Subjective analysis of cold thermal environments

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ABSTRACT

The present work is dedicated to the study of cold thermal environments in food distribution industrial units through a subjective assessment based on an individual questionnaire which aims to describe the working conditions of employees often exposed to cold. The survey was carried out in Portugal and the sample consists of 1575 valid responses obtained in 61 industrial units. The results show that the food distribution activity sector is characterized by a female population (78.1%) and by a young work force (63.4% of the workers are less than 35 years old). Despite the availability of cold protective clothing (52.8% of the workers indicate one garment) its characteristics require improvements. In addition almost 1/3 of the respondents consider the thermal environment cold and 79.6% of the workers report that working in the cold is harder in wintertime. The results also highlight that 37.3% of the workers report having health problems.

1. Introduction

The occupational exposure to extreme thermal environments, either hot or cold, represents an issue that should be duly considered due to the very significant number of workers involved. Based on a field survey carried out in Portugal, this work is dedicated to the study of cold thermal environments. The occupational cold exposure, assessed in terms of the Required Clothing Insulation Index (*IREQ*) (ISO 11079, 2007) developed by Holmér (1984), was first characterized by Oliveira et al. (2008) in an extensive study that has quantified the thermal conditions of six activity sectors mainly in food production, conservation and distribution industrial units. This study, based on the *IREQ* index, shows that in Portugal the number of people working in cold environments is much more important than was initially predicted.

However, it is widely recognized that the activities developed in both moderate and extreme thermal environments should be evaluated from multiple perspectives and subjective assessments are being looked at with growing interest. Cohidon et al. (2009)

studied the perceived health status and psychosocial factors of meat industry employees in France through a postal survey that included 3000 workers. Yasuo et al. (2010) performed a cross-sectional study involving 991 workers in 126 kitchen facilities in Japan to evaluate subjective thermal strain in different working environments using a self-reporting questionnaire survey and subjective judgment scales. The interrelationships of subjective assessments (thermal sensation, perceptions and preferences for individual and climate parameters) as well as their connections with the prevailing thermal conditions were analyzed through interviews to 967 visitors of Szeged, Hungary, by Kántor et al. (2012). Arezes et al. (2013) tested thermal comfort of trekking boots through objective and subjective evaluations and Boschman et al (2013) assessed the psychosocial work environment and mental health among construction workers using a questionnaire. The importance of the subjective surveys is also raised by international standards, namely in the case of cold thermal environments (ISO 15743, 2008; ISO 28802, 2012).

The increasing awareness of the importance of this tool lead the authors to a new and detailed approach that resulted in an additional study focused in a subjective assessment of the occupational exposure to cold thermal environments. Hence, the present contribution represents a complementary analysis of a previous study (Oliveira et al., 2008) but the aim is now restricted to food distribution industrial units. Despite being focused on Portuguese workers, the present analysis can be of potential interest and

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regarded as a valid contribution to other countries and industrial activities.

The present survey was carried out in large and medium size supermarkets owned by an important economic group, which has been formally invited to participate in this study and has immediately accepted and encouraged the project. This active cooperation included the participation of all the industrial units of the group distributed all over Portugal main land. This full cover of the territory and the participation of 61 industrial units turned into the first large characterization of the working conditions through individual questionnaires.

2. Methods

2.1. Study design, population and sample

The economic group that participated in the present study owns 68 industrial units, 14 large and 54 medium supermarkets, spread out through all provinces of Portugal main land (Table 1). The questionnaire was distributed to all workers that performed activities in the cold (2480), but only 1575 inquiries with validated answers (63.5% of the population) were collected. All the workers anonymously and voluntarily participated to the survey and did not receive any recompense.

Therefore, the sample represents very well the population that works in cold thermal environments in the supermarkets of the target group, and is also supposed to roughly represent the whole Portuguese population of workers of the sector, perhaps with some bias to the best practices given the prestige of the target group.

2.2. Questionnaire and data

The questionnaire is formally divided in Parts I (Questions I.1–3) and II (Questions II.1–24) and its structure is shown in Table 2. To complete the questionnaire a period of 15 min was considered to be sufficient.

In particular, Question I.3, on the clinical history, is based on ISO standard 12894 (2001) which lists the health effects, both physiological changes and disorders that may arise as a result of cold or hot exposures. For the characterization of the thermal environment of workplaces, ISO 10551 (1995) was taken into account. Questions I.1–3 and II.1–8 are multiple choice questions, while Questions II.9–24 are based on a 10-degree judgment scale. The questionnaire was aimed to describe the working conditions as perceived by the respondents.

2.3. Statistical analysis

The present statistical analysis was based on SPSS and Excel softwares. A discrete random variable is associated to each question of the Questionnaire; e.g., variable I.1 (Age of worker) is associated with Question I.1. The following statistical tools were used to process each variable or group of variables: i) unbiased mean and standard deviation estimators; iia) probability and distribution functions; iib) *ad hoc* pseudo probability functions; iiia) marginal probability functions; iiib) differential marginal probability functions taking one of them as a reference; iiic) differential marginal probability functions taking the simple probability function of the base variable as a reference; iv) joint probability functions of a pair of variables; and v) linear regression of one variable on another one, including the respective coefficient of correlation. When applying

Table 1
Distribution of the Portuguese population, questionnaires and food industrial units of the economic group by provinces.

	Province	Population		Results	
		Total	%	Questionnaires	Industrial units
	1 – Viana do Castelo	250 275	2,5	58	1
	2 – Vila Real	223 729	2,3	31	2
	3 – Bragança	148 883	1,5	17	1
	4 – Braga	831 366	8,4	76	2
	5 – Porto	1 781 836	18,1	356	16
	6 – Aveiro	713 575	7,2	50	4
	7 – Viseu	394 925	4,0	65	1
	8 – Guarda	179 961	1,8	0	0
	9 – Coimbra	441 204	4,5	84	2
	10 – Castelo Branco	208 063	2,1	12	1
	11 – Leiria	459 426	4,7	65	3
	12 – Santarém	454 527	4,6	52	3
	13 – Portalegre	127 018	1,3	35	2
	14 – Lisboa	2 136 013	21,6	346	9
	15 – Setúbal	788 459	8,0	148	5
	16 – Évora	173 654	1,8	17	1
	17 – Beja	161 211	1,6	19	1
	18 – Faro	395 218	4,0	144	7
	Total	9 869 343	100	1575	61