Original Research Article

Assessment of Health Hazards of the Goldsmiths in Tantibazar Area of Dhaka, Bangladesh

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ABSTRACT

Aims: To find out the major occupational health issues among the goldsmiths and its' causative factors, The study also aims to identify the study populations' health risks in line with their work type, and to estimate the proportion of the goldsmiths vulnerable to those health risks.
Study design: It is a survey research.
Place and Duration of Study: Goldsmith clusters at Tantibazar in Dhaka, Bangladesh, between March 2011 and June 2014.
Methodology: Focus group discussions (FGD) were conducted among 2 focus groups in Tantibazar goldsmith cluster. Each of the groups consisted of 20 respondents. Besides, library search and internet browsing have also been done.
Results: Almost 70% of the goldsmiths work in soldering unit followed by 12% in polishing unit, 6% in cutting unit, 4% in refining unit, 3% in enameling unit and setting unit each, and 2% in designing unit approximately. Many hazardous substances are used in these working units, such as Cd, HNO_3, H_2SO_4. The dusts and fumes generated from these hazardous substances pose various health hazards to the artisans. About 92% goldsmiths are exposed to cold fever, weakness and suffocation, 86% are exposed to jaundice/liver problems and diarrhea each, 84% are exposed to headache and 80% are exposed to dehydration as immediate health hazards. Among the long term health impacts, about 94% goldsmiths are exposed to vision problem, 93% are exposed to back pain, 92% are exposed to respiratory diseases, 86% have health vulnerability to constipation and piles problems, and 16% and 12% goldsmiths are exposed to dermatitis and dental carries respectively.
Conclusion: The gold jewelry manufacturing process followed in Tantibazar involve a number of health hazards. But the goldsmiths are not getting proper attention in improving their environmental health issues. The responsible authority also does not provide any facility in respect to their health issues.
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Keywords: Goldsmith, Tantibazar, Bangladesh, Environmental Health.

1. INTRODUCTION

Tantibazar is one of the largest goldsmith clusters in Bangladesh where the artisans follow the conventional method of jewelry making, and produce handcraft jewelries. The manufacturing process of handicraft gold ornament requires excellent skill with intensive dedication to the work, while the customary working environment of this manufacturing process poses a number of serious health hazards to the artisans which causes their

survival vulnerable. On the other hand, the handcraft gold jewelry has been a heritage of Bengal in history, and this was made famous by its skilled goldsmiths long back [1]. But, now it seems that, because of our lack of long term vision and acknowledgment to our talent, we might lose our golden heritage very soon. Under this context, it is needed to ensure a safe indoor environment in their working studios, and aware them about proper wearing of precautionary safety equipments which will reduce their exposure to health hazards. Hence the sustainability of this golden heritage of Bengal will also be secured

Jewelry making is one of the world's oldest manufacturing operations and has always involved some hazardous processes [2]. And there are quite a few literatures, though scattered, available. The silver ornaments manufacturing in conventional method in Rajarhat silver ornaments cluster, located at Barasat in West Bengal emits deep black fumes and adds pollution to the environment as well as to artisans causing serious health hazard [3]. As noted by Choudhari *et.al*., lung disorders are more common among jewelry workers [4]. Toxic fumes released when gold is soldered with cadmium. Cadmium vapor reacts with air to form poisonous cadmium oxide [5]. Cadmium affects the brain, nervous system, lungs, kidneys, bone, prostrate and digestive tract and can cause acute bronchitis, pneumonia, digestive disorders, dermatitis, allergic hyper sensitization, chronic brain damage, lung damage, prostate cancer and kidney stones [6]. A research conducted on goldsmiths to demonstrate the effects due to the continuous exposure of mainly nitrogen based chemicals revealed that there is much occurrence of acquired Methaemoglobin (MetHb) among the goldsmiths [7]. The study by Lewton indicates that dermatitis is a real hazard for jewelers [8]. On the other hand, the artisans' posture, while designing and soldering, affects the spinal cord badly [3]. For soldering of the pre-fabricated ornaments artisans are blowing air from their mouth through a pipe. Continuous blowing air from mouth affects the chest and lung of the artisans, consequently in long run artisans tend to become the victim of Asthma and T.B. [3]. On the other hand, Bengal goldsmith gets a little solvency in his economic life and a little recognition from society for his contributions [9]. Historically, the social status of goldsmiths of Bangladesh had been low and this too continues to be so more because of their relatively poor incomes [10]. In reference to the above background, the study was conducted to identify the goldsmiths' health hazards due to their occupational behavior and workplace environment in Tantibazar, Bangladesh.

As the study is related to occupational health hazard of goldsmiths of Tantibazar area, it reveals their occupational health issues and the probable causes of their health problems. The study also aims to identify the study populations' exposure to different health hazard in line with their work type and their level of exposure.

Very little research has been done in South Asian countries on the health problems of goldsmiths as a direct result of their workplace environmental condition. Some research has been conducted in India on this issue, but there is virtually no documented study on this problem in Bangladesh. Hence, the present study is expected to bring the problem of goldsmiths' environmental health and associated issues into light.

2. METHODOLOGY

2.1 Study Area

The study area of the present research is Tantibazar that belong to the Kotwali Thana of Dhaka, Bangladesh (Fig 1). The study area occupies one of the largest goldsmith clusters in Bangladesh. According to their local goldsmiths' welfare club *Dhaka Swarna Shilpi Sromik Shongho* (DSSSS), the number of goldsmiths in this cluster was 22,000 during the year 1996. The study area is an ideal representative to exhibit the common scenario of gold ornament manufacturing industry and the goldsmithing in Bangladesh. The study area is

basically a residential area where there are many buildings (known as Market) within which gold ornaments are manufactured. These markets are scattered in a few cluster within the study area. However, from some recent past, both the number of artisans and studios are declining.

Figure 1. Study Area.

2.2 Experiments

The study is basically a qualitative research. A field survey was conducted to calculate the total number of existing studios and goldsmiths in Tantibazar during the research period. Observation and informal interviews were adopted with ten stakeholders to gather in depth information on the gold ornament manufacturing processes, its working environment, its health risk factors and associated health risks. A reconnaissance survey was conducted all over the working area reaching 100% existing studios in order to design the focus group discussion (FGD) checklist, and to determine the representative number of FGD respondents to reveal their common occupational health risks in lieu with the type of working

unit. However, the focus group discussions (FGD) were conducted in August 2013 among the goldsmith group and the middlemen group; each group consisting of 20 respondents. Both the focus groups are exposed to the similar environmental condition in their workplace, and hence exposed to similar health risks. The FGD respondents were selected on purposive sampling basis. The respondents were selected from each category of working units from different integrant clusters of the study area, and they were of different age groups. Respondent from a particular unit of a particular cluster was representative of the total population of similar context. Since no female worker or middlemen exists there, all the participants were male. The composition of FGD participants of the two groups were as shown in table 1.

Table 1: Participant Composition of the Focus Groups

Working Unit	*Goldsmith Group*	*Middlemen Group*
soldering unit	5	3
polishing unit	4	3
cutting & enameling unit	4	2
refining unit	3	2
setting unit	2	2
designing unit	2	2
Total	20	20

The objective of the FGD was primarily to find out the major occupational health risks among the goldsmiths in regards to the type of their work and working manner that generally varies with the type of unit in which they work. The FGD also tried to find out the participants perception on the causative factors of their health risks. Secondary data were analyzed to justify the causative factors of their health risks. Computer software, such as MS excel was used to estimate the approximate proportion of goldsmiths exposed to different types of immediate and long-term health risks. The same software was also used to generate the pie charts and bar diagrams. .

3. RESULTS AND DISCUSSION

3.1 Composition of the Study Area

The total number of goldsmiths in the study area was 5822 during the survey, and all were male. Historically, female workers never work here as goldsmith. The total number of studio was 1287 which were scattered in several markets and clusters all over the study area.

3.2 Unit-wise Jewelry Manufacturing Processes, Demographic Composition, and Health Risks

In the study area, making of gold jewelry in traditional method is accomplished sequentially in different units, i.e. refining unit, soldering unit, design unit, enameling unit, polishing and buffing unit, cutting unit, and setting unit (fig.2). The processes of manufacturing gold ornament in different units are frequently hazardous to the artisans' health.

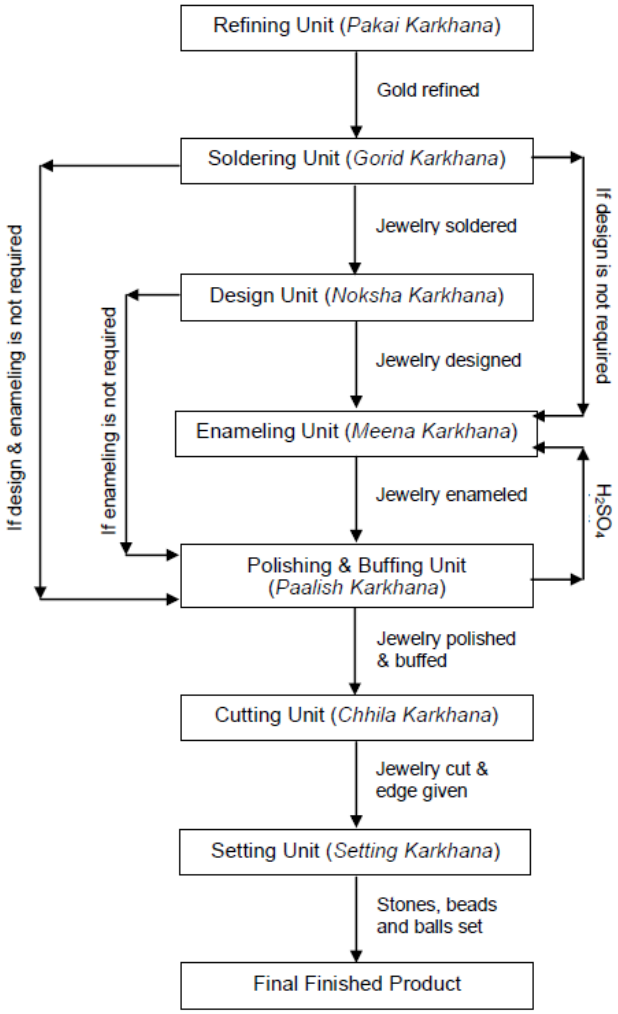

Figure 2: Steps in Manufacturing Gold Ornament in Tantibazar

According to the FGD, almost 70% of the goldsmiths in Tantibazar work at soldering unit followed by goldsmiths of polishing unit at about 12%, cutting unit at about 6%, refining unit at about 4%, both enameling unit and setting at about 3% and designing unit at about 2% (fig. 3).

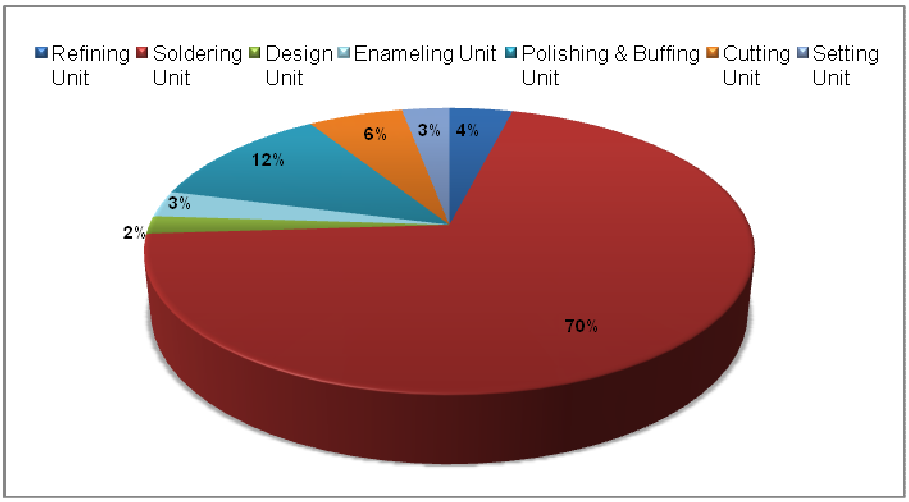

Figure 3: Proportion of goldsmiths work at different units

The studio environments of all units are dingy and congested. The ventilation condition of the studio remains very poor. All day long the goldsmiths work in a suffocated environment. In a soldering unit, interiors are arranged with working desks and wooden sits in such a congested manner that the artisans can only manage to place themselves somehow for sitting inside the studo. For example, about 35 soldering goldsmiths have been found to work in a room of 10 feet by 40 feet. The ventilation condition of those studios remain very poor, and upon that, the electric fans are kept switched off to avoid extinguishing of fire from the lamps. As a result, the room temperature increases incredibly. Hardly any soldering goldsmith was found to work wearing any shirt or tang top. They continuously sweat round the day. Besides, the soldering goldsmiths are exposed to SPMs generated from their indoor tasks, and cadmium fumes during soldering the jewelries. On the other hand the artisans of polishing and buffing unit are continuously exposed to H_2SO_4 fumes directly, whereas the artisans of refining unit are exposed to fumes of HNO_3. These fumes are not channelized to open environment properly, and hence it diffuse easily in the markets indoor environment and goldsmiths of other unit also get exposed to these fumes. The tasks of cutting unit involve high visual concentration and yield micro particles which are thought to have serious and various hazardous health impacts. Since enameling is done mostly in the cutting units, the enameling artisans are also exposed to the same environmental health hazards. The number of artisans of setting unit and design unit are low, and thus they have more workloads. As a result, they have to work in a bent posture day long and their tasks are highly vision intensive.

Depending on the types of work of the goldsmiths in different units, their exposure to the occupational health hazard also varies. The health impacts they face are of two types- 1) immediate health hazard, and 2) long term health impacts. The FGD has revealed their unit wise exposure to different immediate health hazard (table 2) and long term health impacts (table 3).

Table 2: Matrix of goldsmiths' exposure to immediate health risks in different studio units

Appraisal	Jaundice	Cold/ Fever	Dizziness	Weakness	Headache	Diarrhea	Suffocation	Dehydration	Piles
Refining Unit	√	√	√	√		√	√	√	√

Soldering Unit	√	√	√	√	√	√	√	√	√
Design Unit					√				
Enameling Unit					√				
Polishing & Buffing Unit	√	√	√	√		√	√		√
Cutting Unit		√	√	√	√		√	√	
Setting Unit			√		√				

Table 3: Matrix of goldsmiths' exposure to long term health risks in different studio units

Appraisal	Vision Problem	Back Pain	Dermatitis	Respiratory Disease	Dental Carries	Constipation	Piles
Refining Unit			√	√		√	√
Soldering Unit	√	√		√		√	√
Design Unit		√					
Enameling Unit	√						
Polishing & Buffing Unit	√	√	√	√	√	√	√
Cutting Unit	√	√		√			
Setting Unit	√	√					

On the basis of the information on their unit-wise health risks received from FGD and information on unit-wise demographic composition gathered through field survey, it has been estimated that 92% of the total goldsmiths in the study area are exposed to cold fever, weakness and suffocation, 86% are exposed to jaundice and diarrhea each, 84% are exposed to headache and 80% are exposed to dehydration among their identified immediate health hazards (fig. 4). On the other hand, among the long term health impacts, the goldsmiths are prominently exposed to vision problem. About 94% goldsmiths are exposed to vision problem (fig. 5). The second most common heath threat is back pain to which 93% goldsmiths are exposed, and then respiratory diseases to which about 92% goldsmiths are exposed (fig. 5). About 86% goldsmiths have health vulnerability to constipation and piles problems (fig. 5). Exposure of the study population to dermatitis and dental carries constitute the minimum proportions which are about 16% and 12% respectively (fig. 5).

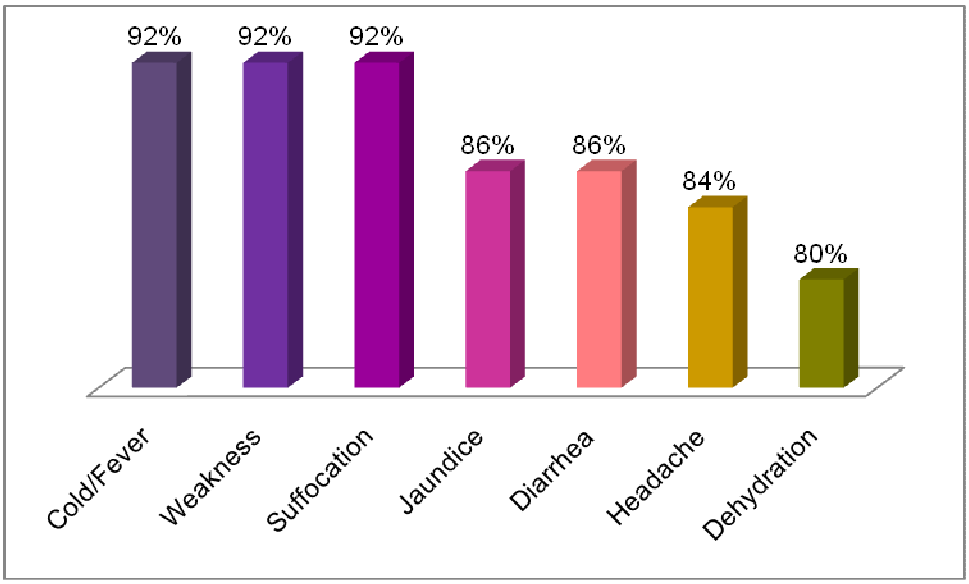

Figure 4: Goldsmiths' Exposure to Immediate Health Hazards

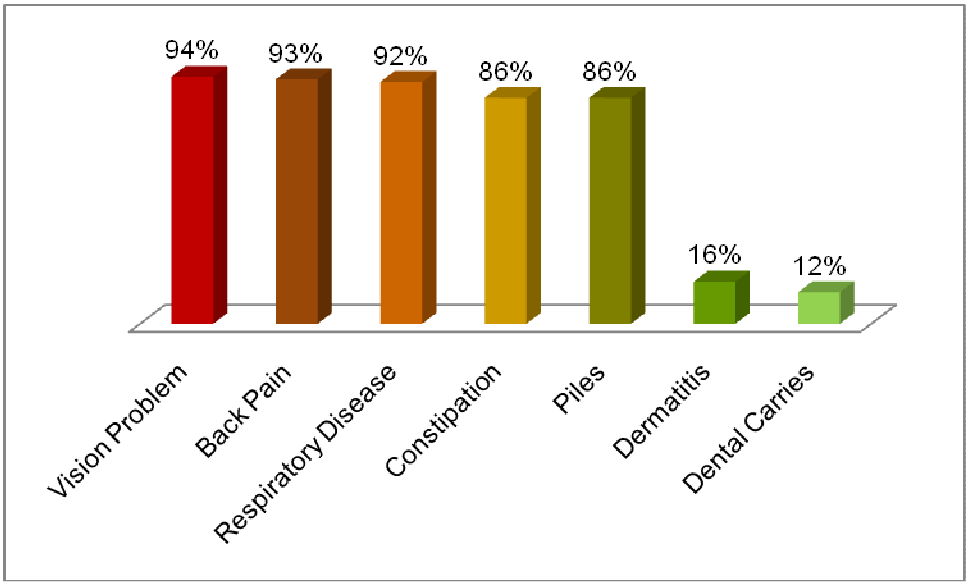

Figure 5: Goldsmiths' Exposure to Long Term Health Hazards

3.3 Discussion

3.3.1 Refining Unit

Nitric acid used for refining releases noxious fumes when gold is refined, and that directly attacks the lungs of the refining artisans. Besides, asthma is also seen among them. According to Weiss, HNO_3 is very irritating to lungs, and exposures to HNO_3 at low concentrations over extended periods of time are cumulative in terms of burning and scarring of the lungs [6]. Several types of skin diseases are also observed among the refining artisans, such as depigmentation, prickly, boils etc. Sometimes contact with HNO_3

causes skin burn followed by scar formation [8]. Besides, chills, fever, and chronic cough can be caused from the overexposure to HNO_3 [6].

3.3.2 Soldering Unit

The tasks of soldering unit involve intense visual concentration for hours after hours. That's why the vision problem is most common among the soldering artisans. According to Colledge *et.al*., continuous working along with extreme visual pressure can cause initially myopic problem followed by blindness also [11]. High eye pressure causes headache too [12] [13]. Besides, Back pain is another common health hazard among the goldsmiths of this unit. Saha and Saha found that the unscientific working posture in conventional jewelry manufacturing process affects the spinal cord of the goldsmiths badly, and in the long run the artisans become victim of Spondylitis [3]. Colledge, *et.al*., in their study, found working continuously in a curved manner for a long period can cause hunchback problem in long run [11]. Besides, the middlemen suspect that there might be so many diseases that can be caused from inhalation of the SPMs and the gases that come from burning of candles and natural gases. After the introduction of hallmarking system in 2006 in this cluster, cadmium is used widely as a soldering metal because of its low melting point. Thus, cadmium gets into their body mostly by inhalation of cadmium contaminated air. Breathing high doses of cadmium can irritate and damage the lungs and can cause death while breathing lower doses of cadmium, i.e 0.01 mg/m^3 of cadmium contaminated air over the long-term (greater than 14 days) may result in chronic lung disease and kidney disease in humans [14]. The SPM in the working studios is thought to be another major cause of their lungs problem. The SPM remain invisible in the air are the most dangerous and stay in lungs; and when enough particles accumulate, they affect breathing [15]. However, almost all the goldsmiths suffer from hepatitis in this cluster. The probable cause of high incidence of their hepatitis is may be inhalation of toxic substances. According to Weiss, though hepatitis is commonly known as a viral disease, it can also be caused by chemical substances [8]. The liver functions to detoxify substances that are produced by body processes as well as harmful substances that enter the body from the environment. When the burden of toxins is too great, the liver gets damaged and cannot detoxify any poisons in the body or otherwise [16]. On the other hand, for soldering purposes, the goldsmiths of Tantibazar use blow-pipes to blow air from their mouth. Saha and Saha reveals continuous blowing of air from mouth affects the chest and lung of the goldsmiths, and in the long run they become the victim of asthma [3]. On the other hand, they suffer from skin problems due to the high temperature of working studio. The high temperature causes prickly and boils resulting in intense itching [12]. Besides, the continuous high indoor temperature in the soldering studio causes continuous sweating of the goldsmiths leading to multifarious health problems, such as weakness, dizziness, cold problem, diarrhea etc.

Hot environment can cause people to suffer from cold problem [12] [13]. Additionally, in such working environment they keep sweating continuously, and excessive sweating causes weakness and dizziness [12] [13]. The poor ventilation is also responsible for the headache, drowsiness and also increase the chances of communicable diseases [13].

Working in very hot environment causes excessive loss of their body fluids, which can result in their dehydration [12]. Constipation is also a common health problem among the artisans. Constipation too can be caused from their continuous dehydration [12]. There are so many artisans in this cluster who have piles. Piles can be caused due to constipation problem and poor dietary habits [17]. It is to be mentioned that artisans continuously work sitting on a wooden tool or on the floor, and sitting on hard seats for prolonged periods is another cause of piles [17].

3.3.3 Design Unit

Occupational diseases are not that much severe in design unit when compared to other units. Their work requires intensive visual attention during working which can cause vision problems [11]. But as long the job of design artisans are not too tiny and precise, the vision problem among them is not very common. They also feel back pain which is thought to be caused from their continuous sitting in a curved manner, while working. Saha and Saha mentioned that working posture in conventional jewelry manufacturing process affects the spinal cord of the goldsmiths badly [3].

3.3.4 Enameling Unit

Vision problem is more common is enameling artisans since they do the job of cutting too. Moreover, the total number of enameling artisans is very low in this cluster. So those few artisans always have to go through high workload. Hence the vision problems are more common among them disregarding the matter that how tiny and precise their work is.

3.3.5 Polishing and Buffing Unit

The process of glazing jewelries in polishing and buffing unit involves severe health hazards. The fumes of H_2SO_4 cause severe irritation to the respiratory tract and skin [6].

Goldsmiths of polishing and buffing unit primarily suffer from respiratory diseases. The H_2SO_4 used for polishing and buffing of ornament generate noxious fumes causing breathing problem to the goldsmiths. However, the goldsmiths' exposure to H_2SO_4 in this cluster is wider since the fumes of are not released out of the studios easily because of poor ventilation system. Inhalation of H_2SO_4 mist or fumes may produce irritation of the nose, throat and respiratory tract [18]. Besides, chronic inhalation of H_2SO_4 mist may cause pitting and erosion of tooth enamel [18].

Skin problem is another major problem among the goldsmiths of polishing and buffing units. The probable major responsible causes are thought to be their close contact with dermatitis-causing chemicals in cleansers, acids, solvents, abrasives etc. Sulfuric acid can cause dermatitis [8], whereas acid fumes too can cause skin ailments [19]. They tend to dip their hands in water regularly while scrubbing the jewelries with degreasing cleaners, such as shampoo. Cleaners can raise the pH of skin and dissolve protective surface fats whereas dipping hands often into water may cause skin to crack [8].

The fine particles come from polishing and buffering may cause health problem. For example, brown tripoli is used in this cluster as an abrasive for polishing and red rouge (Fe_2O_3) for staining the jewelries, and both these substances yield particles in powdered forms during operation. Inhalation of red rouge particles, i.e. ferric oxide (Fe_2O_3) may cause irritation to the respiratory tract [20]. However, the polishing artisans can have vision problem and back pain too.

3.3.6 Cutting Unit

The task performed in cutting unit is very tiny and precise, and requires intensive visual attention. Moreover the task of cutting is performed very near to light sources. So, at the time of working, light reflects on the workpieces and the glazes from the cuts hit directly to the goldsmiths eyes. While working constantly with extreme visual pressure can cause myopic problem often leading to blindness [11] and dazzling reflection of light can be responsible for reducing critical vision [13], vision problem is very common and severe among the cutting artisans. Besides, the fine particles eroded from cutting task often get inside eyes. Sometimes it requires minor surgery too to take out those fine particles from eyes.

Respiratory diseases are also very common among cutting artisans since they perform the task of cutting in a closed cell and get exposure very closely to the SPMs yielded inside the cell. When enough particles accumulate in lungs from by the inhalation of tiny SPMs, those affect breathing [15]. Besides, suffocation, dehydration, cold fever, sinusitis caused from exhausted environment are also common among them.

3.3.7 Setting Unit

Basically the tasks of setting unit do not involve any significant hazardous chemical exposure, but their working posture and manner can lead to back pain, headache, irritation of eyes and vision problems. Setting stones on jewelries is vision intensive work, and hence setting artisans mainly face vision problem in long run. Colledge *et.al*. mentioned that continuous and extreme visual pressure leads to myopic vision problem and can even cause blindness in the long run [11]. Their working posture of sitting continuously in a curved manner also causes back pain among them.

3.4 Research Findings & Corroboration

The conventional manufacturing process of jewelry making pose serious health hazards to the goldsmiths of Tantibazar. Though there is no academically published study on this issue on Bangladesh context, the similar findings of the current study have been observed in other South Asian countries, such as in India and Pakistan, where the context of gold ornament manufacturing process are almost similar.

In the study area of present research, the markets are set up in an extremely congested residential area where the working studios are kept in poor ventilation system. This actually exaggerates the vulnerability of the goldsmiths to their health risks. Almost 92% of the goldsmiths in the study area are exposed to respiratory diseases and suffocation, 16% are exposed to dermatitis and 12% are exposed to dental carries. These health risks are thought to be caused from direct inhalation and/or skin contact of SPMs and mists of HNO_3 and H_2SO_4. Similar context has been claimed by Faiza Iliyas in a report where the author expressed that the goldsmith workshops of Saddar area in Karachi, Pakistan are situated in congested residential areas of the city, and the goldsmiths of that area are exposed to toxic fumes of HNO_3 and H_2SO_4 since their working environment has poor ventilation system [21]. The author also expressed that the resultant acid fumes cause respiratory, eye and skin ailments in goldsmiths [21]. Again, in the Thrissur district of India, jewelries are made by bare hand, and handling of the electroplating chemicals of jewelries, such as, NaCN, HCl, HNO_3 and H_2SO_4 without any precaution poses a threat to the health of the artisans [22]. Conventional method of jewelry manufacturing is also followed in the silver ornaments cluster of Rajarhat at Barasat in West Bengal, India. The artisan work there are exposed to deep black fumes emitted from molten Cd, Cu and Zn during preparation of silver alloy, and become vulnerable to various health hazards. Also, the micro particles of cadmium yielded from silver alloy during buffing process cause damage to chest and lungs of those artisans [3]. A recent research on Indian goldsmiths showed that exposure to the hazardous fumes and some metals during jewelry manufacturing caused a decline in lung volumes and capacities among their studied goldsmiths [23].

Other than the health hazards related to the chemicals and metals that the goldsmiths of Tantibazar use, their working manners in crooked posture makes 93% of the goldsmiths vulnerable to back pain. Because of the similar working posture, the artisans' of silver ornaments cluster of Rajarhat at Barasat in West Bengal, India suffer badly from the health problems of spinal cord [3]. For soldering purposes, the goldsmiths of Tantibazar use blow-pipes to blow air from their mouth which is thought to be a cause of their vulnerability to respiratory diseases. As a result of blowing air from mouth through the pipe which affects the chest and lung, the artisans of Rajarhat at Barasat in West Bengal, India suffer from Asthma

and T.B. in the long run [3]. However, the undertaken study has also found that the most obvious and highest (94%) proportion of goldsmiths in the study area is vulnerable to vision problem, particularly as a long term effect. The reason behind that is probably the goldsmiths of Tantibazar perform tiny and very precise works which require keen visual attention throughout the time they work. Their visual pressure is very continuous. Sometimes it is continuous for whole day and whole night, and sometime it is continuous for consecutive couple of days. Their vulnerability to fever, cold problems, dizziness, weakness, headache, diarrhea, suffocation, dehydration, constipation etc. are thought to be caused from the exhausting indoor environment of the studios.

4. CONCLUSION

Tantibazar, one of the largest gold jewelry manufacturing areas in Bangladesh, not only holds the business of gold jewelry but also the heritage and fate of the famous Bengali artisans. The working environment and methods of making gold jewelries followed in Tantibazar involve a number of health hazards. But the goldsmiths are not getting proper attention on the subject of improving their occupational health issues. The goldsmiths are continuously exposed to various health problems due to their poor occupational environment. Many hazardous substances are used in Tantibazar for gold ornament manufacturing processes, such as cadmium, HNO_3, H_2SO_4, copper etc. The dusts and fumes generated from those hazardous substances in the manufacturing process pose various health hazards to the artisans. Moreover, the exhausting environment of their working studios and their working manners add oil to the fire. The goldsmiths in this cluster frequently suffer from dermatitis, hepatitis, fever, cold problems, dizziness, weakness, headache, diarrhea, suffocation/breathlessness, dehydration, constipation and piles because of their occupational environment and occupational behavior. The contextual obvious long term health impacts from which they suffer are vision problem followed by respiratory diseases and back pain. On the other hand, liver problems are common among them, but severe long term impacts such as liver cirrhosis are not a very common health problem among them. However, *Dhaka Swarna Shilpi Sromik Shongho* (DSSSS) is the responsible authority for assuring the welfare of the goldsmiths, but practically they do not provide any facility in respect of their health issues

It is important to mention here that this study was mainly a qualitative one and focused on revealing the common occupational health risks and their probable causes among the goldsmiths of Tantibazar. Therefore it did not deal with the epidemiological aspects, but would help and inspire to conduct further quantitative studies on the prevalence of the artisans by the experts in the field of public health and/or epidemiology.

COMPETING INTERESTS

No competing interest exists.

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ACRONYMS

DSSSS	Dhaka Swarna Shilpi Sromik Shongho
FGD	Focus Group Discussion
SPM	Suspended Particulate Matter

DEFINITIONS

Chhila Karkhana: A gold ornament manufacturing unit where the workpieces are given edges to enhance glaze by cutting edges and surfaces of the workpieces. This unit is termed as 'cutting unit' in this study.

Gorid Karkhana: A gold ornament manufacturing unit where the fragments of workpieces are soldered. This unit is termed as 'soldering unit' in this study.

Meena Karkhana: A gold ornament manufacturing unit where the workpieces are decorated with different shades by fixing and fusing differently colored vitreous glazes onto it. This unit is termed as 'enameling unit' in this study.

Noksha Karkhana: A gold ornament manufacturing unit where the workpieces are adorned by engraving different types of curves on it. This unit is termed as 'design unit' in this study.

Paalish Karkhana: A gold ornament manufacturing unit where the workpieces are undergone different processes to enhance its' glaze and luster. This unit is termed as 'polishing and buffing unit' in this study.

Pakai Karkhana: A gold ornament manufacturing unit where the gold bar is refined to its purest form. To make the gold bar workable for making jewelries, it is needed to be alloyed with harder metals. The task of adding desired alloys to the pure gold bars is also performed in this unit. This unit is termed as 'refining unit' in this study.

Setting Karkhana: A gold ornament manufacturing unit where stones, beads, pearls etc are embedded to the workpieces. This unit termed as 'setting unit' in this study.

Studio: Rooms where different tasks of gold ornament manufacturing are carried out.

Unit: A particular type of working studio that deals with a specific type of work in the process of manufacturing gold ornaments. For example, 'refining unit' deals with refining of gold, 'soldering unit' deals with soldering of the pre-fabricated pieces of the final jewelry.

Market: Buildings (one storied and/or multistoried) within which there are numbers of different types studios and/or units where gold ornaments are manufactured.

Cluster: A patch of gold ornament manufacturing markets which are located closely having a similarly designed studio setup and interiors, and plausibly having same environmental condition.

Artisan/Goldsmith: A person who works to manufacture gold ornaments. On the basis of their expertise they are classified into 'refining artisan/goldsmith', 'soldering artisan/goldsmith', 'design artisan/goldsmith', 'enameling artisan/goldsmith', 'polishing artisan/goldsmith', 'cutting artisan/goldsmith', and 'setting artisan/goldsmith'.

Middlemen: Middlemen are the employers of the goldsmiths who also stay in the studios daylong. They are locally known as *Mahajon*. Etymologically, they take work orders from the owners of jewelry showrooms and prepare the orders by the goldsmiths. One of the important features among the middlemen of the study area is that, most of them were once goldsmiths in this area and/or still work as goldsmith. Hence, they too are more or less equally exposed to the same health hazards.