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Demographic determinants of chemical safety information recall in workers and consumers in South Africa: A cross sectional study

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A B S T R A C T

Background: Chemical hazard communication (e.g., label) is intended to alert users of the potential hazards of chemicals. Apart from the fact that hazard information needs to be understood, it is also important that it is recalled. Recall of hazard communication is critical when the written form of the information is not available at the time it is required. *Methods:* A cross-sectional study investigating associations between the recall of chemical safety information on labels and safety data sheets among 402 participants including 315 workers (industry, transport and agriculture sectors) and 87 consumers in two provinces of South Africa was conducted. The recall of label information by participants was tested using two modules from a Hazard Communication Comprehensibility Testing (CT) Tool developed by the Centre for Environmental and Occupational Health Research at the University of Cape Town for the UN Institute for Training and Research (UNITAR). *Results:* Respondents were predominantly male (67.7%), the median age was 37 years (IQR: 30–46 years) and less than half of the participants completed high school (47.5%). The skull and crossbones symbol was the label element most recalled, both freely without prompting (79.6%) and recognition after prompting (94.8%). Whereas, the first aid and treatment measures were the least frequently freely recalled (least frequent item 6.0%; most frequent item 29.9%). Multivariate analysis identified the following positive associations with the recall of all the label elements listing the strongest association: call appropriate services and industrial vs. consumer sector (OR = 2.4; 95% CI: 1.2; 4.6); call appropriate services and transport vs. consumer sector (OR = 4.4; 95% CI: 1.2; 16.0); flammable symbol and male vs. female gender (OR = 2.3; 95% CI: 1.0; 5.3); flammable symbol and home language English vs. African languages (OR = 6.6; 95% CI: 2.1; 21.2); any hazard statement and home language Afrikaans vs. African languages (OR = 14.0; 95% CI: 3.6; 54.2), any first aid statement and further education vs. none (OR = 3.3; 95% CI: 1.3; 8.0), correct chemical name and industry blue collar workers vs. non-industry blue collar workers (OR = 2.6; 95% CI: 1.1; 6.1), correct chemical name and non-industry white collar occupations vs. non-industry blue collar workers (OR = 2.7; 95% CI: 1.0; 7.1). *Conclusion:* The study found a number of potential positive associations that influence recall of label elements of which some (e.g., sector, gender, occupation) suggest further research. Relevant policies in South Africa should ensure that the safety information on chemical labels is clearly visible to read and understandable which aids recall and the reduction in harmful chemical exposures.

1. Introduction

Chemical hazard communication (e.g., labels, Safety Data Sheets) is intended to alert users of the potential hazards of chemicals to promote safe behaviors to prevent harmful chemical exposures. Apart from the fact that hazard information on chemical labels should be understandable, it is also important that it should be recalled, which means that hazard words or pictures should be able to be retrieved from memory (Houts, Doak, Doak, & Loscalzo, 2006).

The literature has demonstrated that culture plays a crucial role in the interpretation of hazard information (Smith-Jackson & Wogalter, 2000). Hazard information, which is often intended for specific target audiences, could therefore result in incorrect interpretations due to cross-cultural differences. For instance, a study in Ghana with industry and trade workers showed varied meanings given by the workers to several hazard symbols from the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO) (Smith-Jackson & Johnson, 2002). The authors pointed out that interpretation of hazard information, which is dependent on the interactions of a person with the physical environment, differ even within cultures highlighting the importance of developing inclusive health and safety material.

To harmonize chemical hazard communication, the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

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was endorsed in 2002 by the United Nations Committee on Experts on the Transport of Dangerous Goods (UNCETDG) which is being informally implemented by companies in South Africa as promulgation into law is pending (GHS, 2015; Rother & London, 2008). The GHS aims to promote human and environmental safety, facilitate international trade of chemicals whose hazards have been properly assessed, avoid duplication of hazard assessment procedures across multiple countries and provide an adequate data framework upon which to build comprehensible safety programs (Dalvie, Rother, & London, 2014; Rother & London, 2008). This harmonization of information that is contained on labels and in safety data sheets (SDS) is expected to provide standardized information which in turn promotes better comprehension and recall of chemical hazard information.

Warning labels are comprised of different elements to communicate the hazard and precautionary information to end-users with different levels of literacy as well as drawing attention to crucial information. Recall is likely to be connected to the comprehension of information since comprehension enables a person to recall information (Sundar, Becker, Bello, & Bix, 2012). Previous studies investigating the effect of demographic factors on recall and comprehension have shown that there are contradictory findings in the literature on the effect of education, training, gender, and age on comprehension and sparse research on determinants of recall. (Andreeva & Krasovsky, 2011; Banda & Sichilongo, 2006; Dalvie et al., 2014; Lesch, 2003; Ta et al., 2010). The contradictory findings may be due to a lack of using a consistent methodology for measuring comprehension and recall and due to a limited range in the distribution of demographic and educational variables. This study therefore investigated factors determining the recall of hazard information among workers and consumers in two provinces of South Africa using the GHS methodology and a study sample with a wide range in the distribution of demographic and educational variables.

2. Experimental section

2.1. Study design

This study was part of a larger cross-sectional analytic study that investigated the comprehensibility of chemical hazard communication tools developed by the University of Cape Town among 402 workers and consumers in the Western Cape and Gauteng provinces of South Africa (Dalvie et al., 2014; London, Rother, Tolosana, & Maruping, 2003). Province was used as the primary grouping variable as there are 9 provinces in South Africa with a local government and distinct economic and demographic profile. The four sectors of chemical users investigated were industry, transport, agriculture, and consumers. Budgetary constraints limited the study to two out of nine provinces in South Africa. However, it was felt that the two provinces contain a sufficiently broad range of different rural and metropolitan sectors to allow sampling of all relevant target groups. Gauteng is the most populated and economically active province in South Africa and proximal to Johannesburg and Pretoria, two large cities in the country. The Western Cape has the second largest economy in the country and is proximal to Cape Town, another large city in South Africa.

2.2. Study population

The main study (Dalvie et al., 2014; London et al., 2003) was intended to provide a snapshot view of the comprehensibility of chemical hazard information to support the implementation of the GHS in South Africa. The study population was therefore taken to reflect employees with potential exposure to chemicals (e.g., farmers, factory workers) as well as consumers who are likely to be affected (e.g., clients of hairdressers).

2.3. Sampling

From each sector 100 subjects were sampled, with 50 each from the Western Cape and Gauteng provinces (London et al., 2003). Within the four sectors, there were different types of sampling procedures and participants were stratified accordingly. Chamber of Commerce lists from 2003 were used as the sampling frame for the industrial and transport sectors. In general, the goal for every workplace sampled was to include a range of production workers, shop stewards/safety representatives, managers/supervisors, and technical (e.g., laboratory) staff. If a company declined to participate, or did not respond, one substitution was allowed from the company next on the list. However, even after an allowed substitution, the substituted company may not have participated. This non-participation differed across sectors and sub-sectors, resulting in different sample sizes for each province. A detailed description of the sampling for the study can be found in the NEDLAC report (http://www.unitar.org/cwm/ghs_partnership/CT.htm).

2.3.1. Industrial site

The industrial sector included workers, managers, factory supervisors, and laboratory scientists. The sample included a chemical stratum (users and generators of chemicals such as laboratory workers) and non-chemical stratum which consisted of a combination of Standard Industrial Classification categories (mining, paper, textiles, electricity, gas and water, construction, wholesale and retail trade, health care, domestic works, and cleaning industries) and was about twice the size of the other sectors. The strata were further categorized by company size, which was determined by the number of employees (small <20 employees; medium: 20 to 199 employees; large ≥200 employees). It was intended to reach a balance of 40% small, 30% medium and 30% large.

2.3.2. Transport

The transport sector included road, rail, air, and sea transport, stratified by whether companies were exclusively involved in transport and companies who maintained transport fleets as part of a wider chain of production (e.g., petroleum). The strata were further categorized by company size which was determined by the number of employees (small <20 employees; medium: 20 to 199 employees; large ≥200 employees). It was intended to reach a balance of 40% small, 30% medium, and 30% large.

2.3.3. Agriculture

The agricultural sector included farm workers, managers, and other related agricultural workers. Due to limitation in access, farms were selected by opportunistic sampling and were stratified by large commercial farming (including agribusiness), small commercial farming and emergent farmers (farmers who are new entrants to farming, typically part of a land restitution process involving small farmers seeking to become commercially viable).

2.3.4. Consumer

Consumers were sampled by opportunistic sampling of clients from supermarkets, laundromats, hairdressers, and hardware shops. They

Table 1
Sample from each province (N = 402).

	Cape Town n (%)	Gauteng n (%)	Total n (%)
Industry (chemical)	62 (15.4)	24 (6.0)	86 (21.4)
Industry (non-chemical)	63 (15.7)	27 (6.7)	90 (22.4)
Transport	44 (10.9)	28 (7.0)	72 (17.9)
Agriculture	55 (13.7)	12 (3.0)	67 (16.7)
Consumer	67 (16.7)	20 (5.0)	87 (21.6)
Total	291 (72.4)	111 (27.6)	402 (100.0)

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