Ann Ist Super Sanità 2010 | Vol. 46, No. 3: 323-329
DOI: 10.4415/ANN_10_03_17




# Survey among agricultural workers about interpretation of plant protection product labels and safety data sheets

**Maristella Rubbiani**
*Centro Nazionale Sostanze Chimiche, Istituto Superiore di Sanità, Rome, Italy*

**Summary.** The objective of this work was to examine the effectiveness of risk communication in agriculture through examination and interpretation of safety data sheets and product labels for agriculture products classified as hazardous. Labels and safety data sheets were shown to the users inviting them to report their own interpretation of hazard, risk and the need of preventive measures. One area sample was identified in a cluster of wine companies, chosen in a range of medium to large sizes throughout the country, where 100 subjects were interviewed by telephone or direct interview. Participants were surveyed through questions relating to demographic information, education and perception of risk.

*Key words:* safety data sheets, dangerous preparations, labels.

**Riassunto** *(Indagine nei lavoratori agricoli sull'interpretazione di etichette e schede di sicurezza di prodotti per l'agricoltura)*. Con questo lavoro il nostro obiettivo è stato quello di esaminare l'efficacia della comunicazione del rischio nei lavoratori agricoli attraverso l'esame e l'interpretazione di schede di sicurezza ed etichette dei prodotti per l'agricoltura classificati come pericolosi. Ipotetiche etichette e schede di sicurezza sono state mostrate agli utenti, invitandoli poi a riferire la propria interpretazione dei pericoli, dei rischi e delle necessità di misure preventive. Un settore campione è stato identificato in un cluster di aziende vitivinicole, scelte in una gamma di dimensioni mediograndi lungo tutto il paese, dove 100 soggetti sono stati intervistati (telefonicamente o tramite un'intervista frontale). I partecipanti sono stati intervistati attraverso domande relative ad informazioni demografiche, di istruzione e di percezione del rischio.

*Parole chiave:* schede di sicurezza, preparati pericolosi, etichette.

## INTRODUCTION

The impact of risk information depends not only on its contents but also on how it is expressed. The choice of a presentation format can be vitally important, and subtle changes in the way risks are expressed may have a major impact on perceptions and behaviours [1-4]. Safety data sheets (SDS) should be comprehensible, beside being accurate [5]. Kopl *et al.* (1993) found much of the information on the data sheets to be incomprehensible to 100 workers in manufacturing industries [6]. Moreover, information overload in labeling and personal capability of resuming information is of particular interest in connection with data sheets [7].

It has been stated that there is an upper bound on an individual's ability to process risk information. A study dated 1992 [8] has shown that as the amount of hazard information is increased, consumer recall of other information on the product's label declines. Hence, adding more information to product labels does not necessarily lead to the recall of more information. Above a certain amount of presented information, people may even make less well-informed decisions, if extra information is added. This theory has however been questioned, giving rise to the "information overload controversy" [9]. Our survey provides a methodology for the assessment of the comprehension of labels and SDS for chemical hazards of agricultural products. The results of comprehensibility testing can assist to identify areas where capacity building interventions are needed in order to improve understanding of hazard communication elements, thereby improving protection of human health and the environment.

Subject's ability to comprehend hazard communication messages could be influenced by their past experience related to exposure to chemicals and training in chemical safety [10]. Members of the groups of intended readers of data sheets will be given (hypothetical) labels and SDS that have been manipulated so that the effects of different features of contents and presentation can be studied. They have been asked to report how they judge hazards, risks, and the needs for preventive measures.

*Address for correspondence:* Maristella Rubbiani, Centro Nazionale Sostanze Chimiche, Istituto Superiore di Sanità, Viale Regina Elena 299, 00161 Rome, Italy. E-mail: maristella.rubbiani@iss.it.

## MATERIALS AND METHODS

Before conducting any of the part in this study, participants signed informed consent. Participants should receive a test label, a test SDS made on purpose and a questionnaire. Testing labels and SDS were taken from the web, and then adapted to reflect real appearance and use, as far as possible reflecting the typical local usage patterns. Although the testing material was modified for confidential reasons, we tried to reflect the real ones as much as possible. One category has been identified as agricultural wine yard workers (to include farm workers, managers, responsible and other related agricultural categories). For this category, 100 subjects have been interviewed. Ideally we started with farmers, but the scarce results obtained let us move to a more qualified category within the farm.

The category was sampled using lists from manufacturers, in a cluster of vineyard farms chosen in a range of medium-big size along the whole country. Three regional areas were identified: north, centre, south and isles.

Two types of surveys were conducted: participants responding to questions posed to them over the telephone (after providing label and SDS samples) and face-to-face survey. The participants were completing surveys covering a range of topics related to demographical information and risk perception. Interviews have been set up at a convenient time for both the interviewers and the farmers, lasting not more than 20 minutes. Farm workers should not be requested to attend an interview during a crucial and busy period for farmers (*e.g.*, planting, ploughing, spraying, or harvesting). All of the interviews were conducted between September 2007 and September 2008.

Coding categories include: *i) correct*, meaning is identical, or fully consistent with intention; *ii) incorrect*, meaning given is either completely wrong, or has very poor relation to the intended meaning; *iii) cannot answer*, I don't know.

Analyses proposed are simple computations of proportions and means in relation to different strata. All subjects were offered the opportunity of seeing the final results of the comprehensibility evaluations, and to give feedback on the interview and testing procedures. Subjects participating in these evaluations should be re-interviewed after one year to assess retention and long-term benefits of exposure to eventual training.

### *General interview*

The aim of the generic part of the questionnaire was to ascertain demographic and educational status and other data that will be a basis for further analysis of comprehensibility. The questionnaires were also to ascertain subjects' contact with chemicals and whether they have had any training in safety regarding chemicals and to identify chemical information needs from subjects [11]. Data on work experience, critical to interpretation of comprehensibility assessments are also sought here, as well as number and frequency of contact with SDS and labels to identify prior familiarity with labels and SDS's amongst target groups [6].

After this first approach, different modules were taken into account as follows:

*i) reading and recalling of labels and SDS.* This module was intended to evaluate subjects' familiarity with labels and SDS, to test subjects' recall of label elements, as well as the comprehensibility of the symbols and of R/S phrases in a label – in terms of how they are understood, identifying technical words that are difficult to understand, understanding of ambiguous qualifiers and adjectives. Moreover, it was planned to assess: a) the impact of the label on the subjects (*i.e.* whether from a label subjects can derive information on chemical name, health hazard, physical hazard and use of protective clothing, and whether this information is correctly identified); b) the ability of subjects in identifying information contained only on the SDS, and c) the correct identification of the information;

*ii) rating and understanding of hazards symbols.* Four warning symbols, *highly toxic, flammable, irritating and dangerous for the environment*, were investigated. They are the most frequently recommended terms in standardisation literature, to denote different aspect of hazard and decreasing levels of perceived hazard [12-14]. This question represents a good tool to select for an initial investigation into the perceived hazard of single warning symbol and signal word. Participants were given the opportunity to indicate that they did not know the meaning of a word or pictogram, referring to different grade of the concept of "dangerous" (very dangerous, dangerous, not dangerous) [15]. This gives the analyst the possibility to test subjects' understanding of symbols representing hazard classes, to test subjects' symbol ranking for hazard severity, whether subjects' perception of the label will influence their reported intention to use the chemical, and to explore subjects' views as to what hazard elements on labels mean;

*iii) comprehensibility of safety data sheets*. Comprehension of SDS hazard information has been assessed exploring the interpretation of health hazard information, the scoring of how the subject explains a hazard statement and the extent to which subjects read the SDS. Moreover, it was intended to test subjects' ability to identify safety information from a SDS and to understand the included hazard information, to evaluate which part of the SDS the subject reads and which information finds useful, appropriate and understandable. Finally it has been assessed whether SDS information is related to intention to behave safely;

*iv) description of the interviewed group.* Samples were characterized for demographic variables (age, gender, and scholar grade, responsibility within

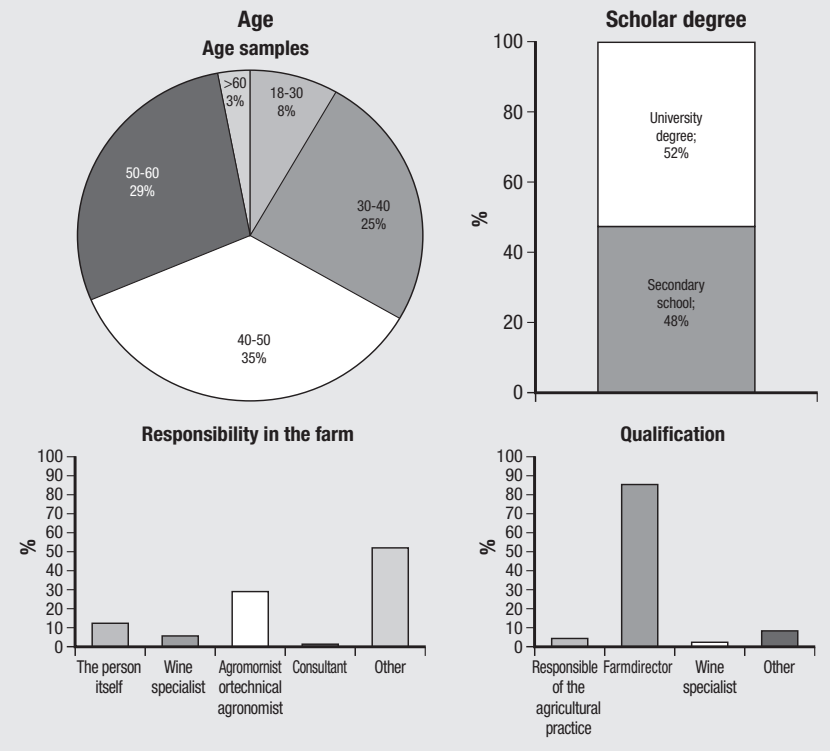


**Fig. 1** | *Characterists of the samples (age, scholar grade, responsibility within the farm, qualification).*

the farm, qualification, farm size and region). To reveal the extent to which there might be within-population differences in perceived hazard, the hazard ratings of the signal words were analysed by age, gender and scholarship degree [16, 17]. The characteristics of the sample were described as in *Figure 1*. Further, the gender distribution was greater for males (90%), the farm location was distributed along North (31%), Centre (50%), South and isles (19%), whilst the distribution of the farm size, defined as small (< 5 ha), medium (from 5 to 30 ha) and big (> 30 ha), was 6%, 38 % and 56%, respectively.

Further details about the sources of information was asked (more than an answer was possible): the resulting distribution is shown in *Figure 2*.

In order to evaluate subjects' familiarity with labels and a SDS in terms of number of access to label and SDS [18], some specific questions addressed the use of the label (100%) and of the SDS (90%), the number of labels read within one year ($5 < n < 15 = 80\%$) and number of SDS read within one year (any = 6%; $5 < n < 15 = 74\%$).

Quality of information taken from the label and from SDS (more than one answer possible) were asked and shown in *Figure 2*.

## RESULTS

The extent of within-population differences in perceived hazard, the hazard ratings of the symbols as well as correct interpretation of some symbols, R

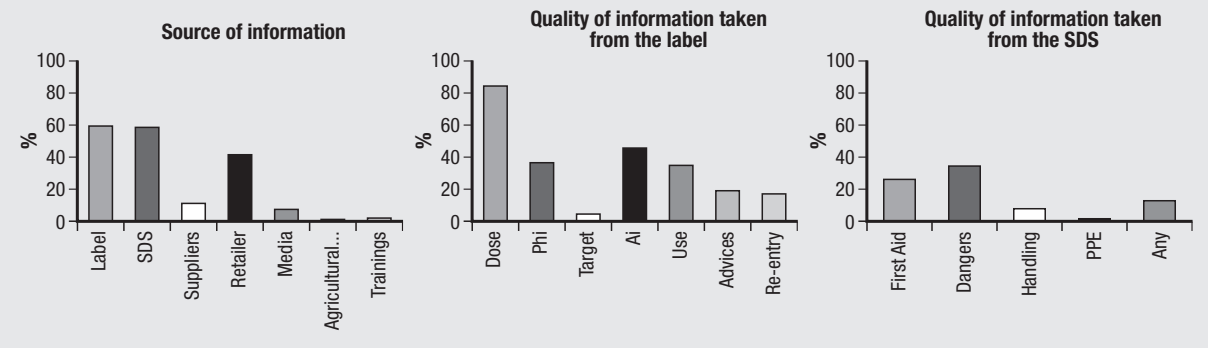


**Fig. 2** | *Sources and quality of information taken from the label/SDS (safety data sheets).*

**Table 1** | *Meanings of the symbols*

| What does the following symbol mean? | | Correct interpretation | Incorrect interpretation | "I don't know" |
|---|---|---|---|---|
|  | **Highly toxic**<br>Exposure to this chemical can cause immediate severe health problems | 91% | 9% | - |
| | **Flammable**<br>A flammable chemical is one that can easily catch fire and burn | 100% | 0% | - |
| | **Environmental hazard**<br>This is a chemical that can damage or kill fish or other aquatic organisms | 52% | 21% | 27% |
| | **Irritating**<br>This chemical may cause immediate health effects/reactions, such as skin rashes and irritation, if exposed to it | 55% | 45% | - |

phrases and S phrase are presented in *Tables 1 and 2*. About risk perception, the answer: "A product labelled with the symbol IRRITATING is...." gave the results shown in *Figure 3*.

About the use of personal protective equipment (PPE), 100% of the interviewed individuals answered: YES; the correct interpretation of the S phrases related to PPE use as well as the corresponding section provided in the SDS [19], (more than one answers possible) is shown in *Figure 4*.

There was no difference in the comprehension level among study participants when taking into account the international hazard communication standard that the SDS complied with. Marginally, age, education level and experience level did not have a significant impact on the comprehension level. Participants did find SDS to be satisfactory in providing the information needed to protect them, regardless of their views on the readability and formatting of SDS, but part of them affirmed the non-use and non-necessity of these two tools.

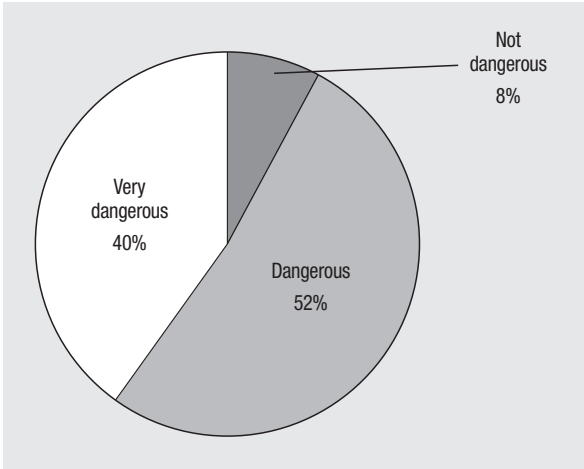


**Fig. 3** | *Interpretation of risk symbol.*

The findings from this research suggest that there is much work needed yet to make label and SDS more comprehensible on a global basis, particularly regarding health-related information. The affirmative answer to the question "Where do you obtain information on right use of products" is very often in contradiction with what was declared in the last part of the questionnaire: "Main information taken from SDS: Any". The resulting impression is that enrolled subjects were highly reluctance to affirm that their SDS consultation is very scant. Some of the interviewed subjects completely ignored this information tool. The right choose of the correct plant protection product, as well its use following good agricultural practice (GAP), is deemed to the experience of the consultants or the suppliers/retailers or the manufacturers himself. There is very often confusion regarding symbols comprehension. Symbol with crossed skull and bones is usually defined as "danger of death" (definition commonly used for high voltage), thus misleading the concept of toxic, although the risk perception is identically high.

The symbol corresponding to "dangerous for the environment" is not yet fully understood and digested: the high percentage of affirmative response is described more to the interviewer description ("What does it mean the dead three with the dead fish aside?") than to the visual impact. Very often this meaning is extrapolated by deduction. Most of the subjects do not know which the meaning of "S. Andrew Cross" is. Regarding the answer "What does it means the cross on the labels", we received several interpretations such as "harmful", "dangerous" or "toxic". There is a general difficulty and slowness in acquiring the most recent symbols, pictograms and definitions. Some of the subjects were dealing with old definitions, referring to the previous hazard classes as they were defined in the national system which has been replaced in 1995 and there is still big confusion about some definitions in terms of R and S phrases. "Possible risk to unborn children" and "In case of insufficient ventilation wears suitable

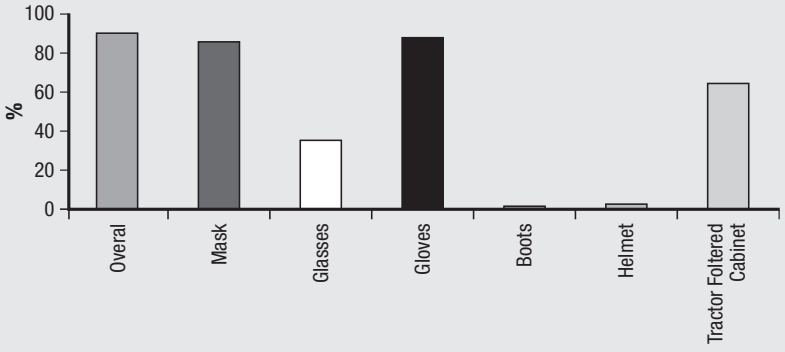


**Fig. 4** | *Use of personal protective equipment (PPE).*

respiratory equipment" are mostly misunderstood and the impression of the interviewer is that the answer was an extemporary interpretation, more than a real knowledge of the meaning of the phrase. All the subjects assured on the PPE use, mostly in big farms, and almost all use cabined filtered tractors. From the label the information related to use, dose, target, post harvest interval, rate of application are the most interesting and useful for the user, whereas from the SDS, all dangers in general are identified, but the highest percentages of the subject declare not to take any information from it.

Many bio-farms (most of them in Tuscany) have been tested: checking the results it seems clear how these people are more involved in the consequences due to the plant protection product use with a greater attention to the information in terms of risk for humans and environment.

Correct information on chemical risk to which agricultural workers are exposed during different phases of their activity is a critical moment for the full implementation of risk mitigation, prevention and safety measures. This step is even more critical when, following acute exposure, physician from poison centre have to act on a subject who is not, or not completely aware, about the cause of the damage, or he has not the capacity to refer about name and characteristics of the dangerous substance/s to which the damage could be referred to [20-22].

There is no convincing scientific evidence that warning labels and SDS are effective in inducing safe behaviour and preventing accidents or exposure. Hadden (1991) was concluding: "Enough is known to confirm the suspicion that label effectiveness is moderate at best" [23]. However, most studies are based on the assumption that label and SDS information are processed instantly, *i.e.* that the consumer makes one judgment and one choice, based on his/her first acquaintance with the label and SDS [24, 25]. On the contrary, in real life, information is processed at several different occasions, and knowledge of a product's risks and benefits will develop over time [26].

Furthermore, warning labels and SDS on chemicals are primarily intended for industrial workers or professional buyers of chemicals and may not be

**Table 2** | *Meanings of the risk phrases*

| What does the following phrase mean? | Correct interpretation | Incorrect interpretation | "I don't know" |
|---|---|---|---|
| It can cause sensitization by inhalation (R phrase R 42) | 91% | 9% | - |
| Avoid contact with eye (R phrase R 36) | 100% | - | - |
| It can cause irreversible effects (R phrase R 40) | 89% | 11% | - |
| Possible risk to unborn children (R phrase R 64) | 76% | 24% | - |
| Use only in a well-ventilated area (S phrase S 51) | 100% | - | - |
| Wear suitable protective clothing (S phrase S 36) | 100% | - | - |
| In case of insufficient ventilation wear suitable respiratory equipment (S phrase S 38) | 78% | 22% | - |

fully appropriate for farmers on which most of surveys have been carried out. These groups may differ in education, risk perception, previous experiences and since workers and professional buyers constitute important target groups for chemicals hazard warnings these groups ought to be prime subjects for further research [27-29] .

## CONCLUSIONS

The risk information sources of the agricultural products, intended as SDS and label, provided on the basis of the in force legislation, are not user-friendly tools for several reasons such as the difficulties for the farm enterprises in collecting SDS, the scarce completeness of information in the SDS, the poor quality of the information contained in the SDS. Moreover, difficulties should be taken into account in interpreting, understanding and recalling the information contained in the label and in the SDS, due to the difficult wording and limited training by the workers. In addition, the "physical" volume of the SDS, makes it difficult to keep them "on the field" during farm activity,

Following these observations, it seems reasonable to conclude that the use of SDS should be supported by a suitable information/training activity at the releasing or renewal time of licences (by trainers), at the moment of supplying (by retailers/suppliers) or at the moment of the use of the plant protection products (by safety responsible personnel within the farm). A periodical worker training (with final evaluation testing) can be suggested together with the promotion of enforcement initiative to identify critical information. Moreover the consideration of labels and SDS implementation as a suitable approach to improve hazard communication, including standardized approaches to labels and to SDS, should be considered. The consistency in interpretation should be stressed and enforcement should be more performance-oriented, emphasizing overall effectiveness. SDS can become very long and complicated because they are used for many purposes: some, mainly small farms, would not like multipage SDS that is not easy to understand, but not many wanted an additional document which would be necessary to accomplish this. Moreover, small farms need implementation aids such as model programs and guidelines for training, evaluation and hazard determination so that harmonization should be encouraged at the international and national levels.

### *Conflict of interest statement*

There are no potential conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias conduct and findings of this study.

Submitted on invitation.
*Accepted* on 22 April 2010.

### *References*

1. Drottz-Sjöberg BM. Risk perception and risk communication. In: Walmod-Larsen O (Ed.). *Intervention principles and levels in the event of a nuclear accident.* (TemaNord, 507). p. 111-31. Copenhagen: Nordic Council of Ministers; 1995.
2. Drottz-Sjöberg BM. Exposure to risk and trust in information: implications for the credibility of risk communication. *Australasian J Disaster and Trauma Studies* 2000. Available from: www.massey.ac.nz/~trauma/issues/2000-2/drottz.htm
3. Lehto MR, Miller JM. The effectiveness of warning labels. J *Products Liabil* 1998;11:225-70.
4. Slovic P, Fischhoff B, Lichtenstein S. Morris LA, Michael BM. Barofsky I (Ed.). *Product labelling and health risks.* Cold Spring Harbor NY: Cold Spring Harbor Laboratory; 1980. (Banbury Report 6). p. 165-83.
5. Cherniak, Michael J. Training tips: SDS forms. Give necessary information only if users know how to interpret them. *Occ Health Safety* 1992;10:78-81.
6. Kolp P, Sattler B, Blayney M, Sherwood T. Comprehensibility of material safety data sheets. *Am J Ind Med* 1993; 21:135-41.
7. Viscusi WK, Magat WA, Huber J. Informational regulation of consumer health risks: an empirical evaluation of hazard warnings. *Rand J Econom* 1986;17:351-65.
8. Magat WA, Viscusi WK. *Informational approaches to regulation.* Cambridge; MA: Massachusetts Institute of Technology; 1992.
9. Magat WA, Viscusi WK, Huber J. Consumer processing of hazard warning information. *J Risk Uncertainty* 1988: 1:201-32.
10. Leonard SD, Matthews D, Karnes EW. How does the population interpret warning signals? In: *Proceedings of the Human Factors Society 30th Annual Meeting*. Santa-Monica: The Human Factors Society; 1986. p. 116-20.
11. Lehto MR. The influence of chemical warning label content and format on information retrieval speed and accuracy. *J Saf Res* 1998;1:43-56.
12. ANSI Z400.1-1993. New York: American National Standards Institute; 1993.
13. FMC Corporation. *Product safety sign and label system.* Santa Clara: FMC Corp; 1985.
14. Chapanis A. Hazards associated with three signal words and four colours on warning signs. *Ergonomics* 1994;37:267-75.
15. Goldhaber GM, Deturck MA. Effectiveness of warning signs: gender and familiarity effects. *J Products Liabil* 1998; 11:271-84.
16. Hellier E, Wrighty DB, Edworty J. *Investigating the perceived hazard of warning signal words. Risk decision and policy.* Cambridge MA: Cambridge University Press; 2000. p. 39-48.
17. Hellier E, Wrighty DB, Edworty J. *Hazard communication.* Washington: Occupational Safety and Health Administration; 1987.
18. Laughery KR, Vaubel KP, Young SL, Brelsford JW, Rowe AL. Explicitness of consequence information in warnings. *Saf Sci* 1993;16:597-614.
19. Ursic M. The impact of safety warnings on perception and memory. *Hum Factors* 1984;26(6):677-82.
20. Wogalter MS, Jarrard S, Simpson S. Effects of warning signal words on perceived hazard of signal words of consumer-product hazard perceptions. In: *Proceedings of 36th Annual Meeting of Human Factors Society.* Santa-Monica: The Human Factors Society; 1992. p. 935-9.

21. Schneider KC. Prevention of accidental poisoning through package and label design *J Consumer Res* 1977;4(2):67-74.

22. Hadden SG. *Read the label: reducing risk by providing information.* St Paul, MN: West View; 1985.

23. Hadden SG. Regulating product risks through consumer information *J Soc Issues* 1991;47(1):93-105.

24. Horst DP, McCarthy GE, Robinson JN, McCarthy RL, Krumm-Scott S. Safety information presentation: factors influencing the potential for changing human behaviour. In: *Proceedings of the 30th Annual Meeting Human Factors Society.* Santa-Monica: The Human Factors Society; 1986. p. 111-5.

25. Ignatowski AJ, Roshental I. The operational material safety data sheet. Key to the effectiveness of a generic approach to the control of health and safety risks. *Applied Occ Env Hygiene* 1993;8:714-720.

26. Saari J, Bederd S, Dufort TV, Hryniewiecki J, Theriault G. Successful training strategies to implement a workplace hazardous materials information system. An evaluation study at 80 plants. *J Occ Med* 1994;36(5):569-74.

27. Takala J. Chemical safety information for developing countries. *Sci Total Environ* 1996;188:112-29.

28. US General Accounting Office. *Employers' experiences in complying with the hazard communications standard.* Washington: US General Accounting Office; 1992. (GAO/HRD-92-63 BR).

29. Wogalter MS, Silver NC. Warning signal words: connoted strength and understand ability by children, elders and non-native English speakers. *Ergonomics* 1995;38(11):2188-206.