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Occupational Vat Dyeing Practices in the Kano Metropolis of Nigeria Part 5: Chemical Exposure, Potential Hazard, and Safety Practices

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ABSTRACT

Since the 1930s synthetic dyes and chemicals are being used in Nigeria where occupational dyers in Kano metropolis followed suit. Exposure to these chemicals may likely endanger the dyers depending on safety practices performed on the job and health effects may be exerted directly at the site of application (affecting workers) and/or later in the life cycle (affecting the consumers of the dyed articles). The aim of this paper is to assess chemical exposure, potential hazards, and safety practices related to occupational dyers in Kano metropolis. A structured questionnaire was administered among 1387 dyers and further information was obtained through focus group discussion and observation. Data were analysed by descriptive statistics (frequency and average) using statistical package for the social sciences (SPSS) software. Findings revealed that health workers enlightened many dyers on chemical toxicity. Most of the dyers use adequate protection to avoid dermal contact but may be vulnerable to the effects of oral and inhalation exposure to chemicals, extreme heat, as well as musculo-skeletal illnesses. The dyers experienced symptoms related to occupational exposure to vat dyes and hydros and also suffered caustic soda burns in the past. The study recommends that relevant government agencies/ministries should test the toxicity of chemicals coming into the state, impose the provision of material safety data sheet by wholesale and retail colour vendors and make the use of complete personal protective equipment by the dyers mandatory.

Keywords*: exposure, hazard, safety, Kano metropolis, vat dyes*

INTRODUCTION

Textile industry workers are exposed to a number of chemicals including dyes, auxiliaries and numerous types of fibre dusts (Singh and Chadha, 2016). There are 2 factors involved in determining the risk assessment of chemicals namely exposure and hazard (Barclay and Buckley, 2000). Exposure refers to the elements that are subject to the impact of a specific hazard and its scenarios depend on the chemical type, its occurrence in textile materials, its bioavailability, as well as proximity of the organisms to the pollution source (Akintayo 2013a). Hazard is defined as a stressor or combination of stressors that is/are capable of causing an adverse health effect (Stewart and Stenzel, 2000). Occupational hazards (OHs) refer to workplace activities that have the potential to cause or increase the risk of injury or ill health (Aluko *et al.,* 2016) and are generally difficult to determine and also less likely to be detected in developing countries partly as a result of inadequate occupational health services (Fabriana *et al.,* 2012). Occupational safety is a control of hazards in the workplace to achieve an acceptable level of risk while workplace safety generally refers to the process of protecting the health and safety of staff on the job (Aluko *et al.,* 2016).

There is no evidence to suggest that the majority of the dyestuff currently used in the textile dyeing are harmful to humans at the levels of exposure that workers generally face in the factories. However, with long term or accidental over exposure, there can be potential health hazards (Gurses *et al.,* 2016). The use of dyestuff and pigments may cause a number of adverse health effects which may be exerted directly at the site of application (affecting workers) and/or later in the life cycle, affecting the consumers (Khan and Malik, 2014). Anthraquinone and its derivatives used in the manufacture of vat dyes are possibly carcinogenic to humans (IARC, 2013). Dyes can affect vital organs such as the brain, kidney, liver, heart etc. and also affect the respiratory, immune, and reproductive systems of humans where diseases may occur either directly through inhalation or indirectly through the food chain such as tuberculosis, cancer etc. (Slama *et al.,* 2021). Certain dyes release aromatic amines which are carcinogenic presenting a risk of cancer to users of

articles dyed with the dyes as well as causing allergy (Silva *et al.,* 2020).

Occupational exposure, hazards, and safety practices related to dye workers in India (Paramasivam *et al.,* 2010; Singhi *et al.,* 2005; Thomas *et al.,* 2019), Ghana (Howard *et al.,* 2019; Bruce-Amartey Jnr and Acquaye, 2022), Sokoto, Nigeria (Okafoagu *et al.,* 2017), and Abeokuta, Nigeria (Adekunle *et al.,* 2017; Akintayo, 2013b) have been reported. Until now, very little work has been done to study exposure and potential hazards with regards to non-industrial vat dyers in Kano metropolis. Previous studies were mainly on heavy metals determination in dye powders used and toxicity of the dyes purchased from local markets (see Abdullahi *et al*., 2016 and Sani *et al*., 2018). In this paper, which is the fifth of a 6-part series, we report the results obtained from an investigation of chemical exposure, hazard, and safety practices involving dyers in Kano metropolis. Kano metropolis was selected because there are many secondary dyeing units engaged in non-industrial dyeing using synthetic vat dyes and chemicals. The study will contribute in addressing the fundamental questions: What are the exposure routs to dye and chemicals? What are the symptoms previously experienced by the dyers and potential health hazards associated with the occupation? Which safety practices are performed? The study will focus on dyers using synthetic vat dyes and chemicals.

MATERIALS AND METHODS

Study Area

Kano metropolis comprises 8 local governments and is boarded by Madobi and Tofa to the South West, Gezawa to the East, Dawakin Kudu to the South East, and Minjibir on the North East of Kano State (Balogun *et al*., 2020). It has a projected population of 3,876,273, growth rate of 3.5 % as at 2015 (Boyi, 2017), and a population density of about 1000 inhabitants per km^2 compared to the national average of 267 per km^2. It lies between Lat. 10º and 12ºN and Long. 8º and 9ºE with an area of 600 km^2, an altitude of 488 m above sea level (Suleiman *et al*., 2020) and predominantly comprised of Hausa and Fulani ethnic groups (Iliyas, 2000). Kano state has a total of 36 secondary health care facilities out of which 10 are in the metropolis, 299 private health care facilities, 2 tertiary health care facilities and 2 military hospitals all within the metropolis, 1148 primary health care facilities out of which 108 are located in the metropolis. However, the distribution of primary health care facilities in Kano metropolis is uneven (Kibon and Ahmad, 2013). For the purpose of this study, the respondents are called "dyers" and the non-industrial dyeing units are referred to as "dyehouses".

Data Collection and Analysis

The study relied on data gathered through a structured questionnaire, focus group discussion (FGD), and observation. Responses and information from FGD were supported by observation to have a clear picture of the situation and better understanding of the processes. A structured questionnaire was developed according to standard protocol for questionnaire design and testing as described by Geer et al. (2006) and questions were developed as a result of insight from Johnson (1999). The validity of the coverage of questions included in the questionnaire (content validity) was gained through experts in the field, colleagues as well as members of the target population. Reconnaissance visits were made in June, 2020 to locate the dyers. The developed questionnaire was pretested among the dyers that did not participate in the study and during the reconnaissance visits. Variability in dyers response and the understanding of question content (face validity) were evaluated and this information was used to produce a revised final version of the questionnaire, specifically questions were added where content coverage was lacking and questions were rephrased where understanding was vague. The questionnaire was prepared in English but was communicated to the dyers in their local dialect (Hausa). This part of the series covered 10 questions in 1 section (e.g. knowledge of exposure to toxic chemicals, ways in which chemicals enter the body, personal protective equipment (PPE) normally used, symptoms experienced due to the dyeing occupation etc.). The research population is the total number of occupational vat dyers in Kano metropolis and participating dyers were chosen as a purposive sample. A total of 1387 questionnaires were administered in 20 dyehouses (geographical location of the dyehouses is shown in part 1 of the series) where willingness to participate in the study was confirmed through completed consent form. Dyers who are at least 18 years of age and had worked for at least 5 years in the dyehouses were eligible to participate in the study. Data was collected from August to December, 2020, with the dyers working, through self-completed questionnaire by the researcher and 3 enumerators over a duration of 25-30 minutes with each dyer being asked the same question in the same order. A monetary incentive of ₦3000 ($7.75) was provided for participation due to initial reluctance to

participate because according to the dyers, the Chinese used similar approach to learn their techniques. Before initial data screening all the completed questionnaires were coded and entered in Excel software after which the data were analysed by descriptive statistics (frequency and average) using SPSS version 26.

Other data sources included observations while the dyers are on the job. For a study such as this, observation approach is indispensable as certain information can best be obtained through direct observation hence we adopted a participant observation method. Additional information was obtained from focus group discussion with the researcher, assistant researcher and 7 dyers, 1 from a dyehouse in each of 7 local government areas (Nassarawa was not represented) in December, 2020 selected by purposive sampling technique. Two key informants were used in the study. Focus group discussion with the dyers centred on a short list of 3 open-ended questions namely how they get exposed to dyes and chemicals, what symptoms they experienced as a result of their occupation, and the safety measures they usually perform. Focus group discussions were audiotape-recorded so that reference could be made to the remarks of the participants in order to ascertain common themes. The discussion lasted for 2 hours and was recorded using paper and pencil.

Table 1: Awareness of toxicity of dye/chemicals through a health worker

Purpose of health worker's visit	Yes N=1387 (%)	No N=1387 (%)	Missing N=1387 (%)	Total N=1387 (%)
To explain the effects of exposure to chemicals on the body	816 (58.8)	0 (0)	571 (41.2)	1387 (100)
To advise the dyers on going to hospital in case of workplace accident	779 (56.2)	37 (2.6)	571 (41.2)	1387 (100)
To enlighten the dyers on how to protect the body from toxic chemicals	380 (27.4)	436 (31.4)	571 (41.2)	1387 (100)

RESULTS AND DISCUSSION

Chemical Exposure

Majority (95.1 %) of the dyers are aware that the dyeing activity exposes them to toxic chemicals. As shown in Table 1, 58.8 % of them know about the toxicity of dyes/chemicals through government health workers under Kano state ministry of health. All the dyers visited were enlightened on the effects of exposure to dyes and chemicals while 56.2 % were advised to visit hospital immediately in case of workplace accident and 27.4 % were informed of protecting the body from chemicals. The high knowledge of potentially being exposed to toxic chemicals could be due to the level of education of the dyers where 81.9 % have secondary school certificate and above (see part 1 of the series) and therefore could have been informed of chemical toxicity in school. Similarly, Okafoagu et al. (2017) attributed the knowledge of toxic effects of chemicals to the level of education of textile dyers in Sokoto. Large proportion of particleboard workers in Ethiopia (Asgedom *et al.,* 2019), and occupational dyers in Sokoto, Nigeria (Okafoagu *et al.,* 2017) and Abeokuta, Nigeria (Akintayo, 2013b) know that their occupation exposes them to toxic chemicals. Majority of particleboard workers in Ethiopia were enlightened about the toxicity of dye/chemicals by a health worker (Asgedom *et al.*, 2019) while occupational dyers in Abeokuta were majorly informed via radio and billboards (Akintayo, 2013b).

More dyers (37 %) believe that chemicals enter the body by dermal contact followed by inhalation (35.6 %), and then ingestion (27.4 %) as shown in Figure 1. This can be due to the large surface area of the skin coupled with the turbulent nature of the dyeing and mercerizing processes (see part 3 of the series) where spills can occur while preparing the dye/mercerizing baths and make contact with any part of unprotected skin. Similarly, dermal exposure was considered more common among particleboard workers in Ethiopia (Asgedom *et al.,* 2019) and occupational dyers in Sokoto, Nigeria (Okafoagu *et al.,* 2017). It has been observed that fumes emanating from caustic and dye baths as well as powders of hydros, dye, and caustic soda can be inhaled. Vapours settling on the face and mixing with sweat can run to the lips and accidently ingested. The primary route of exposure in many industries is inhalation but dermal contact and ingestion contribute to the overall exposure (Stewart and Stenzel, 2000). According to Gad

(2014), exposure to caustic soda may occur via dermal contact, inhalation (as mist or spay) and ingestion.

Symptoms

Figure 2 shows that the dyers experienced several symptoms with coughing being more prevalent (25.3 %). Other symptoms in decreasing order of frequency include shortness of breath, nausea, chest pain, abdominal pain, and vomiting.

Workers exposure to dyes could have resulted to most of these symptoms (Ghaly *et al.,* 2014) especially coughing due to the irritant smell of the dyebath. Shortness of breath, chest pain, and coughing are among the 6 St. George asthma symptom questions (Tabar-Purroy *et al.,* 2003). According to Upadhyay and Panday (2015), exposure of workers to different types of chemicals causes different types of diseases such as skin allergies, respiratory diseases, and musculoskeletal disorders. Chest pain and coughing among small scale dyeing industries in India (Thomas *et al.,* 2019); nasal irritation, itching, and skin irritation within occupational dyers in India (Singhi *et al.,* 2005), headache, chest pain and coughing among dyers in Ghana (Howard *et al.,* 2019), as well as back pain and respiratory diseases experienced by dye workers in Abeokuta, Nigeria (Adekunle *et al.,* 2017) have been reported. Discussion with the dyers revealed that some of them have sustained permanent eye injuries due to accidental splash of caustic soda solution from mercerization bath, others had serious burns and other skin diseases due to contact with caustic soda either in solid form or in solution, and many had work-related asthma.

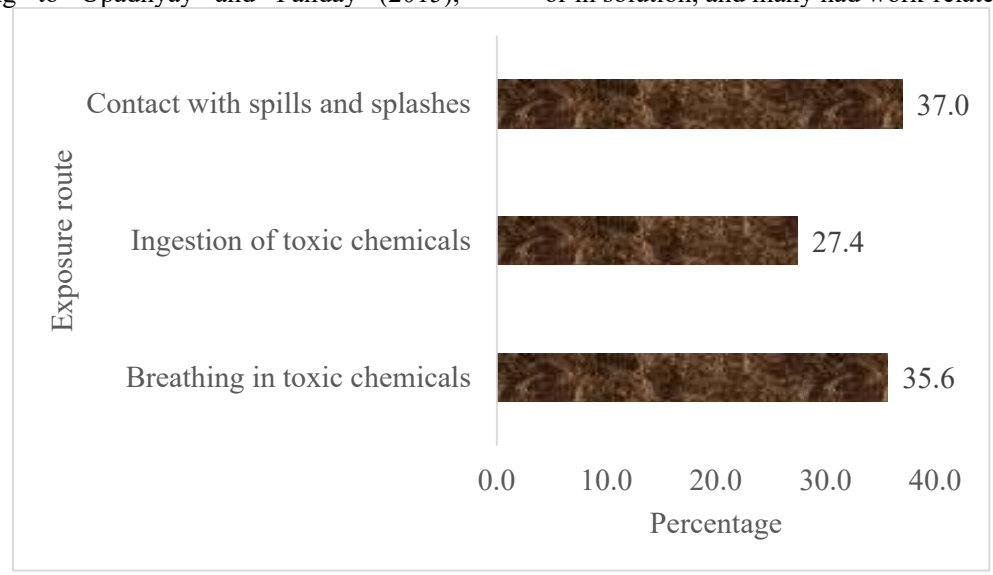

Figure 1: Means of occupational exposure to dye/chemicals

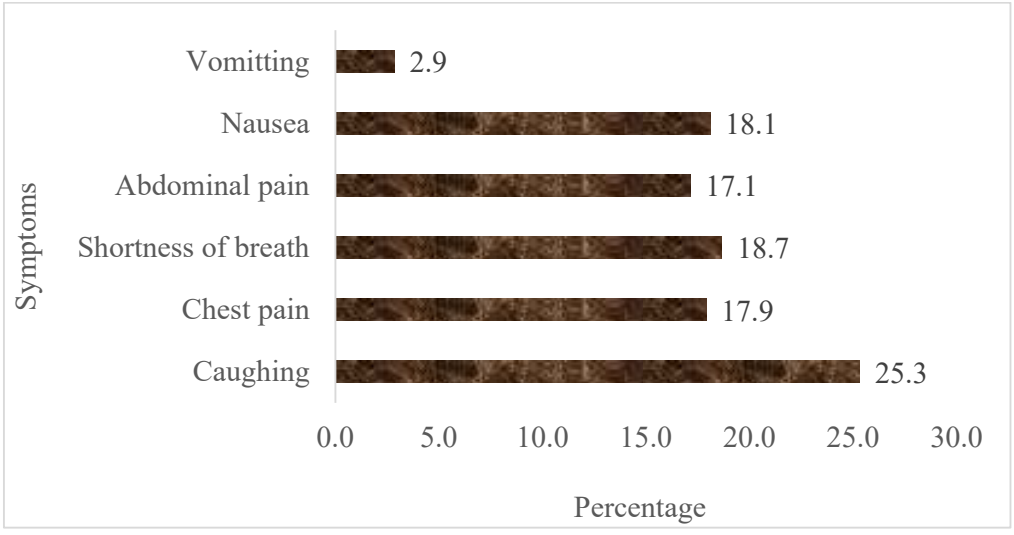

Figure 2: Symptoms experienced by the dyers

Potential Hazards

We reported in part 2 of the series that vat dye, caustic soda, and hydros are the chemicals more commonly used by the dyers. Dyes and chemicals cause skin diseases such as allergic contact dermatitis and irritant dermatitis (Chen *et al.,* 2017; Thomas *et al.,* 2019; Bruce-Amartey and Acquaye, 2022) where the tendency of reactive (Al-Tohamy, 2022; Chavan, 2011) and disperse dyes (Seidenari *et al.,* 1991) to cause dermatitis is well known. Some anthraquinone dyes belonging to mordant, acid, solvent, basic (Sing *et al.,* 2000), vat, reactive, and disperse dyes are recognized as skin sensitizers (Asgher *et al.,* 2008). Dermatitis is an eczematous reaction that occurs as an immunological response following exposure to a substance to which immune system has previously been sensitized (Wilkinson and Orton, 2016). Benzanthrone (BA), an anthraquinone derivative and an important intermediate in the synthesis of a number of vat and disperse dyes (Joshi *et al.,* 1986), cause dermal toxicity (Singh *et al.,* 2000) which is influenced by the numbers of carbonyl, amino-anthraquinone groups as well as by the presence of halogens, nitro, hydroxy, and methoxy groups in the parent molecule (Dwivedi et al., 2013). Workers coming in contact with BA either during manufacture, storage, or use suffer symptoms such as loss of appetite, weight loss, weakness, and decreased sexual potency (Joshi *et al.,* 1986).

Occupational dyers in India were found to be allergic to multiple dyes including a vat dye, Indanthrene Turquoise Blue (Singhi *et al.,* 2005). Some substances used during production can be found also in the finished garment which may cause dermatitis when in contact with a perspiring skin (Suedman *et al.,* 2019). Many different garments have been implicated as causing dermatitis including men's Sox, women's and men's clothing, and military uniforms. Disperse Orange 3 has been found to sensitize a patient wearing muticoloured blouse (Seidenari *et al.,* 1991). Uniform dyed with Disperse Blue 106 and Disperse Red 1 were found to cause eczema among 5 women (Mota *et al.,* 2000). C. I. Vat Green 1 has been implicated to cause dermatitis from the vat green component of navy-blue uniform in British nurses (Wilson and Cronin, 1971).

Besides sensitization, dyes can cause a variety of health problems ranging from headache, lack of concentration, nausea, diarrhoea, fatigue, muscle and joint pain, dizziness, difficulty in breathing, irregular heartbeat etc. Reactive dyes can cause occupational asthma when workers are exposed to the dye dust (Chavan, 2011) and vat dyes have carcinogenic health effects (Asgher *et al.,* 2008; Kariyajjanavar *et al.,* 2013). Indigo Carmine, a blue vat dye class used in textile industry for dyeing and as a diagnostic aid, can cause irritation to the gastrointestinal tract leading to nausea, vomiting, and diarrhoea as well as irritation to the respiratory tract such as coughing and shortness of breath (Lakshmi *et al.,* 2009) which constituted most of the symptoms suffered by the dyers. According to Soyinka et al. (2007), occupational exposure to vat dyes used by "Adire" dye workers in Abeokuta, Nigeria may result in sub-clinical adverse effects on the liver and inhibition of its functions.

Caustic soda pose threat to safety due to possibility of splash which upon skin contact can result in dermatitis (Ahmadi and Seyedi, 2019). Hydros, contained in an opened or partially closed polyethene bag (Figure 3), can be carried by air and deposited either on the skin causing itching or inhaled resulting in coughing, nausea, and vomiting. Some of the symptoms suffered by the dyers could be due to inhalation of hydros because hydros ingestion or inhalation by sensitive individuals results in potential allergoid reactions ("sulphite-asthma"). Toxicity data on hydros is available for skin and eye irritation as well as sensitization (OECD, 2004). According to New Jersey Department of Health, inhalation of hydros can cause irritation, respiratory problems, and back pain which are also symptoms suffered by the dyers investigated. In a study carried out by Reza et al. (2014), chronic hydros ingestion in food was found to cause kidney impairment in experimental animals. Dissolution of hydros liberates sulphur dioxide gasses (Bajpai, 2018) and symptoms of its inhalation include coughing, chest tightness, shortness of breath, chocking, and also induces respiratory irritation in humans (OECD, 2004).

Dye, hydros, and caustic soda dust can enter the eye, nose, or mouth. Dye dust can lead to chronic obstructive pulmonary disease which is a persistent airflow limitation that results in irreversible decline in lung function (ILO, 2022). Additionally, inhalation of mist or dust of caustic soda can cause mild to moderate nasal and throat irritation where burning of nasal and respiratory pathway may occur with higher concentrations (Gad, 2014). Dispersing agents in vat dye formulation is usually a formaldehyde (FA) condensation product (Lacasse and Baumann, 2004) and according to Abdelkafy et al. (2021), acute exposure to FA is associated with respiratory tract inflammation and irritation of the eyes. FA is a known nasal carcinogen in rats and also considered a human carcinogen (Nielsen and Wolkoff, 2010). FA resin

was found to cause sensitization among sewing and ironing workers in Beijing (Chen *et al.,* 2017).

It has been observed that the dyers perform mercerization and dyeing in a prolonged bending position as shown in Figure 4 resulting in abdominal pain which is a musculo-skeletal disease (MSD). Industrially, work-related low back pain is a major contributor to morbidity and workers' compensation costs. MSDs are the largest single cause of work-related illness accounting for more than 33 % of all reported occupational illnesses (Byrns *et al.,* 2002). MSD affects productivity at work and increased economic burden (Upadhyay and Panday, 2015). It has also been observed that heat from mercerizing and dyeing bath is transferred to the hand via hand gloves. The dyers fill the gloves with water to suppress the heat effect but the water itself gets hot because mostly the temperatures are very high (mean dyeing temperature= 76±4.24 ^{o}C) and consequently the hand within the glove suffers from extreme heat for a long period of time. This will invariably cause burns on the palms and wrist resulting to unbearable pain. Increased human exposure to prolonged, frequent, and intense heat significantly affects productivity in physically demanding occupations (Foster *et al.,* 2012). Occupational exposure to heat without sufficient protection increases heat related illnesses and injuries (Pogacar *et al.* 2018) such as heat oedema, heat rash, heat cramps, hyperthermia, renal failure etc. (ILO, 2022).

Figure 3: Dye powders and hydros in polyethene bags

Figure 4: Bending position during dyeing process (Field work, 2020)

Despite all the potential hazards itemized, workers vary in their susceptibility to the effects of chemicals where some are sensitive and experience ill effects while others are inherently more resistant (Quandt *et al.,* 1998). In many workplaces PPE is recommended as an immediate control measure as they are cheap and available and are usually provided by the employer (Asgedom *et al.,* 2019).

Safety Practices

Different PPE used by the dyers are shown in Table 2. All the dyers (100 %) use hand gloves to carry out the dyeing/mercerizing processes. Other PPE used in decreasing order of proportion include protective boots, polyethene skirt (locally fabricated apron tied to the waist as shown in Figure 5), nose guard, and facemask. It is practically impossible to carry out dyeing/mercerization without hand gloves due to the corrosive action of caustic soda in the bath as well as the temperature employed. More than 80 % of occupational dyers in Sokoto, Nigeria use hand gloves but only 20 % observed all the safety practices (Okafoagu *et al.,* 2017). In another study by Akintayo (2013b), all the dyers investigated in Abeokuta, Nigeria (100 %) use respirators, only 27.35 % use hand gloves, 11.11 % use goggles, 2.56 % use protective boots, and only 1.71 % use apron. According to Adekunle et al. (2017), more proportion of dyers in Abeokuta, Nigeria use apron and facemask much more than they use hand gloves. Majority of the dyers (98.7 %) were confident with the outcome of protective behaviour where up to 91.2 % use PPE oftenely as shown in Figure 6.

Table 2: Personal protective equipment used

Personal Protective Equipment	Yes N=1387 (%)	No N=1387 (%)	Total N=1387 (%)
Hand gloves	1387 (100)	0 (0)	1387 (100)
Protective boots	1319 (95.1)	68 (4.9)	1387 (100)
Face mask with eye glasses	196 (14.1)	1191 (85.9)	1387 (100)
Nose guard	528 (38.1)	589 (61.9)	1387 (100)
Polyethene skirt (apron)	687 (49.5)	700 (50.5)	1387 (100)

Figure 5: Locally fabricated polyethene skirt

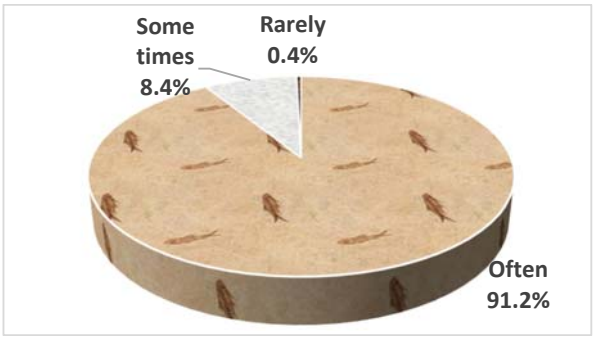

Figure 6: Frequency of engaging in protective behaviour

Discussion with the dyers revealed that the use of PPE is necessary to protect the body from toxic chemicals especially hand glove since the dyeing/mercerizing processes are mainly carried out by hand. According to them, the quantity of material to be dyed determines the use of protective boot, apron, facemask, and respirator and the higher the quantity the more protected they are because of the speed involved and therefore more potential contact with the mercerizing/dyebath. The dyers also disclosed that the use of PPE is uncomfortable on the body and slows down the mercerizing/dyeing processes. It was observed that PPE is not always provided by the employer but always readily available at the colour shops for sale. Some of the dyers just want to get the job done and earn their wage thereby not using hand glove especially at second rinsing stage. The second rinsing water of vat dyed cellulosic fabrics can be very clear without visibility of colour but may contain residual caustic soda which can cause skin problems. The dyers believe that use of local herbs, eating meat, and drinking milk immediately after the dyeing process suppresses the effects of toxic chemicals. It was also noted that material safety data sheet (MSDS)/material safety information (MSI) is not accessible to the dyers because they usually buy dye and chemicals in few kilograms where chemical suppliers do not transfer hazard and safety information to the retail polyethene bags.

Studies have shown that the use of PPE varies from 10-82 % depending on accessibility, adequacy, affordability, fitness on the user, and its discomfort (Asgedom *et al.,* 2019). Many studies reported that majority of occupational dyers investigated find the use of PPE inconvenient (Howard *et al.,* 2019; Upadhyay and Pandey, 2015). Singhi et al. (2005) found that only dye workers preparing the dye solution were using hand gloves and only a few use goggles in India. According to Bruce-Amartey Jnr and Acquaye (2022), 50 % of dyers in a location in Ghana sometimes use PPE while 26 % do not use

at all and 24 % use protection at all times. According to Asgedom et al. (2019), particleboard workers in Ethiopia were reluctant to use PPE because of lack of access, lack of knowledge of its importance, and that it can easily damage. Similar to the current study, dyers investigated in Ghana only use complete PPE when working on bigger contract involving the use of large quantity of chemicals and the dyers also lack access to MSDS due to retail purchase of dye and chemicals. Having access to MSDS is important because it provides pertinent information about dye/chemical such as chemical name, properties, storage, handling, disposal etc. (Bruce-Amartey and Acquaye, 2022).

The use of local herbs by dye practitioners to suppress the effects of chemicals has been reported previously (Adekunle *et al.,* 2017; Howard *et al.,* 2019). There are many reasons why some workers are negligent in the use of PPE. According to Muleme et al. (2017), farmers investigated in Uganda believed that good crop yield was the most important outcome of farming hence they were more concerned about what the pesticide will do than their safety. Farm workers interviewed in California felt that they had little control over experiencing negative consequences of pesticides and this feeling was associated with failure to use PPE (Quandt *et al.,* 1998). A variety of specialized safety clothing and equipment, usually made of either neoprene, natural rubber, or Polyvinyl chloride, is available for use as protection when handling and working with dyes/chemicals which protect the body from splashes, spattering, and spraying. In Nigeria, majority of people engaged in dyeing activities are unskilled (Akintayo, 2013b; Adekunle *et al.,* 2017; Okafoagu *et al.,* 2017) and may therefore find it difficult to observe all the protective behaviours necessary.

CONCLUSION

Findings revealed that health workers enlightened more than half of the dyers on chemical hazards and safety practices. Majority of the dyers are aware that the chemicals they use can be toxic and consider dermal exposure to be more serious than inhalation and ingestion. The dyers experienced respiratory symptoms which could be due to exposure to dye and/or hydros, and also suffered musculo-skeletal illness as a result of prolonged bending posture. The dyers were found to frequently perform safety practices including the use of hand gloves, protective boots, and apron to avoid dermal contact but may be vulnerable to the effects of chemical via oral and inhalation exposure as majority do not use face mask and nose guard. The dyers are also liable to extreme heat coming from mercerizing/dye baths.

The study recommends that relevant agencies should test the toxicity level of chemicals coming into the state to ascertain whether they are within permissible limits The state government should impose attaching material safety data sheet by colour vendors irrespective of the quantity and make the use of complete PPE by the dyers mandatory.

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