

## Safety and health in forest harvesting operations. Diagnosis and preventive actions. A review

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### Abstract

*Aim of study:* to review the present state of the art in relation to the main labour risks and the most relevant results of recent studies evaluating the safety and health conditions of the forest harvesting work and better ways to reduce accidents.

*Area of study:* It focuses mainly on developed Countries, where the general concern about work risks prevention, together with the complex idiosyncrasy of forest work in forest harvesting operations, has led to a growing interest from the forest scientific and technical community.

*Material and Methods:* The main bibliographic and Internet references have been identified using common reference analysis tools. Their conclusions and recommendations have been comprehensively summarized.

*Main results:* Collection of the principal references and their most important conclusions relating to the main accident risk factors, their causes and consequences, the means used towards their prevention, both instrumental as well as in the aspects of training and business management, besides the influence of the growing mechanization of logging operations on those risks.

*Research highlights:* Accident risk is higher in forest harvesting than in most other work sectors, and the main risk factors such as experience, age, seasonality, training, protective equipment, mechanization degree, etc. have been identified and studied. The paper summarizes some relevant results, one of the principal being that the proper entrepreneurial risk management is a key factor leading to the success in minimizing labour risks.

**Key words:** labour risk; forestry; accident rates; preventive measures; entrepreneurial risk management.

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### Studies about accident rates in forestry work

In spite of technological advances, forestry work continues to be one of the most dangerous activities, in particular when the workers do not have adequate training (Klun and Medved, 2007).

There is a great shortage of records about self-employed workers, like forest owners who work occasionally in harvesting; only fatal accidents being recorded; given that monetary compensation does not exist, incidents are not usually reported (Lindroos and Burs-trömb, 2010). Many of these deaths are due to lack of knowledge about health and safety recommendations.

Fatal accidents of full time workers went down in Sweden between 1970 and 1995. Accident rates of

machine operators by 70% and those of chainsaw workers by 48% (Axelsson, 1998). However, these statistics were altered by an increase of fatal accidents among self-employees (Neely and Wilhelmson, 2006).

Taking all this into account, the accident rate in the forestry is significantly higher than in other sectors considered to be of high risk: *e.g.* the fatal accident rate in the United States forestry was 19 times higher than other sectors, but also 11.5 times greater than in the New Zealand forest sector, revealing that forest work is the most dangerous, with loggers being the most exposed (Lefort *et al.*, 2003; Peters, 1991; Bell, 2002). In Australian forestry, injuries were 2 to more than 3 times greater than in the rest of industries (Driscoll *et al.*, 1995).

Fatal accidents rates in Germany were 3 times higher in the forestry sector than in construction, and twice as high as in agriculture. In Great Britain, the severity rate of the other sectors went from 14.3% to 32.1% of

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**Table 1.** Comparison of fatal accident rates in forestry related to timber removals in selected European Countries (Klun and Medved; Cabeças, 2007)

Country	Activity	Number of fatal accidents $\times$ year <sup>-1</sup>	Timber removals (10 <sup>6</sup> m <sup>3</sup> $\times$ year <sup>-1</sup> )	Accidental deaths $\times$ (10 <sup>6</sup> m <sup>3</sup> ) <sup>-1</sup>
Sweden	Forestry	8.47	77	0.11
Austria	Forestry	37	20.1	1.84
Slovenia	Forestry	15.7	3.2	4.9
Switzerland	Forestry	13.6	7	1.94
Germany	Forestry	40.7	60.7	0.67
Finland	Forestry (full time employees)	6.4	64.3	0.1
Croatia	Forestry (full time employees)	2.5	5	0.5
Spain	Forestry (Cabeças, 2007)	7.7	15	0.5

the forest harvesting figure, with a similar increase in the incident rate. In Spain, the incident rate of all other sectors was 3 to 4 times lower than that of forestry (Cabeças, 2007).

Using various sources, in spite of the difficulties of comparison, Klun and Medved (2007) studied the evolution of fatal accidents between 1980 and 2004 in several European countries. A combination of their references with those of Cabeças (2007) in the Spanish case is shown in Table 1.

Slovenia shows the lowest wood production among the countries studied and the highest rate of fatal accidents·million m<sup>-3</sup> (4.9). Spain, according to official statistics is among the countries with lower ratios (0.5). The states with the best records are the Nordic Countries (0.1), while the Central Europeans range from 0.67 to 1.94. These figures can be justified by organizational and technological changes; in the Nordic Countries due to better physiographic conditions mechanization is preferred whereas in Central Europe the physiography is less favourable and mechanization is not complete. Between 2000 and 2004 the number of fatal accidents decreased by 50% in Switzerland and Austria, while in Slovenia there was no progress.

## Characterization of injured forestry workers. Risk factors

Risk perception is of vital importance for workers, as it causes them to expose themselves unduly to unacceptable risks, and so is an important element in training and preventive measures.

Nevertheless, it is noted that occasionally worker voluntarily and consciously take greater risks when

preventive measures are in place, trusting in their efficiency. Risk compensation theory is the subject of a survey completed by Finnish workers (Salminen *et al.*, 1999), according to which more than half underestimated the risk and exposed themselves to when using the safety measures available.

Physical fitness and personality of the worker have great influence on assumed risk and accident rates in the forest (Salminen *et al.*, 1999): impulsive and extrovert people take higher risks compared to introverts; as to the number of accidents, there are only significant differences among neurotic people. The fact of having suffered an accident at work causes the individual to blame himself, transforming this feeling into stress and as a result increasing the risk (Wilhelmson *et al.*, 2005).

The physical fitness of workers affects the accident risk rate in New Zealand, where lack of hydration caused a low cognitive performance and reduced physical strength and aerobic potential, making the worker more prone to illnesses and heatstroke (Bates *et al.*, 2001).

Physical or dangerous jobs are less and less attractive for young Europeans (Blombäck *et al.*, 2003). In Sweden for example the average age of those killed in forestry labour accidents is 60 years (Lindroos and Burström, 2010), while in Ireland this was 40 years (Nieuwenhuis and Lyons, 2002). In Australia the average age recorded is 39 years (Driscoll *et al.*, 1995). In China, in contrast, two thirds of those killed were under 25 (Wang *et al.*, 2003).

The likely influence of workers' age in accident rates has been widely studied. Some authors coincide in a higher rate for younger and older people (Thelin, 2002; Wilhelmson *et al.*, 2005; Neely and Wilhelmson, 2006); while other studies did not detect significant

differences (Salminen *et al.*, 1999). Not only accidents but also injuries to the lumbar region, shoulders and neck are related to a higher age group (Hagen *et al.*, 1998).

Most researchers in this field have found a significant correlation between the lack of experience of the workers and the higher accident rate (Wang *et al.*, 2003; Bentley *et al.*, 2002; Shaffer and Milburn, 1999; Lefort *et al.*, 2003). The workers with very little experience are less aware of the risks that they take, being more prone to injury (Tobisch *et al.*, 2005) except slipping, tripping over and falls, which are more frequent among those of greater experience (Bentley *et al.*, 2002). Low accident rate in Ireland is due to the experience of workers, which in average is 11.5 years (Nieuwenhuis and Lyons, 2002). However, no significant relation between experience and risk or number of accidents was found in Paulozzi (1987) and Salminen *et al.* (1999).

Forest work is characterized by its seasonality: in the majority of companies most workers are not permanent. In Italy, 60% of forest firms are seasonal (Picchio *et al.*, 2010). In China the work is seasonal and the workers are people without any other source of income and with very little practical or safety training (Wang *et al.*, 2003).

The influence of the method of payment in accidents has been studied in Sweden showing that the latter were reduced by changing to a split salary: half for hours worked and half for piecework (Nieuwenhuis and Lyons, 2002). There are many recommendations in favour of a change in the payment system.

There is a relation between method of payment and workers' behaviour and later also with risk, safety and accidents. Payment by piecework encourages risky attitudes working in an irresponsible way, increasing the likelihood of accidents, injuries and death and impeding an efficient prevention of risks (Johansson *et al.*, 2010).

In Finland, payment for production carries a negative change in worker behavior (Klen, 1997). In Spain, the most common method of payment is for production coinciding with high accident rates (Ambrosio *et al.*, 2001).

In Italy, a comparison was made between logging teams with different types of contracts: consortium, private, public/semi-private and registered agency. The private group obtained a performance more than double that of the rest of the teams. As for safety, the public team runs lower risks, and the riskiest one was

the semi-private followed by the private team and the consortium (Montorselli *et al.*, 2010). That partially discredits the idea that higher safety means lower productivity.

Working hours have a great influence on the physical and mental state of workers; *e.g.* in New Zealand they work an average of 9.4 hours/day without including travel, with machine operators working more hours due to maintenance and repairs (Lilley *et al.*, 2002). In this way, rest periods and their duration have a great influence on the reduction of muscular pain, above all in machine operators (Østensvik *et al.*, 2008), and in fatigue, cause of injuries and accidents (Tobisch *et al.*, 2005).

Accident rate peaks are due to a high concentration of accidents in a particular moment of the day, day of the week or month of the year. In each country these peaks vary, but the first hours of the working day and lunchtime hours coincide in several countries as having the highest frequency of accidents (Wang *et al.*, 2003; Bentley *et al.*, 2002; Driscoll *et al.*, 1995). During the year, due to the seasonality of the sector, these peaks were found among the months of autumn and spring. In relation to the days of the week, higher accident rates were found on Wednesdays (20%) and Thursdays (25%).

## Causes and consequences of accidents

In mechanized logging the highest accident rate are found in maintenance and repairs and in the manual logging of inaccessible areas, according to Nieuwenhuis and Lyons (2002) in Ireland, and to Shaffer and Milburn (1999) in United States.

In semi-mechanized logging operations, a great majority of accidents are usually caused by chainsaws, above all in the logging phase (Nieuwenhuis and Lyons, 2002; Neely and Wilhelmson, 2006; Shaffer and Milburn, 1999; Axelsson, 1998; Peters, 1991; Albizu *et al.*, 2010). Forwarding of logs and contact with machinery are also often causes of accidents (Lindroos and Burströmb, 2010; Driscoll *et al.*, 1995). Among the self-employed workers in Sweden between 1996 and 2001 chainsaw accidents were significantly more common than other types of accidents (Wilhelmson *et al.*, 2005).

Body parts injured most frequently were of the lower limb (legs). Chainsaw-related injuries were most commonly to the foot (53% of chainsaw injuries),

while struck by log injuries occurred in greatest prevalence to the lower leg (46%) and foot (21%), according to Bentley *et al.* (2002). Legs were also identified in New Zealand as the most injured body parts (Gaskin and Parker, 1993; Lilley *et al.*, 2002).

In Sweden, accordingly to the accidents reported by authorities, insurance registries and hospitals, the injuries to the upper extremities were the most common, instead of the lower limb, which have similar percentages, depending on the source, as head injuries (Lindroos and Burströmb, 2010). This result could be as a consequence of the usage of safety trousers.

Comparing injuries location in different countries in Germany and New Zealand there was found that the most severe injuries affected feet (Lefort *et al.*, 2003).

In relation to maxillofacial fractures, workers of forestry sector carried a 127 fold higher risk of incurring maxillofacial fractures than did service and office workers in Switzerland. Injuries were most frequently (43%) caused by thrown, projected, or falling objects (Eggensperger *et al.*, 2006).

In the case of fatal accidents, the majority are due to being struck on the head as a consequence of falling trees (Lindroos and Burströmb, 2010; Thelin, 2002; Driscoll *et al.*, 1995; Wang *et al.*, 2003; Cabeças, 2007)

Fatal accidents in forestry in Sweden were completely dominated by those occurring when felling and stacking trees using chainsaw (78%), another 14% when loading or unloading, and 4% working with forest machines (Thelin, 2002).

The major causes of fatal accidents in the felling activity were hang up fell (26%), poor felling technique (15%), butt rebound (11%), broken limbs or tops (11%), working too close (11%), snag felling (8%) and being struck from behind while felling trees (5%) (Peters, 1991).

In motor-manual logging operations, felling trees is the most frequent cause of fatal accidents. It could be because the felling direction is not the desired one (Neely and Wilhelmson, 2006; Lefort *et al.*, 2003; Driscoll *et al.*, 1995; Bell, 2002; Axelsson, 1998; Peters, 1991), because the trunk after felling rolls off (Driscoll *et al.*, 1995; Peters, 1991), because it hits another tree, etc, but the most common situation that provokes a great number of accidents is when felling a tree into a hang-up with the hope of dislodging it (Thelin, 2002; Salminen *et al.*, 1999; Peters, 1991). The risk is due to the fact that the falling tree could rebound after hitting the top of the hang-up tree or that part of a broken top could fall against the worker.

The accident rate between manual loggers is 4 times higher than for machine operators, both in Louisiana (Lefort *et al.*, 2003) and in Sweden (Axelsson, 1998). In U.S.A. there is a significantly lower percentage of crushing and being struck by trees and branches in the case of mechanized harvesting operations (Shaffer and Milburn, 1999).

## Ways to implement labour risk prevention to avoid future accidents

As main sources of materials and resources available to implement a preventive programme, a great quantity of resources and materials are available for workers and companies in Internet. The European Agency for Safety and Health at Work publishes European directives about Individual Protective Equipment, ergonomics and risk preventions in <http://osha.europa.eu/en/legislation/directives>. The British Columbia Forest Safety Council releases training programmes, materials for safety and Handbooks of Good Practices even in multimedia format in <http://www.bcforest-safe.org/>. The Work Safe British Columbia is specialized in prevention resources, policy and regulations in <http://www.worksafebc.com/>. The Government of New Zealand publishes materials about Health and safety in <http://www.osh.govt.nz/order/catalogue/index.shtml#fe>.

The principal recommendations and suggestions about training and company management, include new training programmes about working techniques as well as about safety and health, with work-experiences for chainsaw loggers including revisions and control audits, such as the adaptability of external demands and new technologies, refusing the old methods of teaching and in favour of interactive apprenticeship based on problem solving (Nordin and Comeau, 2003).

The critical parts of the training programmes are the level of studies of contracted companies in order to achieve an integrated focus between safety and rules, the learning of safe logging techniques in semi-mechanized works, as well as the correct use of chainsaws, the use and maintenance of Personal Protective Equipment (from now on, PPE), the design of manual harvesting, the prevention of falls, the prevention of strains (stretching techniques), the training of road driving and the correct usage of hand tools (Lefort *et al.*, 2003).

The training in health and safety of self-employed workers requires a great effort, because healthy habits need to be achieved for their well-being due to the fact that they are not under the umbrella of a company that controls their employees and some training should be done by organizing courses for forest owners (Tobisch *et al.*, 2005; Wilhelmson *et al.*, 2005).

In some cases training programmes are effective and give satisfactory results in the reduction of frequency and severity of accidents (Bell, 2004; Neely and Wilhelmson, 2006; Tobisch *et al.*, 2005; Albizu *et al.*, 2010). However there are also cases when the effectiveness of such training programmes can not be proved because there are not significant differences in the accident rates between companies with training programmes in place and companies without them (Bell and Gruschecky, 2006; Thelin, 2002; Bell, 2004).

The accidents which remain in companies with training programmes in place are due to the quick rotation of employees that makes them ineffective (Bell and Gruschecky, 2006; Albizu *et al.*, 2010). Due to the increased number of immigrant workers, especially in the forest sector, there is a lack of specific training and a precarious or irregular situation that facilitates the quick rotation (Blombäck *et al.*, 2003). Other factor is the lack of interest in being informed and studying among some forestry workers (Thelin, 2002).

An efficient example of a procedure for the implementation of a preventive program can be found in Albizu *et al.* (2010), ranging from the field data collection with direct interviews to the integration of a training programme at all levels of the organization. The key success factor was that all the workers were involved and committed in the improvement of the health and safety, with responsibilities and incentives at all levels and with strict and exigent rules. With that it was achieved that the convinced forest worker chose the safe way voluntarily. Quintana (1999) shares the same view under the slogan: “*safety is every one’s responsibility*”.

As main practical measures to avoid fatal accidents, it is recommended to make an assessment of the state of the trees for each felling plot, especially for semi-mechanized harvesting, identifying the dangerous trees (Egan and Alerich, 1998). Such dangerous trees need to be removed when possible or at least marking the influence area where nobody can enter, as advised by OSHA (USA *Occupational Safety and Health Administration*). That is an essential elements

of the working strategy, and so in the preventive training.

Regarding the influence of the mechanization of logging operations in the operational safety, the degree of mechanization varies from the manual systems to the totally mechanized ones. In the majority of European Countries, the working conditions have improved due to the mechanization, even if the level of improvement varies widely from one country to other. In some countries, especially in Central and Eastern Europe, accident rates are high because the mechanization is incomplete due to low production and the mountainous physiography. Besides, in many European regions fields are abandoned and replaced by forest land under the control of inexperienced farmers (Blombäck *et al.*, 2003). Only 22% of the logging operations were mechanized in 1994 in Ireland (Nieuwenhuis and Lyons, 2002).

Outside Europe, in Countries like China, harvesting is often not mechanized. Felling and delimiting are done manually with chainsaws and forwarding with the cable of skidding tractors (Wang *et al.*, 2003).

The mechanization of harvesting causes a decrease in the number of accidents but causes other injuries that need to be prevented with new measures.

Before mechanization, cuts and scratches were the most common injuries that nowadays have been substituted by sprains and lacerations. Mechanization reduces greatly the number of accidents, but increases their average severity because there are more falls from vehicles and accidents of people being hit by a machine. Nevertheless the most common are due to blows by trees, animals or minerals (Lefort *et al.*, 2003).

There is a reduction in the number of fatal accidents of professional workers due to mechanization, but also an increase in the number of non-fatal accidents (Neely and Wilhelmson, 2006; Salminen *et al.*, 1999; Bentley *et al.*, 2002).

Among the North American logging companies, feller-buncher use accounted for a claim rate that was less than half that of companies not using a feller-buncher. In the delimiting task, mechanization reduced three fold the injuries (Bell, 2002).

In semi-mechanized and totally mechanized operations, injuries produced by chainsaw and crushing are reduced, but in both cases the frequency of injuries is higher when there is a necessity to use the chainsaw because the trees to be felled cannot be harvested by the machine. While all the operations

need to be mechanized, inaccessible trees need to be harvested by experience loggers. Maintenance and repair of machines are also causing more accidents than in the past, so these operations need to be done in safe and controlled conditions, away from noises and distractions and wearing adequate/suitable clothing and equipment (Shaffer and Milburn, 1999).

Mechanized tasks provoke higher stress, as well as repetitive movements and other aspects that have an influence on lower productivity and satisfaction, causing higher fatigue and increasing the risk of some accidents (Tobisch *et al.* 2005; Nieuwenhuis and Lyons, 2002). Frequent injuries in the neck and shoulders could be avoided by a drivers rotation programme and with the reduction of the working hours (Synwoldt and Gellerstedt, 2002).

Regarding Ergonomics and forest labour health, it is highly recommended to carry ergonomic studies in mechanized harvesting as well as in semi-mechanized works and there are many suggested improvements in that area (Lefort *et al.*, 2003; Synwoldt and Gellerstedt, 2002; Axelsson, 1998; Gallis, 2006; Shaffer and Milburn, 1999; Tobisch *et al.*, 2005).

There are very few scientific articles about the benefits of stretching exercises before forestry work, but they are cited as recommendation for improvement (Gallis, 2006).

Many chronic injuries are caused by activities that are not completely mechanized (auditive problems or due to vibration), also by repetitive movements and others which are relatively new because of mechanization (Nieuwenhuis and Lyons, 2002). Many suppliers have introduced in the design of the chainsaw and forestry machinery new elements to reduce problems caused by noise or vibrations. Also PPE such as gloves and auditive protectors can help in many cases.

Improvements in the design of machinery and complementary elements are vital to reduce illnesses such as vibration induced white finger (VWF) caused by chainsaw vibration (Axelsson, 1998; Nieuwenhuis and Lyons, 2002). Lyme disease and other infectious diseases transmitted by ticks are considered professional illnesses in some countries but not in Spain (Ambrosio *et al.*, 2001).

The Forestry Ergonomic studies are presently focused on machine operators, because mechanization increases the risk of muscle-skeletal injuries. Tobisch *et al.* (2005), Hagen *et al.* (1998), Axelsson (1998) and Gallis (2006), among others, identified muscle-skeletal symptoms in forestry workers, defining the “strain

syndrome” among machine operators, characterized by pain and injuries to the neck, arms and cervical column. The short repetitive cycles of hand and arm movement producing the so-called Repetitive Stress Injuries (RSI) are the reason why half of the operators studied had these symptoms, that cause considerable personal suffering, are painful and difficult to cure and often cause long periods of sickness leave and even early retirement (Tobisch *et al.*, 2005).

Some machinery designed to reduce muscular stress on shoulders and arms such as mobile arm-supports or mini-levers reduce muscular strain and increase productivity (Attebrant *et al.*, 1997).

In order to show the impact of behavior and cultural context two mechanized teams were compared, one Norwegian and the other French. Although both had similar tasks, the different external demand and burden had an influence on health, with more symptoms in the neck and shoulders in the case of Norwegian workers because the French workers had longer lunch breaks, used control levers less and had more short breaks during the working day and as such were considered preventive measures. Task rotation was one of the recommendations to solve these problems (Østensvik *et al.* 2008).

Work rotation is an excellent way to counteract the problems of sedentary work and repetitive movements of hands, arms and shoulders (Tobisch *et al.*, 2005).

Research about the use of Personnel Protective Equipment (PPE) and safety in forestry harvesting has shown that the PPE designed for workers’ safety are frequently not used correctly or even it is not worn all the time. Although their use has increased, there are workers who still do not use any of the prescribed equipment. Various authors coincide that among the less used equipment are visual and auditive protectors as well as gloves when they are necessary.

In some parts of China the use of PPE is not widespread causing high accident rates as described by Wang *et al.* (2003). There are also evident faults in active and passive preventive equipment in Spain, emphasizing the lack of professionalism in manual tasks (Ambrosio *et al.*, 2001). On the contrary, in New Zealand all operators wear safety helmets, auditive protectors, highly visible shirts and rubber boots with reinforced toes and ridged soles. Also, in the case of chainsaw operators, cut resistant trousers and boots are used (Bates *et al.*, 2001).

Even if, in some cases, the efficiency of helmets was questioned because after an accident helmet is often

found broken, believing that PPE cannot be relied on alone to prevent serious injury (Driscoll *et al.*, 1995), for light blows the helmet is vital.

Nevertheless, it is essential to adapt the PPE to the work place, causing their improvement a greater awareness about their use. This equipment must be designed and modified according to the conditions and needs of the task (Thelin, 2002; Lefort *et al.*, 2003; Kirk and Parker, 1994; Davis *et al.*, 2000; Shaffer and Milburn, 1999; Montorselli *et al.*, 2010). In New Zealand after risk identification research, such measures were suggested and different equipment were adapted or created (Sullman *et al.*, 1999).

Cut resistant trousers were designed as a result of research that demonstrated the high number of leg cuts caused by chainsaws. Once approved, they were extended to all logging areas resulting in a net reduction of accidents. This decrease was also due to the use of smaller chainsaws and the higher awareness of the risk of cuts. The final assessment of the measure revealed that this type of accident was not eradicated because the trousers, designed to resist chain speeds of  $20 \text{ m} \cdot \text{s}^{-1}$ , received cuts at speeds of even  $34 \text{ m} \cdot \text{s}^{-1}$ . Besides, there were cuts outside the protected area and the wear and tear of the trousers due to the presence of oil lowering their resistance and so, as a preventive measure they recommended oil-proof materials for the making of safety articles (Gaskin, 1989; Gaskin and Parker, 1993).

Forestry workers usually wore dark clothes which made it difficult for them to be seen and so in New Zealand two thirds of the investigated accidents were due to other workers not seeing the victims. The most easily seen colors were tested in the forestry environment with the result of phosphorescent lime being the most visible. So that color was used in tops and helmets achieving the total eradication of that type of accidents (Isler *et al.*, 1997).

Some measures to make safety helmets more comfortable and safer have been proposed (Davis *et al.*, 2000). In New Zealand, some improvements were also suggested to safety boots in an attempt to reduce slipping, researched hobnail boots with satisfactory results, although unfortunately in later years they went out of use due to the additional cost (Kirk and Parker, 1994).

In order to reduce the blows between vehicles and people, vehicle to vehicle and vehicle to wood (which can result in people being hit), it was recommended to use monitors which detect the presence of people

wearing highly visible clothes and warn the driver (Bentley *et al.*, 2002).

The usage of PPE can cause a change in working methods as is affirmed by half of the interviewed people for example doing the same job more quickly (Salminen *et al.*, 1999). This change in behaviour does not eliminate the efficiency of the protective equipment but there is a kind of risk compensation and the worker takes more risks (Klen, 1997). For example, statistics show that the use of PPE reduced the number of injuries and blows, but increased the number of twisted joints. Some fatal accidents in experienced workers who regularly wore PPE can lead to the conclusion that this equipment distorts the sense of safety, reducing care and underestimating risk. With respect to normal clothing it needs to be pointed out that PPE has a disadvantage of adding weight to the worker, occasionally reducing visibility and increasing clumsiness, causing extra risk which future research must minimize —although this is always inferior to the risk which is avoided or reduced—.

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