Determinants of knowledge associated with occupational hazards and perceived health problems among dye workers in Abeokuta, Nigeria

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Key words: chemical hazards, occupational safety, personal protective equipment, work-related diseases, work environment characteristics.

Acknowledgments: the authors sincerely thank the textile dye workers who participated in the study; the trade union leaders and the research assistants.

Contributions: OT, AA, data collection; OT, analysis of data and writing of the manuscript. All authors contributed to the critical revision of the draft, read and approved the version to be published.

Conflict of interest: the authors declare no potential conflict of interest.

Ethics approval and consent to participate: ethical approval of the protocol was obtained from the University of Ibadan/University College Hospital Research Ethics Committee, ref. no. UI/EC/18/0637 dated 1st January 2019. All procedures were in accordance with responsible standards on human experimentation and with the Helsinki Declaration of 1975.

Funding: this research was supported by the Consortium for Advanced Research Training in Africa (CARTA). CARTA is jointly led by the African Population and Health Research Center and the University of the Witwatersrand and funded by the Carnegie Corporation of New York (Grant No--B 8606.R02), Sida (Grant No:54100113), the DELTAS Africa Initiative (Grant No: 107768/Z/15/Z) and Deutscher Akademischer Austauschdienst (DAAD).

Availability of data and materials: data and materials are available by the authors.

Informed consent: written informed consent was obtained after explaining to all respondents the purpose of the study and their right to withdraw at any time. Anonymity was ensured as no names or identifiers were included in data collection.

Received for publication: 20 July 2021.
Accepted for publication: 25 April 2022.

Journal of Public Health in Africa 2023; 14:1985
doi:10.4081/jphia.2023.1985

Abstract

Background. Identification of potential hazards, their adverse health effects, and predisposing factors in the workplace are critical to improving safety. The objective of the study was to assess the knowledge of occupational hazards, the prevalence of perceived health problems and their predictors among textile dye workers in Abeokuta Nigeria who work in unsupervised settings.

Materials and Methods. In this cross-sectional study, data were collected from 199 participants using a validated semi-structured interviewer-administered questionnaire. Multiple linear regression analysis was used to determine the predictors of knowledge while Pearson Chi-square was employed to test the association between perceived health problems, sociodemographics and work environment characteristics.

Results. The mean age of the respondents was 40 (SD=12) years with an average work experience of 19 years. The majority of respondents 139 (69.8%) had lower than average scores on knowledge of 25 questions on chemical hazards. There was no correlation between knowledge score and work experience (P=0.492) or age (P=0.462) but the knowledge was significantly associated with exposure score (P=0.004), gender (P=0.002) and adherence to instructions on chemicals usage (P=0.041) after adjusting for safe practice. The most frequent health problems among the dye workers were respiratory disorders (53.8%), allergies (51.8%), and skin disorders (24.1%). Airborne gaseous pollutants from the mixing of chemicals were associated with allergies (P=0.045), circulatory (P=0.02) and skin disorders (P=0.049) while air-borne textile fiber/dye particles could predict allergies (P=0.028).

Conclusions. Findings revealed that exposure, gender and adherence to instruction labels on dye/chemical containers could determine knowledge of chemical hazards while physical work environment characteristics could determine health problems.

Introduction

Occupational hazards arise from various sources including activities, substances, processes, and practices prevalent in the workplace and as a result are peculiar to vocation, workplace environment and workers. To ensure occupational safety, workers must be able to correctly identify sources of harm in their work environment and be knowledgeable about control measures as well as the consequential health burden of poor occupational safety.[1]

Globally, occupational safety and health remains a public health concern with an estimated 160 million diseases and 2 million deaths being reported every year as a result of working under circumstances that foster ill health.[2] According to the WHO global

estimates of Deaths and Disability Adjusted Life Years lost from selected occupational risks in 2004, the most affected workers are those that are routinely exposed to carcinogens and air-borne particulate matter.[3] This category includes workers in farming, mining, automobile, paint and textile industries. In particular, between 20-50% of textile workers are reportedly exposed to hazardous materials in developed countries.[4] These numbers will likely be higher in developing countries such as Nigeria. This is because while safer working conditions now prevail in developed countries, artisans in low- and medium-income countries such as those found in the study population of the Adire cottage industry in Abeokuta Nigeria, still work in informal settings that do not meet the minimum guidelines for occupational health and safety as prescribed by regulatory bodies.[5,6]

Artisans in the Adire cottage dye industry employ a vast range of commercially available vat dyes which have been implicated in studies to cause adverse health effects including hypersensitivity reactions, dermatitis, respiratory problems, liver abnormalities and cancer in exposed individuals.[3,7,8] For instance, the risk of bladder cancer has been reported to be as high as 6.8 and 3.4 times the expected rate among dye applicators in Japan and Britain respectively.[9,10] However, despite the long history of textile dyeing in Abeokuta, only a few studies have been conducted among this group of workers to assess the impact of dye exposure. While a previous study has assessed the worker's knowledge of hazards, no attempt was made in that study to identify the determinants of knowledge.[11] In addition, biochemical changes in liver function among exposed artisans in Abeokuta have been documented,[12] however no study has identified the prevalent work-related health problems as reported by this group of workers or the factors associated with these problems. The objective of this paper was therefore to determine the predictors of the knowledge of hazards and perceived health problems among textile dye workers in Abeokuta Nigeria.

Materials and Methods

Ethical considerations

Ethical approval of the protocol was obtained from the University of Ibadan/University College Hospital Research Ethics Committee, ref. no. UI/EC/18/0637 dated 1st January 2019. Written informed consent to participate was obtained after explaining to all respondents the purpose of study and their right to withdraw at any time. Anonymity was ensured as no names or identifiers were included in data collection. All procedures were in accordance with responsible standards on human experimentation and with Helsinki Declaration of 1975.

Study design and data collection

The study employed a descriptive cross-sectional design with a random sampling technique and was conducted among textile dye artisans in Abeokuta, Nigeria, where artisans work without any government regulatory roles (as regards occupational safety) or organizational supervision, employ various vat and indigenous dyes to produce tie-and-dye prints popularly called Adire. Participants must have been occupationally exposed to textile dyes for a minimum of one year to be included in the study.

The Fisher's formula () for estimating sample size for a single population was employed. The output of the formula with a 95% confidence interval, a prevalence set at 88.5% knowledge of hazards,[4] and a 5% allowable margin of error gave a sample size of 156 which was rounded off to 199 after including provisions for attrition. Data was collected between July and December 2019 using a semi-structured interviewer-administered questionnaire (*Supplementary material*) which contained questions that have been adapted with modifications from previously validated tools.[4,13] The questionnaire was translated into Yoruba language and back-translated to English by two qualified personnel. It was also pre-tested on a proportion of dye workers with vast work experience and their feedback was incorporated to validate and strengthen the instrument. The questionnaire contained sections on demographic information, knowledge about hazards, safety practices, estimates of exposures and perceived health problems. A knowledge score was calculated as the sum score of 25 questions, each weighing one point, which consisted of knowledge about potential sources of harm in the workplace, routes of entry of chemical hazards into the human body, organs affected and their effects on the organs. The total safety practices included scores for 14 questions on workplace hygiene such as 'do you wash hands with soap and water before eating' and 'do you eat in the workshop or during active dyeing'? The artisans were also asked to identify the Personal Protective Equipment (PPE) that they have consistently used in the last month. The total exposure included questions on hours and days worked per week, type of ventilation available at workplace, and the presence of pollutants such as smoke, textile fiber dust, waste dye solution, *etc*.

Statistical analysis

The data collected was cleaned, checked for consistency, coded and entered into IBM SPSS version 23 for analysis. Univariate analysis, with a level of significance at <5%, was used to analyze the association between predictor and outcome variables (knowledge score and PPE compliance score) followed by multiple linear regression analysis to determine the predictors of both outcome variables. Pearson Chi-square was employed to test the association between perceived health problems of artisans, sociodemographic and work environment characteristics.

Results

Demographic information

Of the 205 persons invited, 199 workers responded to the questionnaires giving a response rate of 97%. The majority (76.9%) of the respondents were females and have at least secondary school education (63.3%). The most predominant age group was 31-40 years while the average work experience was 19 years.

Knowledge about chemical hazards

The majority of respondents 139 (69.8%) had lower than average response on knowledge of 25 questions on chemical hazards. Although up to 170 (85.4%) respondents knew at least one body organ that dyes/chemicals can be hazardous to with the skin reported by 103 (51.8%) participants as the most affected, only 37 (18.6%), 29 (14.6%) and 34 (17.1%) respondents were aware that use of dyes and chemicals can affect the lungs, liver and kidneys respectively. Even lower proportions of the respondents 14 (7.0%) had knowledge that dye/chemical exposure could cause medical conditions such as diarrhea or cancer. Similarly, while 150 (75.4%) of the respondents could identify at least one route of entry of chemicals into the human body, only smaller percentages of the respondents knew that intact skin (51.8%), broken skin (48.7%), mouth ingestion (34.7%) and lungs (15.6%) could serve as routes of entry of dye/chemicals into the body.

The majority of the workers 131 (65.8%) also knew that gaseous fumes are generated during the mixing of chemicals while 129 (64.8%) were aware the fumes are hazardous. However, only 58 (29.1%) and 40 (20.1%) could identify waste dye solutions and textile fiber dust respectively as hazardous to human health.

Safety practices

Although the majority of the workers regularly wash their hands after work (89.4%) or before eating (83.4%) as well as bathe their entire body after work (83.9%), a high proportion still engage in high-risk practices such as eating within the work area (84.4%) and taking work clothes home for cleaning (80.4%). Despite 168 (84.4%) respondents claiming to have prior training on safe handling of chemicals, only 125 (62.8%) follow usage instructions on chemical container labels. When asked to identify the PPE used consistently in the last one month, gloves were the most frequently used while only 8 (4%) participants employ safety goggles during work (Table 1).

Predictors of knowledge about occupational hazards

In univariate analyses, the total exposure score, total safety practices score, sex and adherence to usage instructions on container labels were significantly associated with the knowledge score as shown in Table 2. There was no correlation between the knowledge score and work experience (r=0.049, P=0.492) or age (r=0.032, P=0.462). Multivariable analyses revealed that knowledge score was significantly associated with exposure score, sex and adherence to usage instructions while adjusting for total safety practice scores. The model did not change when age and education were included in the analyses.

Predictors of increasing personal protective equipment compliance

Age, education, exposure score, reading label instructions, prior instructions on safe handling and perceived barriers were associated with PPE usage when analyzed using a univariate simple linear regression model as presented in Table 3. Multiple linear regression revealed that age, exposure score, label familiarization and perceived barriers were significantly associated with PPE usage after adjusting for other factors.

Table 1. Percentage distribution of personal protective equipment usage and responses of participants to perceived barriers constructs.

Respondents who used the following PPE consistently in the last one month	Frequency (n)	Percentage (%)	
Gloves	172	86.4	
Respirator	116	58.3	
Eye goggles	8	4.0	
Overall apron	113	56.8	
Safety boots	21	10.6	
Responses to questions on perceived barriers to PPE usage	**Agree n (%)**	**Undecided n (%)**	**Disagree n (%)**
Use of PPE is cumbersome or uncomfortable	34 (17.1)	0	165 (82.9)
The use of PPE is a waste of resources	9 (4.5)	1 (0.5)	189 (95.0)
Alternatives (such as blood flushing with antibiotics) is as effective as PPE in preventing harmful effects of exposure	113 (56.8)	3 (1.5)	83 (41.7)
Risks associated with dye/chemical exposure are over exaggerated	66 (33.2)	1 (0.5)	132 (66.3)

PPE, personal protective equipment.

Table 2. Association between knowledge score, total exposure score, safety practice score and demographic characteristics of respondents.

Variable	Univariate analysis B	Univariate analysis P	Multivariable analysis B	Multivariable analysis P	Adjustment
Intercept			8.841	0.04	
Exposure score	0.861	0.000	0.704	0.004	0.005
Adherence to usage instructions on containers (0=No, 1=yes)	2.113	0.012	2.026	0.041	0.041
Sex (0=male, 1=female)-3.973	0.000	-3.112	0.002	0.002	
Safety practices score	0.404	0.045	-0.67	0.792	0.781
Age (0=19-30; 1=>30 years)	-0.734	0.462	-0.192	0.845	
Education (0=without secondary education, 1=with at least secondary education)	1.128	0.206	0.045	0.96	

B, regression coefficient.

Table 3. Univariate and multiple linear regression to determine predictors of increased personal protective equipment compliance among dye workers.

Variable	Univariate analysis B	Univariate analysis P	Multivariable analysis B	Multivariable analysis P
Intercept			0.771	0.169
Sex (0=male, 1=female)	-0.074	0.688		
Age (0=19-30; 1=>30 years)	-0.518	0.003	-0.429	0.012
Education (0=without secondary education, 1=with at least secondary education)	0.449	0.005	0.257	0.102
Exposure score	0.140	0.000	0.161	0.000
Received instructions on safe handling (0=No, 1=yes)	0.367	0.047	0.331	0.098
Read label instructions on dye containers (0=No, 1=yes)	0.345	0.007	0.343	0.008
Perceived barriers	-0.133	0.003	-0.113	0.007

B, regression coefficient.

Perceived health problems

The most frequent health problem among the dye workers was respiratory disorder with 107 (53.8%) of participants affected as shown in Table 4. Seventy-five (37.7%) of the participants cough up phlegm every day for at least a part of the year. More than half of the respondents 103 (51.8%) also reported one form of allergy or the other.

The relationship between the prevalence of work-related disorders and variables including sociodemographic and workplace environment characteristics are presented in Table 5. While all the factors are likely to serve as predisposing factors to health problems, the prevalence of circulatory disorders had a significant association with sex (P=0.003), air-bone gaseous pollutants from mixing of chemicals (P=0.020) and organic solvents fumes (P=0.019). There was also a significant association between the prevalence of allergies, air-borne particles (P=0.028) and gaseous products from chemicals (0.045).

Discussion

This study investigated the determinants of the knowledge of hazards and perceived health problems among textile dye workers in Abeokuta Nigeria. We found that artisans who were more exposed to hazards were more likely to have high knowledge about occupational hazards. Workers with increased contact with hazards were therefore more knowledgeable about them. Workers who adhere to usage instructions on dye/chemical containers or safety data sheets were also twice more likely to have high knowledge compared to others. This is corroborated by a study among Nigerian health workers which identified educational materials and literature as contributing up to 8% of their knowledge of occupational hazards.[14]

When the association between the perceived health problems of the textile dye workers and work environment characteristics was investigated, the presence of airborne gaseous products from the mixing of chemicals was found in positive association with a maximum of three health problems- allergies, circulatory and skin disorders. Studies have estimated that the cardiovascular health effects of particulate matter air pollution equal and may even exceed respiratory adverse events.[15,16] Elevated levels of fine particulate matter (with less than 2.5 μM diameter) as well as gaseous co-pollutants (such as those generated during the mixing of chemicals as reported by participants in this study), can lead to acute cardiovascular morbidity in the short term and a reduction in life expectancy over the long term.[15]

Furthermore, we also found a significant association between the prevalence of allergies and larger airborne particles such as suspended dye particles and textile fiber dust. The link between air pollution and respiratory diseases, allergies including asthma is well documented by several epidemiological studies.[17-19] Exposure to textile fiber dust has also been implicated in increased risk for oxidative stress and mesothelioma, a type of cancer of the lining of the lungs, which is characterized by shortness of breath, persistent cough and chest pain.[20] A strong association between excessive heat at the workplace and respiratory disorders among workers was also found in this study. This agrees with previous findings that prolonged exposure to heat can exacerbate preexisting conditions including respiratory diseases.[21]

Table 4. Frequency of work-related disorders among textile dye workers in Abeokuta.

Work related disorders	Symptoms	n (%)
Respiratory	Wheezing, shortness of breath at work, cough, phlegm	107 (53.8)
Circulatory	Chest pain, shortness of breath in sleep, woken by attack of cough from sleep	23 (11.6)
Allergies	Nasal allergies, hay fever, runny nose, confirmed asthma diagnosis by doctor	103 (51.8)
Skin	Contact dermatitis, atopic dermatitis, skin irritation, skin hardening or tenderness	48 (24.1)
Eye	Eye irritation, conjunctivitis, itchy eyes, burning eyes	43 (21.6)
Chronic wounds	Sore on extremities that fail to heal completely, mouth sores that fail to heal	4 (2.0)

Table 5. Association between perceived health problems, sociodemographic and workplace environmental factors of respondents.

Variable	Respiratory		Circulatory		Allergies		Skin		Chronic wound		Eye	
	P	OR (IC95%)	P	OR (IC95%)	P	OR (IC95%)	P	OR (IC95%)	P	OR (IC95%)	P	OR (IC95%)
Sex (0=male, 1=female)	0.445	0.771 (0.39-1.50)	0.003	0.271 (0.11-0.66)	0.200	1.541 (0.79-2.99)	0.054	0.496 (0.24-1.02)	1.000	0.900 (0.09-8.86)	0.980	0.990 (0.44-2.20)
Age (0=19-30; 1=>30 years)	0.909	1.038 (0.54-1.98)	0.733	1.200 (0.42-3.42)	0.437	1.292 (0.67-2.46)	0.402	0.733 (0.35-1.51)	0.986	0.980 (0.10-9.64)	0.814	1.100 (0.49-2.43)
Education (0=without secondary education, 1=with at least secondary education)	0.417	0.786 (0.44-1.40)	0.508	1.371 (0.53-3.50)	0.344	0.756 (0.42-1.35)	0.893	0.955 (0.48-1.86)	0.577	0.573 (0.07-4.15)	0.936	0.972 (0.48-1.95)
Air-borne solid particles (0=No, 1=yes)	0.105	1.588 (0.90-2.78)	0.055	2.447 (0.96-6.24)	0.028	1.872 (1.06-3.28)	0.124	1.675 (0.86-3.24)	0.121	1.041 (1.00-1.08)	0.075	1.870 (0.93-3.74)
Air-borne gaseous products (0=No, 1=yes)	0.354	1.318 (0.73-2.368)	0.020	4.000 (1.14-13.97)	0.045	1.823 (1.01-3.29)	0.049	2.098 (0.99-4.43)	0.300	1.032 (1.00-1.06)	0.292	1.487 (0.70-3.12)
Air-borne combustion products (0=No, 1=yes)	0.073	1.732 (0.94-3.16)	0.541	1.357 (0.50-3.62)	0.426	1.275 (0.70-2.31)	0.775	0.904 (0.45-1.80)	0.592	0.455 (0.06-3.30)	0.55	1.255 (0.59-2.64)
Air-borne organic solvent fumes (0=No, 1=yes)	0.143	1.556 (0.85-2.81)	0.019	2.786 (1.15-6.73)	0.268	0.719 (0.40-1.29)	0.243	1.487 (0.76-2.89)	0.611	1.910 (0.26-13.88)	0.065	1.899 (0.95-3.77)
Dye waste products (0=No, 1=yes)	0.371	1.311 (0.72-2.37)	0.29	1.606 (0.66-3.88)	0.923	1.029 (0.57-1.85)	0.090	1.775 (0.91-3.46)	0.302	0.970 (0.94-0.99)	0.579	1.220 (0.60-2.46)
Excessive heat (0=No, 1=yes)	0.008	2.162 (1.22-3.82)	0.939	1.035 (0.43-2.48)	0.876	1.046 (0.59-1.83)	0.159	1.618 (0.82-3.17)	0.037	0.955 (0.91-0.99)	0.296	1.446 (0.72-2.89)

Although it is regarded as the least effective in safeguarding workers' health, PPE remains invaluable in informal settings such as the study site which lack more effective organizational means to reduce workplace risks. We, therefore, investigated the predictors of PPE usage among the artisans and found that familiarization with labels and safety data sheets was a strong predictor of PPE compliance. This agrees with a study conducted among garment workers in India that showed that safe practice did not depend on knowledge but was positively associated with being supplied with chemical information.[22] Artisans with increased contact with hazards (both in terms of work hours and those who reported poor air quality in the workplace due to inhalation of hazardous substances) were also more likely to use PPE than others. In addition, the perceived barriers in this study were negatively associated with the use of protective equipment and were consistent with findings with other categories of workers. These include discomfort wearing PPE, being expensive as well as a reduced risk perception among workers.[23,24]

Limitations

The limitations of this study are those peculiar to a cross-sectional design such as the inability to establish true causality. Safety practices and health problems were self-reported and may be biased. No cause-effect relationship can also be applied to the association identified in this study. Nonetheless, the results have important implications for occupational safety among this and similar groups of workers who work in informal and unsupervised settings.

Conclusions

This study revealed that artisans with more contact time with the dyeing process and those who read label instructions have more knowledge of occupational hazards. Gaseous products arising from the mixing of chemicals and suspended textile fiber/dye particles were also found to be high-risk factors for health problems (respiratory, allergy, circulatory) among the artisans. The study also revealed a low usage of PPE among textile dye workers in Abeokuta, Nigeria, and perceived barriers including a reduced perception of risk were identified as a determinant of PPE compliance.

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Online supplementary material:
Workplace exposure questionnaire. Part A: sociodemographic information. Part A: sociodemographic information. Part C: safety practices and barriers to PPE compliance. Part D: estimates of exposure. Part E: self-reported health problems.