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## A survey on occupational injuries in works on trees in Italy

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### Abstract

The aim of this work is to know how many injuries occur during climbing and pruning to arborists and other operators who work on trees, the type of accidents and why they happen. This study was carried out during the period from 2002 to 2012 using INFORMO, the database of INAIL (National Organization for the Labour Insurance) that contains a list of serious and fatal injuries occurred to workers and counted by its Prevention Service. From this list only accidents related to operators who was working on trees, at least 2 meters above a stable ground without using elevating work platform, have been extracted. In these workplaces, operators should work safely using tree-climbing techniques with ropes and harness. The scope of the study was to understand the common triggers of injuries, if there are technical problems that can be solved, or other problems that can be addressed to decrease the number of accidents and their severity.

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### 1. Introduction

The presence of trees within the cities, including avenues, private gardens, etc., is now recognized as a necessity for the general well-being of individuals and societies. A number of benefits can be listed, such as the carbon storage (Nowak & Crane, 2002; Di Giacinto, Colantoni, Cecchini, Monarca, Moschetti & Massantini, 2012), the reduction of air pollution (Yang, McBride, Zhou & Sun, 2005); (Nowak, Crane & Stevens, 2006), the mitigation of the heat island effect (Solecki, Rosenzweig, Parshall, Pope, Clark, Cox & Wiencke, 2005); (Onishi, Cao, Ito, Shi & Imura, 2010), the providing of habitat for wildlife (Adams, 1994, Marucci, Pagnello, Monarca, Colantoni & Biondi, 2012; Marucci, Monarca, Cecchini, Colantoni & Cappuccini, 2013); (George & Zack, 2001), the reduction of storm water runoff and flooding (Bartens, Day, Harris, Dove & Wynn, 2008); (Xiao & McPherson, 2002), not counting the high landscape value (Jim & Chen, 2010). These benefits, however, entail the burden of maintenance that includes:

- a proper assessment of the needs of the trees (airspace, radical);
- control of diseases (fungal, bacterial, and insect infestations);
- pruning.

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The latter, which allows reaching the best compromise between the tree growth and the traffic's needs and safety along with the space limitations, must be done by green areas management professionals, because of their knowing about plants biology and the reactions of various types of pruning to the tree, depending on its species and age (Cecchini, Colantoni, Massantini, & Monarca, 2010). Besides the green professional must know the operating procedures to perform the pruning, in order to work efficiently and safely (Bortolini, Cividino, Gubiani, Cecchini, Delfanti & Colantoni, 2016; Colantoni, Marucci, Monarca, Pagnello, Cecchini e Bedini, 2012; Boubaker, Colantoni, Allegrini, Longo, Di Giacinto, Monarca & Cecchini, 2012). In this work, accidents occurred in workplaces during work on trees have been investigated, especially during pruning of tall trees or other operations on trees that provide movements of the operator above two meters in height from a stable work plan, without the aid of a lifting platform. Such technical work in canopy is called tree-climbing, for its characteristic safely climbing into the canopy of the tree using a positioning system with ropes and harnesses (Perry, 1978). This method is used all those times when pruning or consolidation of branches is required but the target tree cannot be reach with an elevation work platform. Thanks to this survey is meant to understand what the most common injuries in this work are and, consequently, what are the measures to limit the occurrence or diminish the severity of the consequences.

## 2. Materials and methods

The data subject of this paper was extracted from the database INFORMO, made by INAIL (National Organization for the Labour Insurance), available on the web at <http://www.ispesl.it/getinf/informo/>. Inside the database, we found over 3800 dynamics to accident, which took place between 2002 and 2012, analyzed by the prevention services with a shared analysis model. It is important to highlight that INAIL is the only insurance institution for workers in Italy and its owned data are complete and reliable because all companies are obliged to declare injuries and workers' number (Fabiano, Curro & Pastorino, 2004). In the "Archive of cases" of the database, you can search for areas of interest using the filters available; you can also make a free search with keywords using a search engine. With the said method, all injuries related to the word "tree" have been searched, and the search engine generated a list of 166 cases, which were analyzed individually to find the correspondence with the type of work investigated. Among these, 21 cases were eligible to the survey, because about pruning or felling of trees working over two meters' height from a stable ground without the use of platforms. The INFORMO database classifies accidents with an alphanumeric code and each event is associated with a brief description to detail the accident (data on the place of the incident, the injured, the company and the consequences), a record card to show the details of the injury factor and, eventually, other cards if, together with the determinant, there are one or more modulators factors that have influenced the development of the accident.

## 3. Results

From the data obtained in this analysis, looking at the modal data of each category, the profile of the standard worker more susceptible to injury was come out. The number of accidents detected about this work method covers the 12.65% of the total of serious injury and/or death occurred during all operations on trees. Of those analyzed, 9.5% has electrocution as a key, while the remaining 90.5% fall from height. Although in the used archive are merged both fatalities and those serious, all injuries related to this type of work were fatal.

### 3.1 Accident's generic characteristics

Considering the period examined, from 2002 to 2012, the average number of injuries was 1.9 per year, ranging from 1 to 3 per year (fig. 1).

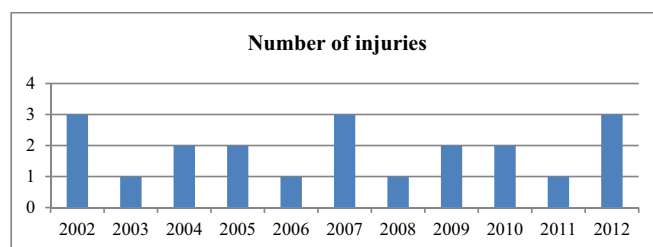


Fig. 1. Number of injuries per year.

In 100% of the analyzed cases there was a "not collective" accident, or it concerned only the injured worker. This is because operators normally work individually on a tree and, very often, wrongly, by themselves even in the yard. In most cases, death occurred for skull fracture (57%), followed by multiple locations fractures (19%) and thoracic organs (9%); a further 15% are in equal measure from injuries to the heart, lungs and specifically the left hemithorax. Clearly, the main nature of fatal injury is due to fractures (71%) which together with contusions (14%) and wounds (5%) reach 90% of the total. Only in 10% of cases, the nature of the lesion was related to the electricity, due to the contact with a power line voltage.

### 3.2 Characteristics of the injured

The record cards analyzed showed that all the injured workers were male, mostly of Italian nationality (81%); only 19% were from non-European workers (14% Romanians and Albanians 5%). Despite the prevalence of Italian subjects, in most cases (48%) the education level is not reached (probably due to the age of the injured workers), 19% of the cases had received his elementary school, 24% middle school or professional training, and only 9% a high school diploma. As for the type of employment relationship, categories are very heterogeneous. The most frequent case is the self-employed with no employees (38% of the total), followed by irregular workers with 19%. Retirees represent a large part of the total (14%), such as the employees on temporary contracts. The remaining 15% is divided equally among the self-employed with employees, partners and atypical employment contracts. Furthermore, there is a clear preponderance of farmers and agricultural workers specialized in pruning and felling of forest trees (52%), followed by not qualified staff in agriculture (14%) and specialized forest workers (10%). The remaining 25% is made up of people who have little to do with works on trees, such as business owners, directors and managers of large companies, responsible managers of small companies (5%), farmers and operators of specialized livestock (5%), unqualified forestry personnel (5%) and a 10% of which it was not possible to know the job. Despite all the injuries reported were fatal, 57% of workers possessed an experience of over 3 years, but specific to the industry. In 30% of cases, it was not possible to know the worker's past experience, while for 15% of the remaining cases the experience was equally divided between 1 and 3 years, between 6 and 12 months and less than 7 days. The presence of other operators together to the injured was quite variable; however, more frequent was the presence of a few people or no (10% alone and 38% with only one other person, often not very close). In 19% of cases, three other workers were on the workplace, and four workers in 5% of cases. In 29% of cases it was not detected the number of people together with the injured.

### 3.3 Details of injury

Within the various categories of place of injury, the word "garden" or "family home" was often repeated, a sign of a concentration of accidents in non-rural areas, but in urban or peri-urban areas or, however, in residential areas. INAIL data also showed the presence or absence of sub-contracting firm for the injured during the execution of the work in question. In 52% of cases, it did not happen but for 29% this data was not available. This finding is also confirmed by the type of activity performed by the victim at the time of the accident: in 62% of cases of their own work, while in 29% of cases was not being reached the data. In 5% of cases the accident happened during other work activity, and 5% in non-work activities (fig. 2).



Fig. 2. Activity of the injured while the accident happened.

As expected, the part of the environment with which the area of the body entered into the contact and has undergone the main lesion is the soil, which covers most of the cases with 71%, being the majority of accidents due to fall from height. 10% of the

cases reported contact with electrical systems, while the remaining 19% is shared equally between floors, plants, plant attached to the buildings-furniture-fixtures, and other equipment, all linked to the type of falling. The occurrence of an accident does not necessarily imply the occurrence of an injury: essential condition is that an exchange of energy (contact) of a certain intensity between the physical environment and at least one person (worker). That is, because biological damage occurs because of an accident is necessary that the energy liberated steps, completely or in part, from the environment to the person or vice versa and that this exchange is large enough to cause damage. In general, the energy that is exchanged is derived from two situations:

- there is rapid and unintentional energy release/transformation (of the seat, type or intensity)
- there is no alteration in the energy situation, but it sees, as the same time, the interface change environment-working, where the latter comes into contact with the energy properly present, in ordinary working conditions, in the environment.

In 86% of reported cases, the accident was caused by the energy change, normally of the operator subject to the same free fall. Given the narrowness of the inquiry, it is not surprising that in 43% of cases the material agent of the injury is "plant" and a complementary vision in 24% of cases "equipment for work at height", obviously missing. 9% of the cases is represented by the electrical systems, in relation to cases of injury by electrocution, and the remaining 24% divided equally among ladders, portable equipment, handling equipment, other parts, altitude, terrain and data not reached.

### 3.4 Details of the injury factors

As anticipated, the determining factor is listed as critical, namely the event without which, potentially, the same injury would not be happened. In some cases there were two key factors to contribute to the occurrence of the accident. In 76% of cases it was precisely the activity of the injured to be identified as a determinant, followed by PPE and clothing (14%), tools machines and installations (5%), and the working environment (5%). Determinants were described in a section where we could read for example: "The worker approached to host power supply, without provisions to protect him from the risk, so they formed an arc that caused electric shock to himself" or "Execution of the work of pruning without the use of the platform or suitable harness" or "Climb a tree about 5 meters high and set on the remaining branches to operate". Therefore, "activity of the injured" and "PPE and clothing" determinants are deemed as errors during the activity and failed or incorrect use of PPE and clothing. In fact, 28.6% of cases reported "Other procedural error - incorrect practice tolerated", 23.8% of cases "Other procedural error", 14.3% of cases "Other procedural error - training - information", and 4.8% of cases "Other procedural error, impromptu action". Basically, for 71% of the cases, the determining injury factor was the execution of procedural errors during the working phases. Failure or improper use of PPE occupies 19% of cases and 4.8% of cases unsuitable choice of working tools: "Balance/other/ladder unsuitable to perform pruning work". Only 4.7% of the determining factors is most likely due to chance, or to a further procedural error / evaluation of the operator: "Fails, landslides, falling weights" (fig. 3).

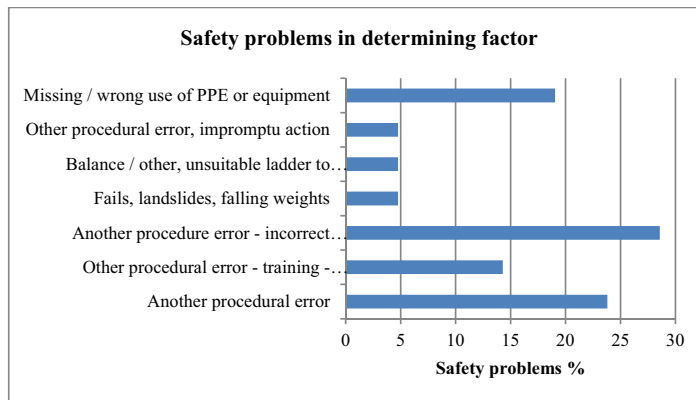


Fig. 3. Safety problems in determining factor.

In comparison with safety standards, it emerged correspondence with deficiencies compared to safety criteria codified in various laws on occupational safety, developed in years in Italy. The comparison with the deficiencies with respect both to the previous laws 547/1955, 626/1994 and the current Consolidated Law on Health and Safety (Legislative Decree 81/2008) covers 43% of the cases, plus an additional 5% compared to the standards of good practice. 43% of comparisons not received with standard coded it is also because this type of work is consolidated only recently, and the legal coding and regulatory environment has yet to be thorough. After comparison with existing standards, the INAIL Prevention Service has also made explicit the type of evaluation of the risks carried by the injured. For 48% of the cases the victim did not assess the risk of the operation was going

to take, the 24% do not have sufficient regard, while 10% of the victim estimated it enough but then were replaced errors of procedure (set forth above), and the 19% was not reached any risk assessment (fig. 4).

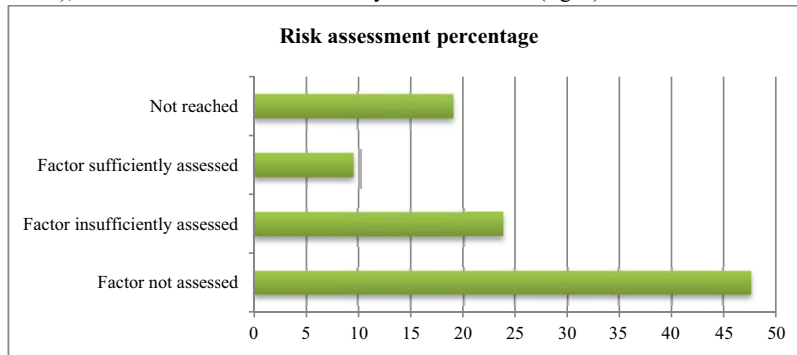


Fig. 4. Risk assessment percentage.

As mentioned, in the majority of cases (71%) was only one factor to be instrumental in the develop of the accident, but in the remaining 29% of the cases a second factor is found to be decisive for the trigger of accident: the PPE and clothing for 9.7% of cases, tools machines and installations for the 9.7%, 4.8% for Materials and 4.8% Injured' activity. Even in the case of the second factor, the most found security issue was a procedural error (28.5%), followed by another 5 cases, all equally occurred in 14.3% of cases: problems related to the characteristics, non-use, incorrect practice tolerated, PPEs not provided, balance - lack of fixed guards (fig. 5).

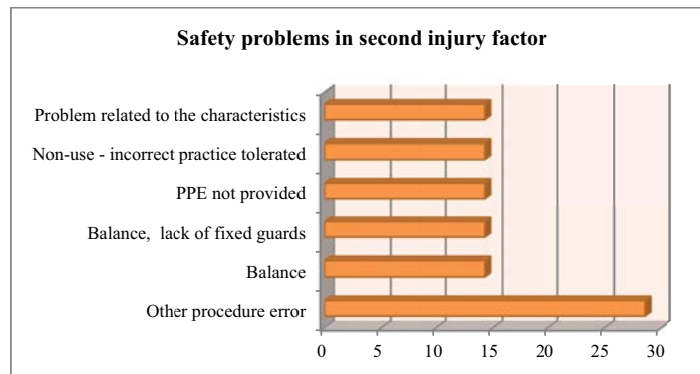


Fig. 5. Safety problems in second injury factor.

As mentioned, in some cases a modulator pejorative factor in the evolution of the accident acted, but only in 24% of cases. This modulator was always to be the failure or improper use of personal protective equipment.

#### 4. Discussion

From the data obtained in this analysis, if you look at the modal data of each category comes out the profile of the type of worker more susceptible to injury and the latter appears to be “falling” always with fatal consequences. These data are reported in the table 1. Where the given modal was not reached (for various reasons), immediately following data were used as the percentage of occurrence. The profile shows that the operator more prone to injury is an Italian male, with a low level of education, working independently in agriculture, with experience in his work. The problem lies in the fact that pruning or felling of tall trees, even if present in agricultural, is not the responsibility of farmers, but are specialized activities, normed by law (Legislative Decree 81/2008) and that can be performed only after completion of an enabler training. In fact, the determining factors are always procedure errors, that the operator did not know what exactly he was doing, or how best to do, nor what were the consequences in case of failure. It also results from the risk assessment carried out by the injured “factor not rated”. Also aggravating factor modulator (but also in the background among the determinants) is the non-use of protective personal equipment such as helmets and restraint systems with ropes and harnesses.

Table 1. Categories and risks associate.

|   |   |
|---|---|
| <b>CATEGORIES</b>   | MODAL DATA  |
| <b>SUMMARY DESCRIPTION</b>                                      | FALL FROM HEIGHT  |
| <b>ACCIDENT DATE</b>  | OMISSIS   |
| <b>ORDINAL WORKING TIME</b>                                     | 2-3   |
| <b>COLLECTIVE ACCIDENT</b>                                      | NO  |
| <b>PLACE OF INJURY (BODY)</b>                                   | SKULL   |
| <b>NATURE OF INJURY</b>   | FRACTURE  |
| <b>TIME OFF DAYS</b>  | 7500  |
| <b>EDUCATION</b>  | MIDDLE SCHOOL DIPLOMA or START TRAINING                   |
| <b>GENDER</b>   | MALE  |
| <b>NATIONALITY</b>  | ITALIAN   |
| <b>EMPLOYMENT</b>   | INDEPENDENT WITHOUT EMPLOYEES or HOLDER WITHOUT EMPLOYEES |
| <b>TASK</b>   | FARMERS AND SPECIALIZED AGRICULTURAL WORKERS              |
| <b>LENGTH OF SERVICE</b>  | > 3 YEARS   |
| <b>NUMBER OF EMPLOYEES PRESENT ON THE SITE WITH THE PATIENT</b> | 1   |
| <b>BUSINESS ACTIVIES</b>  | AGRICULTURAL CROPS, HORTICULTURE, FLORICULTURE, BREEDING  |
| <b>PLACE OF INJURY (LOCATION)</b>                               | AGRICULTURAL SITE, ORCHARD                                |
| <b>SUBCONTRACT Y/N</b>  | NO  |
| <b>TASK OF THE INJURED AT THE MOMENTO OF ACCIDENT</b>           | OWN WORK ACTIVITIES                                       |
| <b>PARTS OF THE ENVIRONMENT THAT HAVE IMPACTED TO BODY</b>      | GROUND  |
| <b>TYPE OF ACCIDENT</b>   | ENERGY VARIATION  |
| <b>MATERIAL CAUSE</b>   | PLANTS  |
| <b>FACTOR 1</b>   | ACTIVITY OF THE INJURED                                   |
| <b>SAFETY PROBLEM (FACTOR. 1)</b>                               | ERROR OF PROCEDURE - IMPROPER PRACTICE TOLERATED          |
| <b>COMPARISON WITH STANDARD</b>                                 | LAW 81/2008   |
| <b>RISK ASSESSMENT</b>  | FACTOR NOT ASSESSED                                       |
| <b>FACTOR 2</b>   | PPE   |
| <b>SAFETY PROBLEM (FACTOR. 2)</b>                               | ERROR OF PROCEDURE  |
| <b>MODULATOR FACTOR</b>   | PPE AND CLOTHING  |

## 5. Conclusion

In conclusion, there are laws that say clearly who can do the job on ropes on trees, there are technical texts that refer to the technical work in safety and above all the safety devices are dedicated to this type of work. The problem behind these accidents is the lack of training, and even before the issue of Italian culture, where everyone can do everything, but actually you have to have specific skills to perform complex jobs. Even the assessment of the difficulty of an operation must be performed by a technical expert in the sector, able to recognize any problem. It 'clear that the procedural errors found in factor 1 and 2 are believed to originate from the lack of knowledge by the operators of the most basic safety standards for the work to be carried out at height. This seems strange in relation to the fact that all the injured players held an activity related to their professional work. Unfortunately, as mentioned above, it is the perception of the technical difficulty of the work fails underestimating the risk of the consequences every time. This is revealed by the fact that the accident event is always a fall from a height, which should be easily estimated by the operator, who should immediately put in place the necessary procedures and use the specific PPE to protect their safety. The first point to be developed to reduce accidents and their severity is definitely the diffusion the culture of safety, followed by a proper professional training. Educational measures include training and information that highlight risk awareness, helping workers carry out their work tasks in the correct manner, use new techniques, and give suggestions concerning break periods (Proto & Zimbalatti, 2015). The data collected by this study are believed to represent the first step in this line of research. These data provide an important and productive background that can be used for additional and more exhaustive future studies (Proto & Zimbalatti, 2010).

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