

**Usage of personal protective equipments among workers of a foundry in South India:
interventional study**

Subramaniyan P¹, Chacko T V², Sriram R M³, Osborn A J⁴.

Affiliation: : 1Professor, Community Medicine, PES Institute of Medical Sciences & Research, Kuppam.2 Professor, Community Medicine, Believers Church Medical College, Thiruvalla.3. Asst. Professor, Community Medicine, Tagore Medical College, Chennai.4 Asst. Professor, Community Medicine, PSG Institute of Medical Sciences & Research, Coimbatore.

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***Author for correspondence:** Dr.Chacko T V. Professor, Community Medicine, Believers Church Medical College, Thiruvalla-689103. Email: drthomasvchacko@gmail.com

ABSTRACT

Introduction: Occupational hazards exist in every industry. Along with engineering and administrative measures, usage of personal protective equipments (PPE) by the workers is equally important in protecting the workers. However a high level of non-compliance to PPE usage among the workers is commonly noted. South India has several foundries, giving employment to many workers. The objectives of the study were to find out the level of PPE usage among the foundry workers, before and after an interventional program and to assess the relative effectiveness of different strategies of the program in bringing out the improved PPE compliance among them. **Materials and methods:** After obtaining ethical clearance, the study was conducted among 78 permanent workers of a foundry in Coimbatore. First the demographic details of the subjects and their level of usage of PPE were recorded, in the pre-test. Then a comprehensive three faceted interventional program, consisting of strategies such as health education to the workers, peer motivation by co-workers, and posters in the working environment, was implemented simultaneously among all subjects. After three months of implementation of the program, the post-test was conducted and the data were analyzed to measure the effectiveness of the intervention. **Results:** After the interventional program, the workers showed significant improvement in PPE usage ($p < 0.001$) from the 'pre-test' level. Regarding their perception about which of the three strategies relatively contributed to bring out the improvement, most of the workers rated the strategy of peer motivation as 'high' effectiveness, health education- 'average' effectiveness and posters in working environment- 'low' effectiveness. **Conclusion:** Interventional program using multiple strategies in an integrated manner has synergistically enhanced the behaviour change among the workers.

Key Words: Foundry, Personal protective equipment, Intervention.

INTRODUCTION

Foundry¹ is an industry which produces metal castings that are made by pouring molten metal into precise moulds. After the metal has cooled, the casting is removed from the mould and the process of 'fettling' involves cleaning and finishing procedures. Occupational hazards² exist in every industry and the hazards in the foundry are heat, electricity, machinery, vibration, noise, dust & fumes, heavy objects, pointed objects, chemicals like formaldehyde and amines etc. Along with engineering and administrative measures, usage of personal protective equipments (PPE) by the workers is equally important in protecting the workers. Various PPE are expected to be used in foundry, such as helmet, goggles, ear plugs, mask, face-shield, gloves, boots, etc. However, a high level of non-compliance for PPE usage among the workers is commonly noted possibly because of ignorance about benefits, or it may cause discomfort. Research studies³⁻⁶ conducted on non-compliance to PPE usage among industrial workers, found that it is a global problem. A study published by Foundry Management & Technology, USA³ recorded high level of non-compliance to PPE usage. An Egyptian study⁴ among

industrial workers found similar findings. A cross-sectional study from Nepal⁵ detected that only 47.7% of workers use at least one kind of PPE during work. A study conducted among factory workers in India⁶ noted that most workers were aware of the benefits of PPE, but only some workers were using PPE regularly. Similarly various other studies have been done on the effectiveness of interventional program in bringing out improvement in PPE usage among industrial workers. A study in USA⁷ demonstrated statistically significant difference in the use of PPE before and after an interventional training program. Similarly a Nigerian study⁸ found significant increase in the usage of PPE, after the intervention. Another multi-faceted interventional study done among foundry workers in Italy⁹ showed significant decrease in occupational injuries, after intervention. Regarding the motivation of workers, Malawi study¹⁰ noted that the workers viewed their high-ability coworkers as a source of motivation. According to WHO¹¹, one of the components essential to community based program and prevention strategies, is that it should

be an integrated program. Each element of the program should support the other elements and the program should be integrated into the settings where people work (e.g. work-sites) or live their lives.

Since behavior change is difficult to sustain unless a good supporting environment is created, we designed an intervention among foundry workers which went beyond just conducting an awareness program. Our design was guided by the Ecological Approach¹¹ to Behaviour Change. This approach addresses the multiple determinants that influence health and health behavior through synergy of multi-pronged interventions. Accordingly a comprehensive interventional program which had three strategies integrated together was adopted, to bring out a synergy of effect. The first strategy was health education to the workers (guided by Health Belief Model¹¹ for behavior change) to create the immediate awareness about the hazards that accrue due to non-usage of PPE. The second one was peer motivation by co-workers and role-models (guided by Social Cognitive Theory¹¹) that will help to translate awareness into practice and to use the peer pressure to ensure compliance with PPE usage. The third strategy was posters in the working environment as constant reminders of the statutory nature of the need to use PPE at the workplace and benefits of usage from the health point of view.

The Objectives of the study were to find out the level of PPE usage among the foundry workers, before and after an interventional program and to assess the relative effectiveness of different strategies of the program in bringing out the improved PPE compliance among them.

MATERIAL AND METHODS

The study was conducted in a foundry at Coimbatore, after obtaining the permission from the relevant foundry authorities and ethical clearance from Institutional Human Ethics Committee. There were two categories of workers, permanent and temporary, in the various sections of production/ manufacturing division of the foundry. It was decided to conduct the study among the permanent workers only, because the temporary workers used to get salary in the week-end and they might go elsewhere in the next week. There were 81 permanent workers in the production division. Those workers, who were missed during a visit, were contacted during the second or third visits. Two workers could not be contacted even after three visits and one worker was not willing to participate in the study. So those 3 workers were excluded and the remaining 78 workers were included in the study.

An interview questionnaire was prepared, translated to local (Tamil) language, and back translated. A pilot study was done among the temporary workers, which helped to refine the interview questionnaire. The finalized questionnaire was then used for the study.

Pre-test: After getting informed written consent, the subjects were interviewed. For each subject, the general personal information and frequency of usage of PPE were recorded.

Interventional program: After the pre-test, all of the following three strategies of the program were started and implemented simultaneously among the subjects.

Strategy 1: ‘Health education’ sessions were conducted for the workers in batches, each batch consisting about 12-15 workers. Thus six sessions were conducted. Power point presentation was used for health education. During the session, it was explained how the different equipments safe-guard the workers from different hazards. ‘Question and answer’ method was also used which encouraged the workers to involve and pay attention. Thus every subject received health education once.

Strategy 2: ‘Peer-motivation by co-workers’ was performed as follows: Some of the workers volunteered to become ‘role-models’. These role-models wore PPE throughout the eight hours of work. Apart from that, for the next three months, they talked with other workers once every week, and motivated them for PPE usage. If any worker was found to be resistant to adopt PPE, the role-models talked with them more often and motivated them.

Strategy 3: ‘Posters’ illustrating the usage of PPE were prepared, laminated and put-up in various prominent places of the working environment. Whenever the workers would see the posters, the posters would remind them to wear PPE.

Post-test: At the end of three months, each subject was interviewed again. Along with the previous questionnaire, some more questions were added to assess the level of effectiveness of each strategy in bringing out the improvement in PPE usage.

Analysis of data: First the data were entered into Microsoft excel sheets and then transferred through SPSS package (Version 19) for analysis. For descriptive analyses, the categorical variables were analyzed by using percentages and the continuous variables were analyzed by calculating mean ± Standard Deviation. Chi-square test was used to ascertain the association between the independent and dependent variables. A ‘p’ value of <0.05 was regarded as statistically significant.

RESULTS

The interventional study was conducted among 78 permanent workers of a foundry.

Demography of the study subjects: Table-1 shows the general demography of the study subjects.

Table 1: General demography of the study subjects.

Demographic details	Group	Frequency (N = 78)	Mean ± SD
Gender	Men	78 (100%)	–
Literacy status	Literate	78 (100%)	–
Training on PPE usage.	All subjects got training.	78 (100%)	–
Age (in years)	< 40 years	1 (1.3 %)	48.38
	40 – 49 years	46 (59.0%)	± 5.49
	50 – 57 years	31 (39.7%)	
	Total	78 (100%)	
Work experience (in years)	5 – 9 years	2 (2.6 %)	25.77
	10 & more years	76 (97.4%)	± 7.44
	Total	78 (100%)	

All workers were men. All were literate. All were of middle age (Range: 38 – 57 years. Mean ± SD = 48.38 ± 5.49). All workers had work experience of more than 5 years (Range: 7 – 40 years; Mean ± SD = 25.77±7.44). All subjects got trained in the usage of PPE, at the time of joining the foundry. However the training was not repeated.

Table 2: Usage of PPE by the subjects during the work time.

	Frequency level of usage of PPE during the work time					Total
	Very low	Below average	Average	Above average	Very high	
Pre-test	7 (9.0)	16 (20.5)	38 (48.7)	11 (14.1)	6 (7.7)	78 (100)
Post-test	0	6 (7.7)	17 (21.8)	26 (33.3)	29 (37.2)	78 (100)

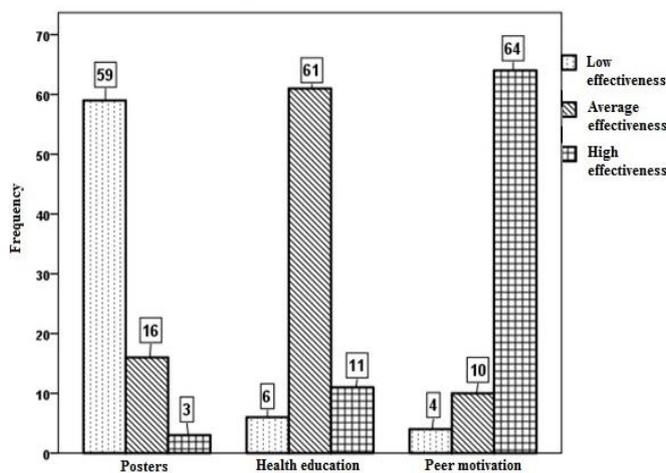
Figures in parentheses are percentage values.

Table 3: Effectiveness of intervention on the workers’ usage of PPE during the work time

	Frequency of usage of PPE during the work time (n=78)			X ² value	‘p’ Value
	Low	Average	High		
Pre-test	23 (29.5)	38 (48.7)	17 (21.8)	38.04	<0.001*
Post-test	6 (7.7)	17 (21.8)	55 (70.5)		

Figures in parentheses are percentage values; ‘p’ <0.05 is statistically significant*

Figure 1: Perception of workers on the effectiveness of each strategy in bringing out the improvement in PPE usage.



Usage of PPE during the work time, before and after intervention:

During the pre-test, each subject was enquired about his own practice and frequency of usage of PPE during the work time. For this purpose, each subject was asked to select any one of the following five responses viz., very low, below average, average, above average and very high. The response of each subject was recorded. Again during the post-test, the responses for this question were noted. Table-2 reveals the usage of PPE by the subjects during the work time.

In the post-test, all of the 78 (100%) workers reported improvement in the frequency level of usage of PPE. During the pre-test, 7 workers reported that their usage of PPE during the work time as ‘very low’. During the post-test, 6 of them reported that their usage of PPE as ‘below average’ and the remaining one worker reported as

‘average’. Similarly the improvement was noted in all categories. Even the six workers who reported in the pre-test ‘very high’ usage of PPE, reported in the post-test ‘still higher level of usage’. However they were included in the same category of ‘very high’.

To measure the effectiveness of the intervention, the above table-2 was condensed as follows: The middle category ‘Average’ was kept as it was. The first two categories were combined together to form one category and named as ‘low’. The last two categories were combined together and named as ‘high’. Table-3 illustrates the effectiveness of intervention in bringing out PPE compliance by the workers, during the work time.

In the pre-test, 21.8% of subjects reported ‘high’ level of usage of PPE and 29.5% reported ‘low’ level of usage. In the post test, 70.5% of workers reported ‘high’ level of usage of PPE and only 7.7% of workers reported ‘low’ level of usage. This improvement in PPE usage was statistically significant (Chi square test; p<0.001), with substantial improvement in the effect size (70.5 minus 21.8 = 48.7). This shows that a comprehensive approach is very effective in bringing out the change in behavior.

Evaluation of the workers’ perception on effectiveness of each strategy:

The subjects informed at the time of post-test, that all three strategies complemented each other in bringing out the improvement in PPE usage, thus validating the synergy of effect described by the Ecological approach to behavior change.

However the subjects were compelled to evaluate their perception of the relative role of each strategy’s ‘level of effectiveness’ in contributing to PPE compliance. For this, they were asked to select any one of the following responses, viz., ‘low’ ‘average’, or ‘high’. Their responses are shown in Figure 1.

Regarding the role of posters in the working environment, 59 workers (75.6%) felt that it had ‘low’ level of effectiveness in bringing out the improvement in PPE usage. On the role of health education, 61 workers (78.2%) felt that it had ‘average’ effectiveness. However, 64 workers (82.1%) felt that the strategy of peer-motivation by co-workers had ‘high’ level of effectiveness.

DISCUSSION

The present study found that the intervention program of three strategies integrated together resulted in significant improvement in PPE usage among the workers. This is in line with the Ecological Approach to Behaviour Change which posits the need to address the multiple determinants that influence health and health behavior and so there is synergy of effect in multi-pronged interventions since they address multiple determinants of health behavior.

We wanted to know the workers’ perception of the relative role played by each strategy, so that we can address any misconception that required remedial action. Our study findings revealed that the workers rightly recognized the strategy of peer-motivation as having

'high' level of effectiveness. This is in line with Social Cognitive Theory which posits that people not only learn through their experiences but also by observing the action of others and the results of that action. In the present study, the 'role-model volunteers' who were fellow workers, had overcome the commonly perceived inconvenience and discomfort in PPE usage and showed by example that it is possible to practice the good behavior in their work environment. Peer-pressure then forced the other workers to fall in line, to avoid being socially rejected as deviant from the expected norm in behavior. That health education had 'average' effectiveness and posters in working environment had 'low' effectiveness goes to show that such interventions they had experienced in the past without leading to increased usage of PPE.

Other interventional studies conducted in various countries had also recorded similar improvement in PPE usage among the workers. A study on the effect of a training program among laborers in USA⁷ found significant changes in the usage of PPE. It was a participatory, peer-facilitated training program. Most workers (66%) shared the information of the program with their co-workers and friends. A study in Nigeria⁸ also found significant increase in the usage of PPE after intervention. In Italy⁹, a multi-faceted intervention study **was done among the workers in two foundries**. The decrease in occupational injuries was significant ($P < 0.01$). Another interventional study in Nigeria¹² revealed that the usage of PPE among the workers in the interventional group were significantly higher than the control group. A study conducted in Behara¹³ concluded that the intervention was effective and the results had noticeable improvement in the workers' compliance with PPE usage. An interventional program among factory workers in Iran¹⁴ was found to be very effective in improving the usage of PPE. An interventional study in Hamedan¹⁵ revealed that integration of motivational interviewing principles into the safety program had improved the safe behaviors of the workers in the motivational group and resulted in significant change in PPE usage among them. Another study in Iran¹⁶ observed that the intervention program using peers was effective in promoting safe practices of the workers.

Conclusion:

Most workers perceived that the strategy of peer-motivation had 'high' level of effectiveness, health education had 'average' effectiveness, and posters in the working environment had 'low' effectiveness. However, when the intervention program consisting of three strategies integrated together, it synergistically resulted in significant improvement in PPE usage among the foundry workers because each strategy addresses a different factor that facilitates behavior change.

Limitations: We did not do a repeat study after 3 months to see whether the benefit in terms of increased PPE usage was sustained.

Recommendations: 1. Training program on the usage of PPE and health education should be conducted

periodically for the workers, to ensure reinforcement of messages as well as to remove barriers to behavior change.

2. The administration should enforce that the workers should wear PPE during the work time, through promoting the peer workers as role-models and putting up posters at prominent places of the work place, where the work exposure to hazards due to non-usage of PPE take place.

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