but anyone who reviews study records would keep your information confidential.

11. Who do I call if I have problems or questions?

If I have questions or would like to know about …	You can call …	At …
General study questions Research-related injuries	Principal investigator: Elida Wilfred Macha	Phone: +255 713 362 307

12. If I join the study, can I stop?

Yes. Taking part in research is always a choice. If you decide to be in the study, you can change your mind at any time. If you decide to leave the study, it will not affect you in any way. You will not have any adverse consequences to leaving the study at any time.

13. What would my signature on this form mean?

Your signature on this form would mean:

- The research study was explained to you.

- You had a chance to ask all the questions you have at this time. All your questions have been answered in a way that is clear.
- **You have rights as a research participant. We will tell you about new information or changes to the study that may affect your health or your willingness to stay in the study.**
- By signing this consent form, you do not give up any of your legal rights

_____

Printed Name of Research Participant

_____

Signature of Research Participant ***Date***

14. Researcher's Signature

I have fully explained the research study described by this form. I have answered the participant questions and will answer any future questions to the best of my ability. I will tell the family and/or the person taking part in this research of any changes in the procedures or in the possible harms/possible benefits of the study that may affect their health or their willingness to stay in the study.

_____

Printed Name of Researcher

_____

Signature of Researcher ***Date***

15. Witness Information – WITNESS IS NEEDED ONLY IF PARTICIPANT IS UNABLE TO READ THIS FORM

Witness Statement

I have been present during the verbal presentation of this research study.

_____

Printed Name of Witness ***Date***

_____

Signature of Witness ***Date***

FOMU YA RIDHAA YA KUSHIRIKI KATIKA UTAFITI

Kichwa cha utafiti : **Tathmini ya viwango vya kemikali ya Zebaki na athari zake katika mazingira na binadamu kwa wachimbaji wadogo wadogo wa dhahabu wilayani Handeni, Tanzania**

Mtafiti mkuu: Elida Wilfred

1. Kauli ya mtafiti mkuu**:**

Una chaguo la kushiriki katika utafiti huu. Lengo la fomu hii ni kukupa taarifa juu ya utafiti huu ili ikusaidie kufanya maamuzi kama unataka kushiriki katika utafiti.

2. Unapaswa kufahamu nini kuhusu utafiti huu?

- Fomu hii inaelezea nini kitatokea kama ukishiriki kwenye huu utafiti.
- Tafadhali chukua muda wa kutosha na soma kwa umakini.
- Tafadhali waulize maswali timu ya utafiti sehemu yoyote ambayo hujaelewa.
- Waweza kuuliza maswali kuhusu utafiti huu wakati wowote.
- Ukikubali sasa, unaruhusiwa kubadilisha mawazo baadae.
- Unaruhusiwa kujitoa kwenye utafiti wakati wowote.
- Ushiriki katika utafiti huu ni hiari. Hutatozwa faini unapoamua kujitoa kwenye utafiti huu baadae

3. Nini lengo la utafiti huu?

Tunafanya utafiti kuhusu tathmini ya viwango vya kemikali ya Zebaki na athari zake katika mazingira na binadamu. Zebaki ni kemikali yenye sumu kali kwa binadamu na mazingira.ikiingia kwenye mazingira na mwili wa binadamu, inaweza kuleta athari za kiafya

Lengo la utafiti huu ni kutoa majibu kwa maswali makuu 3:

- Nini kiwango cha Zebaki kwenye nywele. damu na mkojo wa wachimabji wadogo wa dhahabu na familia zao katika wilaya ya Handeni?

- Nini kiwango cha wastani cha Zebaki kwenye maji na mbogamboga?

- Ni athari gani za kiafya zitokanazo na Zebaki wanazipata wachimbaji wadogo wa dhahabu na familia zao katika wilaya ya Handeni

Una uchaguzi kushiriki katika utafiti huu kwa sababu unafanya kazi katika uchimbaji wa dhahabu au unaishi familia moja na mchimbaji wa dhahabu.

4. Ni watu wangapi watashiriki katika utafiti huu?

Tunatarajia watu 292 watashiriki katika utafiti huu wilaya ya Handeni

5. Kama nikikubali kushiriki katika utafiti, ni kitu gani kinategemewa kutoka kwangu?

Pindi utakapokubali kushiriki katika utafiti huu, utapewa miadi (appointment) kwa ajili ya mahojiano na uchukuaji wa sampuli ya nywele damu na mkojo kwa ajili ya kuangalia viwango vya Zebaki vilivyopo tutakapopeleka maabara.Mahijiano yatafanyika katika eneo lako la kazi au unapoishi. Vipimo vya maabara na maswali utakayoulizwa wakati wa mahojiano vitatusaidia kujua kama una kemikali hii ndani ya mwili wako na kama kuna athari zozote za kiafya zitokanazo na kemikali hii.

<u>Maelezo juu ya utaratibu wa uchukuaji sampuli na utaratibu mwingine:</u>

Sampuli zitakazochukuliwa zitakuwa ni:-

- Mkojo: Mkojo wa asubuhi kiasi cha mililita 50 kitachukuliwa
- Nywele: Kiasi cha nywele kama 20 zenye urefu wa sentimeta 1 kitakatwa eneo la uchogoni kwa kutumia mkasi kuanzia kwenye mzizi wa nywele
- Damu: Kaisi cha mililita 5 za damu kitachukuliwa katika mshipa wa damu kwa kutumia syringe
- Sampuli hizi zitasafirishwa kwenda Dar es salaam kwa ajili ya uchunguzi wa maabara
- Matokeo ya mtu binafsi yatakapokuwa tayari, mawasiliano na mtu huyo yatafanyika ili kumjulisha matokeo hayo
- Mahojiano yatafanywa na wasaidizi wa utafiti
- Matokeo ya mtu binafsi hayatawasilishwa kwa washiriki wengine.

6. Nitashiriki kwenye utafiti huu kwa muda gani?

Utakapokubali kushiriki, tutakutembelea mara mbili. Mara ya kwanza ni kwa ajili ya mahojiano, uchukuaji wa nywele, damu na uchunguzi wa kiafya. Mara ya pili itakuwa ni asubuhi inayofuata kwa ajili ya uchukuaji wa sampuli ya mkojo..

7. Nini madhara au hatari nitakaposhiriki kwenye utafiti huu?

Hutapewa tiba wala dawa wakati wa utafiti huu.

Kutoa nywele kwa utafiti

Kiasi cha nywele zako kitakatwa. Hali hii itapelekea sehemu ndogo sana ya kichwa chako kukosa nywele .

Kutoa damu

Utasikia maumivu kidogo yatokanayo na sindano wakati wa kutoa damu

Mahojiano

Dodoso itakuwa na maswali ambayo yanaweza kuwa binafsi au nyeti. Waweza kujisikia vibaya kujibu baadhi ya maswali kwenye dodoso. Waweza kuruka maswali ambayo hutaki kuyajibu.

Usiri

Wasaidizi wote wa utafiti wamefundishwa namna ya kutunza siri. Hata hivyo kuna uwezekano wa kupoteza usiri pamoja na jitihada zote za kutunza siri.

8.Kuna faida gani nikijiunga na utafiti huu?

Faida kwako:

Hatutegemei utafiti huu kukunufaisha mara moja. Baada ya uchanganuzi (analysis) wote utanufaika kwa kufahamu vitendo na hatua za kukupunguzia uwezekano wa kuumwa. Pia utafahamu hali yako ya kiafya kutokana na kemikali ya Zebaki na kuchukua hatua za haraka

Faida kwa wengine:

Tunatumai kutumia taarifa tutakazozipata kwenye utafiti huu kunufaisha wengine baadae. Hii inajumuisha uelewa juu ya vitu vitakavyopelekea kupata kemikali hii kwa wingi kutokana na matumizi yake katika uchimbaji wa dhahabu na athari zake unapoipata. Kutokana na taarifa hii tunaweza kubadili vitendo vyetu na kutoa msaada kupunguza uwezekeno wa mtu kupata kemikali hii ndani ya mwili wake

9. Kuna chaguzi gani nyingine ninazo?

Ukichagua kutokushiriki katika utafiti huu, hakuna uchaguzi mwingine tena. Kutokushiriki kwako hakuta kuathiri kwa namna yoyote.

10. Utawezaje kufanya taarifa zangu kuwa siri?

Ukishiriki katika utafiti huu, tutafanya kila jitihada kuhakikisha taarifa zako zinakuwa siri

Tutahifadhi nyaraka zote za utafiti katika mababati yaliyofungwa na mafaili ya kompyuta yaliyolindwa. Hatutaweka jina lako katika takwimu ya utafiti huu. Badala yake tutaweka lebo ya utambuzi wa kila mshiriki

Ikiwa matokeo ya utafiti huu yatachapishwa, hatutatumia taarifa zitakazokufanya ujulikane

Tutatumia taarifa yako kwa ajili ya utafiti tu.

Sababu zitakazopelekea sisi kutoa taarifa ulizotupa.

- Kama zitahitajika kisheria.
- Kama tunafikiri wewe au mtu mwingine anaweza kudhuria.
- Kama kamati ya maadili ya utafiti watataka kuhakiki kama utafiti huu unafanywa kiusalama, lakini kila atakayengalia kumbukumbu ya utafiti atakahikisha anatunza usiri wa taarifa.

11. Niwasiliane na nani ninapokuwa na matatizo au maswali?

Kama una swali au unahitaji kufahamu kuhusu…	Waweza mpigia …	Kwa …
Maswali ya utafiti kwa ujumla, au majeraha yatokanayo na utafiti…	Mtafiti mkuu: Elida Wilfred Macha	Simu namba: +255 713 362 307
	Mkurugenzi wa utafiti	

12. Nikijiunga na utafiti, naweza kujitoa?

Ndio. Kushiriki katika utafiti ni chaguo. Kama ukiamua kushiriki, unaweza kubadili mawazo yako wakati wowote. Ukiamua kujitoa kwenye utafiti, haitakuathiri kwa namna yeyote. Hutapata madhara yoyote kwa kujitoa kwenye utafiti wakati wowote.

13. Sahihi yangu inamaanisha nini kwenye fomu hii?

Sahihi yako kwenye fomu hii inamaanisha:

- Utafiti umeelezwa kwako.
- Ulipewa nafasi ya kuuliza maswali yote uliyokuwa nayo, na maswali yote yalijibiwa kwa namna iliyoeleweka
- **Una haki kama mshiriki. Tutakufahamisha taarifa mpya au mabadiliko katika utafiti ambayo yataathiri afya yako au utayari wako wa kukaa katika utafiti**
- **Kwa kusaini fomu hii, haikuondolei haki zako za kisheria**

_____

Jina la mshiriki

_____

Sahihi ya mshiriki ***Tarehe***

14. Sahihi ya mtafiti

Nimeelezea kikamilifu utafiti unaoelezwa kwenye fomu hii. Nimejibu maswali ya mshiriki na nitajibu maswali mengine ya baadae kwa kadri ya uwezo wangu. Nitaieleza familia na/au mtu aliyeshiriki katika utafiti huu juu ya mabadiliko yoyote katika utaratibu au hatari/faida za utafiti ambazo zitaathiri afya zao au utayari wa kuendelea kukaa katika utafiti huu

_____

Printed Name of Researcher

_____

Signature of Researcher ***Date***

15. Taarifa za shuhuda – Shuhuda anahitajika kama mshiriki hawezi kusoma fomu hii

Kauli ya shuhuda

Nilikuwepo wakati wa maelezo yaIiyowasilishwa kwa mdomo kuhusu utafiti huu

_____

Jina la shuhuda ***Tarehe***

_____

Sahihi ya shuhuda ***Tarehe***

<u>Fomu asili kwa:</u>

Faili la timu ya utafiti

<u>Nakala kwa:</u>

Mshiriki