Water and sewage treatment workers differences in psychosocial and ergonomics assessment

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Abstract. Sewage treatment, water treatment and maintenance workers from a utility company, totaling 32 male subjects, participated in a cross-sectional psychosocial and ergonomics assessment. The Washington State Department of Labor and Industries field work ergonomic checklist and the short version Copenhagen Psychosocial Questionnaire (CoPsoQ) were used. The analysis tested the hypothesis that sewage treatment workers, subjected to foul odors, show higher severity of psychosocial factors than water treatment workers. Odds ratios for the sewage treatment condition were computed for all psychosocial sub-scales, suggesting rejection of the hypothesis. Association was found between ergonomic risk factors and some of the psychosocial sub-scales.

Keywords. Musculoskeletal complaints, bad smell at work, cross-sectional study, odds ratios analysis.

1. Introduction

Interventions conducted by ergonomics and occupational health practitioners should focus on more than one factor. Interventions should comprise optimization of the workplace layout in combination with a feedback survey of the psychosocial work environment and individual training focusing on working technique (Wahlström, 2005).

The company focused in the study reported in this paper is a utility company (water and sewage treatment) covering an area of 6393.2 square kilometers corresponding to about 7% of the Portuguese continental territory, in a mountainous area, with a complex and sparsely populated territory. The company had 82 blue-collar workers, who worked in the field, either permanently in field stations, or as part of dispatch teams. Field workers had week day only work times from 8am to 5pm, while dispatch teams worked in rotational shifts, covering 24h of the day, 7 days of the week.

Previous work characterized the work conditions of office workers in this utility company, from an environmental and physical ergonomics standpoint as well as from a psychosocial assessment viewpoint (Tavares et al., 2013; Coelho et al., 2014-a; Coelho et al., 2014-b; Tavares et al., 2014). Those efforts were extended to field workers of the same company. Sewage treatment, water treatment and maintenance workers from a utility company, totaling 32 male subjects, participated in a cross-sectional psychosocial and ergonomics assessment. The Washington State Department of Labor and Industries (WSDLI, 2004) graphical checklists for ergonomic assessment of fieldwork (Keyserling et al., 1992; Keyserling et al., 1993) in caution and hazardous zones were used in adapted form. Psychosocial assessment was carried out using the same instrument deployed in the

previous afore-mentioned studies that were made in the same company: the short version Copenhagen Psychosocial Questionnaire (CoPsoQ) (Moncada et al., 2005).

Houtman et al. (1994) performed an odds ratios analysis for several individual risk factors for different health indicators, for workers from the Netherlands. They reported that "bad smell at work" had an odds ratio of 1.4 (1.13-1.74 95%CI) for the reporting of psychosomatic symptoms, an odds ratio of 1.38 (1.10-1.74 95%CI) for the reporting of muscle or joint complaints and an odds ratio of 1.59 (1.08-2.34 95%CI) for the reporting of chronic back problems. The analysis reported in this study was meant to test the hypothesis that the utility company workers who were regularly subjected to foul odors, endured higher severity of psychosocial factors than other workers of the same company. To this end, odd ratios for the sewage treatment worker condition were computed for all psychosocial sub-scales. Additionally, measures of association between results of the ergonomic assessment (checklist guided assessment of risks revealing caution and hazard zones) and the results of the psychosocial assessment across the subjects were computed. These included Spearman rank order correlations and a regression analysis (using the backward entry method) in order to assess the association between these two important aspects of working conditions for field workers of the company.

2. Methods

2.1 Data collection methods

As a complement to the combined WSDLI (2004) caution and hazard ergonomic field work checklists, the ergonomic checklist for work with computers by Lima and Coelho (2011) was appended, to be used if extended computer usage was encountered, in accordance with the former checklist instructions. None of the 32 participating field workers fell into the condition that required the use of a specific checklist for extended computer usage. The ergonomic fieldwork assessment results were coded with the use of an ordinal categorical scale for each of the WSDLI (2004) combined caution and hazard zone items. The combination was made by the authors, with additional adaptations to tailor the checklist to the jobs analyzed, based on unstructured observations on-site.

In order to complement the assessment based on the checklists, Corlett and Manenica's (1980) body diagram was used in the study. This diagram is a qualitative method, and is divided into body regions (right and left) and each one enables the individual respondent to select the zone corresponding to the location where body pain and discomfort is felt at the time of evaluation. Subjects individually marked the twenty-one area body map supplied to each one of them. After collecting the data on the pain affected areas, from the twenty-one body zones identified in the map, these zones were grouped in only three areas (upper limbs, torso and lower limbs) for subsequent analysis.

To evaluate the disabilities of the arms, shoulders and hands there are two highly interrelated questionnaires: DASH and Quick DASH, which are respectively, the short version and the long version of an instrument for the evaluation of the aforementioned disabilities. In this study the longer version was used (DASH Portuguese version, 2005), because it covers more items and provides more information. With this questionnaire it was intended to collect data on the symptoms and the ability of the worker to perform certain activities involving muscular effort and control. A high score indicates greater disability. All 32 subjects provided valid answers enabling computation of the score.

The short version of the CoPsoQ instrument enabled collecting ratings for three dissatisfaction sub-scales (psychological demands, insecurity towards the future and conflicting demands) and for three satisfaction sub-scales (workers control over work, social support and leadership quality, and, finally, esteem). Low scores in the

dissatisfaction scales indicate small exposure to psychosocial risk factors, while high scores in satisfaction scales indicate the worker is well adjusted to the work psychosocial context. Low satisfaction scores and high dissatisfaction scores indicate a high level of exposure to psychosocial job risk factors (Lima & Coelho, forthcoming).

2.2 Approach to analysis of results

Results were analyzed with assistance of IBM SPSS Statistics 20 package, using non-parametric statistics, following the approach of Coelho et al. (2013). Spearman rank order correlations were computed for the psychosocial assessment sub-scales and the physical ergonomics data. Additionally, associations were sought by resorting to a linear regression analysis, using the backward entry method, considering the psychosocial sub-scales as dependent variables and the physical ergonomics data as independent variables. Analysis of odds ratios (Szumilas, 2010) was performed considering as exposure 'experiencing bad smells or foul odors at work' regularly, and taking as variables of interest each one of the psychosocial assessment sub-scales (for severe ratings), as well as musculoskeletal complaints reported. Based on observations carried out at several field facilities of the utility company studied, sewage and maintenance workers were assigned to the condition of being regularly subjected to foul odors in the course of their work duties, while water treatment workers were not.

3. Results

Mean and standard deviations of psychosocial assessment obtained are represented in Table 1, for the entire sample of field workers, and considering the workers that are subjected to foul odors regularly in the course of their work, and those that are not. The former reported on average more severe levels of psychological demands and conflicting demands than the latter. Additionally, insecurity towards the future and esteem attained on average high severity as risk factors of a psychosocial nature for the entire sample. The results of independent samples Mann-Whitney U tests, only led to rejecting the null hypothesis ($p=0.031$) for psychological demands, proving that the distribution of the scores in this sub-scale are not the same across the two first columns of Table 1.

Table 1: *Results for office and field workers obtained in each of the six psychosocial sub-scales - severe mean results are underlined, according to Moncada et al. (2005).*

CoPsoQ sub-scale	Workers not subj. to foul smell (n=11)	Workers subj. to foul smell (n=21)	All participants (n=32)
	mean (sd)	mean (sd)	mean (sd)
Psychological demands	10.2 (2.3)*	**12.4** (3.0)*	**11.7** (3.0)
Insecurity towards the future	**10.4** (3.5)	**9.1** (4.2)	**9.6** (3.9)
Conflicting demands	5.6 (2.0)	**6.9** (2.2)	6.4 (2.2)
Workers control over work	24.0 (4.5)	26.6 (5.9)	25.7 (5.5)
Social support and leadership quality	30.1 (4.2)	30.0 (6.1)	30.0 (5.5)
Esteem	**10.4** (2.5)	**10.2** (3.6)	**10.3** (3.2)

The DASH scores obtained had a mean of 11.9 (sd=11.76), which is what the average 55 year old male or female in the general population reports, while patients awaiting shoulder surgery reported a mean score of 43 (Hudak et al., 1996). Ordinal categorical data is summarized in Table 2 for musculoskeletal complaints and in Tables 3 and 4 for the WSDLI (2004) field ergonomic checklists results (null responses omitted). The

ergonomic field work checklists results encompass many hazard zone cases, requiring interventions at individual level, focusing on improving working technique.

Table 2: Categorical data results for musculoskeletal complaints.

Musculoskeletal (MS) complaints		Workers not subj. to foul smell (n=11)		Workers subj. to foul smell (n=21)		All participants (n=32)	
MS complaints in the upper limbs	No complaint	9	82%	13	62%	22	69%
	Complaint	2	18%	8	38%	10	31%
MS complaints in the torso	No complaint	3	27%	8	38%	11	34%
	Complaint	8	73%	13	62%	21	66%
MS complaints in the lower limbs	No complaint	9	82%	14	67%	23	72%
	Complaint	2	18%	7	33%	9	28%

Table 3: Categorical data results for the WSDLI (2004) field ergonomic caution and hazard zone checklists (items 1 to 8) (adapted by the authors).

Field work ergonomic checklist item (*abridged)*		Workers not subj. to foul smell (n=11)		Workers subj. to foul smell (n=21)		All participants (n=32)	
1. Working with hand(s) above head...	Caution	3	27%	12	57%	15	47%
	Hazard	0	0%	0	0%	0	0%
2. Repeatedly raising hand(s) above head...	Caution	0	0%	2	10%	2	6%
	Hazard	1	9%	7	33%	8	25%
3. Working with the neck bent...	Caution	4	36%	10	48%	14	44%
	Hazard	0	0%	3	14%	3	9%
4. Working with the back bent forward...	Caution	3	27%	8	38%	11	34%
	Hazard	1	9%	4	19%	5	16%
5. Working with the back bent laterally...	Caution	1	9%	5	24%	6	19%
	Hazard	0	0%	2	10%	2	6%
6. Squatting	Caution	8	73%	9	43%	17	53%
	Hazard	0	0%	2	10%	2	6%
7. Kneeling	Caution	4	36%	8	38%	12	38%
	Hazard	0	0%	2	10%	2	6%
8. Using high impact vibrating tools...	Caution	5	45%	7	33%	12	38%
	Hazard	0	0%	1	5%	1	3%

In performing the statistical analysis of results, significant Spearman rank order correlations results were noted for p-values smaller than 0.05; odds ratios were to be noted with 95% confidence intervals if significant, and linear regression results were to be noted only for significant models achieving 50% or greater coefficient of determination (R^2).

Workers control over work was the psychosocial sub-scale that correlated significantly with most ergonomic fieldwork checklist items (except items 3, 11, 12 and 13), albeit inversely. Insecurity towards the future was positively correlated with checklist items 6, 10, 15 and 17. Esteem was inversely correlated with checklist items 2, 5, 9, 10 and 17.

Table 4: Categorical data results for the WSDLI (2004) field ergonomic caution and hazard zone checklists (items 9 to 17) (adapted by the authors).

Field work ergonomic checklist item (*abridged)*		Workers not subj. to foul smell (n=11)		Workers subj. to foul smell (n=21)		All participants (n=32)	
9. Using vibrating handtools...	Caution	4	36%	3	14%	7	22%
	Hazard	0	0%	2	10%	2	6%
10. Pinching an unsupported object...	Caution	8	73%	8	38%	16	50%
	Hazard	0	0%	2	10%	2	6%
11. Gripping an unsupported object...	Caution	5	45%	9	43%	14	44%
	Hazard	0	0%	3	14%	3	9%
12. Using the same motion with little...	Caution	3	27%	4	19%	7	22%
	Hazard	0	0%	1	5%	1	3%
13. Intensive keying	Caution	8	73%	8	38%	16	50%
	Hazard	0	0%	8	38%	8	25%
14. Using the hand (...) as a hammer...	Caution	2	18%	5	24%	7	22%
	Hazard	0	0%	1	5%	1	3%
15. Lifting heavy objects	Caution	9	82%	4	19%	13	41%
	Hazard	1	9%	8	38%	9	28%
16. Frequent lifting	Caution	6	55%	6	29%	12	38%
	Hazard	1	9%	6	29%	7	22%
17. Lifting adopting awkward postures	Caution	7	64%	3	14%	10	31%
	Hazard	0	0%	5	24%	5	16%

Linear regression analysis (using the backward entry criterion) generally supported the association for the psychosocial sub-scales found from the analysis of correlation, albeit not indicating precisely the same checklist variables and adding association to the DASH score and, or, to some of the types of musculoskeletal complaints included in the dataset.

4. Discussion and Conclusion

The small population size may have contributed to the analysis of odds ratios yielding no significant results, when considering the exposure factor as 'working subjected to a foul smell' and for the variables of interest of MS complaints and having attained a severe rating in the psychosocial sub-scales. Odds ratio values computed are low in general although most are greater than one (but not the ones for torso MS complaints, insecurity towards the future, social support and leadership quality and workers control over work) suggesting that jobs involving contact with the sewage could have greater likelihood of severe outcomes in

most variables of interest (upper and lower limbs MS complaints, psychological demands, conflicting demands and esteem). Based on the odds ratio analysis, the findings of Houtman et al. (1994) were not replicated in the current study, given that the hypothesis that sewage treatment workers, subjected to foul odors, showed higher severity of psychosocial factors endured than water treatment workers is rejected. The possibility of a Healthy Worker Effect (HWE) (Shah, 2009) being present was investigated. T-test showed that age at hire was significantly higher ($p=0.004$) for the workers who got in contact with the sewer ($m=31.8$; $sd=9.2$) than for the remaining participants ($m=22.3$; $sd=6.1$). Overall, duration of employment had a mean of 11.2 years ($sd=1.9$) and did not differ significantly across both groups. Hence, HWE cannot be ruled out, particularly in sewage treatment workers, as a contributor to the low odds ratios obtained. This notwithstanding, the results of this study demonstrate important associations between physical ergonomic characteristics of the job (including lifting in awkward postures, working in awkward postures and pinching) and three psychosocial risk factors (workers control over work, insecurity towards the future and esteem).

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