PULMONIC HEALTH ASESSMENT OF GOLDSMITHS IN RAWALPINDI, PAKISTAN

By

IQRA SHAFAQAT

MEHREEN WAQAZ SHEIKH

Department of Earth and Environmental Sciences

Bahria University, Islamabad

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ABSTRACT

One of the oldest industries in the world is jewelry manufacture, and it requires certain risky procedures. A group of people known as goldsmith workers are employed to make various kinds of jewelry out of gold. When making gold jewelry, the processes of molding, casting, filling, polishing, and plating exposes workers to many inorganic chemicals and work-related hazards. The goldsmith workers who work in various small workshops experience different types of health and respiratory problems. Goldsmith workers are directly exposed to coal dust, high temperature, heavy metals, and acidic fumes, and get exposed to harmful chemical agents. The current study is anticipated to shed light on the topic of the respiratory health status, working environment, and related problems of goldsmiths. The study is focused on the pulmonary health of goldsmiths in the Sarafa Bazaar area of Rawalpindi Pakistan, it aims to identify any respiratory health issues as well as the likely causes of the problems. The study also aims to identify the chosen working groups' exposure to different health problems, consequent impacts, and to see which group is more at risk in line with their work type and due to their extent of exposure for selected workshops in Sarafa Bazaar. A total of 50 male workers aged 19-60 years engaged at gold manufacturing for 40 years. The workers of 5 working units enameling, cutting, setting, polishing, and soldering were surveyed and tested for lung function, respiratory symptoms and to identify presence of restrictive and obstructive respiratory diseases using the spirometry (pre and post bronchodilation) and their health status. Pulse Oximetry was also employed to check the oxygen saturation levels and heart rate of workers. The study also looked at the smokers and the nonsmokers among the working groups. A handheld digital spirometer was used to record FEV1, FVC, and FEV1% (FEV1/FVC), both pre- and post-bronchodilation. There were clear differences in between pre and post bronchodilation which shows there was presence of respiratory diseases in all working unit. However, the most compromised lung function was found in Polishing unit and also in the setting as well enameling unit because of being exposed to HCL that is used for cleaning and buffing ornaments and it produces toxic vapors that make it difficult for goldsmiths to breathe in polishing unit. The severe cases of COPD were identified in three workers of polishing and

buffing unit which lies in GOLD 4 category and four workers were identified in Gold 3 category, one worker was in GOLD 1 category that indicates that he had mild COPD. There were COPD patients in each unit but polishing and buffing Unit had highly severe cases of COPD. Out of 50 workers 31 had shown restrictive disease and 30 had shown obstructive diseases. All working groups showed respiratory symptoms (Cough > phlegm > Dyspnea > tachypnea > wheezing). There could be various causative agents, and irritants present in the working environment which may be responsible for these respiratory problems. This study concludes with the realization of importance for occupational safety and health for the goldsmith workers who are at great risk of getting pulmonary health problems. Use of appropriate Personal Protective Equipment PPEs e.g., masks, especially dust protecting mask, should be worn by workers in polishing units, and therefore proper care and PPEs are advised to reduce exposure to chemical vapors, dust, and acidic fumes.

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ABBREVIATIONS

DSSSS	Dhaka Swarna Shilpi Sromik Shongho
FEV1	Forced expiratory volume in one second
FVC	Forced vital capacity
MVV	Maximum voluntary ventilation
NIOSH	National Institute of Occupational Safety and Health
PFT	Pulmonary function tests
COPD	Chronic obstructive pulmonary
FEF	Forced expiratory flow
JECFA	Joint expert committee on food additives
MetHb	Methemoglobin
PEFR	Peak expiratory flow rate
PPE	Personal protective equipment
PR	Pulse rate
SD	Standard deviation
SPM	Small particulate matter
WHO	World health organization
NO	Nitric oxide
N_2O_5	Nitrogen pentoxide
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxide
N_2O_3	Nitrogen trioxide
N_2O	Nitrous oxide
TB	Tuberculosis
Cu	Copper
Ag	Silver
Cd	Cadmium
Fe_2O_3	Ferric oxide
H_2SO_4	Sulfuric acid
SpO2	Oxygen saturation

SPSS	Statistical package for social sciences
HCL	Hydrogen chloride

CHAPTER 1

INTRODUCTION

One of the oldest industries in the world is jewellery manufacture, and it has always required certain risky procedures. (Anonymous., 2002). People have been creating gold ornaments in a variety of styles from the beginning of human history in an effort to enhance their beauty. People's lifestyles changed as civilization advanced, and they are now more likely to utilize ornaments of various types. A group of people known as goldsmith workers are employed to create various types of jewelry out of gold. (Christoper H, 1999). A goldsmith is a metal worker (ACGIH, 1991) who specialize in working with gold and other precious metals is known as a goldsmith. The only clan that has continued to make gold jewellery and objects as their traditional employment to this day is the goldsmiths, who started doing so in earlier times. They developed a great level of artistic proficiency in the process. Goldsmiths naturally possess the extraordinary talent required to create highly aesthetic ornaments with accuracy. However, the majority of people are blissfully ignorant of the possibility that the goldsmiths who manufacture the jewelry may be doing it at the expense of their health. People who work in goldsmith businesses experience a variety of health issues. Workers in the goldsmith industry are directly exposed to acid, wax, and coal dust vapors. Jewelry is typically made using cyanide, lead, zinc, cadmium, palladium, iridium, sulphuric acid, nitric acid, chalk mould with a high silica content, and other chemicals. Anemia, digestive issues, nerve disorders, memory loss, concentration issues, cancer, and other occupational dangers have been linked to jewellery workers' exposure to the aforementioned substances. (Raj & J, 2003). According to reports, jewellery workers are more likely to have stomach cancer as a result of their line of work. The survey revealed that the majority of the workplaces were extremely filthy, crammed, and lacked appropriate ventilation. Workers typically resided in this area at close quarters. These were their living and working spaces, respectively. However, artists' position when creating and soldering has a detrimental effect on the spinal cord. (TK. & KK.)

When making gold jewellery, the procedures of molding, casting, filling, polishing, and plating might expose workers to inorganic chemicals. Due of the frequent exposures that goldsmiths experience at work, the majority of exposures have a propensity to accumulate over time. Additionally, even with constant exposure, not all metals that enter the body will be removed. On the other hand, exposure can have negative effects and cause disease by building up in human tissues like hair and bones (Abidin., et al., 1994).

Workers in the goldsmith industry are directly exposed to acid, wax, and coal dust vapors. Impurities including zinc, copper, silver, and iron can be found in gold that has been recovered through amalgamation or cyanidation. Cyanide, lead, zinc, cadmium, palladium, iridium, sulphuric acid, nitric acid, chalk molds with a high percentage of silica, and other chemicals are frequently employed for producing jewellery.

The goldsmiths operate in a stuffy environment all day long. A soldering unit's facilities are so crammed with wooden chairs and workstations that the craftsmen can only manage to find a spot for themselves to sit inside the workspace. For instance, it has been discovered that roughly 35 soldering goldsmiths can fit into a room that is 10 feet by 40 feet (Sahu et al., 2013). Those studios continue to have extremely inadequate ventilation, and as a result, the electric fans are kept off to prevent lamp fires from starting. The outcome is an increase in the ambient temperature.

A few jewellery items are made with nitric acid. In the process, irritating fumes are created, and if ventilation is inadequate, they could become dangerously high. Nitric oxide (NO), nitrous oxide (N_2O), nitrogen trioxide (N_2O_3), nitrogen pent oxide (N_2O_5), and two types of nitrogen dioxide are among the nitrogen oxides (NO_2 and N_2O_4). Out of these, nitrogen dioxide is the most harmful. Nitric oxide and nitrogen dioxide (NO_2) are produced during the breakdown of HNO_3 (NO). HNO_3 is typically seen in conjunction with NO_2, which in practice seems to be more hazardous. Brownish-red and deadly gas known as NO_X (NO_2 and NO gas combination). Nitric oxide and nitrogen dioxide (NO2) are produced during the breakdown of HNO3 (NO). In reality, NO_2 appears to be more harmful than HNO_3, and the two are frequently found together. (ACGIH, 1991). When inhaled through the respiratory system and absorbed through the skin, several skin diseases and respiratory problems might result. The ambient concentration of HNO2 is created by the

respiratory system, which is primarily responsible for hydrogen abstraction, and is then changed into H+ and NO2 in a physiological pH, according to in vitro studies. (Beckett WS, 1995).

1.1 Gold making

The conventional method of creating gold jewellery is carried out sequentially in several units, including the units for refining, soldering, design, enameling, polishing and buffing, cutting, and setting. The various unit's techniques for producing gold ornaments regularly endanger the workers' health. Nearly 70% of goldsmiths work in the soldering unit, which is followed by those in the polishing, cutting, refining, and enamelling units at roughly 12%, 6%, 4%, 3%, and 2%, respectively, of the workforce. Each unit has a cramped, dark studio environment.

Working with a jewellery designer who is aware of the benefits and drawbacks of the particular materials used in jewellery as well as how jewellery interacts with the body. The process of cutting metal into pieces or units that can be fashioned into jewellery. Usually, a piercing saw is used for the cutting, however laser cutting can also be an option. It is possible to shape metal by hammering, bending, elevating over a stake, sinking, die-forming, or a variety of other methods. Metal or stone setting is the process of placing or fixing the gemstone in the jewellery. Various metal settings are utilised to create different designs. To give the jewellery piece a captivating appearance, multiple metal settings may even be used. There are several different setting possibilities, including prong, plate prong, pave, bezel, pressure, bead, flush, invisible, fishtail, miraculous plate, and channel. Die striking is a procedure that begins with the creation of a steel pattern known as a die that is specifically designed to produce a certain jewellery item or component. The size and shape of the blanks needed to create the jewellery are determined by a die-striking machine. Gold, silver, and other metal blanks are struck between two dies, forcing the metal into each die's fissure. Strong and lightweight styles are frequently achieved using it. Because of this, die-struck jewellery can be lightweight and thin without compromising strength. Products that are die struck require less finishing than cast and hand-fabricated products. By applying fused, colored glass to the surface of metal, a surface is given color by enameling. Since it

requires a highly specialized talent, the majority of jewelers would hire an expert to handle it. In recent years, its popularity has risen once more.

The final step in the polishing process is when the jewellery is polished. To achieve a better sheen, polishing is done after the stones have been set in the jewellery. For polishing, there are both manual and automatic methods available. The soft buff, solid buff, hair buff, single line ball buff, coin buff, platinum polishing rouse, red and green rouse (to impart shine), black lustre to remove casting or filling layers, and white lustre to erase roughness are the instruments that help the artists hand-polish the jewellery.

1.2 Health impairments

Jewelry workers are more likely to have lung diseases. Acid, wax, and coal dust vapors can all result in pulmonary and extra pulmonary issues. Sneezing, rhinitis, a cough that produces sputum or not, dyspnea, chest pain, and other symptoms of pulmonary issues. Musculoskeletal pain, mechanical injury, conjunctivitis, foreign bodies in the eyes, dermatitis, vertigo, headaches, hyperacidity, etc. are examples of non-pulmonary consequences. Dermatitis, respiratory tract irritation, gastrointestinal tract irritation, and nervous system impairment can all be brought on by toxic substances. (Organization, 1986). Toxic vapors produced during the soldering of gold to cadmium. Toxic cadmium oxide is created when cadmium vapor and air interact. Acute bronchitis, pneumonia, digestive problems, dermatitis, allergic hypersensitivity, chronic brain damage, lung damage, prostate cancer, kidney stones, and other conditions can be brought on by cadmium, which also affects the brain, nervous system, lungs, kidneys, bone, prostrate, and digestive tract. Due to occupational exposure to several sensitizers and irritants (metallic and acidic vapors), respiratory disorders and lung function were more common among goldsmiths. When inhaled in large concentrations, the deep lung irritant NO2 can cause pulmonary edema and even death. A study done on goldsmiths to show the effects of long-term exposure to predominantly nitrogen-based compounds indicated that acquired methemoglobin (MetHb) is very common among goldsmiths. (K, 2003). According to Lewton's study, dermatitis poses a serious risk to jewelers. (C, 2002).

Exposure to low NO2 concentrations causes minor eye and throat discomfort, a dr y cough, and tightness in the chest (Raj & J, 2003) have claimed that jewellery workers face an elevated risk of stomach cancer due to their line of work. (Mehta V, 2010).

The goldsmiths are additionally exposed to cadmium fumes and SPMs from their indoor work when soldering the jewellery. HNO3 fumes are continuously exposed to workers in the refining unit, whereas H2SO4 fumes are continuously exposed to workers in the polishing and buffing unit. Because these gases are not properly directed to the outside, they rapidly spread inside the market, exposing goldsmiths working in adjacent units. Cutting unit actions need intense visual concentration and generate minute particles that could be harmful to one's health in a variety of ways. The majority of enameling is done in cutting units; thus, these same environmental health risks are also present for the enameling artists. Because there are fewer artisans in the setup unit and design unit, their workloads are heavier. As a result, individuals must maintain a bowed posture while performing tasks that require a great deal of eyesight. The occupational health risk that goldsmiths in various units are exposed to vary depending on the sorts of work they do. Long-term health effects and short-term health hazards are the two distinct types of health repercussions they encounter. According to estimates, among their identified immediate health threats, all goldsmiths in the study region are 92% at risk for colds, fevers, weakness, and suffocation, 86% are at risk for both diarrhoea and jaundice, 84% are at risk for headaches, and 80% are at risk for dehydration. However, among the long-term health effects, visual issues are particularly common among goldsmiths. About 94% of the time, goldsmiths have vision problems. The second and third most common health risks, respectively, are back discomfort (93% of goldsmiths are exposed to it) and respiratory diseases (92% of goldsmiths are exposed to it). 86% of goldsmiths are susceptible to constipation and piles issues. Dermatitis and dental caries exposure within the study population accounts for the minimal proportions, which are approximately 16% and 12%, respectively.

Despite the fact that gold is thought to be an inert element, several people have complained of recurrent nodular contact dermatitis to it. The goldsmith employees have little access to literature on pulmonary function parameters. In order to solder the

prefabricated embellishments, the artists blow air via a conduit using their mouths. Since craftsmen' chests and lungs are affected by constant mouth breathing over time, they are more likely to develop asthma and T.B (TK. & KK.).

1.3 Use of copper and silver in gold making

In the manufacturing process, a combination of several harmful and dangerous chemicals is also utilised in addition to the precious metal, gold (Au). During the recycling process, copper (Cu) plates are used to precipitate and separate silver (Ag) into silver oxide precipitates. Jewelry is made using copper plating, either directly or as a base metal for silver and other precious metals. A precious metal is a chemical element that is rare, naturally occurring, metallic, and has significant economic worth. The precious metals are less reactive chemically than most elements, more ductile or softer than other metals, have higher melting temperatures than other metals, and have a high brilliance. (Kutlu, 2005)

Additionally, goldsmiths are exposed to copper oxide or fine copper dust, which has been related to metal fume fever symptoms include fever, nausea, vomiting, burning in the mouth and throat, coughing, sneezing, and redness in the throat. This effect lasts for 24-48 hours and typically occurs after a few hours of exposure. (ATSDR., 2004). In addition to copper, poisonous vapours are the source of the chemicals used in the production of gold jewellery. (Greim., 2006).

One of the materials utilised in the creation of gold jewellery is copper. Although copper is a crucial component of the human immune system, allergies can also be brought on by it. Epigastric discomfort, anorexia, hematuria, dysuria, back pain, metallic taste, convulsions, and coma are some of the clinical signs of copper poisoning. The primary poisoning symptom in humans brought on by exposure to Cu dust or fumes is the onset of upper respiratory tract problems. The mucous membranes lining the nose experience atrophic destruction as a result of the poisoning brought on by exposure to Cu dust or fumes (Palar, 1994) . The combined irritant qualities of the Cu dust or vapors are what cause this harm.

1.4 Exposure to Heavy Metals

Genuine jewellery made from precious metals like gold, silver, and platinum, as well as costume jewellery, are two segments of the jewellery industry. Before shaping and plating with valuable metals, tin and lead are combined (Kulmala, 2006). According to the study's findings, jewellery technicians were significantly exposed to cadmium. Due to the release of cadmium during the production of jewellery, the exposure to cadmium among jewellery technologists is rather high.

Nickel is one of the most typical triggers of allergic contact dermatitis (Burrows D, 1990). It has been noted in a number of industries, including jewellers and nickel platters. A worker's nickel sensitivity persists long after the exposure to nickel has stopped. Inhalation is thought to be the primary route of exposure to nickel and nickel compounds. (Proctor NH, 1991). The European Scientific Journal has linked inhalation exposures among nickel refinery and smelter workers to lung cancer and nasal sinuses. (Mastromatteo., 1994). Other health problems brought on by exposure to nickel inhalation include allergic asthma, nasal irritability, nasal mucosa degeneration, and perforated nasal septum. (Snow SN & Costa, 1992)

There have been reports of numerous organs and systems being affected by various consequences brought on by cadmium exposure. Overexposure to cadmium has been linked to acute negative effects. Currently, chronic consequences are of more concern in the majority of work situations. The primary symptom, which has been demonstrated to be respiratory distress brought on by chemical pneumonitis and edema. High levels of cadmium exposure (40–50 mg/m3 for 1 hour) have been demonstrated to be fatal (Proctor NH H. J., 1991).

The current limit for permissible cadmium intake has been set by the Joint Expert Committee on Food Additives (JECFA) of the World Health Organization (WHO) as 25 micrograms per kilogramme of body weight per month (mg/kg bw-mo). Cadmium is typically consumed at a rate of 5 mg/kg bw each month. It is likely that long-term occupational exposure to cadmium raises the risk of kidney damage, chronic obstructive pulmonary disease, and lung cancer (WHO, 1992). The kidneys are regarded to be the

organs most susceptible to cadmium's harmful effects, and exposure to cadmium can cause kidney damage when cadmium accumulates in the kidneys. This harm is cumulative and irreversible. Employees may develop chronic lung illness depending on the length and severity of their exposure.

However, the effects on the lungs happen gradually. Unknown exposure levels are involved in these consequences. Anyhow, it is believed that the defined level of exposure associated with lung damage is greater than that associated with kidney impairment. (NIOSH, 1992)

According to the National Institute for Occupational Safety and Health, cadmium may cause cancer in humans (NIOSH). Concerns have been raised regarding lung and prostate cancer. While there is a lot of evidence linking high cadmium exposure to lung cancer, the connection between cadmium exposure and prostate cancer is less clear.(Thun JM, 1991). Human upper respiratory tract inflammation, a metallic or sweet taste, and skin and hair pigmentation have all been linked to inhaling copper fumes. Copper fume exposure is a risk factor for metal fume fever, an acute 24- to 48-hour illness characterised by influenza-like symptoms as fever, chills, sweating, weakness, headaches, and muscular aches. (ACGIH, 1999). There are many various types of jewellery, and there are a lot of metal jewellery options, both with and without precious metal content. Jewelry is quite likely to release potentially dangerous substances like heavy metals.

When an unintentionally inhaling a piece of jewellery in the shape of a heart that contained more than 99% lead resulted in the death of a 4-year-old child in the United States. By its chemical and physical characteristics, gold is known. It is supple, adaptable, and glossy. It is coloured yellow. Corrosion cannot corrode gold. Since ancient times, gold has been used as an ingredient in cosmetics, jewellery, and decorations.(Merchant, 1988). Jewelry, tools, and coins must all be made with gold alloys because pure gold is a soft metal by nature. (Van der Voet, 1996)

1.5 Literature Review

A study was carried out in the Department of Physiology's Pulmonary Function Tests (PFT) lab at the Government Medical College in Aurangabad, Maharashtra.

Introduction: The documented occupational risks for jewellery makers are caused by exposure to chemicals such cyanide, lead, zinc, cadmium, palladium, iridium, sulphuric acid, nitric acid, and chalk mold with high silica content. Workers at goldsmiths had their spirometry lung functions evaluated, and they were compared to a control group. Twenty male goldsmiths who had been employed in the field for at least 10 years had their lung function parameters, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and maximum voluntary ventilation (MVV), evaluated (MVV). Compared to matched controls, the outcomes were evaluated. The mean and standard deviation (SD) of the FVC were respectively 63.959.77% and 76.958.1 in cases and controls. FEV1's Mean Standard Deviation (SD) was 73.3 8.31 in controls and 67.25 7.65% in cases. In cases, the mean standard deviation (SD) of the MVV was 61.810.54%, while in controls. All of the examined metrics were noticeably lower in goldsmith workers.(Choudhari et al., 2014). When matched controls and goldsmith employees were compared, the spirometry lung function values were found to be considerably lower in the matched controls. Goldsmith employees, Forced Vital Capacity, Maximum Voluntary Ventilation, and Occupational Hazard

Due to the goldsmith in Malimongan Makassar's exposure to copper and nitrogen dioxide, Risks Assessment conducted a second investigation. The manufacture of gold jewellery is one of the manufacturing processes that makes use of numerous hazardous substances. These chemicals are used to melt, refine, weld, electroplate, and polish the gold metal. In Malimongan Village Sub Wajo, Makassar City, this study aimed to evaluate the health hazards related to the goldsmiths' exposure to copper and nitrogen dioxide. (Mallongi et al., 2018). The environmental health risk assessment approach was employed in the research with an observational design. Using simple random sampling, the 30 environmental samples and 30 person samples were selected. Using IBM SPSS version 21 and Microsoft Excel, the environmental health risk analysis was used to process the data. Copper concentrations measured indoors at several research sites all fall below 1 mg/m3. The mean copper concentration is 0.0268 mg/m^3, with 0.07390 mg/m^3 being the highest and 0.0015 mg/m3 being the lowest. As for NO2 measurement point also is concentrations below 3 ppm, the highest concentration is 0,020 ppm and the lowest is 0,010 ppm, the mean concentration of nitrogen dioxide is 0.0154 ppm. The non-carcinogenic risk to copper of

the goldsmiths showed that the average is 3,927. Copper exposure hazards have been demonstrated by Goldsmiths, but not nitrogen dioxide.

The mean concentration of nitrogen dioxide is 0, 0154 ppm, with the greatest concentration being 0,020 ppm and the lowest being 0,010 ppm for NO2 measurement points. The goldsmiths' non-carcinogenic risk to copper showed that the average is 3,927. The average health risk NO2 for the 30 people who were at risk were 23 goldsmiths (76, 7%) and 7 goldsmiths (23, 3%), respectively. Copper exposure hazards have been demonstrated by Goldsmiths, but not nitrogen dioxide (Sahu et al., 2013). 66 unexposed control persons and a total of 118 goldsmiths were chosen at random for the study. ETA1 (less than 5 years), ETA2 (greater than 5 years but less than 10 years), and ETA3 (more than 5 years but less than 10 years) were the additional classifications made for the goldsmiths (more than 10 years). Using a computerized Spirometer, peak expiratory flow rates (PEFR), forced vital capacity (FVC), and forced expiratory flow rates at various intervals (FEF25%, FEF50%, FEF75%, FEF25 75%) were measured (Maestros Mediline, India). Utilizing a Minitab software version, the statistical analyses were performed. The goldsmiths' lung functions were considerably (P 0.01) worse than those of the control group. When workers were exposed for a longer period of time, their lung function efficiency decreased significantly (P 0.01), according to the results of the intergroup comparison. The goldsmiths' lung function status deteriorated as a result of workplace gases and pollutants.

The Kotwali Thana neighborhood of Dhaka, Bangladesh's Tantibazar, was the subject of a study. The location under study is home to a significant cluster of goldsmiths in Bangladesh. There were 22,000 goldsmiths in this cluster in 1996, according to the neighborhood organization Dhaka Swarna Shilpi Sromik Shongho (DSSSS) (Hossain et al., 2015). The study's other goals include identifying the study populations' health risks in relation to their employment types and estimating the proportion of goldsmiths sensitive to such health risks in order to determine the key occupational health issues among goldsmiths and their underlying causes. This research is a survey. Between June 2014 and June 2015 in Tantibazar, Goldsmith clusters were investigated. Focus group talks, or FGDs, were held by two focus groups in the Tantibazar goldsmith cluster. The sample size for each group

was twenty respondents. Additionally, searches were conducted in the library and online. The soldering unit employs about 70% of goldsmiths, followed by the polishing unit (12%), the cutting unit (6%), the refining unit (4%), the enameling unit (3%), the setting unit (3%), and the designing unit (2%). The hazardous chemicals used in these operations include Cd, HNO3, and H2SO4. The dust and fumes that these harmful substances emit endanger the health of the craftspeople. Over 92% of goldsmiths are at risk for acute health problems such colds, fevers, weakness, and suffocation. They also run the danger of getting diarrhea, jaundice, liver disorders, headaches, and dehydration. 94% of goldsmiths are at risk for vision problems, 93% for back problems, 92% for respiratory problems, 86% for piles and constipation, and 16% and 12% for dermatitis and dental caries, respectively. The method employed in Tantibazar to produce gold jewellery carries a number of health concerns. The environmental health issues affecting the goldsmiths, however, are not getting the necessary attention. Furthermore, the relevant government does not provide any facilities in connection with their health-related worries.

To determine the prevalence of respiratory sickness among goldsmiths, a study was done among them at various goldsmith's workshops in Islampur, Dhaka. There was a descriptive cross-sectional study done. A questionnaire and checklist were used to purposefully sample 120 goldsmith employees and inquire about their respiratory conditions. The survey indicated that out of 120 respondents, 5% were illiterate, 40% had just finished basic school, and 55% had finished their secondary education or above. According to the respondents, respectively, 31.7% and 30.8% reported monthly salaries of 7100–9000 and 9100–11,000 taka.(Rahman & Sajani, 2017). 72.5 % of them had between six and twenty years of service, while 25. % had more than twenty. According to the survey, 37.5% of respondents experienced respiratory ailments, with 75.6% of those experiencing coughs lasting three months or longer in a year, 66.7% coughing up phlegm, 18.9% coughing up blood, 71.1% sneezing, and 33.3% experiencing shortness of breath. 96.7 percent of survey respondents knew how to use personal protection equipment (PPE). A total of 58.3% of those surveyed admitted to smoking, and the average length of time they had smoked was 15.59 (7.36) years. PEFR was noticeably low (p 0.001) in both the sitting and standing positions, at 426.22L/min and 430.33L/min, respectively, in individuals with respiratory problems. This shows that 37.5% of respondents have chronic obstructive

pulmonary disease, necessitating the use of therapeutic and preventive measures to lessen the suffering of goldsmiths.

Mercury exposure and health condition of 40 gold workers were investigated in a study in the region of El Callao, Venezuela. On three consecutive days, the amount of mercury in the air at work was measured. Spot urine and hair samples were also collected for analysis. The subjects got a physical examination and answered questions about their employment history, occupational activities that exposed them to mercury, their usage of protective gear and clothing, and how frequently they experienced 37 symptoms linked to mercury toxicity. 29 of the subjects had a full set of health data gathered. Only a small percentage of individuals used protective equipment, and 17.9%, 24.1%, and 48.3% of them had mercury amounts in their urine, hair, and breath that exceeded current occupational exposure recommendations. The workers were usually healthy and showed no overt signs of mercury toxicity during a physical examination. There was no correlation between the frequency of psychiatric, neurological, gastrointestinal, cardiopulmonary, or cutaneous symptoms and any measure of mercury exposure. N-acetyl-D-glycosaminidase levels in the urine of two patients were slightly higher. Few negative health effects were noticed that could be credibly attributed to mercury, despite several of the participants having significant occupational exposure to mercury. In the region surrounding El Callao, Venezuela, 40 gold miners' exposure to mercury and health status were investigated. On three consecutive days, the amount of mercury in the air at work was measured. Spot urine and hair samples were also collected for analysis. The subjects got a physical examination and answered questions about their employment history, occupational activities that exposed them to mercury, their usage of protective gear and clothing, and how frequently they experienced 37 symptoms of mercury toxicity (Rojas., et al., 2001). 29 of the subjects had a full set of health data gathered. Only a small percentage of individuals used protective equipment, and 17.9%, 24.1%, and 48.3% of them had mercury amounts in their urine, hair, and breath that exceeded current occupational exposure recommendations. The workers were usually healthy and showed no overt signs of mercury toxicity during a physical examination. There was no correlation between the frequency of psychiatric, neurological, gastrointestinal, cardiopulmonary, or cutaneous symptoms and any measure of mercury exposure. Few negative health effects were noticed that could be credibly

attributed to mercury, despite several of the participants having significant occupational exposure to mercury.

1.6 Problem Statement

The goldsmiths who labour in numerous tiny workshops have a variety of respiratory and health issues. Workers in the goldsmith industry are directly exposed to hazardous chemicals, high temperatures, heavy metals, and acidic vapours. The majority of exposure to metal vapours, smoke, and dust occurs through inhalation. They might be the culprits behind their pulmonary and non-pulmonary conditions. Sneezing, rhinitis, a sputum-producing or non-producing cough, dyspnea, chest pain, and other pulmonary symptoms. Therefore, knowing these types of exposures, it is required to investigate the respiratory health status of these workers. The undertaken study is focused on the pulmonary health of goldsmiths in Rawalpindi, Pakistan's Sarafa Bazaar, to investigate any respiratory health problems that may exist among them as well as the most likely causes of those difficulties. The study also attempts to determine which working groups are most at risk in relation to their area of work and because of the degree of exposure to particular workshops in Sarafa Bazaar.

1.7 Objectives

This study is intended to address the following objectives.

1. To identify presence of major respiratory symptoms (among different goldsmith cohorts.
2. To assess the pre and post bronchodilation lung function of workers in different working units
3. To identify presence of restrictive and obstructive (including COPD) diseases among goldsmiths working groups.

CHAPTER 2

METHODOLOGY

2.1 Study area

We conducted our research in Rawalpindi's Sarafa Bazar. One of Rawalpindi's largest goldsmith clusters are located in this study region. There were hundreds of goldsmiths located within the study area. The gold underwent various processes, including cutting, designing, stone fitting, ball manufacturing, and polishing, among others. This region is primarily residential, although it contains a large number of structures known as workshops where ornaments are made in various stages. Within the study region, the workshops were dispersed in a few small clusters. We selected some of the workshops for our study and related health assessment.

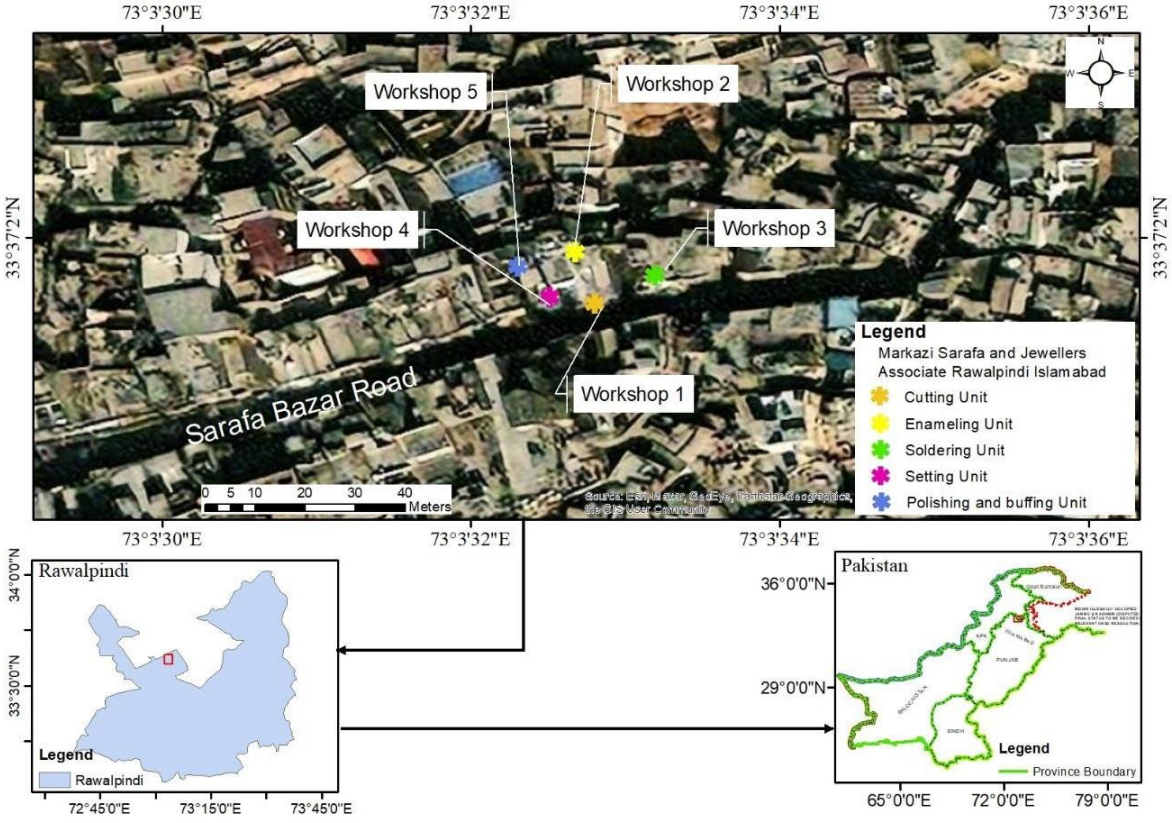

Figure 2.1 Study area map

2.2 Inclusion and exclusion criteria

50 male employees, aged 19 to 60, who had worked 40 years in the gold manufacturing industry were recruited as subjects. Those with respiratory diagnoses as well as those with anaemia, abnormalities of the thoracic or spinal column, diabetes, respiratory TB, asthma, or bronchitis were disqualified from the study. In addition to drug enthusiasts, smokers were also left out of the study. Since cigarette smoking is thought to play a significant role in the development of lung conditions and occupational COPD, both smokers and nonsmokers were included in the study and compared.

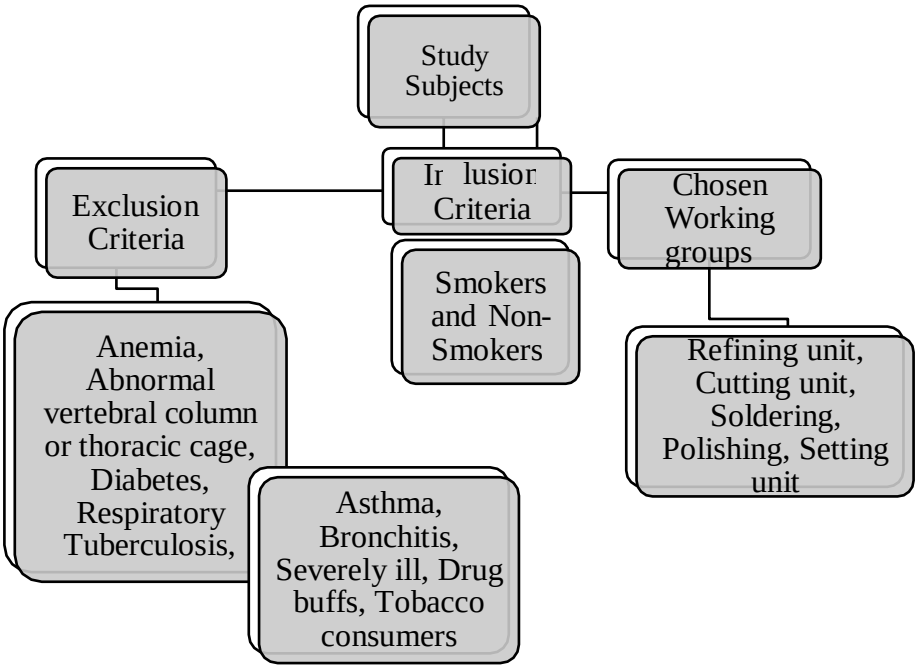

Figure 2.2 Inclusion and exclusion criteria

2.3 Division of workers in group

2.3.1 Cutting

Cutting unit work is extremely minute and exact, requiring a great deal of visual focus. Additionally, cutting is done quite near sources of light. Because of this, as a goldsmith is working, glazes from the cuts and reflections from the work pieces shine directly into his eyes. While working continuously under high visual strain might result in myopia, which can eventually lead to blindness (Colledge NR, 2010) and bright light reflection may be to blame for impairing vision. (Rashid KM, 2010) Cutting artists

frequently and severely suffer from eyesight issues. Additionally, cutting tasks frequently cause tiny particles to erode into the eyes. To remove those tiny particles from the eyes, it occasionally also necessitates minor surgery. Since cutting artisans work in closed cells and come into close contact with the SPMs produced inside the cell, respiratory illnesses are also highly common among them. The ability to breathe is hampered when enough particles from inhaled small particulate matter (SPMs) build in the lungs (C., 2002). Additionally, they frequently suffer from suffocation, dehydration, colds, fevers and sinusitis brought on by an exhausted environment.

Figure 2.3 Cutting Unit

2.3.2 Setting unit

The method by which the precious or semi-precious stone of a piece of jewelry is held in place in the precious-metal mounting is known as a jewelry setting. In general, the tasks of the setting unit do not expose workers to considerable amounts of hazardous chemicals, but their posture and way of work might cause back pain, headaches, eye irritation, and vision issues. Setting stones on jewelry requires a lot of eyesight, thus over time, setting artisans tend to develop vision issues (Colledge NR W. B., 2010) warned that long-term, intense visual pressure can lead to blindness and myopia-related vision

problems. Their working posture, which entails sitting continuously in a curved position, is another cause of back discomfort among them.

Figure 2.4 Setting unit

2.3.3 Soldering Unit

In the process of soldering, a metal alloy known as solder is heated until it melts. The link between two pieces of material can then be created using the solder.

Soldering unit duties require prolonged periods of intense visual focus. Because of this, artisans who work with solder are most likely to experience eyesight issues (K., 2009). Continuous employment combined with high visual demands can lead to myopia at first, then blindness. Headaches can also bring on by high ocular pressure. A further common health risk among the goldsmiths in this area is back discomfort. It is stated that the improper working posture in the traditional jewelry making process negatively affects the goldsmiths' spinal cords, eventually leading to spondylitis in the craftsmen (Saha TK). It has been discovered that working consistently in a curved manner for an extended period of time can lead to hunchback issues. In addition, the intermediaries worry that inhaling SPMs and the gases produced by candle and natural gas burning could lead to a variety of ailments. Cadmium has been a popular soldering metal since the advent of the hallmarking system in this cluster in 2006 due to its low melting point. Inhaling air contaminated with

cadmium is therefore the main way that cadmium enters a person's body. While breathing small amounts of cadmium, such as 0.01 mg/m3 of air contaminated with the metal over an extended period of time (more than 14 days), may result in chronic lung disease and kidney disease in people, breathing large amounts of the metal can irritate and harm the lungs and may result in death. (O., 2010). The SPM in the working studios is thought to be another important cause of their lung problem. The most dangerous SPM are invisible in the air, remain in the lungs, and when a large enough concentration accumulates, they obstruct breathing. But among this group of goldsmiths, practically everyone has hepatitis. Inhaling poisonous substances may be the likely reason of the high occurrence of their hepatitis.

Although hepatitis is typically thought of as a viral illness, Weiss asserts that it can also be brought on by chemical agents. The liver detoxifies harmful substances that are produced by biological processes as well as those that enter the body from the outside. When the liver is overworked, it becomes damaged and unable to eliminate any toxins from the body (L, 1978). On the other side, the goldsmiths of Sarafa Bazaar utilize blowpipes to blow air from their mouths when soldering. It has been discovered that the chest and lungs of goldsmiths are harmed by constant mouth breathing, which eventually leads to asthma (TK. & KK., 2011). On the other side, they have skin issues as a result of the hot working studio. Intense itching is brought on by boils and prickly skin caused by the high temperature. Additionally, the goldsmiths' constant perspiration in the soldering studio leads to a variety of health issues, including fatigue, vertigo, cold-related issues, diarrhea, etc. People who live in hot environments may experience cold-related issues.

Additionally, people constantly perspire in a setting like that, and perspiration that is too much might make you weak and lightheaded. Additionally, to causing headaches and drowsiness, poor ventilation also raises the risk of communicable infections (Rashid, Rahman, & Hyder, 2010). When people work in extremely hot environments, they lose a lot of body fluids, which can lead to dehydration. Another prevalent health issue among craftspeople is constipation (NS., CJK., & O'Connell., 2004). Their ongoing dehydration can also result in constipation. In this group of artists, there are a ton of stacks. Poor eating habits and a constipation issue might result in piles. It should be mentioned that artists

frequently work while seated on a wooden tool or the ground, and that extended sitting on hard seats is another issue that contributes to piles.

Figure 2.5 Soldering Unit

2.3.4 Enameling unit

Applying a decorative covering to metal while using a powder and high temperatures is known as enameling. Since enameling artisans are also involved in work of cutting, vision issues are more prevalent among them. Additionally, there are very few enameling artisans in this cluster overall. The burden for those selects few craftspeople is therefore consistently heavy.

Figure 2.6 Enameling Unit

2.3.5 Polishing and buffing unit

The polishing stage is the last stage, during which the jewelry is polished. After the stones have been put in the jewelry, polishing is done to ensure a brighter sheen. Both human and automated methods are available for polishing. The soft buff, solid buff, hair buff, single line ball buff, coin buff, platinum polishing rouse, red and green rouse (to impart shine), black luster to remove casting or filling layers, and white luster to eliminate roughness are the instruments that assist the craftsmen in hand-polishing the jewelry.

In the polishing and buffing section, glazing jewelry poses serious health risks. The respiratory system and skin are severely irritated by H_2SO_4 vapors. The most common illnesses among goldsmiths in the polishing and buffing section are respiratory illnesses. The H_2SO_4 used for cleaning and buffing ornaments produces toxic vapors that make it difficult for goldsmiths to breathe. However, because the studios' insufficient ventilation prevents vapours from being quickly evacuated outside, the goldsmiths' exposure to H2SO4 in this cluster is higher. H_2SO_4 mist or fume inhalation may irritate the nose, throat, and respiratory tract (Anonymous., 2012). Additionally, prolonged exposure to H_2SO_4 mist may lead to dental enamel degradation and pitting (Arafat, 2008). Another significant issue facing the goldsmiths of the polishing and buffing equipment is skin problems. Their near proximity to substances found in cleaners, acids, solvents, abrasives, etc. can cause dermatitis is regarded to be one of the most likely significant causative factors. Dermatitis can be brought on by sulfuric acid, and skin problems can also be brought on by acid vapors. When cleaning the jewels with degreasing agents like shampoo, they frequently dip their hands in water. Cleaning agents can raise the pH of skin and eliminate barrier-protecting surface lipids as opposed to routinely dipping hands in water. Your health could be harmed by the minute particles produced during cleaning and buffering. For instance, red rouge (Fe_2O_3) and brown Tripoli, both of which are used in this cluster as abrasives for cleaning and coloring the jewelry, produce powdered particles when utilized. Ferric oxide (Fe_2O_3), which component of red-colored dust, can irritate the respiratory system when

inhaled (Anonymous, 2009). However, back pain and visual issues can also affect polishing artists.

Figure 2.7 Polishing and buffing unit

2.4 Spiromtery

In Rawalpindi's Sarafa Bazar, spirometry was conducted. Pre- and post-bronchodilation measurements of FEV1, FVC, and FEV1% (FEV1/FVC) were made using a portable digital spirometer. Before testing, equipment quality control was carried out with regular calibration checks in compliance with the American Thoracic society's standards. (M., J., & V, 1995). A mixture of 0.4 mg salbutamol and 80g ipratropium bromide was used to bronchodilate the airways. (S., H., A., & al., 2015). FEV1 and FVC > 80% are regarded as normal, FEV1 and FVC 80% but FEV1/FVC > 0.7 indicates limitation, and FEV1 80% with decreased FVC indicates blockage. (I., Z., & H., 2021).

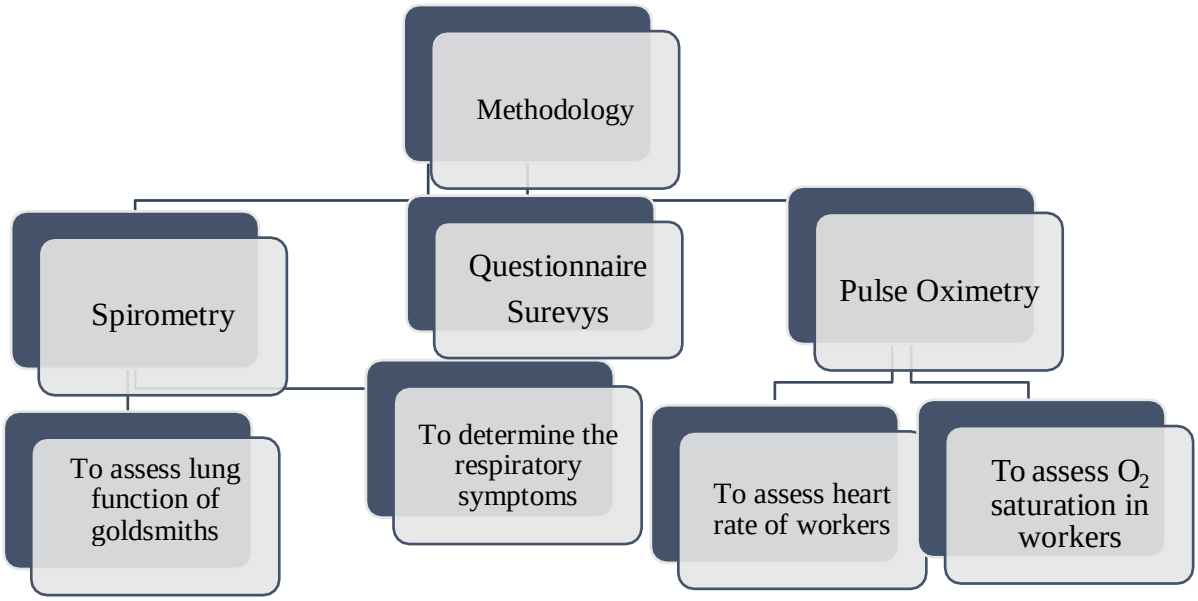

Figure 2.8 Methodology

Figure 2.9 Spirometry

2.4.1 Classification of COPD patients

COPD, often known as chronic obstructive pulmonary disease, is a set of illnesses that cause breathing problem and airflow blockage.

Subjects with COPD were categorized into grades 1–4 according to GOLD (R., DM., & Dias M, 2011). The GOLD classification of airflow-limitation severity in COPD (based on postbronchodilator FEV_1) is 1 (mild) = $FEV_1 \geq 80\%$ predicted 2 (moderate) = $50\% \leq FEV_1 < 80\%$ predicted, 3 (severe) $30\% \leq FEV_1 < 50\%$ predicted, and 4 (very severe) $FEV_1 < 30\%$ predicted.

2.5 Questionnaire survey

A well-designed survey to assess the respiratory health of goldsmith employees. We examine respiratory conditions in employees who operate in the refining, cutting, soldiering, and polishing and buffing departments. The questionnaire asks about demographics, respiratory problem, general health, personal protective equipment (PPE), and working conditions. Cough, phlegm, tachypnea, dyspnea, and wheezing were among the symptoms. It was also changed to mention whether these symptoms were brought on by frequent exposure. The questionnaire was first translated into local languages to facilitate communication before being retranslated into English to ensure the accuracy of the findings.

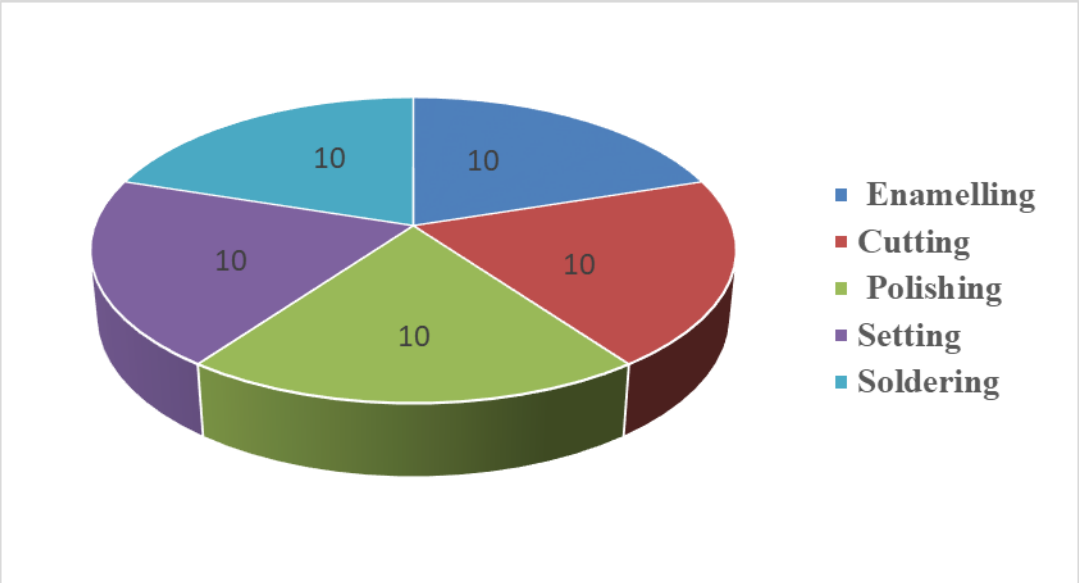

Figure 2.10 Number of workers surveyed in all five working units.

2.6 Pulse Oximetry

To evaluate the workers' blood oxygen levels and heart rates, we also used pulse Oximetry. Results were visible in a matter of seconds after we turned on the pulse oximeter and clipped it to the end of the worker's finger. An optimal heart rate is between 60 and 100 beats per minute, while an ideal oxygen level is between 96% and 99%. Even when we are feeling well, we may have lung diseases indicated by the decreased oxygen levels. Therefore, the study also assessed workers for their oxygen saturation levels (SpO_2) and heart rate in each of the working departments. The tool provides two results:

1. The Employee's Blood Oxygen Saturation (SpO_2)
2. Pulse Rate (PR)

Figure 2.11 Pulse oximetry

2.7 Statistical analysis

The statistical programme for social sciences (SPSS) version 25 was used to perform a statistical analysis on the data. Pearson Correlation was also applied between the recorded symptoms in goldsmiths in each working units to their smoking years, age of workers, their working units, and their job hours, to see if these symptoms are due to any of these parameters.

CHAPTER 3

RESULTS AND DISCUSSION

This chapter discusses the results of spirometry, pulse oximetry, identification of COPD, restrictive and obstructive diseases assessed in the goldsmith workers in each of the working departments.

3.1 Results of Spirometry

Table 3.1 displays the typical process-based FEV1, FVC, and PEF values. There were obvious disparities between before and post bronchodilation, indicating that respiratory illnesses were present in every operational unit. However, due to exposure to HCL, which is used for cleaning and buffing ornaments and produces toxic vapours that make it difficult for goldsmiths to breathe in polishing units, the most compromised lung function was discovered in the polishing unit as well as in the setting as well as enamelling unit. FEV1 1.5 0.42 was the prebronchodilator for the polishing unit. The polishing unit did, however, significantly improve after bronchodilation (1.8 0.53). Likewise, the FVC before bronchodilation was 1.5 0.34 and increased to 2.1 0.81 after the reversibility test was conducted. Similarly, the prebronchodilation for Setting unit was FEV1 1.7 ± 0.49. However, considerable improvement in setting unit was observed after Bronchodilation 2.1 ± 0.55. Similar to this, the prebronchodilation FVC was 1.7 0.50 and when the reversibility test was used, it increased to 2.0 0.65. FEV1 2.00.54 was the prebronchodilation for the enamelling unit. However, following bronchodilation, which was 2.3 0.64, there was a noticeable improvement in the enamelling unit. Similar to this, the prebronchodilation FVC was 3.4 1.02 and changed to 2.4 0.51 following the use of the reversibility test.

Table 3.1 Results of pre and post bronchodilation assessed in goldsmith workers in each unit.

Department	**FEV1**			**PEF**			**FVC**			**FEV/FVC**	
(n=10)	Pre-B	Post-B	% Improved	Pre-B	Post-B	% Improved	Pre-B	Post-B	% Improved	Pre-B	Post-B
Enameling	2.0±0.54	2.3±0.64	9.9%	2.0±0.56	4.4±0.96	11.7%	3.4±1.02	2.4±0.51	7.5%	0.8±0.11	0.9±0.09
Cutting	1.8±0.49	2.0±0.50	6.2%	3.3±0.89	4.1±1.2	10.3%	1.8±0.59	2.3±0.79	6.40%	1.0±0.15	0.9±0.10
Polishing	1.5±0.42	1.8±0.53	12.2%	3.7±1.16	4.6±1.43	14.3%	1.5±0.34	2.1±0.81	16.6%	0.9±0.12	0.9±0.12
Setting	1.7±0.49	2.1±0.55	11.5%	2.8±1.15	3.8±1.21	13.7%	1.7±0.50	2.0±0.65	14.7%	1.0±0.44	1.2±0.65
Soldering	1.8±0.33	2.0±0.30	9.0%	5.5±1.85	6.0±1.94	5.7%	1.7±0.31	1.9±0.26	6.7%	1.0±0.08	1.0±0.08

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3.2 Results of COPD

In enameling unit one worker was in stage 1, one was included in stage 2 and two were included in GOLD 3 category. For cutting unit two workers were identified in GOLD 2 category and two were in GOLD 3 category. For setting Unit three workers were in GOLD 2 category and one worker was in GOLD 3 category. Soldering unit includes four workers in GOLD 2 category and two in GOLD 3 category.

Although highly severe cases of COPD were identified in three workers of polishing and buffing unit which lies in GOLD 4 category. And four workers were identified in Gold 3 category, one worker was in GOLD 1 category that indicates that he has mild COPD.

Basically, there are COPD patients in each unit. But polishing and buffing Unit includes highly severe cases of COPD.

Table 3.2 Identification of COPD

Department (N)	**Gold 1**	**Gold 2**	**Gold 3**	**Gold 4**	**Total**
Enameling (10)	1	1	2	-	4
Cutting (10)	-	2	2	-	4
Polishing (10)	-	1	4	3	8
Setting (10)	-	3	1	-	4
Soldering (10)	-	4	2	-	6

3.3 Results of restrictive and obstructive disease

As shown in table 3.3 all groups have patients of restrictive and obstructive disease. There was total 10 workers in each department.

In enameling Unit, six workers were identified as patient of restrictive disease in which one had mild, one had moderate and 4 had severe restrictive disease. Similarly, there were total 5 patients of obstructive disease in which one was mild, two were moderate and two were severe.

In Cutting Unit, six workers were patients of restrictive disease in which one had mild, two had moderate and three had severe restrictive disease. Similarly, there were seven patients of obstructive disease from which four had moderate and two had severe obstructive disease.

In polishing unit, eight workers were suffering from restrictive disease, two were having moderate and six were having severe disease. In the case of obstructive disease one worker was suffering from moderate and five were suffering from severe disease.

In setting unit, total 5 workers were affected. From which two of them were suffering from moderate and three were suffering from severe restrictive disease. In the case of obstructive disease out of 6 patients, four were having moderate and two were having severe disease.

In soldering unit, six workers were affected, from which two were having moderate and four were having severe restrictive disease. Similarly, four workers were having moderate, and two workers were having severe obstructive disease.

There were 8 patients of restrictive disease in polishing unit and 6 patients were included in severe category. That means that workers working in polishing unit has more patients of restrictive disease

There were seven patients in cutting unit whereas 2 workers were in severe category and four were in moderate category. Which means that workers working in cutting unit has more patients of obstructive disease.

Table 3.3 identification of restrictive and obstructive disease

Department	Restrictive				Obstructive				% of smokers
	Mild	Moderate	Severe	Total Patients	Mild	Moderate	Severe	Total Patients	
Enameling (10)	1	1	4	6	1	2	2	5	40%
Cutting (10)	1	2	3	6	-	4	2	7	60%
Polishing (10)	-	2	6	8	-	1	5	6	80%
Setting (10)	-	2	3	5	-	4	2	6	60%
Soldering (10)	-	2	4	6	-	4	2	6	60%

3.4 Demographic characteristics

The Total number of workers from whom we obtained demographic information were 50. The mean age (years) was 36 ±10.88, average value of BMI was 23.96 ± 5.1, Body weight 69.33±13.65. In each department where we assessed 10 workers, 60 percent were smokers whereas 40 percent were nonsmokers.

Table 3.4 Demographic characteristics of participating workforce (n-50)

Parameter	**Enameling**	**Cutting**	**Polishing**	**Setting**	**Soldering**
Age(years)	23.1±5.2	35.3±4.03	40.3±10.5	37.3±9.9	43.67±11.6
BMI	20.8±3.6	28.95±4.16	21.9±5.05	20.57±3.7	25.5±2.72
Bodyweight (kg)	59.76±10.22	82.3±14.0	66.5±12.8	64±13.1	73.6±8.3
Smokers (%)	40%	60%	80%	60%	60%
Nonsmokers	60%	40%	20%	40%	40%

Enameling unit includes four workers who were smokers. In cutting, soldering, and setting unit six workers were smokers and four were nonsmokers. In polishing and buffing Unit, eight workers were smokers and two were nonsmokers.

Because smoking is a recognized cause of COPD flare-ups, the distribution of COPD patients was calculated using this component. It's important to remember that not all of the identified COPD patients were smokers. It might be because smoking cigarettes is not the only risk factor for lung obstructions. Nonsmokers may become more susceptible to this ailment as a result of their exposure to dust and infectious organisms.

3.5 Respiratory symptoms

All working groups showed respiratory symptoms as shown in Table 3.5 (Cough> phlegm > Dyspnea > tachypnea > wheezing). These symptoms are brought on by extended occupational contact to the chemicals and dusts released during various gold manufacturing processes. Chest pain, coughing, dyspnea, phlegm, wheezing and other respiratory indications are signs of pulmonary dysfunction in goldsmiths. According to studies,

symptoms among goldsmiths include coughing, dyspnea, tachypnea, wheezing and phlegm.

Table 3.5 Respiratory Symptoms

Symptoms	Workers (n=50)
Cough	30 (60%)
wheezing	10 (20%)
phlegm	25 (50%)
Tachypnea	12 (24%)
Dyspnea	20 (40%)

3.6 Long term health risks

The most noticeable context-related long-term health effects that they experience are visual problems, followed by respiratory conditions and back pain. The goal of this study, which was mostly qualitative in nature, was to pinpoint the occupational health risks that frequently affected goldsmiths in Sarafa Bazar as well as their most likely underlying causes. Highest number of workers suffering from vision problem are in Enameling Unit. Setting Unit includes highest number of workers having backpain.

Table 3.6 Matrix of goldsmith's exposure to long term health risks in different units

Department	Vision problem	Back pain
Enameling	60%	90%
Cutting	-	75%
polishing	-	-
Setting	55%	85%
soldering	40%	-

3.7 Results of Pulse Oximetry

The mean values of SpO_2 and heart rate have been shown in the table and two tailed test was also applied to the pre and post work values to see any significant difference between the values. The result of the two tailed test showed that the values were statistically insignificant P>0.05.

Table 3.7 Results of Pulse Oximetry

Department	**SpO2**			**Heart Rate**		
	Pre work	**Post work**	**P value**	**Pre work**	**Post work**	**P value**
Enameling	93.6±1.36	96.8±1.47	0.504	81.3±5.75	85.1±3.37	0.191
Cutting	94.3±1.21	97.5±1.76	0.655	83±2.40	84.5±10.3	0.074
polishing	96±2.28	97.1±1.94	0.102	80.1±6.73	80.1±10.6	0.217
Setting	93.3±2.16	96.6±2.25	0.118	73.1±7.08	85.1±7.52	0.104
Soldering	93±1.64	94.8±2.40	0.022	76.3±8.73	76.3±7.81	0.196

3.8 Statistical analysis

The result of Pearson correlation is shown in table 3.8. Pearson Correlation was also applied between the recorded symptoms in goldsmiths, e.g., cough, wheezing, tachypnea, dyspnea, and phlegm in each working unit to their smoking years, age of workers, their working units, and their job hours, to see if these symptoms correlate and may be due to any of these parameters. The results of the Pearson Correlation between symptoms the hours of working showed that there is a strong negative correlation between all symptoms with hours of working except for tachypnea which showed a moderately positive correlation. The results of Pearson correlation for smoking years with symptoms also showed a strong negative correlation except for wheezing and Dyspnea which had a weak positive correlation with the smoking years. The results of Pearson correlation for the age of workers with the symptoms showed a strong negative correlation except for cough and Dyspnea which showed a weak positive correlation with the age of workers. The results of

Pearson correlation for working units with recorded symptoms showed a strong negative correlation for cough and phlegm, a moderate positive with tachypnea, and a weak positive with wheezing.

These findings are very similar to Rahman et al (2015), who also recorded the symptoms in 45 goldsmith workers Cough, Wheezing, blood-mixed Phlegm breathlessness, the correlation was reported for the length of work, smoking habits of workers, work environment, and age of workers. The cough showed a strong positive correlation with the age of workers whereas, in the present study, it was weakly positive. Wheezing and Breathlessness correlated with the smoking habits of workers having a strong positive correlation, the present study had shown a weak positive correlation. The symptoms also correlated with the working environment of the goldsmith workers showing a strong relationship between the variables. The present study had also shown a weak positive correlation between wheezing and moderate tachypnea (Rahman & Sajani, 2017).

Table 3.8 Results of Pearson correlation

Symptoms	**Age of workers**	**Smoking**	**Working Unit**	**No. of Working Hours**
Cough	0.4454	-0.2167	-0.1265	-0.4856
Wheezing	-0.5698	0.4134	0.079	-0.501
Phlegm	-0.8233	-0.4305	-0.352	-0.1104
Tachypnea	-0.5048	-0.3371	0.5328	0.5108
Dyspnea	0.4628	0.3832	0.4105	-0.08575

DISCUSSION

The study assessed one of main gold jewelry manufacturing districts for twin cities Islamabad and Rawalpindi, Sarafa Bazar. There are many small workshops in the said location where gold jewelry is made. There are a lot of health risks associated with the working conditions and gold jewelry manufacturing techniques used at Sarafa Bazaar. But when it comes to addressing their occupational health risks, goldsmiths do not receive the required attention. This study was conducted to assess the pulmonary health issues that goldsmith workers might be experiencing. Additionally, certain demographic information e.g., age, body weight, etc., relating to the goldsmith employees was also obtained. Due to their poor working conditions, goldsmiths are frequently exposed to a variety of health issues especially dust and acidic fumes in their working units. The survey revealed that the majority of the small work shops where the jewelry undergoes many stages were extremely filthy, crammed, congested, and lacked appropriate ventilation. Additionally, the stressful environment of their shops and their working practices fuel the flames.

Most of the workers were in the age range of (19-60**).** None of them were younger than 16 years old. The workers under study have a different level of education than workers in other industrial sectors. The majority (40.8%) of the examined workers had a secondary education. The study's respondents all stated that they spend more or less 12-15 hours a day in their workshops, on average, in the goldsmith workshop, with breaks of between one to two hours. The goldsmiths typically take Friday off for the weekend. According to the study, the majority of respondents (60%) were smokers. This is troubling since it corresponds with social tendencies in our country. 88.5 percent of smokers smoked 12-15 cigarettes daily which further aggravates their lungs.

For the fabrication of gold ornaments in Sarafa Bazaar, many dangerous materials are employed, including HCL especially in polishing and buffing unit. In this investigation, symptoms of respiratory issues were discovered in 45 respondents. These symptoms included phlegm (50%), Tachypnea (24%), dyspnea (40%), wheezing (20%) and coughing (60%). Based on the readings of spirometer we also found that many workers were suffering from COPD, obstructive and restricted diseases working in different units. The workers' lung functions were abruptly changed as a result of prolonged exposure to such

contaminants and poor working environment. There could be various causative agents, and irritants present in the working environment which may be responsible for these respiratory problems. The goldsmiths' pulmonary function was also affected by the dust and fumes in some units. None of them were wearing any personal protective equipment.

Thomas Kronborg et al. (2019), tested 23,433 individuals who were combined from the National Health and Nutrition Examination Survey (NHANES) 2007-2012. COPD was defined as having a post-bronchodilator FEV1/FVC ratio of 0.70 or above. The cutoff for diagnosing COPD based on pre-bronchodilator FEV1/FVC was altered while evaluating accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. The findings for COPD based on pre-bronchodilator FEV1/FVC 0.70 contributed to the COPD misdiagnosis because of the low classification rates. Pre-bronchodilator FEV1/FVC of 0.66 considerably improves categorization rates overall, improving accuracy by 15% when the threshold is changed. According to their analysis, pre-bronchodilator FEV1/FVC 0.66 can be used to marginally modify the diagnosis of CCOPD made by pre-bronchodilator spirometry. This approach might prevent occurrences of incorrect COPD diagnosis, which can result in the treatment of those who don't have the disease and the denial of care for COPD patients. Similar to this study, the present study assessed the goldsmiths utilizing pre- and post-bronchodilation criteria to detect any diseases. (Thorax, 2003)

Many other research have looked into the usefulness of bronchodilator spirometry in COPD assessment and diagnosis, which is similar to our study. Lung function before and after bronchodilators accurately predicts illness, according to Mannino et al. (Mannino, et al., 2011). They coincide with our findings and those of Mohamed et al., (2012) who discovered significant variation when diagnosing using pre- or post-bronchodilator, respectively (Mohamed, et al., 2012)

Post-bronchodilator testing, according to Johannessen et al., (2005) significantly changed estimations of the prevalence of COPD. However, the COPD predictors remained constant despite post-bronchodilator testing. The current study also found that the COPD predictors remained constant despite testing post-bronchodilation for a better ability to detect any disease. (Johannessen, et al., 2005)

Pre-bronchodilator testing, according to Schermer et al., (2008) overestimates airflow restriction. (Schermer, et al., 2008). These findings are similar to those of a study by Waheed et al., (2011) which discovered that pre-bronchodilator testing overestimates air-flow blockage (Waheed, et al., 2011). To reduce this overestimation, post-bronchodilator testing has been suggested as adopted in this study. Furthermore, Probst-Hensch et al. (2010) came to the conclusion that pre-bronchodilator testing can lead to a misclassification of COPD. Instead of contrasting pre- and post-bronchodilator prevalence and predictors, changing the pre-bronchodilator threshold (Probst-Hensch, et al., 2010).

CONCLUSIONS

The importance of occupational safety and health for goldsmith employees, who are at a high risk of developing respiratory health issues, is acknowledged in the study's conclusion. The study's respondents were well aware of the annoying risks, but many of them neglected to wear personal protection equipment while they were at work. Because they smoked and were exposed to dust and fumes, they had pulmonary symptoms such tachypnea, dyspnea, phlegm, and cough more frequently, which resulted in significantly decreased lung function. It was discovered that the frequency of respiratory issues was directly correlated with the respondents' tenure of employment, and that the frequency of respiratory issues increased with daily cigarette smoking. The results of the individuals' spirometry tests in the current investigation showed that their lung volumes and capacities had decreased. This decline in lung capacity is probably brought on by variables including ageing, working in a crowded workplace, smoking habits of employees, and some crucial tasks performed while producing jewellery. The number of hours worked, the years of smoking, and the working environment at Goldsmiths all have a significant impact on the workers' general health.

Goldsmiths are not given the required attention while trying to address occupational health problems. Goldsmiths are frequently exposed to a range of health problems as a result of their subpar working environment. There are many materials utilised in the production of gold jewellery. The dust and fumes generated during the manufacturing process from those materials expose workers to a number of health dangers. Additionally, the physically demanding environment of their workshops has already harmed their health. For the benefit of the workforce, appropriate preventive measures should be taken, PPE should be worn by all employees during working hours, sensitive working units with higher risks should receive more care and attention, and the affected cases should have access to appropriate treatment facilities. Using prebronchodilator spirometry, it was discovered that chronic obstructive pulmonary disease occurred more frequently (COPD). Participants' pre- and post-bronchodilator spirometry findings allowed us to compare differences in COPD's symptoms and outcomes. The change in reading to detect the disease may be better predicted using postbronchodilator spirometry.

RECOMMENDATIONS

To improve their health, these workers must receive primary care, and according to the current study, they are in a prime position to identify early-stage COPD and other disorders and do spirometry and other tests to confirm the diagnosis. The majority of COPD management occurs in primary care, and there is now much that can be done to alleviate symptoms, enhance quality of life, and lessen the frequency and severity of illness. All goldsmiths should get this information in order to alert them of the dangers involved with their line of work and to lay forth additional recommendations.

Local exhaust ventilation should be used for all soldering operations (e.g., slot hood or window exhaust fan at work level 1-2 feet away). Use of appropriate Personal Protective Equipment PPEs e.g., masks, especially dust protecting mask, should be worn by workers in polishing units, and therefore PPEs are advised to reduce exposure to chemical vapors, dust, and acidic fumes. They must take precautions during work and undergo health check-ups once in six months. Given their risky line of work, goldsmiths must give up smoking.

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Annexure 1

Research Survey

To be conducted in Sarafa Bazaar

RawalpindiGeneral Health status of

Goldsmith workers

1. Demographic Information

1. Name of Respondent _____
2. Age
   - 26-35
   - 36-45
   - 45 +
3. Level of education

- Illiterate
- Primary
- Matric
- FA/FSC

2. Distribution of respondents by working hour and length of service

1. How many workers work in the following workstations?

    1. Soldering Unit
    2. Polishing
    3. Refining unit
    4. Cutting
    5. Setting Unit

1.	2.	3.	4.	5.

2. Working hours per day

- 8 hours or less
- 9-10 hours
- 11-12 hours

- 12-15 hours

3. Length of service
- 1 years
- 5 years
- 5-10 years
- 10-15 years
- More than 15 years

3. Smoking habits of workers/respondents

1. Do you smoke?
- Yes
- No

2. Number of cigarettes smoked per day

- 1-5
- 6-10
- 11-15

3. Duration (years) of smoking habit?
- 5
- 6-10
- 11-15
- 16-20
- More than 20

4. Did you ever get ill or sick because of prolonged smoking habit?
- Yes
- No

5. Has Smoking damaged your health?
- Yes
- No

4. Knowledge of the respondents on PPE use

1. Do you know about the use of PPE in workplace and its importance?
- Yes
- No

2. If yes, what PPE do you us in your work?
- Mask
- Gloves
- Safety Goggles

5. Workplace Environment and Conditions.

1. Do you think the place where you work is appropriate for working?
   - Yes
   - No
2. Is it too congested for you to work? Do you ever feel shortness of breath/ headache/nausea?
   - Yes/No
   - If yes, Reason
3. Depending upon your work? Is being a jeweler physically demanding?
   - Yes
   - No
4. Do you think dust is a problem while polishing and cutting?
   - Yes
   - No
5. Is there any workplace hazard you know that happened?
   - Yes
   - No

What If yes, explain what happened

6. Do you get exposed to various acidic and metallic fumes at work
   - Yes
   - No

6. Health and Respiratory problems

1. Demands for speed and quality, can cause fatigue or stress?
   - Yes
   - No
2. Have you ever experienced any injury or accidents when handling machines?
   - Yes
   - No

3. Do you suffer from any of these symptoms?
    - Cough
    - Phlegm
    - Wheezing
    - Tachypnea
    - Dyspnea.

4. Do you suffer from cough more often?
    - Once in a month
    - Once in a week
    - More often
5. Do you suffer from dry cough only?
    - Yes
    - No
6. Do you feel chest congestion, uneasiness, headache, and shortness of breathing, once in awhile?
    - Yes
    - No