

# Safe use of chemicals by professional users and health care specialists

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Received November 10, 2017; Accepted December 13, 2017

DOI: 10.3892/br.2018.1037

**Abstract.** The awareness of Greek professional users and health care specialists regarding the safe use of chemicals was investigated, to be the best of our knowledge, for the first time after the introduction of Regulations (EC) 1907/2006 (REACH) and 1272/2008 (CLP) on chemicals. A total of 200 professional users and 150 health care specialists from various regions of Greece contributed to the use of a closed-ended, anonymous and validated questionnaire. The findings showed that over 85% of the responders were not aware of classification, labelling and packaging (CLP) and 67.8% of the responders were unaware of any changes made in the labeling of the products they were using. The majority (>75%) of individuals were cognizant that they were using hazardous products; however, the perception of hazard varied significantly between the two groups ( $P=0.012$ ) and statistically were dependent on the educational ( $P=0.022$ ) and the profession ( $P=0.014$ ) level. One third of the professional users read the label as the main source of information for the product, while for health care specialists the number increased to 65% and a strong correlation was detected with the educational level ( $P=0.017$ ). In both groups, 7% of professional users and health care specialists declared that hazard communication through product labeling is not well understood. The use of personal protective equipment (PPE) is almost universal for health care specialists with women being more sensitive

( $P=0.041$ ), while 25% of the professional users do not use any PPE. Almost 60% of the health care specialists are required to provide instructions regarding the safe use of chemicals or the action to be undertaken in case of accident. In the latter situation, the National Poisoning Centre is the reference point for information. Limited use of the safety data sheets has been observed both for professional users (18%) and health care specialists (23%). In conclusion, rising awareness campaigns are needed, in collaboration with trade unions and health care professional associations, in order to alert professionals regarding the safe use of chemicals and protect human health and the environment.

## Introduction

Chemicals constitute a part of everyday life. Approximately 1,000 new chemicals are placed on the market each year, usually found as mixtures in commercial products, while more than 100,000 chemical substances are used worldwide (1). Many of these chemicals may, especially if not properly used, possess hazards for human health and be toxic to the environment.

The hazards of chemicals can be classified based on physical, chemical and ecotoxicological endpoints using criteria developed in the framework of scientific or regulatory processes (2). A number of national and international schemes have been developed over the past 50 years. To avoid multiplicity and confusion at the user level, the globally harmonized system (GHS) for the classification and labeling of chemicals was adopted in 1992 during the Rio Earth summit. GHS includes easily understandable symbols that can be applied in the manufacture, transport, use and disposal of chemical substances (2).

At a European Union (EU) level, two Regulations have been introduced, Regulation (EC) 1907/2006 (REACH) and Regulation (EC) 1272/2008 aimed to effectively handle hazards and risks from chemicals. The new EU chemicals legislation applies to all industry sectors dealing with chemicals along the

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**Key words:** CLP, labeling, chemicals, safe use, poisoning centres

entire supply chain. It therefore makes companies responsible for the safety of chemicals they place on the market.

The CLP Regulation, which is based on GHS, ensures that the hazards presented by chemicals are clearly communicated to workers and consumers in the European Union through the classification and labelling of chemicals. The industry must establish the potential risks to human health and the environment of substances and mixtures prior to placing them on the market as commercial products, by classifying them using the classification, labelling and packaging (CLP) criteria, in line with the identified hazards. The need to develop harmonized criteria for classification is essential in ensuring effective communication of the risk (3). Hazardous chemicals also have to be accordingly labeled using hazard and precautionary statements and pictograms.

In addition, suppliers established in the EU and placing hazardous products on the market have to provide standardised information to be used only by Poison Centres (Article 45 of the CLP). The Poison Centres provide medical advice in case of poisoning due to exposure to hazardous chemicals or to other toxic agents to the general public and to physicians. Poison centres in the EU answer on average 600,000 calls for support each year. However, EU legislation does not specify the precise information needed for this product notification. Therefore, varying requirements have been developed by each EU member state (4).

Safety data sheets (SDSs) are the main communication tool under the REACH Regulation between suppliers and users of substances and mixtures and it is a regulatory obligation for the industry. SDSs include information on the physical, chemical and hazardous properties of the substance or mixture as well as instructions for their handling, disposal and transport, and for first-aid, fire-fighting and exposure control measures.

The aim of the present study was to assess for the first time, to the best of our knowledge, the level of comprehension of the hazard and risk communication and awareness regarding the safe use of chemicals among Greek professional users and health care specialists eight years after the introduction of the respective EU legislation.

## Materials and methods

A total of 1,500 individuals (850 industrial workers and professional users of chemicals from 35 different small and medium enterprises, self-employed professionals included, and 650 health care specialists from 6 public and private hospitals/medical centres, 40 private practitioners included), in Athens; Thessaloniki; Larissa; Ionnina; Patras and Heraklion Crete, Greece, were asked to answer an anonymous validated, self-administered questionnaire with 26 close-ended questions from May 2016 to April 2017. The questionnaire was left at the reception desk of the various workplaces, accompanied with an explanatory opening page, where it was stated that the results of the survey were to be published. The return of the completed questionnaire was considered as written consent of the study population. A total of 350 individuals (200 workers and professional users, 150 health care specialists) returned the questionnaire by placing it in a specifically marked receptacle at the reception desk of the various workplaces (return rate 23.3%, in the range of the typical self-completed surveys) (5).

The questionnaire was developed at the University of Thessaly, Department of Biochemistry and Biotechnology (Larissa, Greece) in the framework of the MSc Course on Toxicology and was structured in three sections. The first section addressed demographic information (6 questions); the second investigated the risk/hazard communication of chemicals (14 questions); and the third explored the use and application of personal protective measures (6 questions).

Once the questionnaire was constructed, a multidisciplinary group of professionals that were not participating in the research group was asked to review the document and provide input. This expert group consisted of a toxicologist, a regulatory officer, an officer from the industry and a psychiatrist. The group provided input on the general content and face validity of the questionnaire (Content Validity Ratio-CRV =0.993,  $P<0.05$ ) (6), which was proven complete and adequate for distribution.

The 103rd General Assembly of Specific Interest (09/03/2016) of the Department of Biochemistry and Biotechnology, University of Thessaly, provided approval for the conduct of the study and distribution of the questionnaire, as part of the dissertation theses of the students M.A. and I.K.

*Statistical analysis.* Statistical analysis was performed using the SPSS 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were calculated as frequencies and percentages. Chi-square ( $\chi^2$ ) tests were computed to reveal meaningful associations between supplements use and the categorical study variables (sex and level of education) and Pearson's correlation was performed for continuous variables (i.e., age and exercise years).  $P<0.05$  was considered to indicate a statistically significant difference.

## Results

*Demographic characteristics.* The demographic characteristics of the study population are shown in Table I. Professional users (group 1) and health care specialists (group 2) were of statistically similar age ( $P=0.323$ ) and work experience ( $P=0.224$ ). Women are statistically more in the health care specialists group, while men dominate the professional workers group. Twenty different professions were identified in the participants of group 1, including industrial workers (chemical products, plastics, pharmaceuticals, food industry and energy products/fuels), gas station employees, painters, carpenters, farmers, hairdressers and drivers. The vast majority of these professions belong to the private sector (>80%). The level of education in group 1 was significantly lower than 2, as expected. More specifically, in group 1, 81% of the responders did not go to University or attend post-graduate courses, whereas in group 2 the respective value was 29%. Of note is the low percentage of professional users of chemicals with no diagnosed health problems (28%), while the prevalence of allergies (skin and respiratory system) is high in this population (>50%). The picture is opposite in health care specialists.

*Perception of various GHS pictograms.* In several issues the two groups had statistically similar responses. Over 85% of the responders are not aware of the CLP Regulation per se, while 20% of professional users of chemicals are aware of the

Table I. Demographical characteristics and diagnosed health status, type of working activity, work experience and educational level of the studied population.

Characteristics	Professional users	Health care specialists
Population (no)	200	150
Age (years)	41.8±7.5 (21-61)	38.8±9.5 (24-64)
Sex		
Male	115 (60)	55 (37)
Female	85 (40)	95 (63)
Occupation		
Workers (private sector)	78 (39)	
Workers (public sector)	37 (18)	
Self-employed	85 (42)	
Medical doctors		116 (77) <sup>a</sup>
Nurses		22 (15)
Clinical chemists		12 (8)
Working experience (years)	12.0±8.80 (1-40)	16.2±9.78 (5-52)
Education		
Primary	42 (21)	0 (0)
Secondary	74 (37)	11 (7)
Technological	46 (23)	33 (22)
University	22 (11)	63 (42)
Post-graduate	18 (9)	51 (32)
Diagnosed health problems		
None	56 (28)	104 (69)
Dermatological problems	66 (33)	4 (3)
Respiratory problems	38 (19)	4 (3)
Musculoskeletal problems	20 (10)	9 (6)
Cardiovascular problems	4 (2)	2 (1)
Hypertension	10 (5)	9 (6)
Other	6 (3)	18 (12)

<sup>a</sup>Numbers in parentheses are percentages.

REACH Regulation. Over 65% of the responders did not notice any changes in the labeling of the products being used. The most common pictogram encountered is the old hazard symbol of a black cross on an orange background from the Dangerous Substances/Products Directives (approximately 40%), which became obsolete in June 2015. In general, 50-60% of professional users perceive pictograms adequately, while for health care specialists the percentage rises to 80%. Nevertheless, both groups understand only the corrosive hazard for the skin/eyes in pictogram GHS05 and only 8% in group 1 and 26% in group 2 also comprehended the corrosivity for metals depicted by the same pictogram (Fig. 1). Over 65% of the responders consider pictograms GHS06 and GHS08 equally hazardous for human health, but only 5% in group 1 expect carcinogenicity or reproductive toxicity to be communicated with the use of GHS08 (Fig. 2).

The majority of the responders (>75%) are aware of the use of hazardous products during their everyday life, but the

perception of hazard and the severity varies significantly between the two groups ( $P=0.012$ ) and statistically depends on the educational ( $P=0.022$ ) and professional ( $P=0.014$ ) level. Professional users declare that they commonly use flammable liquids (26%), while 7% declare use of carcinogens and chemicals hazardous for the environment.

In general, age ( $P=0.02$ ), work experience ( $P=0.025$ ) and profession ( $P=0.022$ ) significantly correlate with the level of familiarization with CLP. One third of the professional users enrolled in this study read the label as the main source of information for the product, while for health care specialists the number increased to 65%. A strong correlation was detected with the educational level of the responders ( $P=0.017$ ). In both groups a significant 7% declared that hazard communication through the labeling of the product is not well understood. Limited use of SDSs regarding the safe use of chemicals has been observed both in professional users (18%) and in health care specialists (23%).

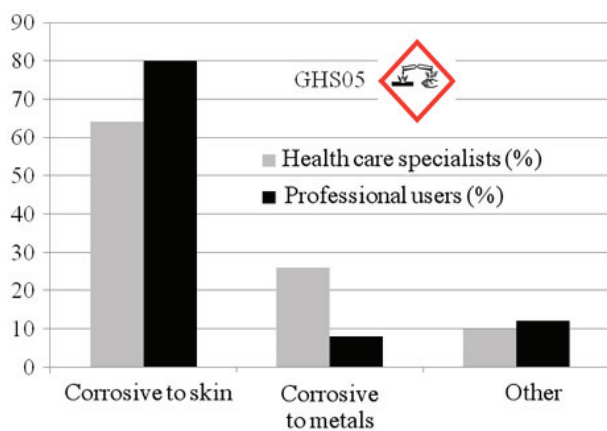


Figure 1. Perception of the pictogram GHS05 by the study population.

The use of personal protective equipment (PPE) is almost universal in health care specialists with women being more sensitive ( $P=0.041$ ), while 25% of the professional users do not use any PPE. In addition, 30% of the professional users who use PPE, do so after being instructed by their employer or the shift supervisor. The most commonly recommended PPE are gloves (50% in group 1 and 80% in group 2) followed by protective goggles/mask (35% in group 1 and 15% in group 2). Nevertheless, when it comes to everyday practice, only gloves are used in group 1. In both groups, 15% of the responders do not take any special precautions regarding their workwear at home, while younger ( $P=0.015$ ) and more educated ( $P=0.035$ ) users of chemicals utilize special cleaning practices.

Almost 60% of the health care specialists interviewed have been informed on the safe use of chemicals or actions to be undertaken in case of accident. In the latter situation, the National Poisoning Centre is the reference point for information, whereas 20% of the health care specialists prefer SDSs.

## Discussion

Use of chemicals in the work environment may have consequences on human health, which influences the protection measures that need to be employed and the supportive system in case of accidents or poisonings by health care specialists.

Workers in gas stations are reported to suffer from headaches (32%) and fatigue (20%) (7). In addition, a statistically significant increase in red blood cell counts, haemoglobin, mean corpuscular hemoglobin and platelet counts were found in all self-reported health-related complaints among liquefied petroleum gas workers (8). These symptoms are directly associated with benzene inhalation and workers are found to be exposed regardless of their position in the gas station (9,10).

The prevalence of respiratory and pulmonary problems and even cholangiocarcinoma in printing workers is markedly elevated, with concerns also being applicable for consumers (11-13). In addition the association between exposure to chemicals and asthma and rhinitis remains independent of exposure to dust (14). A meta-analysis of 13 European cohorts spanning births from 1994 to 2011 indicated that employment during pregnancy in occupations classified as possibly or probably exposed to endocrine disruptors was associated with

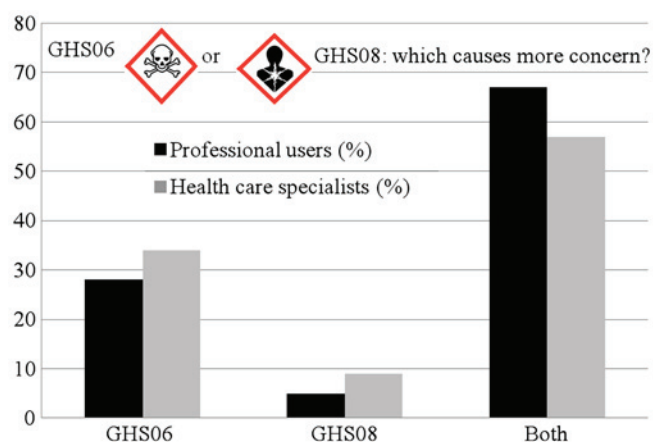


Figure 2. Perception of the hazard severity depicted by pictograms GHS06 and GHS08 by the study population.

an increased risk of term (15). An association has also been reported between textile industry and different types of cancer including lung, bladder, colorectal and breast cancer (16).

In the present study, 72% of professional users of chemicals face health issues connected to skin and respiratory sensitisation.

Several studies have attempted to elucidate the comprehension of the legislation on chemicals and the hazard communication among workers and the general public (17-21).

Pictograms are the prevailing element in hazard/risk communication. It has been shown that the underlying core elements that enhance understanding of GHS pictograms, which are also essential in developing competent individuals in the use of SDSs, are training and education (22). Cleaning workers found not to be familiar with the pictograms had not been properly informed on the safe usage of chemicals by their employers (20). Age and educational level may impact workers' performance and cognitive process of comprehension of pictograms (19), as evidenced in the present study. Some pictograms are more easily perceived, while others remain controversial, such as GHS05, GHS06 and GHS08, as identified in our study. Similar concerns have been raised regarding the labeling of fragrances (23).

In a meta-analysis of 9 research studies published from 1983 to 2005 evaluating the relationship between literacy and hazard communication three main gaps were recognized regarding lack of learner involvement to improve hazard communication, lack of employer assessment of employee understanding of training provided, and lack of studies assessing retention of the material taught and its application at the worksite (18). In the present study, 30% of the professional users of chemicals tend to perceive the hazard/risk of a chemical after instruction by the employer or the shift supervisor to use PPE. Of note, low PPE compliance persists despite worker awareness of herbicide exposure risks, potentially as a result of the influence of the sex dynamics and social culture (24).

Appropriate work practices and selection and use of PPE are strongly recommended and measurements at the workplace have proven the efficacy thereof (25,26). Nevertheless, use of PPEs is restricted, as observed in the present study. Farmers that are overexposed to pesticides toxicity do not use PPE (27). On the other hand, disposable latex gloves commonly worn

by gardeners provide inadequate protection even for contact with pesticides over a short period of time (28). Thus, more emphasis should be given on awareness-raising activities and increase of the communication of chemicals hazard/risk.

Health care specialists are expected to use PPE more extensively to protect themselves from infectious diseases and pathogens (29,30). Nevertheless, these PPEs are not adequate for protection from chemicals and lack of compliance is evident regarding PPEs, even among medical technicians (31). Consequently, the observed almost universal use of PPEs by health care specialists in the present study is potentially misleading. Regarding compliance of the medical staff engagement of the personnel in auditing PPE use and reporting activities may significantly improve compliance (32).

Health care specialists are often asked to treat cases that are linked with exposure to different chemicals. In the present study, 60% of responders were informed regarding the safe use of chemicals or actions to be undertaken in case of accident. In the latter situation, the National Poisoning Centre is considered the reference point for information for the vast majority of medical doctors. However, the National Poisoning Centers are less often consulted when emergency poisonings are treated in the primary or tertiary care centers (33). Data legally required to be declared to National Poisoning Centers should be harmonized within EU and the new regulatory framework, which is the primary aim of these legal frameworks (34,35).

In conclusion, on a national level, awareness-raising campaigns are imperative (36,37), in collaboration with trade unions and health care professional associations, in order to alert professionals regarding the safe use of chemicals to protect human health and the environment.

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