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Accidents in the greenhouse-construction industry of SE Spain

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ABSTRACT

This work analyses the labour accidents in the greenhouse-construction industry of SE Spain for the period 1999–2007 through a sample of 180 accident reports. The accidents were characterised by studying 5 variables in order to know the day of the week in which the accident occurred, the hour of the day of the accident, type of accident, the region of Spain in which the accident happened, and the resulting injury. The data characterising the accidents were submitted to a descriptive multiple-correspondence analysis. The incidence of accidents in the greenhouse-construction industry presented a high mean value of 15133.7 per 100 000 workers per year. The days with the greatest incidence of accidents were Thursday and Monday, while the period of greatest number of accidents occurred in the first 4 h of the workday. No significant correspondence was found between the day of the week, the hour of the day, or any of the other 3 variables studied. The types of accidents with most frequency were: cuts, punctures, contact with hard or rough material, overexertion, and falls from one level to another. The most affected parts of the anatomy were the eyes, thorax, back, sides, lower legs, and feet. The most common types of injury were bone fractures, twists and sprains, distended muscles, contusions, and being crushed. The study calls attention to the high number of accidents at work, which needs to be corrected by fulfilment of safety regulations at work, on the part of the company. Finally, recommendations are made to correct this situation of high number of accidents at work.

1. Introduction

Table 1 shows that Spain is the country of the European Union (15 countries, [EU-15]) with the highest mean incidence rate for the period 1996–2007, with 12896.2, followed by France (10547.0), Luxembourg (10181.0), and Portugal (8217.8), these rates being higher in these four countries than the mean of the EU-15, with 6971.7. However, for this period a descent of 39.2% was registered in Spain for this rate, while the descent for the EU-15 was 34.7%. According to the incidence rate of fatal accidents, Spain occupies the third place in the EU-15, with a mean value of 4.4 for the period 1996–2007, with Portugal being the country with the highest index, 7.3, followed by Austria, 5.0, while the mean of the EU-15 is 2.7. A decline in this index of 61.0% was registered in Spain for this period, while for the EU-15, the decline was 41.7% (EUROSTAT, 2008). However, this high accident rate is not only limited to Spain, but also there is a world scale, with workers falling from heights being the primary and most frequent cause of mortality (Sorock et al., 1993; Chi and Wu, 1997; Hinze et al., 1998; Janicak, 1998; Jeong, 1998; Kines, 2002; Larsson and Field, 2002; Huang and Hinze, 2003; Tam et al., 2004; Chi et al., 2005; Chia-Fen et al., 2005; Haslam et al., 2005; Hoonakker et al., 2005; Macedo and Silva, 2005; Müngen and Gürcanli, 2005; Snashall, 2005; Adam et al., 2008; BLS, 2008; Camino-López et al., 2008; Prasana and Dewangan, 2009). In addition, slips, trips, and falls are the most common cause of worker injuries, which bear a high economic cost to companies due to the days off work (Bentley and Haslam, 2001; Kemmlert and Lundholm, 2001; Lehane and Stubbs, 2001; Haslam et al., 2005; Bentley et al., 2006; Gard and Berggard, 2006; Lipscomb et al., 2006; Gao et al., 2008; Bentley, 2009).

In this context, Spain is the country with the greatest surface area of plastic-covered greenhouses, reaching 45 000 ha (Castilla and Hernández, 2005; Callejón-Ferre et al., 2009a), with the greatest concentration situated in SE Spain, particularly in the province of Almería, with 26 500 ha (Fundación Cajamar, 2007). Here, intensified agriculture specialises in greenhouse-grown vegetables, with high input and yield, which generates the greenhouse-construction industry. Greenhouses are agricultural buildings with light, low-cost structures that provide the microclimatic conditions needed for year-round crops (Soriano et al., 2004). New greenhouse construction as well as the maintenance and rehabilitation of the pre-existing ones occur mainly from June to September (Pérez-Alonso et al., 2011), raising high demand for labourers and making it common to hire workers without training or experience. Saha et al.

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Table 1
Trends in incidence rate of accidents at work and Incidence rate of fatal accidents at work in European Union (EU-15), Spain, France, Luxembourg and Portugal.

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
European Union (15 countries)												
Total EU-15[a]	6368.0	6288.5	6288.0	6260.5	6026.5	5716.5	5008.5	4740.7	4652.0	4457.5	4346.7	3965.5
Construction[a]	8023.0	7963.0	8008.0	7809.0	7548.0	7247.0	6890.0	6492.0	6257.0	6069.0	6117.0	5237.0
Total EU-15[b]	3.6	3.4	3.2	2.9	2.8	2.7	2.5	2.5	2.4	2.3	2.4	2.1
Spain												
Total National[a]	7349.5	7341.2	7872	8360	8287.5	8148.7	7927.7	7849.5	7450.7	7149	6933	5693.5
Construction[a]	13315.0	12870.0	14332.0	14901.0	14807.0	14797.0	14246.0	13651.0	11947.0	11166.0	10632.0	8090.0
Total National[b]	5.9	6.3	5.5	5.0	4.7	4.4	4.3	3.7	3.2	3.5	3.5	2.3
France												
Construction[a]	11354.0	11872.0	12205.0	11409.0	11407.0	10864.0	10716.0	10066.0	9824.0	9712.0	9479.0	7656.0
Total National[b]	3.6	4.1	4.0	3.4	3.4	3.2	2.6	2.8	2.7	2.0	3.4	2.2
Luxembourg												
Construction[a]	10344.0	10486.0	10027.0	10743.0	10942.0	11335.0	11620.0	10812.0	10106.0	8373.0	9236.0	8148.0
Total National[b]												
Portugal												
Construction[a]	12131.0	10375.0	10093.0	8370.0	7048.0	8089.0	6851.0	6821.0	7640.0	7311.0	7376.0	6509.0
Total National[b]	9.8	8.3	7.7	6.1	8.0	9.0	7.6	6.7	6.3	6.5	5.2	6.3

[a] Incidence rate of *accidents* at work: (number of accidents at work with more than 3 days' absence that occurred during the year/number of persons in employment in the reference population) × 100 000.
[b] Incidence rate of *fatal accidents* at work: (number of fatal accidents at work that occurred during the year/number of persons in employment in the reference population) × 100 000.

(2004), Waehrer et al. (2007), and Fabiano et al. (2008) relate this to labour accidents in the construction industry. The greenhouse-construction companies, and the low-technology construction systems used in general, implement few accident-prevention techniques for work safety (Carreño-Ortega, 2005; Pérez-Alonso et al., 2011). Several authors have considered that the preliminary stages of the engineering and architecture design process are essential to prevent or reduce risks. Thus, many studies have examined design for hazard-prevention, integrating preventive measures for worker safety in the planning phase of the project by architects and engineers (Behm, 2005; Haslam et al., 2005; Gambatese et al., 2008; Van Gorp, 2007; Toole and Gambatese, 2008; Behm, 2008; Vázquez et al., 2011). Four paths have been proposed in relation to incorporating prevention in the design process: (1) The use of more prefabricated construction elements; (2) greater use of safer systems and materials; (3) increased application of engineering in construction; and (4) more thorough consideration and spatial investigation in the design.

On the other hand, the greenhouse-construction companies are small (SME), with limited resources and few workers (Pérez-Alonso et al., 2011), leading to a greater probability of accidents due to poor preventive measures (Beaver, 2003; Fabiano et al., 2004; JØrgensen, 2008; Hasle et al., 2009; Pérez-Alonso et al., 2011). As indicated Walters (2004), the health and safety problems in SMEs are more a result of poor management of risk than of the actual magnitude of the hazards present. Also, most accidents are apparently simple and related to human behaviour, and very often result from everyday conditions which are not considered to be especially hazardous. This is perhaps another important reason why the rate of injury is high. This fact must be taken into account when developing a risk evaluation system for small enterprises (JØrgensen et al., 2010). Ale (2006) in The Netherlands has developed an occupational risk model (ORM) that is based upon the bow-tie model of accident causation and is used for the analysis of accidents reported within the national registration of the Dutch Factory Inspectorate. The model is focussed on accident scenarios and barrier failures, not only in terms of failure of hardware, but also of management factors (WORM Metamorphosis Consortium, 2008). These management factors provide a link to a quality assessment of safety management systems within a branch of industry, or within individual companies. The main aim of the program is to facilitate learning, and to introduce effective improvement projects (Swuste, 2008). Also, JØrgensen et al. (2010) seek to determine whether they can use the ORM method to collect information about risks in SMEs and, if so, whether they can present this information in a way that allows SMEs to use it constructively. Finally, they seek to evaluate the impact of this method on occupational safety in SMEs, as the project also focuses on management factors that can motivate the SMEs to heighten their risk-awareness and expand their own initiatives. Khanzode et al. (2010) have developed a scheme for classifying accident/injury events based on three incident attributes: person, system and interaction. The scheme uses injury narratives for classification of accident/injury events. Use of injury narratives for analysis and control of the occurrences of workplace accidents was explored previously by Helander et al. (1983) and more recently by JØrgensen (2008). A conceptual model was developed by Khanzode et al. (2010) to assess injury severity to industrial workers, and a mathematical scheme was proposed for assessing the associations between the factors of the injury severity model.

Safety studies in the greenhouse-construction industry are rare and thus, when the regulation took effect in Spain concerning safety and health devices at construction sites (BOE, 1997), Callejón-Ferre et al. (1998) studied the enforcement of this regulation in the greenhouse-construction sector. Ponce (2005), showed the great deficiencies in the sector in terms of applying of standards on the prevention of occupational hazards, the lack of financial means, and the absence of training, but did not quantify the accident rate. Pérez-Alonso et al. (2008) evaluated the labour risks of different greenhouse-construction phases of SE Spain, later Pérez-Alonso et al. (2011) characterised the preventive activity of the greenhouse-construction industry of SE Spain, concluding that the management of labour risk is very poor, no internationally recognised work-risk prevention programmes being adopted, and correlating the size of the company with its preventive activity (larger companies having more preventive activity). Also, Callejón-Ferre et al. (2009b, 2011b) analysed labour conditions of agricultural workers in greenhouses of SE Spain in general, without considering those of the builders. Later, several direct indices of heat stress determined the stress suffered by workers inside the greenhouses performing cultivation tasks Callejón-Ferre et al. (2011a).