ADDIS ABABA UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

OCCUPATIONAL LEAD EXPOSURE AND RENAL FUNCTION IMPAIRMENT AMONG GARAGE WORKERS ADDIS ABABA, ETHIOPIA. A COMPARATIVE CROSS-SECTIONAL STUDY.

BY

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A research thesis submitted to the graduate program of Addis Ababa University, College of Medicine, Health Sciences, and School of Public Health in partial fulfillment of the Master of Public Health degree in environmental and occupational health specialty.

DATE: 03/06/2024 G.C

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Occupational lead exposure and renal function impairment among garage workers Addis Ababa, Ethiopia. A comparative cross-sectional study.

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Acknowledgment

First and foremost, I would like to thank Almighty God for granting me the strength, knowledge, and ability to undertake this thesis. Without divine blessings, this achievement would not have been possible.

I am grateful for the financial support provided by the Norwegian Agency for Development Cooperation (Norad) through the Norwegian Program for Capacity Building in Higher Education and Research for Development (NORHEDII), specifically through the research project "Safe work conditions by innovative research and education."

Special gratitude is extended to my advisors, Dr. Meaza Gezu and Dr. Teferi Abegaz, for their unwavering encouragement, endless support, and invaluable guidance throughout the research process, from inception to thesis approval.

My deepest appreciation goes to Addis Ababa University, the Ethiopian Food and Drug Authority, and the National Clinical Chemistry Reference Laboratory of the Ethiopian Public Health Institute. Their cooperation in approving this research thesis, providing necessary materials, and facilitating laboratory testing during the research implementation was invaluable.

I want to acknowledge the contribution of the garage and water bottling factory management and the study participants, whose willingness to participate was essential to this research. My gratitude also extends to the data collectors for their field support. Finally, my sincerest thanks go to my family and friends for their unwavering support.

Abbreviation and Acronym

BMI	Body Mass Index
BUN	Blood Urea Nitrogen
CDC	Centers for Disease Control and Prevention
CI	Confidence Interval
CKD	Chronic Kidney Disease
DALYs	Disability Adjusted Life years
DM	Diabetic Mellitus
eGFR	Estimated Glomerular Filtration Rate
IQR	Inter Quartile Range
KDIGO	Kidney Disease Improving Global Outcome
MP-AES	Microwave Plasma Atomic Emission Spectroscopy
NCD	Non-communicable Disease
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PPE	Personal Protective Equipment
Scr	Serum Creatinine
SPSS	Statistical Package for Social Science
DBP	Diastolic Blood Pressure
IAF	Intra-abdominal fat
SBP	Systolic Blood Pressure
SCF	Subcutaneous fat
UN	United Nation

Abstract

Background: Lead exposure is a major occupational hazard in the automotive industry, where workers routinely handle lead-containing materials. Chronic kidney disease is a serious health risk associated with lead exposure.

Objective: This study aimed to assess the blood lead levels and renal function test parameters of garage workers in Addis Ababa, Ethiopia.

Method: A comparative cross-sectional study involving 120 exposed garage workers and 110 non-exposed water bottling factory workers. Data collection included questionnaires, blood samples, body mass index (BMI), and blood pressure measurements. Blood analyses determined blood lead level and renal function parameters. Data analysis was performed using SPSS version 26 software. The Mann-Whitney U test and the Kruskal-Wallis test was used to assess differences in blood lead levels and renal function parameters between groups. In addition, a generalized linear regression model was employed to examine the association between the glomerular filtration rate and independent variables. The significance level was set at ($P < 0.05$).

Result: The median blood lead level of garage workers (11.98 µg/dL) (IQR) = 5.78ug/dL – 21.54ug/dL) was significantly higher than water bottling factory workers (6.87 µg/dL) (IQR = 4.17ug/dL– 10.13 ug/dL) ($p < 0.001$). Workers in mechanic and welding departments have higher blood lead levels than the comparison group. Creatinine levels were statistically higher in garage workers compared to the comparison group ($p<0.030$). In addition, the estimated glomerular filtration rate was significantly lower among garage workers ($P<0.001$). However, there were no significant differences in blood urea nitrogen (BUN) between garage workers and water-bottling factory workers. Diastolic blood pressure, older age, and higher body mass index were associated with the estimated glomerular filtration rate.

Conclusion: Garage workers had significantly higher blood lead levels, indicating possible occupational exposure to garage workers compared to water bottling workers. In addition, serum creatinine was significantly higher among garage workers. So, preventive methods should be implemented to reduce lead exposure in garage workshops.

Keywords: Garage workers, lead exposure, blood lead level, glomerular filtration rate.

1. Introduction

1.1. Background

Heavy metals pose significant risks to human health, with exposure heightened due to industrial and anthropogenic activities, as well as modern industrialization (1). Lead stands out as the predominant heavy metal of concern in industrial environments, particularly within garage workshops (2). Lead has no beneficial role within the human body, and its presence can potentially result in harmful and toxic effects; in addition, it is a toxic heavy metal that is known to accumulate in the body over time, particularly in bones, blood, and soft tissues and (3) it has no safe threshold limit value (4).

Lead is classified by the World Health Organization as one of the top ten chemicals of public health concern (5). In addition, it is a known risk factor for non-communicable diseases, affecting the peripheral and central nervous systems, renal function, hepatic, hematopoietic, and reproductive systems (6).

The Occupational Safety and Health Administration (OSHA), part of the United States Department of Labor, categorizes blood lead levels (Pb) in adult workers as follows: levels below 10 µg/dL are considered normal or unexposed, levels between 10 and 40 µg/dL are deemed acceptable for long-term exposure with a recommendation for retesting in 6 months, and levels exceeding 40 µg/dL are viewed as dangerous, warranting medical removal and retesting within one month until levels fall below 40 µg/dL (7).Lead, as a heavy metal, is ubiquitous and has special characteristics such as resistance to corrosion and low melting point, which have made it widely used in industries (6). Among these industries, lead has been commonly used in automobile repair. In addition, due to its non-biodegradable nature and continuous use, its concentration accumulates in the environment with increasing hazards.

Lead may enter the human body through food, water, air, or absorption through the skin when exposed to humans in industrial settings. Exposure to Lead has been identified to cause detrimental impacts on various bodily systems, including the nervous system, heme biosynthesis, kidneys, reproductive system, liver, hearing, endocrine system, gastrointestinal tract, blood pressure regulation, and cardiovascular health among individuals exposed to it in occupational settings (8).

The kidney stands as a primary target organ for lead toxicity due to its unique ability to reabsorb and concentrate divalent ions and metals (9). Lead is a nephrotoxin and can cause chronic kidney disease (10). A renal function test is a medical examination, and laboratory tests are performed to assess the overall functioning of the kidneys. Urea and creatinine are commonly used biomarkers to evaluate renal function (11, 12). Therefore, this study aimed to assess blood lead levels and renal function test parameters among garage workers.

1.2. Statement of the Problem

Globally, workers' safety and protection have been a significant concern for workers, employers, and society (13). In low- and middle-income countries, there is a data limitation, particularly concerning exposure (14). Similarly, in Ethiopia, occupational health and safety were not well addressed as there are limited studies on exposure assessment and the effect on workers' well-being (15).

Lead exposure causes a significant burden of disease. The World Health Organization's (WHO) latest data estimates that more than 2 million deaths globally were attributed to chemical exposures in 2019. Nearly half of these were attributed to lead exposure. Additionally, lead exposure was estimated to account for 21.7 million years lost to disability (disability-adjusted life years, or DALYs). 98% of adults affected by lead live in low- and middle-income countries (16). worldwide in 2019, 3.0% of the global burden of chronic kidney diseases is attributable to lead exposure (16).

Garage workshops are a major contributor to lead exposure (17, 18). Several studies suggest that blood lead levels were higher among garage workers compared with other non-garage groups (19-22). Individuals exposed to low lead levels are asymptomatic. The kidney is the major route of lead excretion. Lead exposure can result in impairment of proximal tubular function, manifested by decreased estimated glomerular filtration rate, impaired tubular transport, and histopathological damage (23). Some studies suggest that renal biomarkers, such as urea and creatinine, are higher in garage workers than in the comparison group. However, there is controversy, as other studies have found no difference in renal biomarkers between exposed and non-exposed groups (24).

Although many large and small industries in Ethiopia use lead-based raw materials that could be harmful to workers' health, there are no workplace regulations for lead exposure. Many people who work for various manufacturing or service-oriented companies, such as those who make batteries, working in gas stations, workers who fix radiators, solders of lead products, and welders, are employed in jobs that gradually expose them to health risks from lead exposure without realizing what materials they are handling (19). Reductions in the use of lead in petrol (gasoline), paint, plumbing, and solder have resulted in substantial reductions in blood lead concentrations in developed countries. However, a variety of sources of exposure to lead remain, particularly in low- and middle-income countries. Further efforts are required to continue to reduce the use of lead-based materials (25).

In Addis Ababa, studies on lead exposure among automobile workers are limited. To our knowledge, only two studies have been conducted among garage workers. The first study, conducted 14 years ago, examined lead exposure and its effect on renal function indices among lead acid repairing units of city bus enterprises. However, it was limited to lead acid repairing units, excluding workers responsible for other tasks in the garage (26). The second study focused solely on assessing lead exposure without investigating its impact on renal function. Therefore, this study aims to address these gaps by examining blood lead level and renal function test parameters in garage workers.

1.3. Rationale and significance of the study

Rationale of the study

The health and well-being of workers in various occupational settings are of paramount importance, particularly in industries where exposure to potentially hazardous substances and working conditions is common. Lead toxicity is a significant public health issue with far-reaching consequences, particularly in developing countries where regulatory oversight may be inadequate.

Garage workers are exposed to a lot of dangerous substances daily, including lead-containing materials such as paints, batteries, and gasoline. The Lack of adequate protective measures in these workplaces raises concerns about the potential health risks faced by workers, particularly in relation to lead exposure and its adverse effects on renal function.

Despite the known hazards associated with lead exposure, there is a shortage of research explicitly focusing on garage workers in Addis Ababa, Ethiopia. Given the rapid urbanization and industrialization in Addis Ababa, there is a pressing need to assess the magnitude of lead exposure among garage workers and its potential impact on the function of kidney. This study aims to evaluate the blood lead level and renal function parameters of garage workers in Addis Ababa, Ethiopia.

Significance of the study

This study aims to establish a baseline understanding of garage workers' potential exposure to lead and its effect on renal function. By targeting this specific and underexplored population, it will contribute valuable insights to the scientific community. Furthermore, it will serve as a guide for concerned bodies such as the Ministry of Health and Ministry of Labor and Skill in formulating policies for exposure assessment and implementing safety training programs for workers.

Ultimately, through the dissemination of awareness and the promotion of preventive measures, this research endeavor seeks to reduce the burden of lead exposure and enhance the overall occupational health outcomes for garage workers.

The outcomes of this study hold the potential to inform the development and execution of tailored interventions and occupational health policies. These measures would be aimed at mitigating the risks of lead exposure and safeguarding the health and well-being of garage workers.

2. Literature Review

2.1. Overview of garage (Automobile) workshops

An automobile workshop is a place where repairs and servicing of automobiles and automobile systems are done. Automobile technician workers, among other occupation groups, are exposed to some health hazards (2). In a garage workshop, there are typically various job classifications and roles depending on the size and nature of the workshop. These include service technicians/Mechanics, body and paint work technicians, welders, electricians, and tire repair technicians (27).

Service Technicians/Mechanics: These are skilled professionals who perform repairs, maintenance, and diagnostics on vehicles. Technicians may specialize in certain types of cars or specific repairs, such as electrical systems, brakes, or transmissions.

Body and Paint Technicians: These professionals specialize in repairing and refinishing vehicle bodies. They may fix dents, perform frame straightening, apply paint, and handle other cosmetic repairs.

Auto Electricians: These technicians specialize in diagnosing and repairing electrical and electronic systems in vehicles. They work with complex wiring and vehicle electronics. Parts Specialists: Parts specialists are responsible for ordering, organizing, and managing the inventory of parts and supplies needed for repairs. They work closely with service technicians to ensure the availability of necessary components. Tire Technicians, Detailers, and Shop Assistants are the other roles (27, 28).

2.2. Epidemiology of Lead Exposure and renal function indices among Garage Workers

Lead has been highlighted as an environmental and occupational hazard (29, 30). Common sources of lead exposure in the automotive repair industry include battery lead-acid recycling, radiator repair, auto mechanic repair, and welding (31, 32). A study conducted in India found that blood lead levels among garage workers ranged from 13.54 to 46.75 mcg/dL, with a mean level of 23.52 mcg/dL (33). Another similar study in India found a significant difference in blood lead levels between garage workers and the control group (34).

A study conducted in Bangkok showed a high blood lead level among garage workers. Significant higher blood lead levels were observed among the mechanics and dye sprayer groups ($P<0.05$) (21).

A study conducted in Iran among 35 male automobile repair workers found that more than 30 µg/dL of blood lead levels were found in the workers (35).

Another study conducted by Ishola et al., (27) Occupationally exposed automotive workers in Benin City revealed that greater levels of Lead were found in auto mechanics, spray painters, and battery recyclers compared with the non-exposed controls.

A study conducted in Sagamu, Nigeria, found that the mean blood lead level among technicians was 43.5 ± 15.3 µg/dL, significantly higher than the recommended levels of 5 µg/dL set by the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO). Elevated blood lead levels were observed in 87.5% of the technicians (36). Another cross-sectional study conducted in Nigeria found 4.4±2 µg/dL of blood lead level among automobile mechanics (37).

The study was conducted in informal automobile repair workshops in Nakuru, Kenya, and involved 20 male artisans. The average Pb exposure level across all tasks was 22.55 µg/m3, with measured values ranging from 1.15 to 86.19 µg/m3 (38).

A comparative cross-sectional study conducted on the blood lead levels [BLLs] of 45 automotive garage workers and 40 non-garage workers was carried out in the town of Jimma, Ethiopia, and showed that the mean BLL of the automotive garage workers was found to be significantly greater than that of the comparison group (19).

Several studies suggest that lead is a nephrotoxic substance. When lead enters the bloodstream, more than 95% of it binds to erythrocytes and is then circulated throughout the body (39). Since most lead is initially stored largely in the kidneys and liver, it can cause pathobiological changes in these organs (40).

A study done on 39 male and seven female workers in a secondary lead refinery suggests that moderate lead absorption may cause renal tubular impairment (41). Wang et al., (12) also found significantly higher mean serum urea levels in occupationally exposed subjects compared to controls. Similarly, another study conducted in North Karnataka (India) in automobile workshops found elevated levels of serum creatinine and blood urea nitrogen(BUN) compared to the non-exposed group (22). Previous studies have associated elevated levels of some of these renal biomarkers with exposure to Lead. A Study conducted among 45 garage workers and 25 age and BMI (Body mass index) matched control in Bangladesh Automobile workers had significantly higher levels of blood lead compared to healthy controls, with workers having

40.5±11.2 μg/dL and controls having 29.7±10.1 μg/dL in addition, Workers exhibited lower levels of serum creatinine (SCr), blood urea nitrogen (BUN) compared to controls (42).

A study conducted in South Africa reported elevated serum creatinine levels in battery factory workers (43). In addition, other findings indicate that the elevated blood levels of kidney biomarkers in garage workers compared to unexposed individuals could perhaps be attributed to their work practices' inadequacy of protective measures against hazardous metals at work (17, 22, 44).

A comparative cross-sectional study was conducted in Kenya, comprising 30 exposed garage workers and 30 non-exposed college students. Blood lead levels were assessed, and GFR was estimated. The result shows the artisans had a significantly decreased eGFR (128.37 mL/min/1.73m2 ± 4.37SE) compared to the control participants (152.93 mL/min/1.73m2 ± 3.91SE), (t (29) = -4.49, p =0.000) (44).

2.3. Factors associated with renal impairment.

Pre-existing medical conditions

Individuals with pre-existing conditions like diabetes, hypertension, or chronic kidney disease are more susceptible to renal impairment. The study conducted among the adult population in Luxembourg revealed that Hypertension and diabetes were associated with more than 3-fold and 4-fold higher risks of chronic kidney disease (CKD) (45). Another study done on 70 chronic renal failure patients shows that hypertension and diabetes have a significant effect on the concentration of urea and creatinine (46). A study conducted in Tanzania among chronic kidney disease showed a statistically significant association between renal function impairment and being hypertensive and diabetic (47). Several studies in Ethiopia reveal the risk factors for renal impairment, such as hypertension and diabetic mellitus (48-50). Those studies show that hypertension and diabetes are major risk factors for renal impairment. Therefore, in this study, our primary concern is to evaluate the effect of lead exposure on renal parameters. To better understand the impact of lead exposure on renal function, we excluded individuals with pre-existing kidney disease, hypertension, and diabetes mellitus.

Socio-demographic factors

A cross-sectional study conducted on a total of 229 workers of both genders from two lead battery factories showed that a positive correlation between PbB levels, and individual renal was found ($P<0.01$). The PbB levels and renal function indices showed significant differences between male and female workers (51). A meta-analysis conducted by Nitsch et al. found no association between sex differences and estimated glomerular filtration rate (eGFR) (52).

Age is a considerable risk factor for CKD (53). As age increases, the capacity of kidney function decreases. A study conducted at the University of Washington suggests that age and sex are risk factors for CKD (54).

A cross-sectional study of the Japanese-American community in Seattle, Washington, showed that the association between creatinine clearance and BMI is significant after adjustments for IAF, SCF areas, and fasting insulin levels (55), besides systematic review and meta-analysis study done on the impact of body mass index on adverse kidney events also reported same findings (56); moreover, a retrospective study conducted using a nationwide database from the registry of the Japanese also showed that BMI is significantly associated blood creatinine level (57). In a study done in Addis Ababa among Ethiopian Public Health Institute worker kidney function test for screening of chronic kidney disease at an older age, high BMI was significantly associated with reduced glomerular filtration rate (58).

Behavioral risk factors

A study conducted on Japanese men on the association of cigarette smoking and renal function showed that current smoking was associated inversely with low eGFR (59). In a cross-sectional study conducted on 280 participants, 140 were non-smokers, and 140 were smokers (70 passive smokers and 70 active smokers showed that Serum urea, serum creatinine, serum cotinine levels, and urinary albumin were statistically significantly higher in the smokers group in comparison to non-smokers (60).

The World Health Organization reported that alcohol, one of the most used substances worldwide, has been raised as a potential cause of kidney damage, as studies have shown that excessive alcohol consumption is associated with hypertension, one of the major risk factors for chronic kidney disease (61), but contrary to this several studies showed there is no statistical association between alcohol consumption and renal function impairment.

Occupational risk factors

Occupation is the hidden risk factor for the progression of Chronic kidney disease in a population (62). Several studies suggest that garage workers exposed to lead dust have higher blood lead levels than their comparison group (44, 63)

The impact of lead exposure on health is likely influenced by factors such as the timing and duration of exposure and other conditions. It can potentially result in the onset of acute and chronic kidney disease. Notably, heavy metals, with Lead being a prominent example, have been extensively documented as contributors to both acute kidney injury (AKI) and chronic kidney disease (CKD) (64).

Inadequate use of personal protective equipment, such as gloves, masks, and protective clothing, can expose garage workers to harmful substances and increase the risk of kidney damage. Garage workers and employers need to prioritize safety measures, such as implementing proper ventilation systems, providing adequate personal protective equipment(PPE), and offering training on handling hazardous substances to minimize the risk of renal impairment and promote a healthy work environment (65, 66). A study done in Nigeria shows there was little difference between renal biomarkers and working sections. For instance, mechanics have higher Creatinine and BUN values than painters and battery recycling section workers (17). As observed, Workers' significant exposure to hazardous substances is primarily a result of their working conditions, which are fundamentally deficient and lack sufficient safety protocols. This observation was evident in the data collected from Commercial Automobile Workers in Benin City, Edo State, Nigeria. The findings indicated that 2% of workers consistently use protective gear, while 40% use it occasionally, and a significant 58% never employ any protective equipment (17). Similarly, another study done in the city of Makkah, Saudi Arabia, found that car painters who worked for more than ten years used protective equipment such as gloves and masks more than those who worked for less than ten years (18). Another study conducted in Harer, Ethiopia, found that 80% of workers are working without personal protective equipment (65).

3. Conceptual framework

This conceptual framework was designed to guide the research. It describes the independent factors (personal, clinical, and work-related) that affect the outcome of the study**.** Also, the framework helps to understand the scientific background and determine the scope of the literature review. This conceptual framework was developed based on existing literature. Figure 1 describes the framework used for the study.

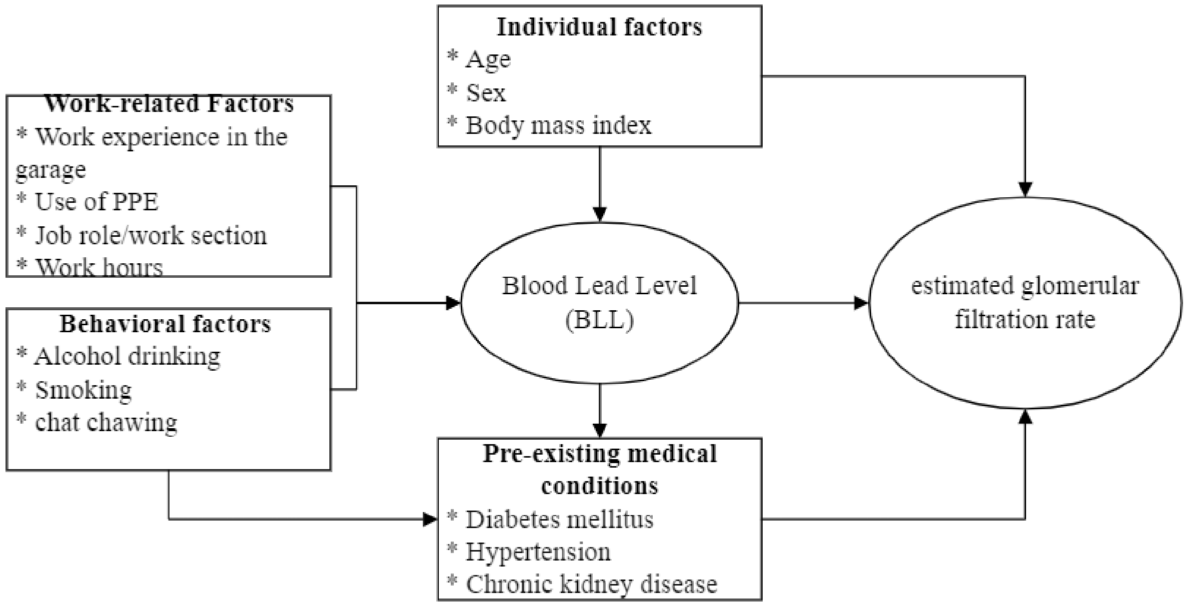

Figure 1 Conceptual framework of the relationship of dependent and independent variables (Source: Author's design)

4. Objective

4.1. General Objective

The main objective of this study is to assess blood lead levels and renal function parameters among garage workers in Addis Ababa, Ethiopia.

4.2. Specific Objective

- To determine blood lead levels among garage workers
- To evaluate renal function test parameters (urea and creatinine) among garage workers
- To determine factors associated with renal function impairment among garage workers.

5. Methods and Materials

5.1. Study setting

This study was conducted in five purposively selected Garages and one water bottling factory. The garages are located in Addis Ababa, and the water bottling factory is situated in Sheger City (located around Addis Ababa).

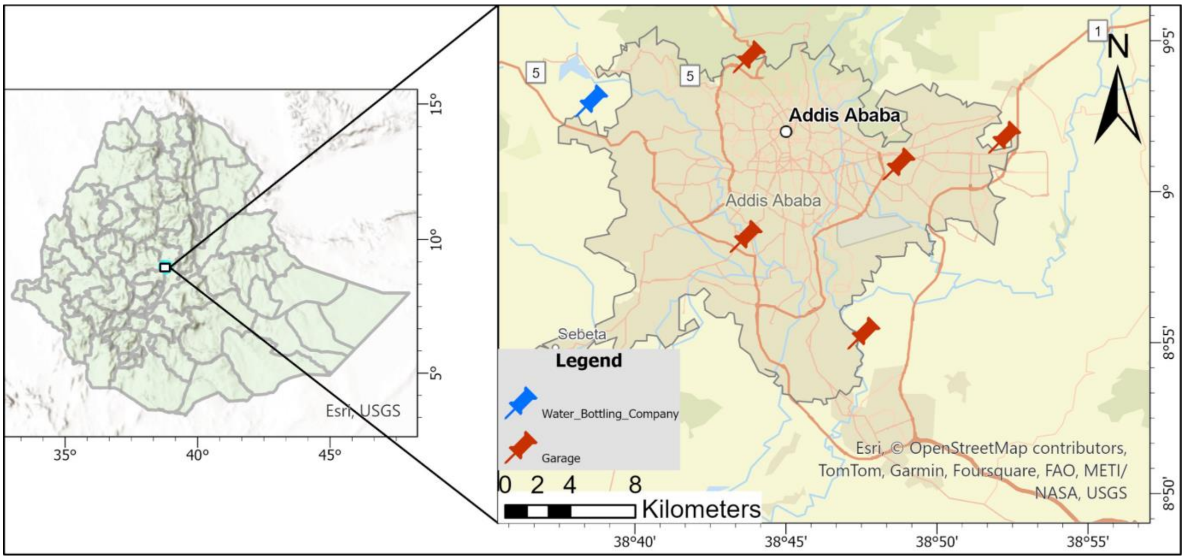

Figure 2 Map of the study area.

5.2. Study design and period

A comparative cross-sectional study was conducted to assess lead exposure and renal function impairment among garage workers and water bottling company workers from September 2023 to April 2024.

5.3. Source and study population

Source population

All employed in the selected garages (Technic department) were used as a source population, and all water bottling factory workers were also used as a comparison group.

Study population

Selected garage workers in the chosen garages and selected water bottling factory workers were used as the study population.

5.4. Sample size determination

Objective 1

The study conducted in Bangkok shows blood lead level of 0.42 ± 0.13 µmol/l among mechanics and 0.32± 0.07 µmol/l among the control group (21). The following formula, 80% power and 95% confidence level, was used.

$$n = \frac{2xSD^2(z\frac{\alpha}{2} + Z\beta)^2}{E^2}$$

$$n = \frac{2x0.42^2(1.96 + 0.84)^2}{0.42 - 0.32^2}$$

n = 26

Considering 10% non-response rate n =30

Objective 2

The study done in Nigeria shows serum creatinine among exposed garage workers and non-exposed was 0.95 ± 0.35 and 0.82 ± 0.24, respectively. The sample size calculation considered 80% power and 95% confidence level used (17).

$$n = \frac{2xSD^2(z\frac{\alpha}{2} + Z\beta)^2}{E^2}$$

$$n = \frac{2x(0.35)^2(1.96 + 0.84)^2}{(0.95 - 0.82)^2}$$

$$n = 113$$

n = 113+10% non-response rate

n =124 for the exposed group and 124 for the non-exposed group

= 248

In another study conducted in Nigeria, the BUN levels among exposed (garage and control groups were 27.41 ± 14.85 and 20.18 ± 4.40, respectively. 80% power and 95% confidence level were used.

$$n = \frac{2x(14.85)^2(1.96 + 0.84)^2}{(27.41 - 20.18)^2}$$

$n = 66$ for the exposed and 66 for the non-exposed group. Thus, the calculated sample size was 132.

Considering 10% non-response rate, the total sample size was n=146

Therefore, we used the largest sample size, which was 248 (124 for exposed garage workers and 124 for non-exposed water bottling company workers).

5.5. Sampling Method

A report from the Addis Ababa Road and Transport Bureau indicates that there are more than 4,500 small and large-scale garages in the city, with 322 classified as large-scale garages. From these garages, we purposively selected five based on their high number of workers. The participants were selected using a simple random sampling technique, and we selected 124 workers from these sites. We obtained workers list from their Human resources for garage workers and water bottling company annual medical checkup lists used to pick participants who met our inclusion criteria. However, 14 workers in the water bottling factory and 4 workers from garage declined to participate in the study. Both questionnaire data and blood samples were collected from the study participants who provided consent.

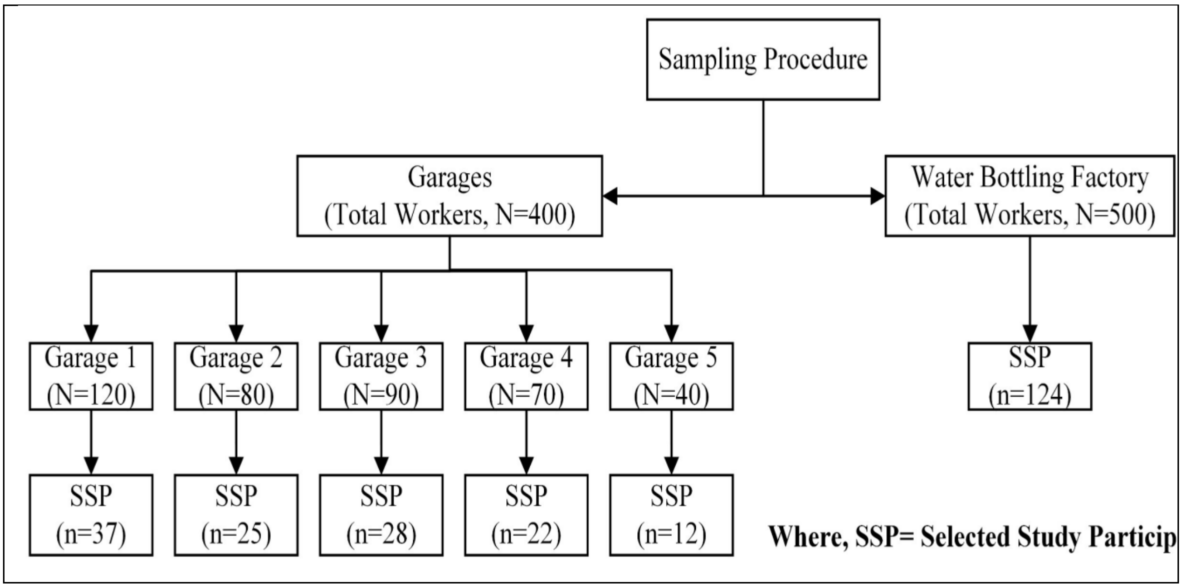

Figure 3 Schematic representation of sampling procedure.

5.6. Inclusion and Exclusion criteria

Inclusion criteria

- Age >18 years.
- Participants who worked for more than 12 months were included in the study.

Exclusion criteria

- Study participants having a history of Diabetic Mellitus and Hypertension (28, 65) were excluded from this study not to affect the study results.

5.7. Variables of the study

Dependent variable

Blood lead level (BLL)

Renal function test parameters (creatinine, urea, eGFR)

Independent variable

Individual factors: Age, Sex, BMI, blood pressure; Behavioral factors: Alcohol drinking habit, cigarette smoking habit. Chat chawing and Occupational risk factors: Duration of employment in the garage, use of personal protective equipment, working hours, Blood Lead Level, and Eating in the workplace.

5.8. Demographic and clinical data collection

The structured questionnaire was used to obtain data from the study participants associated with socio-demographic characteristics occupational, behavioral, and comorbidity information.

The questionnaire was pre-tested in one garage. Ten workers were interviewed. The observed shortcomings in the relevance and scope of questions were corrected before the final administration of the questionnaires to the respondents. After informed consent was obtained, each participant was interviewed using the structured questionnaire developed to capture the data of both exposed and non-exposed participants. Trained nurses and laboratory professionals collected the data. Data collection was conducted under the close supervision of the principal investigator in the garages and water bottling factory clinics.

Standardized techniques were employed to gather physical measurements, including weight and height. Weight measurements were conducted without individuals wearing shoes to ensure accuracy. Height measurements were taken while individuals stood in an upright position, ensuring consistency in the procedure. The body mass index was measured using the formula BMI=weight/height^2. The blood pressure was measured according to WHO guidelines using an automated sphygmomanometer at the midpoint of the left arm after participants were rested for at least 5 min or 30 min for those who were taking hot drinks like coffee and in a resting place, sitting in a chair. Systolic and diastolic blood pressure was expressed as mm/Hg.

Apparatus and Equipment

The EDTA tube, Nunc tube, Nunc tube holder, Tourniquet, Serum separator tube, Cold box, Glove, Alcohol swab, Vacutainer needle, Vacutainer holder, Sphygmomanometer**,** Tips, micro pipet were used for specimen collection. Conical flask (50ml), Volumetric flask (100ml), Funnel, Filter paper, Hotplate, and MP-AES were used for blood lead level analysis, whereas Cobas 6000 analyzer was used for renal function testing.

Blood sample collection and preparation

A total of 230 whole blood specimens were collected from 120 garage workers and 110 water-bottling factory workers. As all specimens collected for laboratory investigations were considered potentially infectious, appropriate precautionary safety procedures and standard operating procedures (SOPs) were maintained throughout the specimen collection and handling. This procedure was conducted by proficient medical laboratory technicians utilizing properly labeled serum separator tubes for renal function assessment and EDTA tubes for blood lead measurement. Adhering to strict hygiene protocols, a dedicated sterilized needle and set of gloves were employed for each participant, ensuring separate usage for every participant.

Three milliliters of venous blood were drawn into test tubes containing potassium ethylenediamine tetra acetic acid (EDTA K3) as an anticoagulant for the determination of blood lead level. At the same time, 3-4 ml of blood was collected in a serum separator tube and subsequently centrifuged at nearby health centers within two hours to isolate the serum. Both whole blood and serum were separately stored in a cold chain box of 2-8°C, maintaining the triple packaging procedure, and transported to the Ethiopian Public Health Institute laboratory (EPHI) for analysis. All utilized needles and gloves were carefully packaged in appropriately labeled disposable bags and disposed of in the waste disposal unit.

Laboratory investigations

Blood lead level analysis

The blood lead level was measured using microwave plasma atomic emission spectroscopy (MP-AES) with model 4210 at a wavelength range of 180–780 nm at the Ethiopian Food and Drug Authority. Analysis of lead levels in the blood samples of the study participants was performed based on the NIOSH 8005 method (67).

Standard operating procedures prepared by the laboratory for this technique were critically followed for testing. Initially, all equipment was washed and immersed in a 5% Nitric acid solution for twelve hours, followed by drying in an oven. Subsequently, they were coded according to the specified code. Once the sample was thawed, it was agitated, and 2ml of the blood sample was measured and added to 50ml of the conical flask. A freshly prepared solution, composed in a 6:4 ratio (6 nitric acid to 4 hydrogen peroxide), was added. The mixture was then placed on a hot plate and digested for 1-2 hours at 250°C. After cooling, the sample was filtered using filter paper into a 100ml volumetric flask, and distilled water was added until reaching the meniscus. During sample digestion, sample blanks were digested. The solution was then transferred to a falcon tube and stored at four °C until the time of analysis.

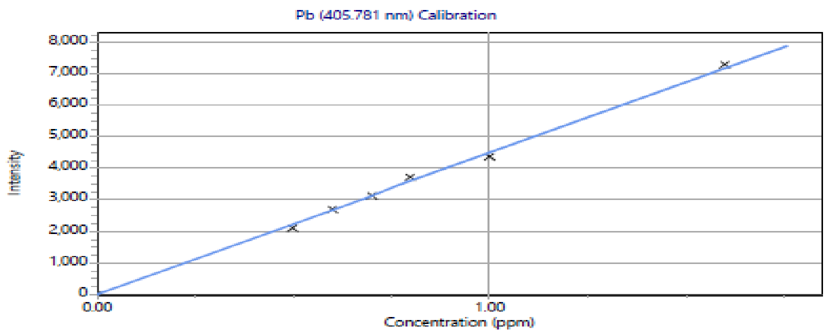

Figure 4 Calibration curve for blood lead analysis Addis Ababa, Ethiopia. 2024

Renal function testing

Renal function tests, which include urea and creatinine, were tested for both garage workers and water-bottling factory workers participants. The parameters were conducted on Cobas 6000 fully automated chemistry analyzer at the national clinical chemistry reference laboratory of the EPHI, which was accredited in the field of Medical Testing in accordance with the requirements of ISO 15189:2012, Medical laboratory Requirements for Quality and competence. Urea utilized a kinetic test with urease and glutamate dehydrogenase method, whereas creatinine utilized the enzymatic colorimetric method. The tests were performed as per the manufacturer's instructions and specific standard operating procedures prepared by the laboratory for testing. Moreover, internal quality control was performed before the sample processing to ensure and monitor the laboratory test results were valid. The reference range for creatinine in females was considered 0.51–0.95 mg/dL, while in males, 0.67–1.17 mg/dL. For urea, the reference range for both males and females was 16.6–48.5 mg/dL (68, 69).

For the calculation of eGFR, we used A formula that allows for an assessment of creatinine clearance (GFR) in men that accounts for age-related decreases in GFR, body weight, and Cockcroft-Gault has derived sex: Creatinine clearance (mL/min) = (140-age) × body weight (kg)/plasma creatinine (mg/dL) × 72. This value should be multiplied by 0.85 for women (70).

5.9. Data quality assurance

Stringent quality control measures were integrated at every stage of the study design. These measures encompassed several key aspects: The questionnaire was initially crafted in English and then meticulously translated into Amharic, the local language, followed by back-translation to ensure accuracy and consistency in both versions. Data collectors, under the supervision of investigators, underwent comprehensive training tailored to the study's objectives before commencing data collection. This training aimed to ensure consistency and reliability in data collection procedures. Prior to obtaining blood samples, precautions were taken to prevent sample contamination, and barcodes were prepared to identify samples. Samples were collected in the garages and water bottling factory clinic. Standardized, calibrated, and sterile techniques were employed for blood sample collection to maintain uniformity and precision in the collection process. Collection procedures adhered to standard operating procedures and manufacturer's instructions to uphold the quality of laboratory tests. The laboratory tests were conducted in a national reference laboratory, which was accredited in the field of Medical Testing in accordance with the requirements of ISO 15189:2012, Medical Laboratory Requirements for Quality and Competence. All glassware and Plastic ware which contacts standards, blanks, or samples were detergent-washed, thoroughly rinsed with tap and deionized water, soaked 12 h in 5% (v/v) HNO 3 and soaked 12 h in deionized water. Both questionnaire-based data and laboratory results were entered separately into an Epi data software and Excel sheet, respectively, for quality purposes and checked for completeness and accuracy. Data cleaning was done to minimize errors and assure the quality of the data prior to analysis.

5.10. Data Management

Questionnaire data were entered into Epi Data software version 3.1, and a standardized protocol was followed for sample collection. The collected blood samples were transported to the testing laboratory, stored at 4°C, and then frozen at -20°C until analysis. After obtaining the results from the Ethiopian Food and Drug Authority (EFDA) and EPHI, the data were entered into an Excel sheet and double-checked for accuracy. The data were cross-checked against the unique identifiers to ensure proper matching with the questionnaire data. Blood sample results were standardized to ensure comparability. Finally, the data were exported to SPSS software version 26 for analysis.

5.11. Operational definition

GFR = eGFR >90 mL/min/1.73 is considered normal by Kidney Disease Improving Global Outcomes (KDIGO) 2012 Guideline Recommendation (71).

Creatinine value: For females, 0.51–0.95 mg/dL, while in males, 0.67–1.17 mg/dL.

Urea: for both males and females, 16.6–48.5 mg/dL.

Blood lead level: According to OSHA, blood lead classification <10 ug/dL = normal, 10-40 ug/dL = acceptable, and >40 ug/dL is dangerous (7).

Cigarette smoking:

- Non-smokers: Individuals who have never smoked or have smoked fewer than 100 cigarettes in their lifetime.
- Former smokers: Individuals who used to smoke regularly but have quit.
- Current smokers: Individuals who currently smoke cigarettes. (CDC National Health Interview Survey Glossary)

Alcohol consumption– for males, more than two drinks per day, and for females, more than one drink per day (National Institute on alcohol abuse and alcoholism)

Exposed group: A person who works in an automotive garage workshop.

Non-exposed group: A person who has minimal exposure to Lead or who did not perform a lead-based job.

Personal protective equipment: In this study, the use of personal protective equipment (PPE) varies between the two groups. For garage workers, relevant PPE includes respirators (masks), safety glasses, safety shoes, gloves, and protective clothing. In contrast, for water bottling factory workers, essential PPE consists of hairnets, gloves, protective clothing, and masks.

5.12. Data analysis

Data analysis was performed using SPSS version 26 software. The chi-square test and the Mann-Whitney U tests were used to see the difference between groups for the categorical and continuous variables, respectively. In a separate analysis restricted to the garage group only, Kruskal Wallis was used to see the difference in blood lead levels between departments. Generalized linear regression models were also used to see associated factors with blood lead level and estimated glomerular filtration rate. The significance level was set at $P < 0.05$.

5.13. Ethical consideration

Ethical clearance was obtained from the Addis Ababa University School of Public Health Ethical Review Committee. An official letter was also provided from Addis Ababa University and sent to the garages and water bottling factory. Permission to collect the data and samples was provided from the study sites. Participants were provided with all the necessary information about the study using simple and non-technical terminology. The objective and the procedure of the study were explained to the study participants. Informed consent was obtained from each participant before running the question and sample collection. All the principles of ethics, such as informed consent, confidentiality, and privacy, were kept. Data collection was run without personal identifiers or using codes. All study participants read and signed the informed consent. Participants with abnormal laboratory test results have been linked to the health facility for further healthcare service.

6. Results

6.1. Socio-demographic Characteristics of the study participants

A total of 230 study participants, 120 garage workers, and 110 water bottling company workers were included in this study with 92.7% response rate. The mean (±SD) age of the study participants was 39.55±9.95 years among the Garage workers and 37.31±5.42 among the water bottling factory workers non-exposed). Of the total participants, the majority were male, 85.7% in the exposed and 80% in an unexposed group. Based on the chi-square test, there was no significant difference regarding the socio-demographic and economic characteristics of the two groups (Table 1).

Table 1 Socio-demographic and economic characteristics of garage workers and water bottling factory workers in Addis Ababa, Ethiopia, 2024.

Variables	**Category**	**Exposed group n(%)**	**Unexposed group n (%)**	**Statistical analysis p-value**
Age(years)	18–30	25(20.8)	22(20.0)	0.9
	31–44	55(45.8)	49(44.5)	
	≥45	40 (33.3)	39(35.5)	
	Mean ±SD	39.55±9.95	37.31±5.42	
Sex	Male	105 (87.5)	88 (80)	0.13
	Female	15 (12.5)	22 (20)	
Education	No formal education	1(0.8)	3(2.7)	0.13
	Primary school	4(3.3)	8(7.4)	
	Secondary school	16(13.4)	21(19)	
	Diploma	82(68.3)	58(52.7)	
	Degree and above	17(14.2)	20(18.2)	
Marital status	Single	42(35)	30(27.3)	0.38
	Married	68(56.6)	72 (65.5)	
	Divorced	10(8.3)	8(7.2)	
Monthly Salary from the work	≤3000	8(6.7)	13(11.9)	0.41
	3000–6000	40(33.3)	41(37.2)	
	6001–9000	48(40)	36(32.7)	
	≥9001	24(20)	20(18.2)	

6.2. Behavioral characteristics and use of personal protective equipment of the study participants

Regarding personal protective equipment use, only 13 (11%) of the exposed group use personal protective equipment while they do their job. About 85 (70.8%) of study participants who work in Garages eat at workplaces, whereas 76 (69%) of the comparison group eat at workplaces. (Table 2). There was no statistically significant difference in behavioral characteristics and use of PPE in exposed groups and non-exposed groups.

Table 2 Behavioral characteristics and use of PPE in Garage workers and water bottling factory workers in Addis Ababa, Ethiopia, 2024.

Variables	Cate gory	Exposed group n (%)	Unexposed group n (%)	Statistical Analysis p-value
PPE Use	Yes	13(11.1)	21(19.1)	0.16
	No	107(88.9)	89(80.9)	
Drinking Alcohol	Yes	38(31.9)	33(30)	0.75
	No	82 (68.1)	77(70)	
Chat chewing	Yes	7(5.8)	4(3.6)	0.43
	No	113 (94.2)	106(96.4)	
Smoking cigarette	Yes	7(5.8)	2(1.8)	0.12
	No	113(94.2)	108(98.2)	
Eats in workplace (in the production room)	Yes	85 (70.8)	76(69.1)	0.77
	No	35 (29.2)	34(30.9)	

X^2 test

6.3. Comparison of blood lead levels, Urea, Creatinine, and eGFR among the garage workers and water bottling factory workers

The Mann-Whitney U Test was used to assess the concentration of blood lead, eGFR, urea, and creatinine median difference between the garage workers and water bottling factory workers. The median of blood lead concentration among garage workers was 11.98ug/dL (interquartile range (IQR) = 5.78ug/dL – 21.54ug/dL) which was statistically higher than the median blood lead level among water bottling factory workers, 6.87ug/dL (IQR = 4.17ug/dL– 10.13 ug/dL) ($P < 0.001$) [Fig 5c].

The median of eGFR concentration among garage workers was 117 mL/min/1.73m² (interquartile range (IQR) = 109.8 mL/min/1.73m²– 122.6 mL/min/1.73m²) which was statistically higher than workers eGFR in water bottling company 125.2 mL/min/1.73m² (IQR = 119.3 mL/min/1.73m² – 128.4 mL/min/1.73m²) ($P <0.001$) [Fig 5a]. In addition, 2(1.7%) of garage workers have <90 mL/min/1.73m². However, none of the water bottling factory workers have <90 mL/min/1.73m² eGFR concentration among water bottling factory workers.

The median of urea concentration among garage workers was 17.35mg/dL (interquartile range (IQR) = 14.23mg/dl – 19.80mg/dl) while among water bottling factory workers, 16.10mg/dL (IQR = 13.57mg/dL – 19.65mg/dL) (P = 0.288) [Fig 5b]. The median of creatinine concentration among garage workers was 0.66mg/dL (interquartile range (IQR) = 0.58mg/dL – 0.74mg/dL), which was statistically higher than water bottling factory workers, 0.63mg/dl (IQR = 0.50mg/dL – 0.72 mg/dL) (*P=0.030*)[Fig5d].

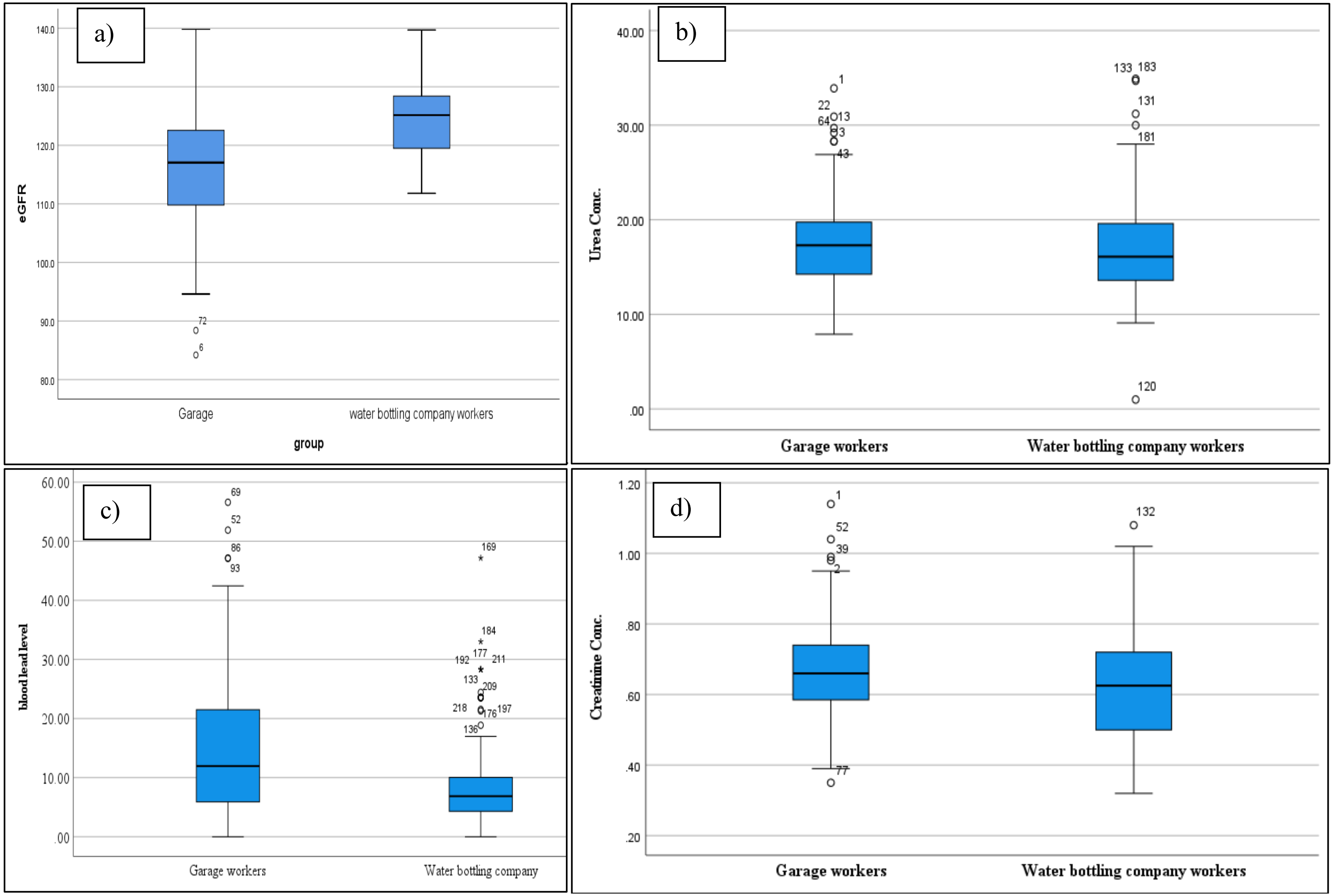

Figure 5 Median difference of GFR, Urea, blood lead level, and creatinine concentration between garage workers and water bottling company workers.

6.4. Comparison of blood lead among different departments in the garage

The pairwise Kruskal-Wallis test was employed to determine which specific group differs significantly from the other. According to this test, the blood lead level is significantly higher in mechanics *($p = 0.02$)* and welders *($p = 0.05$)* compared to water bottling factory workers.

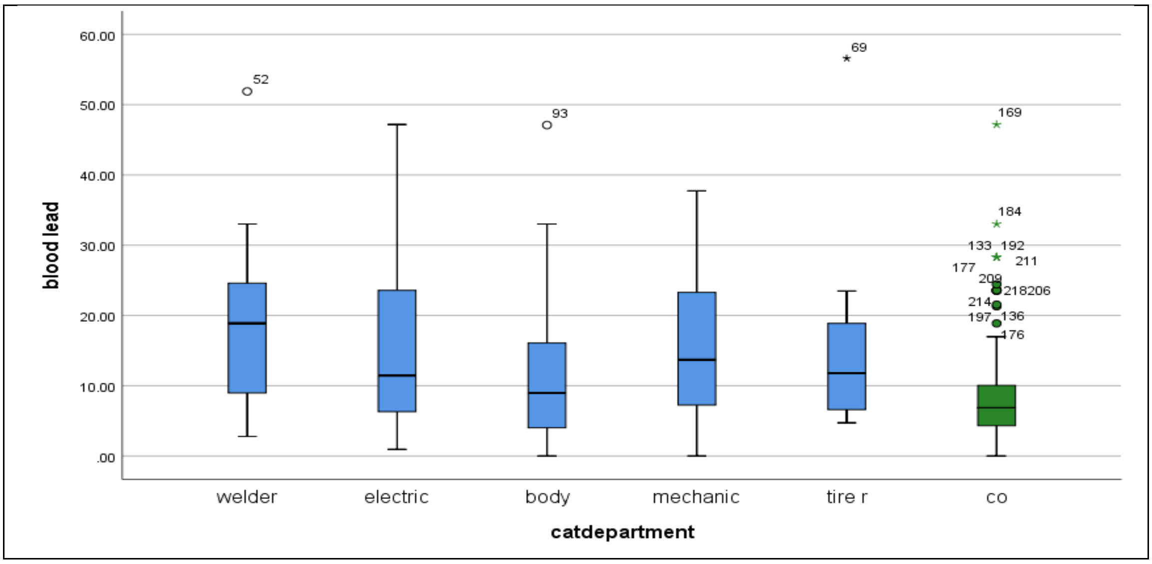

Figure 6 Median difference of blood lead level among different departments in the garage compared with water bottling factory workers.

6.5. Categorization of BLLs of study workers according to OSHA recommendation limits and comparison with urea and creatinine.

About 47%, 49%, and 2% of study participants in the Garage group had normal, acceptable, and dangerous levels of blood lead levels, respectively.

Kruskal-Walli's test was conducted to assess the median difference in concentration of creatinine and urea among the three categories of blood lead level between the garage workers and the water bottling factory workers. The result shows that there is no statistical difference in urea and creatinine values between the classified blood lead levels with significance levels of ($p=0.4$) and ($p= 0.33$), respectively.

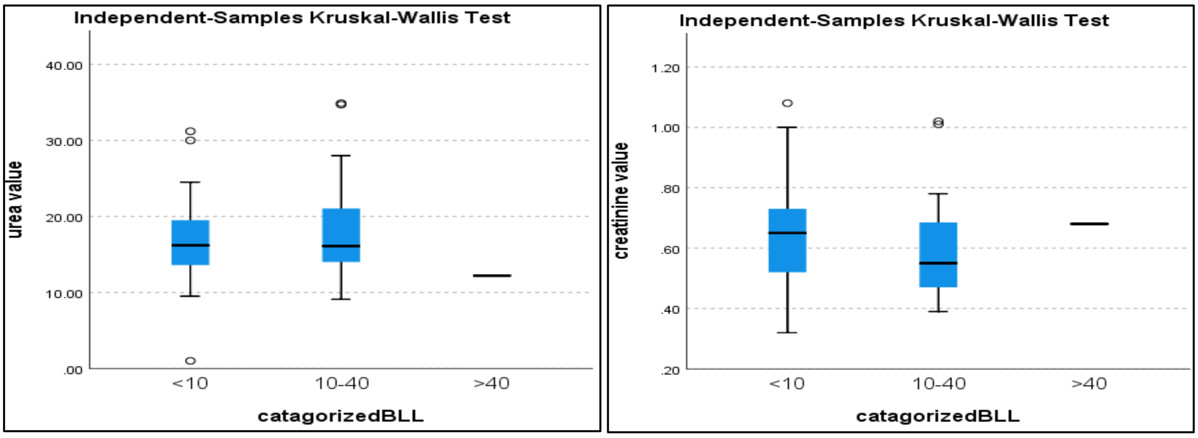

Figure 7 Comparison of renal parameters among OSHA-classified blood lead level.

6.6. Factors associated with blood lead level among garage workers.

According to the generalized linear regression model, eating in the work area (*P= .037*), older age(*P=.019),* and working in the welding department (*P=.010*) are significantly associated with blood lead level among garage workers.

Table 3 Factors associated with blood lead level in garage workers based on an adjusted generalized linear regression model.

Variable	Category	Adjusted β	95% CI of β Lower	Upper	P value
Sex	Female	-4.397	-10.698	1.903	.171
	Male	0	.	.	.
Smoking cigarette	Yes	-1.096	-14.204	12.011	.870
	No	0	.	.	.
Alcohol consumption	Yes	-1.577	-6.589	3.436	.538
	No	0	.	.	.
Use of personal protective equipment	Yes	2.815	-5.096	10.726	.486
	No	0	.	.	.
Eating in the work area	Yes	4.941	.303	9.580	.037*
	No	0	.	.	.
Age		.337	.054	.620	.019*
Systolic blood pressure		.096	-.160	.353	.463
Diastolic blood pressure		-.184	-.406	.039	.106
Work section in the garage	Welder	11.24	2.633	19.846	.010*
	Electric	4.588	-4.209	13.386	.307
	Body	2.203	-5.323	9.729	.566
	Mechanic	5.829	-1.658	2.329	.127
	Tire r	0	.	.	.
Work experience in the garage(years)	>20	.545	-6.931	8.021	.886
	15-20	-1.117	-9.520	7.286	.794
	10-15	-4.653	-12.074	2.767	.219
	5-10	.359	-9.224	9.941	.942
	1-5	0	.	.	.

*Significance level P < 0.05

6.7. Factors associated with GFR concentration in garage workers.

The association between independent variables and GFR concentration results was assessed separately using simple generalized linear regression models. Being female (*P < 0.001*), older age (*P = 0.013*), and having a high body mass index (*P <.001*) and diastolic blood pressure were significantly associated with GFR concentration [Table 4].

Table 4 Factors associated with the concentration of GFR in garage workers based on an adjusted generalized linear regression model.

Variable	Category	Adjusted β	95% CI of β Lower	95% CI of β Upper	P value
Sex	Female	-20.420	-29.418	-11.422	<.001*
	Male	0	.	.	.
Smoking cigarette	Yes	-4.498	-23.121	14.124	.636
	No	0	.	.	.
Alcohol consumption	Yes	3.777	-3.782	11.337	.327
	No	0	.	.	.
Garage department	Welder	2.310	-9.975	14.596	.712
	Electric	-10.212	-22.605	2.181	.106
	Body	1.231	-9.404	11.866	.820
	Mechanic	.666	-9.993	11.326	.903
	Tire r	0	.	.	.
Age		-.531	-.948	-.114	.013*
Systolic blood pressure		.056	-.308	.420	.763
Diastolic blood pressure		-.351	-.670	-.032	.031*
Body mass index		2.373	1.584	3.162	<.001*
Blood lead level		-.086	-.341	.169	.509

*Significance level $P < 0.05$

7. Discussion

In this study, garage workers exhibited significantly higher blood lead levels than the comparison group. Regarding renal indices, creatinine levels were significantly higher among garage workers compared to water-bottling factory workers. The estimated glomerular filtration rate was considerably lower in garage workers than in the comparison group. However, in both groups, eGFR was in the normal range.

The results obtained in our study have shown the auto garage workers have significantly higher blood lead levels than the comparison group. This clearly indicates that garage workers are more likely to be exposed to lead than the general population due to their occupation. Furthermore, the result obtained in our study is similar to the study conducted in North Kataranta and the study done in Nakuru town, Kenya (19, 22, 44).

In our study, the median blood lead level among garage workers was 11.98ug/dL, while among water bottling company workers, 6.87ug/dL is lower than the findings from a cross-sectional study done in Jimma (19) and Nakuru, Nigeria (44). In addition, it is also lower than a study conducted in Auto repair workshops in Benin City, Nigeria (27). This might be due to the fact that in our study setting, we observed maintenance, welding, and electrical work performed in open spaces, which might reduce lead exposure. Open environments allow for better air circulation, which helps to dilute and disperse airborne lead particles and fumes. Also prevents the accumulation of high concentrations of lead that workers might otherwise inhale in enclosed spaces.

In addition, the continuous exchange of air in open spaces reduces the settling of lead-containing dust on surfaces, thereby minimizing the chances of resuspension and subsequent inhalation of these particles. Natural air movements, such as wind, further aid in dispersing contaminants. However, the blood lead levels found in our study were higher than those in the study done in Pakistan automobile repair workers (72).

World Health Organization (WHO) and Centers for Disease Control and Prevention (CDC) recommended that the blood lead level standard limit of the general population was 10 µg/dL. However, when we compare the blood lead level of the study participants from the general population, of all the study participants, about 53% of exposed and 22.5% of non-exposed groups BLLs were above the WHO and CDC general population's BLL recommendation limit (73, 74).

Eating in the workplace showed a significant association with BLL; this result is similar to findings from a study done in the town of Jimma, Ethiopia (19) and Benin, Nigeria (27). Contaminated surfaces are one key cause of lead dust settling on various surfaces in the working area, including tables, benches, tools, and equipment. If workers eat in the same area without proper cleaning procedures, they may unknowingly consume lead-contaminated dust that has settled on these surfaces. Once ingested, lead can be absorbed into the body (75, 76). Moreover, lead particles can adhere to workers' hands during their tasks in the garage, especially if they come into direct contact with lead-containing materials. If workers do not wash their hands before eating, they may transfer lead particles from their hands to their food or mouth. This hand-to-mouth transfer is a common pathway for lead ingestion (77).

Older age groups had higher blood lead levels compared to relatively younger workers. This finding is similar to the study done in Jordanian automobile workers, where Age group 41–45 years had the highest mean blood lead concentration (16.1 µg/dl), compared to group 25–30 years and group 31–35 years with blood lead means of 13.8 µg/dl and 12.7 µg/dl, respectively (78). In addition, several normative aging studies suggest that aged individuals tend to accumulate lead over time, and lead can be stored in the bone for decades. A study done on the Chinese population also revealed that the level of blood lead is higher among older groups than that of younger participants (79).

This study shows that working in the welding department is associated with higher blood lead levels. This result is similar to the study done in Jimma town, Ethiopia (19) and Nukuru town, Kenya, where blood lead levels were higher among welders and spray painters (44). This might be due to welders being exposed to lead fumes during Welding on Painted Surfaces. If welders work on materials coated with lead-based paints, the heat generated during welding can vaporize the lead, releasing toxic fumes and particles. in addition, some soldering materials contain lead. During the welding process, lead can be released as fumes. The inhalation of these fumes is a significant route of exposure. contrary to this, studies found that there was no difference in blood lead levels among different occupational tasks in the automobile workshops (80). Moreover, the study done on Jordanian automobile workers found higher blood lead levels among automobile electronics and lower observed in welders (78).

Though median creatinine value was in normal values garage workers had higher compared to the comparison group. This finding is similar to a study conducted on Commercial Automobile Workers in Benin City, Edo State, Nigeria (17), and Nnewi metropolis (63) and the study done on the Association of Lead Exposure, Serum Uric Acid, and Parameters of Renal Function in Nigerian Lead Exposed Workers (81). This result might show us the effect of lead on renal parameters. However, contrary to this, the study done in Harer, Ethiopia, did not find any difference in creatinine value among garage workers and the comparison group (28).

In this study, we found a significantly lower value of the estimated glomerular filtration rate among garage workers than the comparison group. This finding is similar to the study done in Nakuru, Kenya, among informal auto repair artesian (44). This might be due to garage workers being exposed to lead, which is also a known nephrotoxic substance that can affect the filtration capacity of the kidney.

We found a significant association with older age-reduced eGFR. As age increases, the glomerular filtration rate (GFR) decreases. This decline is partly due to the increasing percentage of glomeruli affected by global glomerulosclerosis, which steadily rises with advancing age, even in the absence of comorbidities such as hypertension. Additionally, the overall number of functioning nephrons steadily declines with age. GFR is naturally lower in women compared to men (82). This might be due to physiological differences such as lower muscle mass, hormonal influences, and smaller body surface area.

Body mass index is significantly associated with eGFR. This consistent with the study by Ryuichi et al, found increased BMI is strongly associated with decreased eGFR in community-dwelling healthy persons (83). Creatinine is a waste product generated from the breakdown of creatine phosphate, which is primarily found in muscles. Individuals with higher BMI, particularly those with a higher proportion of muscle mass, may naturally have higher creatinine levels because they have more muscle tissue (84); moreover, creatinine is filtered from the blood by the kidneys and excreted in urine. The glomerular filtration rate (GFR), which is a measure of kidney function, plays a significant role in determining blood creatinine levels. In some cases, individuals with higher BMI may have a reduced GFR, which can result in higher creatinine levels in the blood (56, 57).

Furthermore, we found a negative association between diastolic blood pressure (DBP) and estimated glomerular filtration rate (eGFR). This finding is consistent with a longitudinal study conducted on Iranian automobile maintenance workers (85). Lead exposure has been linked to various cardiovascular and renal effects in workers, with studies showing that lead-exposed workers experience increased DBP. Additionally, high blood pressure is a major risk factor for reduced eGFR. Therefore, continuous health monitoring is needed for garage workers.

Strengths and limitations of the study

Strengths

Comprehensive Data Collection: The study employed a thorough data collection method, including questionnaires, blood samples, body mass index (BMI), and blood pressure measurements, ensuring a well-rounded dataset.

Comparative Analysis: By comparing garage workers with water-bottling factory workers, the study provides a clear contrast between an exposed and a control group, strengthening the findings related to occupational exposure.

Limitations

Cross-Sectional Design: The study's cross-sectional design can identify associations but cannot establish causality. Longitudinal studies would be needed to determine causal relationships.

Sample Size and Generalizability: Selecting the garages purposively may limit the generalizability of the study.

Self-Reported Data: Data collected through questionnaires can be subject to recall bias and inaccuracies, which may affect the reliability of the information on habits, behaviors, and pre-existing medical conditions.

8. Conclusion and recommendation

Conclusion

This study did not found a significant association between Pb exposure & renal dysfunction. However, blood lead level was significantly higher among garage workers than the water bottling factory workers. Thus, strict regulations are still necessary to reduce lead exposure in garage workshops.

Recommendation

Employers: Employers need to provide appropriate PPE, including gloves, masks, protective clothing, and respiratory protection suitable for the tasks, and monitor its proper use and maintenance.

Provide designated areas for eating, and good hygiene needs to be practiced among workers, such as regular handwashing with soap and water before eating.

Providing designated areas for eating and drinking that are separate from the work area to prevent ingestion of lead-contaminated dust or particles.

Organize training and awareness creation events by collaborating with occupational health and safety officers and labor inspectors.

Policymakers need to make policies that help, govern, and regulate employers in a healthy work environment. In addition to that regular monitoring and supervision is needed.

Researchers need to conduct interventional studies, including behavioral change interventions about lead exposure.

In addition, longitudinal studies better evaluate the effect of lead exposure on renal function.

9. Reference

1. Balali-Mood M, Sadeghi M. Toxic mechanisms of five heavy metals: mercury, lead, chromium, cadmium, and arsenic. Frontiers in pharmacology. 2021;12:643972.

2. Saliu A, Adebayo O, Kofoworola O, Babatunde O, Ismail A. Comparative assessment of blood lead levels of automobile technicians in organised and roadside garages in Lagos, Nigeria. Journal of Environmental and Public Health. 2015;2015.

3. Lead Poisoning. World Health Organization; 2023

4. Lanphear BP, Rauch S, Auinger P, Allen RW, Hornung RW. Low-level lead exposure and mortality in US adults: a population-based cohort study. The Lancet Public Health. 2018;3(4):e177-e84.

5. Olufemi AC, Mji A, Mukhola MS. Potential health risks of lead exposure from early life through later life: implications for public health education. International journal of environmental research and public health. 2022;19(23):16006.

6. Flora G, Gupta D, Tiwari A. Toxicity of lead: a review with recent updates. Interdiscip Toxicol 5: 47–58. 2012.

7. Staudinger KC, Roth VS. Occupational lead poisoning. American family physician. 1998;57(4):719-26.

8. Assi MA, Hezmee MNM, Sabri MYM, Rajion MA. The detrimental effects of lead on human and animal health. Veterinary world. 2016;9(6):660.

9. Lentini P, Zanoli L, Granata A, Signorelli SS, Castellino P, Dell'Aquila R. Kidney and heavy metals-The role of environmental exposure. Molecular medicine reports. 2017;15(5):3413-9.

10. Luyckx VA, Tuttle KR, Garcia-Garcia G, Gharbi MB, Heerspink HJ, Johnson DW, et al. Reducing major risk factors for chronic kidney disease. Kidney international supplements. 2017;7(2):71-87.

11. Gowda S, Desai PB, Kulkarni SS, Hull VV, Math AA, Vernekar SN. Markers of renal function tests. North American journal of medical sciences. 2010;2(4):170.

12. Wang V-S, Lee M-T, Chiou J-Y, Guu C-F, Wu C-C, Wu T-N, et al. Relationship between blood lead levels and renal function in lead battery workers. International archives of occupational and environmental health. 2002;75:569-75.

13. Monney I, Bismark D-A, Isaac O-M, Kuffour RA. practices among vehicle repair artisans in an urban area in Ghana. J Environ Occup Sci. 2014;3(3):147.

14. Rushton L. The global burden of occupational disease. Current environmental health reports. 2017;4:340-8.

15. Kumie A, Amera T, Berhane K, Samet J, Hundal N, Michael FG, et al. Occupational health and safety in Ethiopia: a review of situational analysis and needs assessment. Ethiopian journal of health development. 2016;30(1):17-27.

16. Organization WH. Preventing disease through healthy environments: exposure to lead: a major public health concern. 2023.

17. Adejumo BIG, Awelogun KO, Uchuno GA, Emmanuel AM, Dimkpa U, Omosor KI, et al. Assessment of renal biomarkers of renal function in commercial automobile workers in Benin City, Edo State, Nigeria. Open Journal of Nephrology. 2018;8(01):18.

18. Al-Ghamdi SS. Occupational exposure to paints causes impairment of kidney functions. Journal of Environmental Protection. 2011;2(05):533-6.

19. Adela Y, Ambelu A, Tessema DA. Occupational lead exposure among automotive garage workers–a case study for Jimma town, Ethiopia. Journal of Occupational Medicine and Toxicology. 2012;7:1-8.

20. Ataro Z, Urgessa F. 16. Clinical, Biochemical and Hematological Parameters among Occupationally Lead Exposed Garage Workers Compared to Haramaya University, College of Health and Medical Science Teachers and Students in Harar Town, Eastern Ethiopia. Edited and Compiled by. 2017:257.

21. Suwansaksri J, Teerasart N, Wiwanitkit V, Chaiyaset T. High blood lead level among garage workers in Bangkok, public concern is necessary. BioMetals. 2002;15:367-70.

22. Dongre NN, Suryakar A, Patil AJ, Rathi D. Occupational lead exposure in automobile workers in North Karnataka (India): effect on liver and kidney functions. Al Ameen J Med Sci. 2010;3(4):284-92.

23. Atsdr U. Toxicological profile for lead (Atlanta, GA: US department of health and human services, agency for toxic substances and disease registry (ATSDR), public health service). US EPA (2006) Air quality criteria for lead. 2007.

24. Pócsi I, Dockrell ME, Price RG. Nephrotoxic biomarkers with specific indications for metallic pollutants: Implications for environmental health. Biomarker insights. 2022;17:11772719221111882.

25. Organization WH. Exposure to lead: a major public health concern. Preventing disease through healthy environments: World Health Organization; 2023.

26. Ahmed K, Ayana G, Engidawork E. Lead exposure study among workers in lead acid battery repair units of transport service enterprises, Addis Ababa, Ethiopia: a cross-sectional study. Journal of Occupational Medicine and Toxicology. 2008;3:1-8.

27. Ishola AB, Okechukwu IM, Ashimedua UG, Uchechukwu D, Michael E, Moses O. Serum level of lead, zinc, cadmium, copper and chromium among occupationally exposed automotive workers in Benin city. Int J Environ Pollut Res. 2017;5(1):70-9.

28. Ataro Z, Geremew A, Urgessa F. Chemical exposure in garage workers and related health risks on the biochemical levels: A comparative study in Harar town, eastern Ethiopia. SAGE Open Medicine. 2019;7:2050312119846792.

29. Pinto de Almeida AR, Carvalho FM, Galvão Spinola A, Rocha H. Renal dysfunction in Brazilian lead workers. American journal of nephrology. 1987;7(6):455-8.

30. Lai J-S, Wu T-N, Liou S-H, Shen C-Y, Guu C-F, Ko K-N, et al. A study of the relationship between ambient lead and blood lead among lead battery workers. International archives of occupational and environmental health. 1997;69:295-300.

31. Sakai T. Biomarkers of lead exposure. Industrial health. 2000;38(2):127-42.

32. Hashim D, Boffetta P. Occupational and environmental exposures and cancers in developing countries. Annals of global health. 2014;80(5):393-411.

33. Bawaskar HS, Bawaskar PH. Blood lead level among fuel station workers, Ganesh idol painters, persons with routine daily application lead containing black pigment to eyes and Garage workers. Journal of Family Medicine and Primary Care. 2020;9(3):1376-9.

34. Basu R, Biswas A, Biswas K, Mukhopadhyay A, Talapatra S, Ray S, et al. An attempt to search the health status of garage workers: a neglected part in India. Int J Adv Res. 2015;3(7):1466-71.

35. Fazli D, Malekirad AA, Mirzaee M, Dastjerdi HA, Mostafalou S, Karkhane A, et al. Study on the link between lead exposure and hematological, psychological, and memorial parameters in automobile repair workers. Health. 2014;2014.

36. Nwobi NL, Nwobi JC, Adejumo EN, Usiobeigbe OS, Adetunji OA, Atulomah NO, et al. Blood lead levels, calcium metabolism and bone-turnover among automobile technicians in Sagamu, Nigeria: Implications for elevated risk of susceptibility to bone diseases. Toxicology and Industrial Health. 2021;37(11):705-13.

37. Adejumo M, Olaiya Y, Sridhar M. Blood lead levels among automobile mechanics in a megacity, Lagos, Nigeria. International journal of health sciences. 2017;5(2):17-27.

38. Odongo OA, Moturi W, Obonyo MA. Influence of task-based airborne lead exposures on blood lead levels: a case study of informal automobile repair artisans in Nakuru town, Kenya. Environmental Geochemistry and Health. 2020;42(7):1893-903.

39. Kshirsagar M, Patil J, Patil A, Ghanwat G, Sontakke A, Ayachit R. Biochemical effects of lead exposure and toxicity on battery manufacturing workers of Western Maharashtra (India): with respect to liver and kidney function tests. Al Ameen J Med Sci. 2015;8(2):107-14.

40. Nakhaee S, Amirabadizadeh A, Brent J, Mehrpour O. Impact of chronic lead exposure on liver and kidney function and haematologic parameters. Basic & clinical pharmacology & toxicology. 2019;124(5):621-8.

41. Endo G, Horiguchi SI, Kiyota I. Urinary N-acetyl-β-D-glucosaminidase activity in lead-exposed workers. Journal of Applied Toxicology. 1990;10(4):235-8.

42. Zinat A, Hossain M, Bhowmik S, Khanom M, Islam L, Nabi A. Modulation of renal function indices of the occupationally lead exposed Bangladeshi automobile workers. International journal of environmental sciences. 2012;3(2):910-20.

43. Ehrlich R, Robins T, Jordaan E, Miller S, Mbuli S, Selby P, et al. Lead absorption and renal dysfunction in a South African battery factory. Occupational and Environmental medicine. 1998;55(7):453-60.

44. Odongo A, Moturi W, Meshack O. Health effects of occupational lead exposures among informal automobile repair artisans: a case study of Nakuru town, Kenya. International Journal of Toxicology and Environmental Health. 2019;4(2):79-88.

45. Alkerwi Aa, Sauvageot N, El Bahi I, Delagardelle C, Beissel J, Noppe S, et al. Prevalence and related risk factors of chronic kidney disease among adults in Luxembourg: evidence from the observation of cardiovascular risk factors (ORISCAV-LUX) study. BMC nephrology. 2017;18:1-10.

46. Ali NH, Maher FT, Al-Halbosiy M. The effect of hypertension, diabetes, and smoking on the levels of some biochemical parameters in chronic renal failure patients. Tikrit journal of pure science. 2019;24(3):69-76.

47. Meremo AJ, Masalu MB, Sabi I, Ngilangwa DP, Kapinga J, Tagalile R, et al. Prevalence and risk factors associated with chronic kidney disease among patients presenting at a haemodialysis unit in dodoma, Tanzania. The East African Health Research Journal. 2018;2(1):53.

48. Alemu H, Hailu W, Adane A. Prevalence of chronic kidney disease and associated factors among patients with diabetes in northwest Ethiopia: a hospital-based cross-sectional study. Current Therapeutic Research. 2020;92:100578.

49. Hunegnaw A, Mekonnen HS, Techane MA, Agegnehu CD. Prevalence and associated factors of chronic kidney disease among adult hypertensive patients at Northwest Amhara Referral Hospitals, Northwest Ethiopia, 2020. International Journal of Hypertension. 2021;2021.

50. Animaw Z, Walle Ayehu G, Abdu H. Prevalence of chronic kidney disease and associated factors among patients with chronic illness in Ethiopia: A systematic review and meta-analysis. SAGE Open Medicine. 2022;10:20503121221089442.

51. Wang X, Liang H, Wang Y, Cai C, Li J, Li X, et al. Risk factors of renal dysfunction and their interaction in level-low lead exposure paint workers. BMC Public Health. 2018;18:1-7.

52. Nitsch D, Grams M, Sang Y, Black C, Cirillo M, Djurdjev O, et al. Associations of estimated glomerular filtration rate and albuminuria with mortality and renal failure by sex: a meta-analysis. Bmj. 2013;346.

53. O'Hare AM, Choi AI, Bertenthal D, Bacchetti P, Garg AX, Kaufman JS, et al. Age affects outcomes in chronic kidney disease. Journal of the American Society of Nephrology. 2007;18(10):2758-65.

54. Yu MK, Lyles CR, Bent-Shaw LA, Young BA, Authors P. Risk factor, age and sex differences in chronic kidney disease prevalence in a diabetic cohort: the pathways study. American journal of nephrology. 2012;36(3):245-51.

55. Gerchman F, Tong J, Utzschneider KM, Zraika S, Udayasankar J, McNeely MJ, et al. Body mass index is associated with increased creatinine clearance by a mechanism independent of body fat distribution. The Journal of Clinical Endocrinology & Metabolism. 2009;94(10):3781-8.

56. Wan J-F, Chen Y, Yao T-H, Wu Y-Z, Dai H-Z. Impact of body mass index on adverse kidney events in diabetes mellitus patients: A systematic-review and meta-analysis. World Journal of Clinical Cases. 2024;12(3):538.

57. Zhang Y, Gao W, Li B, Liu Y, Chen K, Wang A, et al. The association between a body shape index and elevated urinary albumin–creatinine ratio in Chinese community adults. Frontiers in Endocrinology. 2022;13:955241.

58. Molla MD, Degef M, Bekele A, Geto Z, Challa F, Lejisa T, et al. Assessment of serum electrolytes and kidney function test for screening of chronic kidney disease among Ethiopian Public Health Institute staff members, Addis Ababa, Ethiopia. BMC nephrology. 2020;21:1-11.

59. Noborisaka Y, Ishizaki M, Nakata M, Yamada Y, Honda R, Yokoyama H, et al. Cigarette smoking, proteinuria, and renal function in middle-aged Japanese men from an occupational population. Environmental health and preventive medicine. 2012;17:147-56.

60. Eid HA, Moazen EM, Elhussini M, Shoman H, Hassan A, Elsheikh A, et al. The influence of smoking on renal functions among apparently healthy smokers. Journal of Multidisciplinary Healthcare. 2022:2969-78.

61. Organization WH. Global status report on alcohol and health 2018: World Health Organization; 2019.

62. Rubinstein S, Wang C, Qu W. Occupational risk and chronic kidney disease: a population-based study in the United States adult population. International journal of nephrology and renovascular disease. 2013:53-9.

63. Amah UK, Madu NK, Ahaneku JE, Ahaneku GI, Onah CE, Onuegbu JA, et al. Evaluation of nephrotoxic effect of lead exposure among automobile repairers in Nnewi Metropolis. International Journal of Research in Medical Sciences. 2014;2(3):1107-11.

64. Scammell MK, Sennett CM, Petropoulos ZE, Kamal J, Kaufman JS, editors. Environmental and occupational exposures in kidney disease. Seminars in nephrology; 2019: Elsevier.

65. Ataro Z, Geremew A, Urgessa F. Occupational health risk of working in garages: comparative study on blood pressure and hematological parameters between garage workers and Haramaya University community, Harar, eastern Ethiopia. Risk management and healthcare policy. 2018:35-44.

66. Amfo-Otu R, Agyemang JK. Occupational health hazards and safety practices among the informal sector auto mechanics. Applied Research Journal. 2017;2(1).

67. Sciences HDoP. NIOSH, Manual of Analytical Methods: US Department of Health and Human Services, Public Health Service, Centers …; 1994.

68. diagnostic R. Creatinine insert kit. 2022. Roche diagnostic.

69. Diagnostic R. Urea inset kit. 2022. Roche Diagnostic.

70. Brown DL, Masselink AJ, Lalla CD. Functional range of creatinine clearance for renal drug dosing: a practical solution to the controversy of which weight to use in the Cockcroft-Gault equation. Annals of Pharmacotherapy. 2013;47(7-8):1039-44.

71. KDIGO CK. clinical practice guideline for the evaluation and management of chronic kidney disease (Chapter 1). Kidney Int Suppl. 2013;3:19-62.

72. Khan K, Room SA, Bacha A-U-R, Nabi I, Ahmad S, Younas M, et al. Assessment of heavy metals among auto workers in metropolitan city: a case study. Frontiers in Public Health. 2023;11:1277182.

73. WHO E. Biological monitoring of chemical exposure in the workplace. World Health Organization: Geneva. 1996;1.

74. Crinnion WJ. The CDC Fourth National Report on Human Exposure to Environmental Chemicals: what it tells us about our toxic burden and how it assists environmental medicine physicians. Alternative medicine review. 2010;15(2).

75. Sweeney LC. Exposure evaluation for benzene, lead and noise in vehicle and equipment repair shops. Hanford Site (HNF), Richland, WA (United States); 2013.

76. Patharkar SA, Benwal SJ, Nerurkar AV, Patil N. Estimation of urinary delta aminolevulinic acid levels in garage workers as an index of lead exposure. Indian J Med Biochem. 2019;23(3):312-5.

77. Basu R, Talapatra SN, Mukhopadhyay A, Ray SS, Chakrabarti P, Chaudhuri U, et al. Assessment of biomarker with special reference to antioxidant level in blood as occupational exposure of sewage and garage workers. International Letters of Natural Sciences. 2014(09).

78. Shraideh Z, Badran D, Hunaiti A, Battah A. Association between occupational lead exposure and plasma levels of selected oxidative stress related parameters in Jordanian automobile workers. International journal of occupational medicine and environmental health. 2018;31(4):517-25.

79. Li Y, Chen J, Bu S, Wang S, Geng X, Guan G, et al. Blood lead levels and their associated risk factors in Chinese adults from 1980 to 2018. Ecotoxicology and Environmental Safety. 2021;218:112294.

80. Sanyang E, Jabbi A, Ndow M, Reynolds EM, Egiebor E, Alamu J. Group-specific Differences in Blood Lead Levels among Occupationally Exposed Workers in Greater Banjul Area, The Gambia. Current Research in Public Health. 2023:105-18.

81. Alasia D, Emem-Chioma P, Wokoma F. Association of lead exposure, serum uric acid and parameters of renal function in Nigerian lead-exposed workers. Int J Occup Environ Med (The IJOEM). 2010;1(4 October).

82. Hoang K, Tan JC, Derby G, Blouch KL, Masek M, Ma I, et al. Determinants of glomerular hypofiltration in aging humans. Kidney international. 2003;64(4):1417-24.

83. Kawamoto R, Kohara K, Tabara Y, Miki T, Ohtsuka N, Kusunoki T, et al. An association between body mass index and estimated glomerular filtration rate. Hypertension research. 2008;31(8):1559-64.

84. Chen X, Jin H, Wang D, Liu J, Qin Y, Zhang Y, et al. Serum creatinine levels, traditional cardiovascular risk factors and 10-year cardiovascular risk in Chinese patients with hypertension. Frontiers in Endocrinology. 2023;14:1140093.

85. Assadi SN. Is a long term work in automotive industry a risk factor for renal dysfunction? Annals of Medical and Health Sciences Research. 2015;5(2):103-7.

10. Annex

Participants' information sheet English version

Title: Assessment of Lead Exposure and Renal function impairment among garage workers and water bottling company workers in Addis Ababa, Ethiopia.

Principal investigator: Firehiwot Getahun (MPH candidate).

Introduction: You are invited to participate in a research study to assess lead exposure and renal function among garage workers in Addis Ababa. Before you decide to participate, you should understand the purpose of the study, what your participation involves, potential risks and benefits, and your rights as a participant. Please take the time to read this form and ask any questions you may have before deciding whether to participate.

Purpose of the study: This study aims to evaluate the blood lead level and renal function of individuals working in garages due to potential exposure to occupational factors that may impact kidney health. By participating, you will contribute to advancing scientific knowledge about occupational health in this specific work environment, and it will help you know the health status of your kidney.

Procedure: If you agree to participate, you will be asked to undergo a specific medical test to evaluate your blood lead level and renal function. This test may include blood tests and other assessments related to kidney health. Your participation will involve providing samples and relevant information regarding your work conditions and health history.

Benefits: While there may be no direct benefits to you personally, the information gathered from this study could potentially benefit garage workers in Addis Ababa by improving our understanding of the blood lead level and its effect on renal health and could lead to better workplace health policies and practices.

Confidentiality: Your identity and personal information will be kept confidential. Data collected during the study will be stored securely, and your details will not be disclosed in any publications or presentations arising from this research.

Result Dissemination: The researcher is responsible for the dissemination of findings. In addition, the findings will be published in a reputable scientific journal.

Voluntary Participation and Right to Withdraw: Your participation in this study is entirely voluntary. You have the right to refuse to participate or withdraw from the study at any time without any penalty or loss of benefits to which you are otherwise entitled.

We want to express our heartfelt appreciation for your collaboration and thank you in advance.

In case you need to contact the investigator, you may use the following address:

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Advisors

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Addis Ababa University School of Public Health Department of Preventive Medicine

English Consent Form

I, the selected participant, heard the information in the study's information sheet and understood the purpose, benefits, and requirements for me as well. I understood that all the information regarding me, like my name and all answers given by me, would never be transferred to a third party. So, I am willing to participate in the study.

Signature of Participant ______________Date ____________

Data Collector Name __________________

Signature ________________

Date__________

English version questionnaire

Participant Identification no: ______________________________
Data collection groups: **Garage** _____________ **Water bottling company** ________________
Data collection site: ____

I. Demographic Questions

No	Questions	Response	Skip
1.	Age		
2.	sex	1. Female 2. male	
3.	Educational Level	1. Read and write 2. Primary school 3. Secondary school 4. Diploma 5. Degree 6. Above-degree	
4.	Marital status	1. Single 2. Married 3. Divorced 4. Widowed	
5.	How much is your monthly income?	1. $\leq$3000 2.3000-6000 3.6000-9000 4.$\geq$9000	

II. Smoking habit and Alcohol consumption

No	Questions	Response	Skip
6.	Have you ever smoked a cigarette in the past? (**No** means less than 20 packs of cigarettes in a lifetime or less than one cigarette a day for one year)	1. Yes 2. No	
7.	If yes, do you now smoke cigarettes? (as of 1 month ago)	1. Yes 2. No	
8.	How many cigarettes do you smoke per day now?	1.1-5 2. 5-10 3.10-15 4. Above 15	
9.	For How many years do you smoke?	1.1-5 years 2.5-10 years 3.10-15 years 4. Above 15 years	
10.	Do you drink alcohol?	1. Yes 2. No	
11.	How many glasses of alcohol do you typically drink per day?	1.1- 5 glass 2. 5- 10 glass 3. 10 -15 glass 4. Above 15 glass	
12.	How many glasses of alcohol do you typically drink per week?	1.1-5 glass 2. 5-10 glass 3 Above ten glass	
13.	Do you chaw chat?	1. yes 2.no	

III. Occupational factors

No	Question	Response	Skip
14.	In which department do you work? (job category)		
15.	Employment status	1. permanent 2. Temporary	
16.	For how long you have been working in this garage (years)	1.1-5 2.5-10 3.10-15 4.15-20 5.≥20	
17.	What was your previous work?		
18.	For how many years have you worked in your previous job?	1.1-5 2.5-10 3.10-15 4.15-20 5.≥20	
19.	How many hours do you work per day?	1. less than 8hr 2.8hr 3. Above 8hr	
20.	For how many days do you work per week?	1.5 day 2.6 days 3. 7 days	
21.	Do you use any personal protective equipment during work time?	1. Yes 2. No	
22.	If yes, What type of personal protective equipment do you use?	1. Glove 2. Respirator Mask 3. Safety shoes 4. eye google 5. Protective clothing	
23.	If not, why do you did not use personal protective equipment b/c	1. There is no available personal protective equipment. 2. Discomfort	

		3. Other specify_____________	
24.	Do you eat in the work area?	1. Yes 2. No	
25.	Do you wash your hands before eating food?	1. Yes 2. No	

IV. Physical Measurement

No	Measurement	Record
1.	Blood pressure	Systolic: Diastolic:
2.	Body mass index	Weight: Height:

No	Laboratory parameters	Record
1.	Renal function test parameters	Creatinine: Urea: GFR:
2.	Blood lead level	

Amharic version participant information sheet

የተሳታፊዎች መረጃ ወረቀት

የ አማርኛ ቅጂ

የጥናቱ ርዕስ፡ *በአዲስ አበባ ውስጥ ባሉ ጋራዥ ሰራተኞች እና የዉሃ ማምረቻ ሰራተኞች ያለው የእርሳስ ተጋላጭነት እና የኩላሊት ተግባር ግምገማ።*

የጥናቱን ዋና ተመራማሪ፡ *ፍሬህይወት ጌታሁን*

መግቢያ፡-*በአዲስ አበባ ጋራዥ ሠራተኞች መካከል የ እርሳስ ተጋላጭነት እና የኩላሊት (የኩላሊት) ተግባርን ለመገምገም በምርምር ጥናት ላይ እንድትሳተፉ ተጋብዘዋል። ለመሳተፍ ከመወሰንዎ በፊት የጥናቱን ዓላማ፣ ተሳትፎዎ ምንን እንደሚያካትት፣ ሊኖሩ ስለሚችሉ አደጋዎች እና ጥቅሞች፣ እና እንደ ተሳታፊ ያለዎትን መብቶች መረዳትዎ በጣም አስፈላጊ ነው። ለመሳተፍ ከመወሰንዎ በፊት እባክዎ ይህን ቅጽ ለማንበብ ጊዜዎን ይውሰዱ እና ማንኛውንም ጥያቄ ይጠይቁ።*

የጥናቱ ዓላማ፡-*የዚህ ጥናት አላማ የኩላሊት ጤና ላይ ተጽእኖ ሊያሳድሩ በሚችሉ የ ስራ ተጋላጭነት እንደ እርሳስ ያሉ ዉህዶች በጋራጅ ቤቶች ውስጥ እና የዉሃ ማምረቻ የሚሰሩ ግለሰቦችን የኩላሊት ተግባር መገምገም ነው። በመሳተፍ በዚህ ልዩ የስራ አካባቢ ስለስራ ጤና ሳይንሳዊ እውቀትን ለማዳበር አስተዋፅዖ ያደርጋሉ።*

ለተሳታፊዎች መመሪያ፡ *ለመሳተፍ ከተስማሙ የ እርሳስ ተግጋላጭነት እና የኩላሊት ስራዎን ለመገምገም የተለየ የህክምና ምርመራ እንዲያደርጉ ይጠየቃሉ። ይህ ምርመራ የደም ምርመራን እና ከኩላሊት ጤና ጋር የተያያዘ ሌላ ግምገማን ሊያካትት ይችላል የእርስዎ ተሳትፎ ናሙናዎችን እና የስራ ሁኔታዎን እና የጤና ታሪክዎን በተመለከተ ጠቃሚ መረጃዎችን መስጠትን ያካትታል።*

ጥቅሞች፡-*ለአንተ በግልህ ምንም አይነት ቀጥተኛ ጥቅም ላይኖረው ቢችልም፣ ከዚህ ጥናት የተሰበሰበው መረጃ የኩላሊት ስራን ሊጎዱ የሚችሉ እና የተሻለ የስራ ቦታ የጤና ፖሊሲዎችን እና አሰራሮችን በመረዳት ሰራተኞችን ሊጠቅም ይችላል።*

ሚስጥርን መጠበቅ፡ *የእርስዎ ማንነት እና የግል መረጃ በሚስጥር ይጠበቃል። በጥናቱ ወቅት የተሰበሰበው መረጃ ደህንነቱ በተጠበቀ ሁኔታ ይከማቻል፣ እና የግል ዝርዝሮችዎ ከዚህ ጥናት በሚነሱ ህትመቶች ወይም አቀራረቦች አይገለጡም።*

ዉጤትን ማሰራጨት፡ *የጥናቱ ተመራማሪ ሙሉ በሙሉ ሃላፊነቱን ወስዶ ውጤቱን ያሰራጫል፡፡ እንዲሁም ወጤቱን በታወቀ የሳይንስ ምርምር ጆርናል ላይ አቅም በፈቀደ መጠን ያሳትማል፡፡*

በፈቃደኝነት መሳተፍ እና የመተው መብት፡-*በዚህ ጥናት ውስጥ ያለዎት ተሳትፎ ሙሉ በሙሉ በፈቃደኝነት ነው። ያለ ምንም ቅጣት ወይም ሌላ መብት ያለዎት ጥቅማጥቅሞች በማንኛውም ጊዜ ለመሳተፍ ወይም በጥናቱ ለመሳተፍ እምቢ የማለት መብት አልዎት።*

ለትብብርዎ ያለንን ልባዊ አድናቆት ለመግለጽ እንወዳለን እና አስቀድመን እናመሰግናለን።

መርማሪውን ማነጋገር ከፈለጉ፣ የሚከተለውን አድራሻ መጠቀም ይችላሉ።

ስም፡ ፍሬህይወት ጌታሁን

ስልክ፡ +2519-45-67-87-48

ኢሜይል፡- frehiwotgetahun@gmail.com

Amharic version consent form

የስምምነት ቅጽ

እኔ የተመረጠው ተሳታፊ በጥናቱ የመረጃ ወረቀት ላይ ያለውን መረጃ ሰማሁ እና አላማውን እና ጥቅሞቹን ተረድቻለሁ; እና ከእኔ የሚፈለገውም. እኔን የሚመለከቱ መረጃዎች ሁሉ እንደ ስም እና በእኔ የተሰጡ መልሶች በሙሉ ለሶስተኛ ወገን እንደማይተላለፉ ተረድቻለሁ። ስለዚህ በጥናቱ ለመሳተፍ ፈቃደኛ ነኝ።

የተሳታፊ ፊርማ………………… ቀን …………………

የጠያቂው ስም …………………

ፊርማ …………………

ቀን …………………

Amharic version questionnaire

የመለያ ኮድ ___________________________
መረጃ የተሰወበሰበበት ቡድን፡ **1. ጋራጂ** ____________________ **ዉሃ ማሸጊያ ፋብሪካ** ____________________
መረጃ የተሰበሰበበት ቦታ: ____

ስነ ህዝብ መረጃ

ተ.ቁ	ጥያቄዎች	መልስ	ማሳለፊያ
1.	ዕድሜ		
2.	ጾታ	1.ሴት 2.ወንድ	
3.	የትምህርት ደረጃ	1. ማንበብ እና መጻፍ 2.የመጀመሪያ ደረጃ 3. ሁለተኛ ደረጃ 4. ዲፕሎማ 5. ደግሪ 6. ኮሌጅ እና ከዚያ በላይ	
4.	የጋብቻ ሁኔታ	1. ያላገባ 2. ያገባ 3. የተፋታ 4. ባል የሞተባት/የሞተበት	
5.	የወር ገቢዎ ምን ያክል ነው?	1. ≤3000 2.3000-6000 3.6000-9000 4.≥9000	

ሲጋራ የማጨስ ልማድ እና አልኮል መጠጣት

ተ.ቁ	ጥያቄዎች	መልስ	ማሳለፊያ
6.	ሲጋራ አጭሰው ያዉቃሉ (የለም ማለት በቀን ከአንድ ሲጋራ በታች ለአመት ማጨስ ወይም እስካሁን ድረስ ከ20 ፓኮ በታች ማጨስ)	1. አዎ 2. የለም	ጥ10
7.	መልስዎ አዎ ከሆነ አሁን ሲጋራ ያጨሳሉ (ባለፈው አንድ ወር ውስጥ)	1. አዎ 2. የለም	
8.	ምን ያህል ሲጋራ በቀን በአማካይ ያጨሳሉ	1.1-5 2.5-10 3.10-15 4. ከ15 በላይ	
9.	ምን ያህል አመታት ሲጋራ አጨሱ (በአመት)	1.1-5 2.5-10 3.10-15 4. ከ15 አመት በላይ	
10.	አልኮል ትጠጣለህ?	1. አዎ 2. አልጠጣም	ጥ13
11.	በቀን ስንት ብርጭቆ/ጠርሙስ አልኮል ይጠጣሉ?	1.አንድብርጭቆ/ ጠርሙስ 2. 2 ብርጭቆ/ ጠርሙስ 3. 3-5 ብርጭቆ/ ጠርሙስ 4. ከ5 በላይ	
12.	በሳምንት ስንት ብርጭቆ/ ጠርሙስ አልኮል ይጠጣሉ?	1.1-5 ብርጭቆ/ ጠርሙስ 2. 5-10 ብርጭቆ/ ጠርሙስ 3. ከ 10 በላይ	
13.	ጭት ይቅማሉ?	1.አይ 2.አዎ	ጥ15
14.	መልስዎ አዎ ከሆነ, ስራ ቦታ ላይ ይቅማሉ?	1.አይ 2.አዎ	

የሙያ ስጋት ምክንያት

ተ.ቁ	ጥያቄ	መልስ	ማሳለፊያ
15.	በየትኛው ክፍል ነው የሚሰሩት? (የስራ መድብ)		

16.	የቅጥር ሁኔታ	1.ቋሚ 2.ጊዜዊ	
17.	በዚህ ጋራዥ (አመታት) ውስጥ ለምን ያህል ጊዜ እየሰሩ ነበር?	1.1-5 2.5-10 3.10-15 4.15-20 5.≥20	
18.	የቀድሞ ስራዎ ምን ነበር?		
19.	በቀድሞው ሥራዎ ውስጥ ስንት ዓመት ሰርተዋል?	1.1-5 2.5-10 3.10-15 4.15-20 5.≥20	
20.	በአማካይ ለምን ያህል ሰዓት በቀን ይሰራሉ? (በሰዓት)	1. ከ 8 ሰአት በታች 2.8 ሰአት 3.ከ 8 ሰአት በላይ	
21.	በሳምንት ስንት ቀናት ነው የሚሰሩት?	1.ሶስት 2.አምስት 3.ስድስት	
22.	በስራ ጊዜ ማንኛውንም የ ስራ የግል መከላከያ መሳሪያ ይጠቀማሉ?	1. አዎ 2. አልጠቀምም	ጥ25
23.	ምን አይነት የ ስራ የግል መከላከያ መሳሪያ ነው የምትጠቀመው?	1.ጓንት 2.የመተንፈሻ ጭንብል 3. የደህንነት ጫማዎች 4. የደህንነት መነጽር 5. ጠንካራ ባርኔጣዎችቅ	
24.	የማይጠቀሙ ከሆነ ምክኒያቶ ምንድን ነው?	1.ስለማላገኝ 2.ስለማይመች 3.ሌላ ካለ ይገለጸ________	
25.	ስራ ቦታ ምግብ ይመገባሉ?	1.አዎ 2. አይ	
26.	ምግብ ከ መመገብዎ በፊት እጂዎትን ይታጠባሉ?	1.አዎ 2. አይ	

ቁመት እና ክብደት ፣ የደም ግፊት

ተ.ቁ		
1.	የደም ግፊት	1. Systolic________________________________ 2. Diastolic ________________________________
2.	Body mass index	1. Weight(kg)__________________________ 2. Height(cm)_____________________________