Suggestion of an inverse relationship between perception of occupational risks and work-related injuries

Sugestão de uma associação inversa entre percepção de riscos ocupacionais e acidentes do trabalho

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Abstract *Worker perception of risk influences worker behavior and consequently exposure to risks. However, an inverse relationship between perception of occupational risks and work-related injuries has not yet been clearly established. A matched case-control was performed aiming to investigate possible differences in perception of occupational risks between workers who had suffered occupational injuries and those who had not. Cases were defined as all 93 workers from a large metallurgical factory in southeastern Brazil, who had suffered occupational injuries during the year 1996. Controls were 372 workers who had not suffered occupational injuries, matched on the basis of the factory sector and jobs performed. Assessment of occupational risk perception was performed by asking the workers to fill out a questionnaire consisting of questions on specific risks related to problems in work relations, work per se, and mode of production. The findings suggest that the degree of perception that workers with occupational injuries have of some occupational risks is lower than that of their non-injured coworkers.*
Key words *Metallurgy; Case-control Studies; Occupational Accidents*

Resumo *A percepção que o trabalhador tem dos riscos ocupacionais a que está exposto, influencia seu comportamento e sua própria exposição a riscos. Entretanto, uma relação inversa entre percepção de riscos ocupacionais e acidentes do trabalho, embora especulada, não foi ainda claramente estabelecida. Este é um estudo caso-controle objetivando investigar a existência de diferenças na percepção de riscos ocupacionais entre trabalhadores acidentados e não acidentados. Os casos foram todos os 93 trabalhadores de uma grande metalúrgica de Botucatu, que sofreram acidentes do trabalho no ano de 1996. Para cada caso foram aleatoriamente alocados quatro controles não acidentados, emparelhados segundo a seção de trabalho e a função do trabalhador acidentado na semana do acidente. A mensuração da percepção de riscos ocupacionais de casos e controles se deu analisando-se as respostas dadas pelos trabalhadores estudados a um questionário sobre riscos associados a tarefas específicas, relações no trabalho e organização do trabalho. Os achados sugerem que o grau de percepção que trabalhadores acidentados têm de alguns riscos ocupacionais é menor que o de trabalhadores não acidentados.*
Palavras-chave *Metalurgia; Estudo de Casos e Controles; Acidentes de Trabalho*

Introduction

Occupational injuries are defined as injuries occurring due to work performed at the service of a company, causing a functional alteration and/or bodily lesion in the worker. Such injuries generally entail a sudden interruption in the work process, which is traumatic for both the victim and his/her coworkers, who are often subject to similar risks. In addition, occupational injuries constitute a burden for the company, leading to a reduction in the number of personnel hours worked, and thus a loss in production and an increase in cost per unit produced.

Methods used to study the causality and control of occupational injuries include those focusing on workers' perception of risks experienced at work. Examples of such approaches are the Causal Tree Method (Monteau, 1977) and the Italian Worker's Model (Oddone et al., 1967).

Worker perception of risk influences worker behavior and consequently exposure to risks. Prevention depends partially on risk identification (Schilling, 1989). Moreover, workplace safety relies partially on worker ability to recognize hazards that could result in personal injury (Harrel, 1990). In fact, many authors have hypothesized an inverse relationship between perception of risk and self-protective behavior (Arbuthnot, 1977; Laurence, 1974; Preston, 1983; Rundmo, 1992; Stewart-Taylor & Cherries, 1998). This notion appears to be essential to some theoretical models, holding that the motivation for self-protective behavior is a function of anticipation of negative consequences of risk exposure and the desire to minimize these outcomes (Ajzen, 1988; Becker, 1974; Prentice-Dunn & Roger, 1986). Also, as in many other models related to the adoption of protective behavior, perception of risk plays an important role (Cleary, 1987; Dejoy, 1996; Prochaska et al., 1992; Weinstein, 1988; Weinstein & Sandman, 1992). However, an inverse relationship between perception of occupational risks and work-related injuries has not yet been clearly established.

Understanding relationships between risk perception, behavior and occupational exposure is important in the control of work-related injuries. This is an area of occupational health research requiring more study (Stewart-Taylor & Cherries, 1998). Research on perceptions of occupational risk is important because perceptions are a logical and empirical precursor to actions that could reduce danger (Harrel, 1990).

This study aimed to assess differences in perception of injury risks in the workplace among workers who had suffered occupational injuries as compared to those who had not, as a contribution to methods focusing on the accident victims' views in studying occupational injuries.

Subjects and methods

A matched case-control study (Rothman & Greenland, 1998) was performed with a case-control ratio of 1:4 (Ury, 1975) in a metallurgical factory with some 1,800 workers in the State of São Paulo, in southeastern Brazil.

Cases were defined as all workers who had suffered occupational injuries in the factory from January 1 to December 31 1996, and who met the following conditions: (a) the injury caused the worker to miss at least one day of work for treatment and recovery; (b) the injury victim agreed to participate in the study; and (c) the injury did not prevent the worker from filling out the questionnaire during the first 7 days after it occurred.

After an occupational injury has occurred in a sector of the factory, a member of the research team interviewed the injured worker, explaining the aims of the research and asking for his participation. After that, the injured worker's colleagues were also told about the purpose of the research and were asked to collaborate in the study. Controls were matched to injury victims (cases) based on factory sector and job. Thus, for each injured victim included in the study, four other workers who had not suffered accidents were allocated to the study as controls. Controls were chosen from among individuals working in the same sector, and on the same job as the victim on the day of the injury, as well as during the four previous workdays. Controls were allocated at random after their agreement to participate in the study.

In this study, occupational risks are defined as risk factors (Kleinbaum et al., 1982) present in the work process and environment, associated to an increased likelihood of the occurrence of an occupational injury. Perception of risk for occupational injuries is defined as the capacity to identify and quantify an occupational risk.

Perception of risks for occupational injuries was assessed by using a questionnaire developed by Corrêa Filho (1994), who wrote, tested, applied, and discussed its validation in a case-control study held in the city of Campinas, Brazil, during the years 1993 and 1994. The questionnaire, which was modified slightly for the purposes of this study, consisted of two sections. In the first section the workers answered questions posed to them by an interviewer, including personal identification data, years of schooling, time on the current job in the factory, and number of previous injuries. In addition, for injury victims, the questionnaire characterized the injury in terms of the ultimate causative agent, topography of the lesion, and resulting time off the job. The workers themselves filled out the second section of the questionnaire. It consisted of 18 direct questions on specific risks pertaining to problems in work relations, work per se, and mode of production. The following is a list of risks investigated in the 18 questions, along with the names allotted to them to facilitate reference (in parentheses and italics):

- Problems in work relations

a) Non-compliance with safety instructions (*non-compliance*)
b) Dissatisfaction with work (*dissatisfaction*)
c) Disputes with superiors (*dispute*)
d) Hostility among coworkers (*hostility*)
e) Threat of firing or punishment (*threat*)

- Problems related to work per se and mode of production

a) Wrong job (*wrong*)
b) No work rules, methods, or norms (*adequate*)
c) Lack of risk-control measures (*avoid*)
d) Lack of safety norms (*safety*)
e) Faulty maintenance of equipment (*maintenance*)
f) Safety devices turned off (*turned off*)
g) Inadequate equipment and installations (*awful*)
h) Collective safety negligence (*inspect*)
i) Hazardous load movement (*sloppy*)
j) Lack of individual protective equipment (*individual*)
k) Natural accidents (*local*)
l) Wage problems (*wages*)
m) Lack of equipment (*equipment*)

Workers were instructed to mark the answer by drawing a line intercepting a horizontal straight line 11 centimeters long, based on the importance they ascribed to the risk referred to in the question. Answers were quantified as the distance between the beginning of the straight line on the left and its intersection with the mark made by the worker. This procedure was based on response measurement methods proposed by Monk (1989), and Horne & Ostberg (1976). The questionnaire is shown in Table 1.

Both injury victims and control group members answered the same questionnaire in two stages at home, under the supervision of an interviewer. This two-stage application was per-

Table 1

Questionnaire on occupational risks filled out by the workers.

Question
1 – Did you fail to comply with safety instructions? (*non-compliance*)
2 – Were you dissatisfied with the job or required to do work that you did not want to do? (*dissatisfaction*)
3 – Were you harassed or persecuted, or did you have an argument with your bosses or superiors? (*dispute*)
4 – Was there an argument or fight with your coworkers or subordinates? (*hostility*)
5 – Were you warned or threatened about being punished or fired? (*threat*)
6 – Did you work at things that were not part of your job? (*wrong*)
7 – Was there a lack of proper work rules or methods? (*adequate*)
8 – Do the superiors fail to promote ways of avoiding the risks that occur on your job? (*avoid*)
9 – Was there a lack of safety instructions, manuals, or training? (*safety*)
10 – Was there neglect with maintenance of service equipment? (*maintenance*)
11 – In your sector, were there machines with safety or protective devices that did not work or were turned off? (*turned off*)
12 – Is your work done with equipment or installations that are bad for the job? (*awful*)
13 – Did the superiors fail to determine whether employees were complying with safety instructions? (*inspect*)
14 – Do employees move or mix materials with the proper care to avoid accidents? (*sloppy*)
15 – Is there a lack of individual safety equipment like goggles, gloves, hard-toed boots, etc.? (*individual*)
16 – Was there a heavy rain, flood, lightning, cave-in, or fire at the workplace? (*local*)
17 – Have wages caused major problems at your workplace? (*wages*)
18 – In the company where you work, is there a lack of the necessary equipment to do the job? (*equipment*)

Notes: Code words for the questions are in italics and parentheses.
The horizontal straight lines were omitted.

formed in order to evaluate changes in the perception of occupational risks among injured workers and colleagues between the time the injury occurred and three months later. The first stage, called t_1, occurred from 1 to 7 days after the injury had occurred. Accident victims and controls were asked to answer the questionnaire using the day of the injury and the four workdays preceding it as the time reference. The second stage, called t_2, occurred between 91 and 97 days after the injury. Both injury victims and controls were asked to answer the questions in the second round based on this last workweek.

Risk recognition by injury victims and controls at the time of the injury (t_1) was compared in two ways. The first relied on Wilcoxon rank-sum tests (Snedecor & Cochran, 1980), a non-parametric procedure for testing whether distribution of answers to the 18 questions has the same location parameters in cases and controls. The second comparison was performed by adjusting a conditional logistic regression model (Armitage & Berry, 1994) with a matching ratio of 1:4 (Ury, 1975), where the dichotomous dependent variable was the occurrence of occupational injury (where no = 0 and yes = 1) and the continuous independent variables were the measurements taken from the answers to the 18 above-mentioned questions, along with the covariables age, time on the job, years of schooling, and number of prior occupational injuries. The variables were selected using the forward method, with a significance level for entering the model of $\alpha = 0.05$.

A complementary analysis was the comparison of injury victims' and controls' perceptions of occupational risks at time of injury (t_1) and 90 days after (t_2). This comparison was performed by adjusting a conditional logistic regression model with a 1:1 matching ratio, where the moment in which the questionnaire was applied is a dependent dichotomous variable ($t_2 = 0$, $t_1 = 1$), and the independent variables are the 18 questions. This model was adjusted separately for injury victims and controls.

The Wilcoxon rank-sum tests and the logistic regression analysis were performed using the *SAS 6.12 for Windows* software, sub-programs NPAR1WAY Procedure (SAS Institute Inc., 1989) and PHREG Procedure (SAS Institute Inc., 1990), respectively.

Results

Do to well-planned vigilance in the factory, there were no under-diagnosed injuries during the research period. During the study period 93 occupational injuries entailing at least one day off the job occurred in the factory area, corresponding to an incidence density of 51.7 injuries/1,000 worker-years. Injury victims were all males, aged from 19 to 60 years (mean = 32.2, standard deviation = 8.7). Their years of schooling ranged from 2 to 13 (mean = 7.4, standard deviation = 7.7). Their occupations included the following: automobile painter, carpenter, electric equipment fitter, electrician, finisher, glass painter, glassworker, laminator, leather machinist, locksmith, operator, production assistant, stockroom controller, and toolmaker. The injured workers and their colleagues were informed about the purposes of this study, and they all agreed to participate in the research. As all injuries were mostly light or moderate, they didn't prevent the injured workers from filling out the applied questionnaire.

Most injuries were contusions, fractures, cuts and acute arthopathies. They affected primarily the workers' hand, eyes, thoracolumbar region and feet. Most ultimate causative agents of these injuries were falls, shocks, motorized hand-operated tools and excessive physical effort. Most injuries caused the worker to miss up to 14 days of work for treatment and recovery. Tables 2, 3, 4, and 5 show the distribution of injuries based on the above-mentioned variables.

A total of 372 controls that were matched for work sector and job occupied at time of injury were allocated to the 93 injury victims, making a total of 465 workers included in the study.

Use of the two-tailed Wilcoxon rank-sum tests with a level of a significance equal to 0.1 led to rejection of the hypothesis of equivalent answers by injury victims and controls to the questions referring to the risks coded as *non-compliance, hostility, wrong, avoid, safety, maintenance, turned off, inspect, sloppy, individual, local*, and *equipment*. Table 6 shows the mean values ascribed by injury victims and controls, as well as the statistics obtained by applying this test to the 18 questions.

Upon adjusting the conditional logistic regression model to the data obtained using the questionnaire with injury victims and controls at moment t_1, the following variables were selected as significant ($\alpha = 0.05$):

- *Non-compliance* (question 1, Table 1), odds ratio (OR) = 1.20, 95 percent confidence interval (95% CI): 1.10-1.32;

- *Wrong* (question 6, Table 1), OR = 0.93, 95% CI: 0.86-0.99;
- *Turned off* (question 11, Table 1), OR = 0.86, 95% CI: 0.75-0.98;
- *Sloppy* (question 14, Table 1), OR = 0.92, 95% CI: 0.85-0.99.

Estimates of the coefficients for the other variables in the test model produced results with p values greater than 0.05, and these variables were ruled out. No statistically significant interaction term was identified among the selected variables. Analysis of the adjusted model residuals did not identify any outliers or suggest any violation of the premises under the logistic regression model used (Armitage & Berry, 1994). Table 7 shows statistics and estimates obtained in the above-mentioned adjustment.

Upon adjusting the above-mentioned model to the data obtained from the questionnaire filled out by the injury victims at times t_1 and t_2, no significant variable was observed (a = 0.05). When adjusting the same model using data given by the control group at times t_1 and t_2, the following variables were selected as significant:

- *Turned off* (question 11, Table 1), OR = 1.17, 95% CI: 1.01-1.36;
- *Awful* (question 12, Table 1), OR = 1.14, 95% CI: 1.02-1.29;
- *Individual* (question 15, Table 1), OR = 0.19, 95% CI: 0.06-0.60.

All of the other variables in the tested model had coefficients with p values greater than 0.05 and were ruled out. No statistically significant interaction term was identified among the selected variables. Analysis of the residuals from the adjusted model did not identify any outliers or suggest any violation of the premises from the logistic regression model used (Armitage & Berry, 1994). Table 8 shows the statistics and estimates obtained by the adjustment applied to the control's data.

Discussion

This study aimed to compare victims of occupational injuries and non-injured workers as to their perception of occupational risks. Cases and controls were matched as part of the strategy to achieve this aim. Differences in answers to the questionnaire resulted from individual differences in recognizing these risks. That is, since matching was performed in strict agreement with the job position and de facto occupation during the week preceding the injury, one can say that each matched group was subject to the same occupational risks, except for

Table 2

Distribution of injuries based on resulting lesions among occupational injury victims in a metallurgical factory. Southeastern Brazil, 1996.

Type of lesion	Number of events	Relative frequency (%)
Contusions	29	31.2
Fractures	13	14.0
Cuts	11	11.8
Acute arthopathies	10	10.8
Muscle distentions and contractions	8	8.6
Perforations	5	5.4
Amputations	1	1.1
Other	16	17.2
Total	93	100.0

Table 3

Distribution of injuries based on main body region affected among occupational injury victims in a metallurgical factory. Southeastern Brazil, 1996.

Region	Number of events	Relative frequency (%)
Hands	27	29.0
Eyes	23	24.7
Thoracolumbar	12	12.9
Feet	10	10.8
Upper limbs, except hands	9	9.7
Lower limbs, except feet	6	6.5
Head, except eyes	3	3.2
Anterior thoracic	2	2.2
Abdomen	1	1.1
Total	93	100.0

Table 4

Distribution of injuries based on ultimate causative agent among occupational injury victims in a metallurgical factory. Southeastern Brazil, 1996.

Agent	Number of events	Relative frequency (%)
Falls, shocks, loss of balance	34	36.6
Motorized hand-operated tools	11	11.8
Excess physical effort	11	11.8
Non-motorized hand-operated tools	8	8.6
Physical agents	6	6.5
Chemical agents	4	4.3
Machines	2	2.2
Transport vehicles/equipment	1	1.1
Other	16	17.2
Total	93	100.0

Table 5

Distribution of injuries based on time off the job among occupational injury victims in a metallurgical factory. Southeastern Brazil, 1996.

Time off job (days)	Number of events	Relative frequency (%)
1-14	59	63.4
15-29	15	16.1
30-44	9	9.7
45-59	6	6.5
60-74	4	4.4
Total	93	100.0

the individual perception of occupational risks tested in the questionnaire. It is important to realize that a lower perception of an occupational risk is in itself an occupational risk.

One limitation of this study relates to the reference period for which the questions were drafted. *"Building deterministic models for work-related lesions involves long-term variables, many of which are inherent to production activities. To ask about events from the last seven days prior to the injury means that one only touches the surface of the causal networks involved"* (Corrêa Filho, 1994:133).

The Wilcoxon rank-sum test was used as a non-parametric procedure for testing whether distribution of answers to the 18 questions has the same location parameter for cases and controls. This was an initial, exploratory, univariate approach that did not take into account possible confounders and interactions among the study variables and aimed to check differences in response patterns by injury victims and controls that might be associated with their degrees of recognition of the risks under investigation. Using this test, it was observed that for 12 of the 18 questions, answers from injury victims and controls were significantly different. Particularly noteworthy was the fact that for 11 of these 12 questions, the z statistic associated with the comparison between injury victims and controls was consistently negative, indicating that the location parameters for the distributions of these 11 answers from the injury victims were to the left of the respective parameters for the control group, as shown in Table 6. Based on the way the questions were drafted, under the premise that as a result of matching, injury victims and controls were exposed to the same occupational environment and process, the higher the score marked by the worker, the greater the perception of the respective risk tested. Thus, based on this first approximation, one can conclude that on an average the perception of occupational risks was lower among injury victims than among controls.

Use of logistic models in case-control studies traditionally aims to identify differentials in exposure to risk factors for a given disease or attribute, controlling confounders and identifying interactions among the risks studied. However, due to the matching mentioned above, it makes no sense to interpret the results of the conditional logistic model used as indicators of exposure differentials. In this particular situation, the adjustment acts as an indicator of differences in risk perception between injury victims and controls. Thus, in adjusting the above-mentioned logistic model, exclusion of 14 of the 18 questions contained in the questionnaire does not mean absence or non-perception of the risks specifically raised in these questions. What it does mean is that perception of those risks by injury victims did not differ from that of their controls. The forward method for selection of variables was used due to the lack of a prior hierarchical explanatory model.

Based on Table 7, injury victims and their controls differed at the time of injury with regard to recognition of the risks *non-compliance, wrong, turned off*, and *sloppy*. As for the risk *non-compliance*, perceived to a greater degree by injury victims, the response pattern may be related to a prevalent culture among Brazilian companies, which tends to ascribe heavy responsibility for the occurrence of injuries to non-compliance with the standards established by their safety services (Almeida et al., 2000). However, what calls one's attention is the response pattern associated with the risks *wrong, turned off*, and *sloppy*. On average, injury victims had a more limited perception of these risks than their controls. Unit increases in the values ascribed to the questions on the risks *wrong, turned off*, and *sloppy* were associated with variations in the odds ratio perception/injury of 0.93, 0.86, and 0.92, respectively. Due to the design used, a population-based case-control study (Rothman & Greenland, 1998) with risk set sampling of controls (Robins et al., 1986), the odds ratio estimates obtained coincide with incidence density ratios (Pearce, 1993), which are relative risk measures. As compared to controls, during the week of the injury, victims reported working less on jobs other than their own (*wrong*) and that there was less hazardous load movement and mixing (*sloppy*) in their workplace. What is most noteworthy are the answers to the question on the

Table 6

Mean value among cases and controls, z statistic observed, and associated p-value upon applying two-tailed Wilcoxon rank-sum tests for comparison of answers given by occupational injury victims and controls in a metallurgical factory. Southeastern Brazil, 1996.

	Mean (cm)*		z_{obs}**	p value
	Injury victims	Controls		
Non-compliance (question 1)	1.78	0.71	2.14	0.0321
Dissatisfaction (question 2)	0.89	0.93	-1.33	0.1824
Dispute (question 3)	0.56	0.56	-1.10	0.2712
Hostility (question 4)	0.24	0.55	-1.85	0.0641
Threat (question 5)	0.49	0.31	0.09	0.9310
Wrong (qeustion 6)	1.63	2.43	-1.67	0.0953
Adequate (question 7)	2.19	1.99	-0.60	0.5471
Avoid (question 8)	3.30	4.01	-1.75	0.0799
Safety (question 9)	1.09	1.88	-3.13	0.0018
Maintenance (question 10)	1.55	1.56	-1.77	0.0760
Turned off (question 11)	0.52	1.31	-3.30	0.0010
Awful (question 12)	3.06	2.95	-0.83	0.4041
Inspect (question 13)	1.80	2.45	-2.61	0.0091
Sloppy (question 14)	2.42	3.29	-2.29	0.0222
Individual (question 15)	0.28	0.43	-2.43	0.0151
Local (question 16)	0.42	0.61	-1.87	0.0620
Wages (question 17)	3.37	4.00	-1.49	0.1371
Equipment (question 18)	1.90	2.28	-1.82	0.0690

Lower values approach NO, higher values approach YES
* centimeter
** observed z statistic

Table 7

Estimates and statistics produced by adjusting a conditional logistic regression model with data obtained from applying the questionnaire among occupational injury victims and controls at the time t_1 in a metallurgical factory. Southeastern Brazil, 1996.

Variable	Estimated coefficient ± standard error	p value	OR	95% CI
Non-compliance (question 1)	0.18 ± 0.05	0.0001	1.20	1.10-1.32
Wrong (question 6)	-0.07 ± 0.04	0.0444	0.93	0.86-0.99
Turned off (question 11)	-0.15 ± 0.07	0.0209	0.86	0.75-0.98
Sloppy (question 14)	-0.08 ± 0.04	0.0418	0.92	0.85-0.99

OR = odds ratio; CI = confidence interval

risk *turned off*. Injury victims systematically referred to a lower frequency of machines with safety or protective devices that did not work or were turned off as compared to the control group, which, due to the matching, worked exactly at the same jobs, with the same occupations, and during the same period as their coworkers and were thus subject to the same situation with regard to these machines.

Admitting that injury victims and controls were similar with regard to the risks to which they were exposed, one concludes that at least for the risks *wrong, turned off*, and *sloppy*, the injury victim group tended to recognize risks less than the control group at the time of the accident. This low perception is perhaps even underestimated, as recall bias might be expected to cause workers to remember higher risks

Table 8

Estimates and statistics obtained from a conditional logistic regression model with controls of occupational injury victims at time t_1 and t_2 in a metallurgical factory. Southeastern Brazil, 1996.

Variable	Estimated coefficient ± standard error	p value	OR	95% CI
turned off (question 11)	0.16 ± 0.08	0.0499	1.17	1.01-1.36
awful (question 12)	0.13 ± 0.07	0.0425	1.14	1.02-1.29
individual (question 15)	-1.67 ± 0.65	0.0107	0.19	0.06-0.60

OR = odds ratio; CI = confidence interval

during and shortly before the time of their accident (Johnson & Tversky, 1983). Considering that individual risk perception is directly related to attitudes and behaviors in prevention of occupational injuries (Dejoy, 1996), one can raise the hypothesis that more limited perception of certain risks makes workers more vulnerable to occupational injuries, *which obviously does not imply that responsibility for such injuries falls on the victims themselves*.

These results match those of Laurence (1974), who classified 405 mining injuries in terms of a human error model. He found perceptual failures to be the most important source of error underlying these injuries. Also, Corrêa Filho (1994) studied a group of 164 occupational injury victims (cases) and 325 non-injury victims (controls), and his findings appear to agree with the hypothesis raised above. When asking the study group about risk situations perceived in the workplace, the author observed that *"only 2.4% of the cases recalled some risk situation in the previous 15 days, as compared to 16.3% of the controls"* (Corrêa Filho, 1994:80).

No difference was observed when comparing occupational risks perceived by injury victims at the time of the injury (t_1) and 90 days later (t_2). Upon attempting to adjust a 1:1 conditional logistic regression model, in which the moment the questionnaire is answered is analyzed as a function of the answers marked by the injury victims at the two different moments in time, none of the questions was kept in the model. That is, no differences were found between the answers given by occupational injury victims at these two different points in time. However, when the same adjustment was performed on the data furnished by the control group, perception of the risks: *turned off, awful*, and *individual,* were significantly different 90 days after the injury as compared to the time at which it occurred. In this case, too, the forward method for selecting variables was used due to the absence of a prior hierarchical explanatory model. Table 8 illustrates this adjustment. It is important to note that among the questions selected, two indicate that the occupational risk situation at the time of the injury was greater than that experienced 90 days later. That is, the control group reported, on average, that with regard to the second round of the questionnaire (t_2), at the moment of the injury (t_1) there were more machines with safety devices not working (*turned off*) and more work being done with bad equipment for the job (*awful*).

One possible explanation for this data is that at different times and in different sectors of the factory under study, specific, temporary risk configurations were established, sparking off sets of events that contributed to the occurrence of the 93 reported injuries. Although such configurations imply non-differentiated risks for the workers directly involved, the injuries were not randomly distributed. On the contrary, there was a greater probability that they would affect workers with less perception of such risks, thus placing them at greater risk of these occupational injuries. In the second round of the questionnaire, 90 days after the injuries, the above-mentioned risk configurations may no longer have been present, or they may have been present to a lesser degree, given that no injuries occurred at such time in the specific factory sectors. Since risk perception by injury victims was less than that of controls, as shown in the first model performed as described above, analysis of injury victims' answers did not differentiate the two points in time. Still, it was possible to differentiate on the basis of the answers from the control group, who displayed a more acute perception of the occupational risks studied. The control group indicated a situation of greater risk at the time of the injury than at the second point in time.

By way of conclusion, this study's findings suggest that the degree of perception that workers with occupational injuries have of at least some risks for such injuries is lower than that of their non-injured coworkers. As a corollary, the set of measures needed to reduce the frequency and severity of occupational injuries should also include ways to expand risk-perception capacity by workers, *in addition – obviously – to decreasing hazardous conditions in the workplace*. The immediate implication of this finding is that risk assessment for occupational injuries based on self-reported questionnaires filled out by injury victims can underestimate or even distort the presence and relevance of such risks. Such assessments should also consider the opinions of coworkers who have not suffered occupational injuries.

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References

AJZEN, I., 1988. *Attitudes, Personality and Behavior*. Chicago: Dorsey.

ALMEIDA, I. M.; BINDER, M. C. P. & FISCHER, F. M., 2000. Blaming the victim: Aspects of the Brazilian case. *International Journal of Health Services*, 30:71-85.

ARBUTHNOT, J., 1977. The roles of attitudinal and personality variables in the prediction of environmental behavior and knowledge. *Environment and Behavior*, 9:217-232.

ARMITAGE, P. & BERRY, G., 1994. *Statistical Methods in Medical Research.* 3rd Ed. Oxford: Blackwell Scientific Publications.

BECKER, M. H., 1974. *The Health Belief Model and Personal Health Behavior*. San Francisco: Society for Public Health Education.

CLEARY, P. D., 1987. Why people take precautions against health risks? In: *Taking Care – Understanding and Encouraging Self-protective Behavior* (N. D. Weinstein, ed.), pp. 119-149, Cambridge: Cambridge University Press.

CORRÊA FILHO, H. R., 1994. *Percepção de Riscos na Ocupação Precedendo Lesões do Trabalho: Um Estudo no Município de Campinas, São Paulo, 1992-1993*. Tese de Doutorado, São Paulo: Faculdade de Saúde Pública, Universidade de São Paulo.

DEJOY, D. M., 1996. Theoretical models of health behavior and workplace self-protective behavior. *Journal of Safety Research*, 27:61-72.

HARRELL, W. A., 1990. Perceived risk of occupational injury: Control over pace of work and blue-collar versus white-collar work. *Perceptual and Motor Skills*, 70:1351-1359.

HORNE, J. A. & OSTBERG, O. A., 1976. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *International Journal of Chronobiology*, 4:97-110.

JOHNSON, E. J. & TVERSKY, A., 1983. Affect, generalization, and the perception of risk. *Journal of Personality and Social Psychology*, 45:20-31.

KLEINBAUM, D. G.; KUPPER, L. I. & MORGENSTERN, H., 1982. *Epidemiologic Research – Principles and Quantitative Methods*. Belmont: Lifetime Learning Publications.

LAURENCE, A. C., 1974. Human error and accidents in gold mining. *Journal of Safety Research*, 6:78-89.

MONK, T. H., 1989. A visual analogue scale technique to measure global vigor and affect. *Psychiatry Research*, 27:89-99.

MONTEAU, M., 1977. *A Practical Method of Investigating Accident Factors: Principles and Experi-*

mental Applications. Luxembourg: Commission of the European Communities.

ODDONE, I.; MARRI, G. & GLORIA, S., 1967. *L'Ambienti di Lavoro – La Fabbrica nel Territorio*. Roma: Editrice Sindicale Italiana.

PEARCE, N. E., 1993. What does the odds ratio estimate in a case-control study? *International Journal of Epidemiology*, 22:1189-1192.

PRENTICE-DUNN, S. & ROGER, R. W., 1986. Protection motivation theory and preventive health: Beyond the health belief model. *Health Education Research*, 1:153-161.

PRESTON, V.; TAYLOR, S. M. & HODGE, D. C., 1983. Adjustment to natural and technological hazards. *Environment and Behavior*, 15:143-164.

PROCHASKA, J. O.; DI CLEMENTE, C. C. & NORCROSS, J. C., 1992. In search of how people change. *American Psychologist*, 47:1102-1114.

ROBINS, J. M.; GAIL, M. H. & LUBIN, J. H., 1986. More on biased selection of controls for case-control analysis of cohort studies. *Biometrics*, 42:1293-1299.

ROTHMAN, K. J. & GREENLAND, S., 1998. *Modern Epidemiology*. 2nd Ed. Philadelphia: Lippincott-Raven Publications.

RUNDMO, T., 1992. Risk perception and safety on offshore petroleum platforms – Part II: Perceived risk, job stress and accidents. *Safety Science*, 15:53-68.

SAS INSTITUTE, 1989. *SAS/STAT. User's Guide, Version 6.12*. 4th Ed., v. 2. Cary: SAS Institute.

SAS INSTITUTE, 1990. *Statistical Analysis System*. Cary: SAS Institute.

SCHILLING, R. S. F., 1989. Health protection and promotion at work. *British Journal of Industrial Medicine*, 46:683-688.

SNEDECOR, G. W. & COCHRAN, W. G., 1980. *Statistical Methods*. 7th Ed. Ames: Iowa State University Press.

STEWART-TAYLOR, A. J. & CHERRIES, J. W., 1998. Does risk perception affect behaviour and exposure? A pilot study amongst asbestos workers. *Annals of Occupational Hygiene*, 42:565-569.

URY, H. K., 1975. Efficiency of case-control studies with multiple controls per case: Continuous or dichotomous data. *Biometrics*, 31:643-649.

WEINSTEIN, N. D., 1988. The precaution adoption process. *Health Psychology*, 7:355-386.

WEINSTEIN, N. D. & SANDMAN, P. M., 1992. A model of the precaution adoption process: Evidence from home radon testing. *Health Psychology*, 11:170-180.

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