

1 **Assessment of chainsaw operators training in Andalusia (Spain)**

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5 6 **Abstract**

7 The chainsaw as a work equipment is considered one of the most dangerous in the field of occupational
8 health and safety. The chainsaw is especially used in the forestry sector, although it is also used in other
9 different sectors such as agriculture, construction or gardening. This study was carried out using an ad-
10 hoc questionnaire as a research tool in order to assess the weaknesses in the training received by
11 workers who use chainsaws in Andalusia, Spain, since it has never been addressed before. To achieve
12 the objective set, the questionnaire was completed by 378 operators working with chainsaw and their
13 responses were analysed. The results of this study show that there are obvious shortcomings related to
14 work with chainsaws in very significant aspects for the occupational health and safety. Of special
15 importance is the lack of training detected on rescue techniques and work at height, since these are
16 aspects of special risk for workers' health which could cause accidents with severe injuries. Also, a
17 common denominator in all aspects studied was the lack of safety inspections and the state of the
18 equipment to be used. These results evidence that there is a need to regulate chainsaw operator
19 training.

20 **Keywords:** Chainsaw worker; learning requirements; occupational health and safety, labour risk;
21 ABA International

22 **1. Introduction**

23 The chainsaw as a work equipment, is considered one of the most dangerous in the field of occupational
24 health and safety (Potočnik and Poje, 2017, Robb and Cocking 2014, Enez et al. 2014, Cabeças, 2006).
25 So much so, that as assert Ambrosio et al. (2001), it is observed that the risk in the use of the chainsaw
26 is of the order of 4 or 5 times higher than that of other risks in sectors such as agriculture.

27 This work equipment is used especially in specific sectors such as forestry, although it is also used in
28 other sectors such as agriculture, construction or gardening (Hammig and Jones, 2015, Cividino et al.
29 2012).

30 Despite the technological advances introduced in this work equipment, the inadequate training of
31 workers in the use of the chainsaw continues to be one of the main problems (Albizu-Uriónabarrenetxea
32 et al. 2013). The most dangerous activity for operators is felling or cutting trees. Specifically, the three
33 most common types of fatality are due to being hit by a tree or branch, slips and trips, and cut by the
34 chainsaw (Robb and Cocking 2014).

35 Specifically, in Spain, work in the forestry sector shows a significantly higher accident rate than other
36 sectors considered high risk. Especially the workers who deal with the felling of trees are the most
37 exposed to the risks in the forestry sector. These aspects reveal that forestry work is very dangerous
38 (Robb and Cocking 2014, Albizu-Uriónabarrenetxea et al. 2013, Lefort et al. 2003, Bell 2002, Peters
39 1991). In the semi-mechanized logging operations, the great majority of accidents are generally caused
40 by chainsaws, above in the logging phase (Albizu-Uriónabarrenetxea et al. 2010, Neely and Wilhelmson
41 2006, Nieuwenhuis and Lyons 2002, Shaffer and Milburn 1999, Axelsson 1998, Peters 1991). The main
42 risk factors that have been identified and studied in relation to the use of the chainsaw are related to
43 experience (Wang et al. 2003, Lefort et al. 2003, Bentley et al. 2002, Shaffer and Milburn 1999), age
44 (Neely and Wilhelmson 2006, Wilhelmson et al. 2005, Thelin 2002, Salminen et al. 1999), seasonality
45 and type of company (Picchio et al. 2010, Montorselli et al. 2010, Wang et al. 2003), frequency with
46 which the chainsaw is used (Albizu-Uriónabarrenetxea et al. 2013, Lilley et al. 2002), training (Cividino
47 et al. 2015, Blombäck et al. 2003), use and maintenance of protective equipment (Albizu-
48 Uriónabarrenetxea et al. 2013), work technique (Thelin 2002, Salminen et al. 1999, Peters 1991), work
49 at height (Tamboreno et al. 2015, Robb and Cocking 2014, Tamboreno 1989), use of winches (Bellmunt
50 1986) and intervention in emergency work (Robb and Cocking 2014).

51 Further, some of these detailed factors may result in workers being unduly exposed to unacceptable
52 risks. In this context, the perception of risk is articulated as of vital importance in the use of this work
53 equipment. Thus, it is essential that workers receive a good training that includes both the theoretical
54 knowledge needed and practical exercises on work techniques (Albizu-Urionabarrenetxea et al. 2013).
55 Similarly, it is important to improve the training content on occupational safety and health focused on
56 the use of chainsaw that workers receive during general job training. In this way, as stated by authors
57 such as Damalas et al. (2019) and Allman et al. (2017), lifelong education and training is a key element
58 to reduce accidents. Likewise Landekić et al. (2018) stated vocational training in modern forestry
59 emphasizes the introduction of specialized training in the use of a chainsaw and certified by accredited
60 professionals in the field.

61 In relation to training for chainsaw operators, there is no compulsory training in Europe for workers
62 using a chainsaw in their work beyond the requirements set by Directive 2009/104/EC of 16 September
63 2009 concerning the minimum safety and health requirements for the use of work equipment by workers
64 at work (European Parliament and of the Council 2009). Nonetheless, there is voluntary training
65 regulated through Professional Qualifications and Professional Certificates. In this sense, specifically in
66 Spain, there are vague mandatory specifications about the type of training, content and duration, just
67 according to the direct translation of the EU Framework Directive (Pardo-Ferreira et al. 2017, Albizu-
68 Urionabarrenetxea et al. 2010). Therefore, there are no minimum clear and concrete specifications of
69 mandatory status concerning the skills and training that chainsaw operators should be acquired in terms
70 of safety and health. However, these specifications exist in the case of other dangerous equipment such
71 as removable tower cranes, mobile cranes or various activities in the construction, metal industry, and
72 even in work at height.

73 Therefore, the aim of this paper is to assess the weaknesses in the training received by chainsaw workers
74 in Andalusia, Spain. To do this, based on the theoretical knowledge that these workers should receive,
75 a questionnaire has been developed to evaluate the weaknesses in the training received by chainsaws
76 workers, since, as Albizu-Urionabarrenetxea et al. (2010) indicated, it is an effective method in the
77 collection of field data for the purpose of implementing the preventive program. The results obtained
78 will help to establish minimum mandatory training for chainsaw operators, filling the legal gap that
79 currently exists in Spain. In fact, we believe that the findings of this research would be useful for future
80 research focus on needs for the implementation of periodic safety training, the precise time to evaluate
81 the transfer of training received by chainsaw operators as well as the characteristics of effective safety
82 training.

83 This study is developed by the University of Malaga as partner, along with other entities from various
84 regions throughout Europe, of the project VET-SAFETY project 2014-2017 and the EU Erasmus +
85 programme & ABA International.

86 **2. Materials and Methods**

87 This study was carried out using an ad-hoc questionnaire as a research tool. The following documents
88 were used as the main sources of information in the questionnaire's design:

- 89 • ABA International-European Chainsaw Standards (ABA 2012)
 - 90 ECC 1: Chainsaw Maintenance & Crosscutting Techniques (Robb 2011a)
 - 91 ECC 2: Basic Tree Felling Techniques (Robb 2011b)
 - 92 ECC 3: Advanced Tree Felling Techniques (Robb 2011c)
 - 93 ECC 4: Windblown & Damaged Trees (Robb 2011d)
 - 94
- 95 • Doctoral dissertation by Albizu Urionabarrenetxea (2012): *Diagnóstico de la seguridad en los*
96 *aprovechamientos forestales a partir de registros empresariales, bases de datos oficiales y*
97 *muestreos de campo: propuestas de actuación.*
- 98
- 99 • Professional forestry worker qualification AGA343_2, recognized by the Spanish Ministry of
100 Education, Culture and Sport, and its corresponding professional forestry worker certificate
101 AGAR0108, recognized by the Spanish Ministry of Labour and Social Security (2011).
- 102
- 103 • The technical standards of the Spanish National Institute of Occupational Health and Safety,
104 like those on Mobile lifting platforms (Tamboreno et al. 2015), Blocks and tackles, hoists and
105 pulleys (Bellmont 1986) and ladders (Tamboreno 1989).

106

107 From these selected sources of information, the essential skills of workers who use the chainsaw at
108 work were obtained. Subsequently, these skills would be evaluated through a questionnaire focused on
109 the training and practices that these workers currently have.

110 For this purpose, the questionnaire developed was assessed by a panel of experts, using the Individual
111 Aggregate Method proposed by Corral (2009) to validate it. Thus, five experts were selected, two more
112 than the required minimum. They used a previously adapted version of the evaluation form model
113 proposed by Corral (2009). This form assessed general aspects of the questionnaire analyzing clarity,
114 coherence, language and bias of both the personal information requested and the open-ended questions
115 and items. Finally, the necessary changes resulting from the evaluation were carried out and a final
116 version of the questionnaire was obtained.

117 The questionnaire was divided into two parts. The first part comprised 9 questions: The first four aimed
118 at gathering information about the sociodemographic data of the sample of participating workers. The
119 other five questions were open-ended ones to find out their experience working with a chainsaw; how
120 they learned to use it; and their general training; occupational health and safety training; and specific
121 training in how to use a chainsaw. The second part comprised 25 items, assessed using a 5-point Likert
122 scale to represent the following options: Always (5), Almost Always (4), Sometimes (3), Hardly Ever (2)
123 and Never (1). These 25 items were divided into 7 different sections, as per Table 1.

124 Finally, a space was included at the end of the document for possible comments by the workers.

125 **Table 1.** Number of items and contents of each part of the questionnaire

SECTIONS		SUBJECTS	NUMBER OF QUESTIONS OR ITEMS	TOTAL
PRELIMINAR SECTION	Personal Information	Sex	1	9 questions
		Age	1	
		Type of company	1	
		Frequency of use of a chainsaw	1	
	Open-ended questions	Time worked with the chainsaw	1	
		Chainsaw use learning way	1	
		General education	1	
		Training on health and safety	1	
		Training on the use and operation of a chainsaw	1	
QUESTIONNAIRE SECTION	Personal protective equipment	3	25 items	
	Chainsaw	2		
	Work techniques	7		
	Work at Height without Mobile Elevating Work Platforms	3		
	Mobile elevating work platforms (MEWPs)	5		
	Winches	3		
	Emergency	2		

126

127 As for the workers who completed the questionnaires, they worked in Andalusia (Spain) and used a
128 chainsaw in their work. They completed the questionnaires during their workday on a voluntary basis.
129 All of them worked directly or indirectly for the Andalusian government entities, which collaborated in
130 the present study by sending the questionnaire to the workers and providing them with enough time to
131 complete it properly. Once the questionnaires were received, they were examined and some were
132 discarded based on different reasons such as they were incomplete, the respondent chose more than
133 one answer for the same item, they gave almost all the same answers, the answers were exactly the
134 same as those of a colleague or the worker indicated that they never used a chainsaw. In this way,
135 initially 474 questionnaires were received. These were examined and 96 were discarded. Finally, 378
136 questionnaires were obtained that would be analysed to extract the main results. Thus, a descriptive
137 analysis of the information collected in the questionnaires was carried out and correlations between
138 variables were analysed.

139 3. Results

140 This section presents all the information extracted from the questionnaires received. In the first place,
141 the analysis of personal information and open-ended questions are presented, which allow
142 characterizing the workers who participated in the study by filling the questionnaire. These results were
143 portrayed in different tables, showing the number of cases in each category, percentage and frequency
144 out of the total of 378 questionnaires that were analysed. Second, the results of analyzing the 25 items
145 included in the questionnaire are presented. For this purpose, means (\bar{x}) and standard deviation (σ)
146 are also analyzed. The "unknown" category shows the number of items not filled in by the respondents.

147 **3.1. Preliminar Section: Personal information and open-ended questions**

148 Regarding the personal information of the workers surveyed, results are shown in Table 2. Only three
 149 of the respondents were women. The respondents had an average age of 44, with almost half the
 150 respondents (48%) being aged between 40 and 49. Regarding the type of company where the surveyed
 151 workers performs his duties, the results show that 95% of the workers were employed in the public
 152 sector. From frequency analysis with the workers used a chainsaw at work it follows that most workers
 153 used chainsaws several months a year (53%).

154 **Table 2.** Results of the items on personal information

Variable	Frequency	Percentage
Sex		
Men	375	99.2%
Women	3	0.8%
Age		
Unknown	5	1.3%
20-29 years	5	1.3%
30-39 years	79	20.9%
40-49 years	182	48.2%
50-59 years	100	26.5%
More than 60 years	7	1.8%
Type of company		
Unknown	8	2.1%
Private Company	2	0.5%
Public Company	323	85.4%
Public Company and Private Company	10	2.7%
Emergency services	27	7.2%
Public Company and self-employed	3	0.8%
Public Company and Emergency Services	5	1.3%
Frequency of use of a chainsaw		
Unknown	29	7.7%
Daily	35	9.3%
2 or 3 times a week	45	12%
1 time per week	29	7.7%
1 time per month	39	10.1%
Several months a year	201	53.2%

155
 156 As for open-ended questions, in Table 3 are presented the questions raised as well as the results
 157 obtained in terms of their experience working with a chainsaw; how they learned to use it; their general
 158 training; occupational health and safety training; and specific training in how to use a chainsaw.

159 **Table 3.** Results of the items on open-ended questions

Variable	Frequency	Percentage
How long have you been working with a chainsaw?		
Not defined/Unknown	34	9%
10 years or les	91	24%

Between 11 and 20 years	142	37.6%
Between 21 and 30 years	103	27.3%
More than 30 years	8	2.1%
How did you learn to use a chainsaw?		
Unknown	21	5.6%
At work/the company	127	33.6%
Training courses	119	31.5%
Self-taught/alone/practicing	82	21.7%
From a co-worker	16	4.2%
From a relative	13	3.4%
General education		
Unknown	144	38.1%
Basic education	46	12.2%
Compulsory secondary education	5	1.3%
Full secondary school	10	2.7%
Professional training	16	4.2%
Superior technician	19	5%
University	8	2.1%
Training company	40	10.6%
Courses	90	23.8%
Training on occupational health and safety (OHS)		
Unknown	47	12.4%
Received training in OHS	330	87.3%
Not received training in OHS	1	0.3%
Training on the use and operation of a chainsaw		
Unknown	54	14.3%
Received training in use and operate of chainsaw	302	79.9%
Not received training in use and operate of chainsaw	22	5.8%

160

161 The results show that 64.9% of the workers had between 11 and 30 years of experience using a
162 chainsaw. Also, it should be noted that only 31.5% of workers learned to use a chainsaw in training
163 courses. In terms of their level of education, 23.8% did not indicate their level of education but just
164 gave information on courses, for example, courses taught by training companies to improve the
165 employability and knowledge of workers, by the Public Administration in Andalusia. Even 10.6%
166 indicated the training given by the company where they currently worked or had previously worked.
167 Further, as shown in Table 3, 87.3% of the interviewees indicated that they had received occupational
168 health and safety training and 79.9% indicated they had received some training on the use and operation
169 of a chainsaw. The courses received consist of training in occupational health and safety, light
170 machinery, accident procedures, fire extinction, safety in forestry work, first aid, preventive measures
171 in forestry, civil and hydraulic works, vertical work, pruning at heights, mobile elevating work platforms
172 (MEWPs) and winches.

173 Table 4 shows the number of hours dedicated to occupational health and safety training by the workers
174 who stated that they had received occupational health and safety training. Of the 378 operators working
175 with chainsaw, 66 indicate they do not know the number of hours they have received in occupational
176 health and safety training.

177

178

179 **Table 4.** Training devoted to occupational health and safety

Occupational health and safety training time	Frequency	Percentage
Not received training in OHS	1	0.3%
Less than 25 hours	62	16.3%
Between 25 and 50 hrs	69	18.2%
Between 51 and 100 hrs	92	24.3%
Between 101 and 150 hrs	17	4.6%
More than 150 hrs	24	6.3%
Unknown	66	17.5%
Does not answer	47	12.5%
Total	378	100%

180 Meanwhile, as for training in the use and operation of chainsaws, the workers that they had
 181 received training on using a chainsaw mentioned having completed the following courses:
 182 professional chainsaw qualification; advanced chainsaw operator course; chainsaw operator
 183 course; chainsaw maintenance course; online chainsaw and scrub-clearing course; chainsaw
 184 and scrub-clearing course; safety in chainsaw tasks; cutting and processing of timber with
 185 chainsaws; reading manufacturer's instructions; and courses or conferences on international
 186 companies.

187 Table 5 shows the number of hours training they received on the use and operation of chainsaws.
 188 Of the total workers surveyed (378), 57 say they unknown the number of hours training they
 189 have received on the use and operations of chainsaws.

190 **Table 5.** Training in use and operation of chainsaws

Chainsaw training time	Frequency	Percentage
None	22	5.8%
Between 1 and 50 hrs	159	42.1%
Between 51 and 100 hrs	51	13.4%
Between 101 and 150 hrs	16	4.2%
Between 151 and 200 hrs	10	2.7%
More than 200 hrs	9	2.4%
Unknown	57	15.1%
Does not answer	54	14.3%
Total	378	100%

191

192 **3.2. Questionnaire Section**

193 **3.2.1. Personal protective equipment**

194 Almost all respondents always use personal protective equipment (PPE); three out of four workers
 195 always inspect the state of personal protective equipment and two out of every three workers always
 196 carry out the maintenance of their personal protective equipment, as shown in Table 6.

197 **Table 6.** Results of the items on personal protective equipment

Please indicate how often you perform the following tasks	Results of responses						Descriptive statistics
	Number Percentage	Always	Almost Always	Sometimes	Hardly ever	Never	
							\bar{x} (σ)

You use personal protective equipment such as a hard hat, safety gloves, hearing protectors...	355	22	1	0	0	0	4.93 (0.25)
	93.9%	5.8%	0.3%	0.0%	0.0%	0.0%	
You inspect the state of the personal protective equipment	290	65	20	1	1	1	4.70 (0.60)
	76.7%	17.2%	5.3%	0.3%	0.3%	0.3%	
You carry out maintenance to the personal protective equipment	250	70	45	6	4	3	4.48 (0.84)
	66.1%	18.5%	11.9%	1.6%	1.1%	0.8%	

198

199 3.2.2. Chainsaw

200 As for the chainsaw itself as shown in the Table 7, over half the workers always carry out maintenance
 201 to it, two out of three always know how to sharpen the teeth of the chainsaw, and perform these tasks
 202 daily.

203 **Table 7.** Results of the items on the chainsaw

Please indicate how often you perform the following tasks	Number Percentage	Results of responses					Descriptive statistics
		Always	Almost Always	Sometimes	Hardly ever	Never	
You know how to sharpen the chainsaw teeth and do so daily, taking into account the right angles, depth gauges etc.	231 61.1%	52 13.8%	56 14.8%	14 3.7%	19 5.0%	6 1.6%	4.23 (1.15)
You conduct maintenance operations to the chain catcher, throttle trigger, spark plugs and air filters, chain brake and bar	212 56.1%	68 18.0%	64 16.9%	22 5.8%	9 2.4%	3 0.8%	4.20 (1.07)

204

205 3.2.3. Work Techniques

206 With regard to the work techniques, Table 8 shows that the majority of the respondents always refuel
 207 the chainsaw away from the work area and never smoke while refuelling. In relation to the question of
 208 whether they carry the chainsaw over their shoulders without their scabbards, the average of this
 209 question is 1.27. As for the question of whether they cut with the chainsaw pointing towards their legs
 210 or body, the average is at 1.17. It should also be noted that only 43% of the workers always use the
 211 right felling method, 32.3% takes regular breaks to avoid distractions and 40.5% sometimes cuts the
 212 fallen tree using log length marks on the trunk to help. In addition, before felling, the majority (320)
 213 said that plan an escape route depending on the type of tree and the way it falls.

214 **Table 8.** Results of the items on work techniques

215

Please indicate how often you perform the following tasks	Number Percentage	Results of responses					Descriptive statistics
		Always	Almost Always	Sometimes	Hardly Ever	Never	
You refuel the chainsaw away from the work area and you do not smoke while refuelling	302 79.9%	41 10.8%	15 4.0%	3 0.8%	16 4.2%	1 0.3%	4.61 (0.93)
You carry the chainsaw on your shoulder without the sheath on it	9 2.4%	7 1.9%	14 3.7%	19 5.0%	327 86.5%	2 0.5%	1.27 (0.82)

216

Before felling, you plan an escape route depending on the type of tree and way it falls	320 84.7%	31 8.2%	12 3.2%	4 1.1%	1 0.3%	10 2.6%	4.80 (0.56)
You use the right felling method, with the right auxiliary tools, and you use hinges according to the diameter, appearance and condition of the trunk	161 42.6%	75 19.8%	69 18.3%	40 10.6%	28 7.4%	5 1.3%	3.80 (1.29)
You cut with the chainsaw pointing towards your legs or body	4 1.1%	4 1.1%	6 1.6%	27 7.1%	335 88.6%	2 0.5%	1.17 (0.60)
To cut up the fallen tree, you use log length marks on the trunk to help you	62 16.4%	57 15.1%	153 40.5%	40 10.6%	61 16.1%	5 1.3%	3.05 (1.25)
You take regular breaks to avoid distractions	122 32.3%	95 25.1%	112 29.6%	19 5.0%	17 4.5%	13 3.4%	3.78 (1.10)

217 3.2.4. Work at Height without Mobile Elevating Work Platforms

218 In the case of work at height without lifting platforms or ladders, approximately two out of five workers
 219 always use lifelines, anchors, ropes, harnesses and retractable lanyards and they inspect their state
 220 before use. However, it was found that 15% of the workers use ladders when working with chainsaws,
 221 as shown Table 9.

222 **Table 9.** Results of the items on work at height without mobile elevating work platforms

Please indicate how often you perform the following tasks	Number Percentage		Results of responses				Descriptive statistics \bar{x} (σ)
	Always	Almost Always	Sometimes	Hardly Ever	Never	Unknown	
You use ladders when working with a chainsaw	3 0.8%	10 2.6%	47 12.4%	29 7.7%	204 54.0%	85 22.5%	1.56 (0.94)
When working at height without an elevating work platform or ladder, you use anchors, ropes, harnesses and retractable lanyards and you inspect their state before use	160 42.3%	27 7.1%	16 4.2%	13 3.4%	43 11.4%	119 31.5%	3.95 (1.54)
If you work at height without an elevating work platform or ladder, you use a lifeline	147 38.9%	33 8.7%	16 4.2%	11 2.9%	43 11.4%	128 33.9%	3.92 (1.54)

223

224 3.2.5. Mobile elevating work platforms

225 As shown Table 10, just over half the workers always mark off the work area and always stay in the
 226 basket at all times wearing the harness and protective equipment, without exceeding the rated load and
 227 with the corresponding support. Just under half the workers stated that, when the platform is moving,
 228 they always ensure that they have clear visibility at all times and they adapt the speed and maintain
 229 safety distances. A similar number of workers (n=179) indicated that, before and after using the MEWP,
 230 they check the state of the safety devices and always park the MEWP properly after use.

231 **Table 10.** Results of the items on work with mobile elevating work platforms

Please indicate how often you perform the following tasks	Number Percentage		Results of responses				Descriptive statistics \bar{x} (σ)
	Always	Almost Always	Sometimes	Hardly Ever	Never	Unknown	
Before and after using the mobile elevating work platform, you check the state of the safety devices for any possible defects or faults	179 47.4%	42 11.1%	28 7.4%	10 2.6%	16 4.2%	103 27.2%	4.30 (1.15)

You mark off the working area to keep others away and to avoid high voltage power lines	235 62.2%	31 8.2%	12 3.2%	5 1.3%	7 1.9%	88 23.3%	4.66 (0.83)
You stay inside the basket at all times, wearing the harness and protective equipment, without exceeding rated load and with the corresponding support	193 51.1%	33 8.7%	9 2.4%	3 0.8%	23 6.1%	117 31.0%	4.41(1.20)
When the platform is moving, you make sure you have clear visibility at all times, you avoid reversing, and you adapt and limit the speed to the terrain, always maintaining safety distances	179 47.4%	35 9.3%	9 2.4%	3 0.8%	23 6.1%	129 34.1%	4.38 (1.22)
After use, you park the platform with all everything turned off, making sure it is completely immobile, clean and in its place	184 48.7%	27 7.1%	11 2.9%	4 1.1%	25 6.6%	127 33.6%	4.35 (1.27)

232 3.2.6. Winches

233 As for winches, over half the workers always inspect the state of winch ropes and chains, they always
234 ensure clear communication with the operator handling the winch, and they always take all necessary
235 steps to avoid injury or accidents.

236 **Table 11.** Results of the items on winches

Please indicate how often you perform the following tasks	Results of responses						Descriptive statistics \bar{x} (σ)
	Number Percentage	Always	Almost Always	Sometimes	Hardly Ever	Never	
You inspect the state of winch ropes and chains	200 52.9%	37 9.8%	15 4.0%	4 1.1%	13 3.4%	109 28.8%	4.51 (1.01)
You take all necessary steps to avoid cuts, scrapes, entrapment, falls from height, falls of loads or collapses, or an overturned support or anchor structure	227 60.1%	32 8.5%	8 2.1%	0 0.0%	9 2.4%	102 27.0%	4.69 (0.81)
There is clear communication with the operator handling the winch	208 55.0%	35 9.3%	12 3.2%	5 1.3%	7 1.9%	111 29.4%	4.61 (0.86)

237 3.2.7. Emergencies

238 In this last section on emergencies as you can see on Table 12, two out of every three workers always
239 know how to conduct rescue operations in the event of trapped, hurt or injured people and four out of
240 five stated that there is always a first aid kit in the workplace.

242 **Table 12.** Results of the items on emergencies

Please indicate how often you perform the following tasks	Results of responses						Descriptive statistics \bar{x} (σ)
	Number Percentage	Always	Almost Always	Sometimes	Hardly Ever	Never	
You know how to conduct rescue operations in the case of trapped, hurt or injured people (i.e. to provide assistance, immobilise and move the victim to a safe area)	243 64.3%	57 15.1%	29 7.7%	6 1.6%	6 1.6%	37 9.8%	4.53 (0.85)
There is a first aid kit in the workplace	300 79.4%	37 9.8%	10 2.6%	1 0.3%	9 2.4%	21 5.6%	4.73 (0.75)

243

244 **3.3. Correlación analysis**

245 In order to test the correlation between the factors analysed, different hypotheses were proposed and
246 studied using non-parametric tests. On the one hand, it was analysed whether the chainsaw use
247 behaviours reported by the workers in the questionnaire were related to the age of the workers. For
248 this, different age groups were established (20-29 years, 30-39 years, 40-49 years, 50-59 years and
249 more than 60 years) and average variables of worker responses were calculated for each of the seven
250 sections of the questionnaire. The results showed that there are a significant differences ($p=0.05$) in
251 chainsaw use according to the age of the worker in terms of chainsaw maintenance (H de Kruskal-
252 Wallis=9.843; $p=0.043$), work at height without mobile elevating work platforms (H de Kruskal-
253 Wallis=10.466; $p=0.033$), mobile elevating work platforms (H de Kruskal-Wallis=15.625; $p=0.004$),
254 winches (H de Kruskal-Wallis=18.679; $p=0.001$) and emergency (H de Kruskal-Wallis=14.551;
255 $p=0.006$). However, no significant differences ($p=0.05$) by age were found in the case of the use of
256 personal protective equipment (H de Kruskal-Wallis=0.881; $p=0.927$) and the work techniques applied
257 (H de Kruskal-Wallis=3.035; $p=0.552$).

258 In addition, other correlations were explored. In this sense, it is noteworthy that it was found that,
259 according to the information reported by the workers, there are significant differences ($p=0.05$) between
260 the existence of a first aid kit in the workplace by type of company in which the worker claims to work
261 (H de Kruskal-Wallis=17.568; $p=0.004$). However, there are no significant differences ($p=0.05$) in
262 reported knowledge of emergency manoeuvres according to the periodicity of chainsaw use reported
263 by the worker (H de Kruskal-Wallis=6.752; $p=0.150$) or the type of company in which the worker claims
264 to work (H de Kruskal-Wallis=9.503; $p=0.091$).

265 A significant difference ($p=0.05$) was also found in the use of a lifeline in work at height, without an
266 elevating work platform or ladder, according to the frequency of use of the chainsaw (H de Kruskal-
267 Wallis=22.774; $p=0.000$). Thus, the more frequent the use of a chainsaw, the less frequent the use of
268 a lifeline. However, no significant differences ($p=0.05$) were found in the use of anchors, ropes,
269 harnesses and retractable lanyards and their inspection (H de Kruskal-Wallis=5.131; $p=0.274$). Finally,
270 the use of ladders also showed a significant difference ($p=0.05$) with respect to the frequency of
271 chainsaw use (H de Kruskal-Wallis=13.946; $p=0.007$). In this case, those who reported using ladders
272 the least were the workers who used the chainsaw daily and those who reported using them the most
273 were those who reported using the chainsaw once a month or once a week.

274 **4. Discussion**

275 As for analysis of the weaknesses in the training received by learning chainsaws at work in Andalusia,
276 Spain, work-related shortcomings have been detected in relation to the different aspects that were
277 analysed. With regard to the personal information of the worker who uses a chainsaw analyzed in
278 preliminar section, the results of the questionnaire show that 96% of the workers who participated in
279 the study were between 30 and 59 years old, with 48% between the ages of 40 and 49. This is in line
280 with the claims of other authors such as Blombäck et al. (2003) who indicated that this type of job is
281 an unattractive for young people. Likewise, a significant correlation is found between the age of the
282 chainsaw user and some of the main risk factors identified. It should also be noted that 10.1% of the
283 respondents perform chainsaw operations at least once a month, 9.3% of them use it daily and 20%
284 weekly. This last data seems to indicate the importance of the chainsaw in their work. In this sense, it
285 should be considered that working hours have a great influence on the physical and mental state of
286 workers (Albizu-Uriónabarrenetxea et al. 2013, Lilley et al. 2002). The findings of this study show that
287 53.2% of workers used a chainsaw for several months per year. This could be due to the seasonal
288 nature of the work with a chainsaw, which leads to the majority of workers not developing their activity
289 continuously and permanently. In fact, previous studies coincide in pointing out this seasonality as a
290 risk factor in chainsaw tasks (Picchio et al. 2010, Montorselli et al. 2010, Wang et al. 2003).

291 Continuing with the personal information analyzed, 85.4% of the workers were employed in public
292 companies. In principle, that the company is public or private should not influence in terms of safety in
293 the use of the chainsaw. Nevertheless, Montorselli et al. (2010) found that public crews took significantly
294 less risks and the riskiest one was semi-private crews followed by private and consortium crews.
295 According to the authors of that study, best safety performance by public crews could be related to the

296 stronger commitment of public management to safety and to the fact that public organizations
297 administered formal safety training to their crews. In line with this, in the specific case of this study, the
298 majority of workers, who worked mostly in public companies, reported having received training in
299 occupational health and safety and in use and operate of chainsaw. Despite this, there were deficiencies
300 in the knowledge acquired by the workers in some subjects related to safety. For example, the results
301 of this research show that only 31.5% of workers surveyed had learned to use a chainsaw on training
302 courses. The rest they had learned in the company where they worked by themselves or from a co-
303 worker. It is important to note that, with regards to training and education, there is currently no
304 minimum specific and compulsory training for the chainsaw workers. Only the basic training in
305 occupational safety and health defined by European Directive 89/391/CEE (European Council 1989) on
306 the introduction of measures to encourage improvements in the safety and health of workers at work.
307 Then, all workers using a chainsaw would have to know how to use it safely and how to comply with
308 occupational health and safety legislation. To guarantee that this is fulfilled and to ensure that all
309 workers who use the chainsaw have adequate training, it would be advisable to regularly be trained in
310 a common framework.

311 The second part of the questionnaire focused on analyzing the knowledge of the workers who use the
312 chainsaw. This information could be helpful for the regulation of training in this regard. The results
313 obtained in the questionnaire section have clearly demonstrated that almost all respondents always use
314 PPE; however some respondents expressed that they did not use correctly or even did not use it all the
315 time the PPE. This data is confirmed by authors such as Albizu-Uriónabarrenetxea et al. (2013), who
316 argue that, there are still a minority of workers who do not use the prescribed PPE. However, these
317 same authors affirm that it would be essential to adapt the Personal Protection Equipment to the working
318 conditions and improve awareness of its correct use.

319 Regarding the use and maintenance of the chainsaw, almost 9% of the workers surveyed never or
320 hardly ever perform the sharpening or maintenance of chain catcher, throttle trigger, spark plugs and
321 air filters of the chainsaw and only 16.9% sometimes take it into account, confirming therefore with
322 what was exposed by references authors (Albizu-Uriónabarrenetxea et al. 2013, Robb and Cocking
323 2014), who found an absence of proper maintenance of this equipment under controlled safety
324 conditions.

325 When workers were asked about the techniques, the results showed obvious deficiencies related to the
326 felling methods and bucking of felled trees. In short, coinciding with the theories of Thelin (2002),
327 Salminen et al. (1999) and Peters (1991), one of the main causes of accidents with chainsaws are due
328 to ignorance of the proper work techniques.

329 The highest rate of fatal accidents occurring in the use of chainsaw is due to falls at height (Robb and
330 Cocking 2014). In the questionnaire section of work at height without MEWP, MEWP and winches, the
331 percentage of workers who did not respond was high when compared with the other sections, with a
332 figure of between 22.5% and 34.1%. It was hypothesized that these workers do not work at height and
333 do not use winches or MEWP, as indicated by some of them in their comments. Notably even though
334 European Directive 2009/104/EC (European Parliament and of the Council 2009) prohibits workers from
335 using a chainsaw on a ladder, it was found that 15% of the workers so they did it in their daily work.
336 Even so, the results show that the more frequent the use of the chainsaw, the less frequent the use of
337 the ladder.

338 Finally in questionnaire section, when dealing with emergencies, lack of knowledge regarding rescue
339 operations is detected. The low response rate in the emergency section (9.8% does not answer the
340 section on rescue and 5.6% on first aid kit) is not justified since all workers may be affected at some
341 time by a critical situation in which they need to use the rescue operations or the first aid kit. Therefore,
342 they must be trained to do so in order to be able to respond to these situations. Furthermore, the results
343 obtained show a relationship between the existence of a first aid kit and the type of company where the
344 interviewees works. Not being so between the type of company and the rescue operations in case of
345 emergency.

346 The knowledge about safety emergency plan is very important because these documents contain all the
347 information for proper safety and health management. For example, with the emergency plan, workers
348 can know the evacuation routes that are essential in an emergency. Despite the importance of the need
349 for proper planning and execution of emergency actions, authors like Robb and Cocking (2014) highlight
350 that the action with use of the chainsaw in rescue or emergency work still does not have a regulated
351 training in Europe.

352 Therefore, a general common deficiency in all the aspects studied was the lack of safety inspections of
353 both the state of the equipment, the work techniques and the PPEs to be used.

354

355 **5. Conclusions**

356 The purpose of this research was to determine whether occupational health and safety training in the
357 use of the chainsaw as a work equipment is effectively and identify their weaknesses in the training
358 received by chainsaw workers. This particular aspect had not been addressed until now, so the findings
359 of this research could offer original contribution by determining whether it could stimulate occupational
360 health and safety implementation through the improvement of the weaknesses detected in the training
361 of workers who use the chainsaw at work. Thus, learning performance and training transfer are
362 significant measurement to determine training effectiveness because the main purpose of providing
363 employee training is to increase employees' knowledge, skills, and attitudes and finally use it to improve
364 job performance.

365 The conclusions of this research indicate that lack of training detected on rescue techniques and work
366 at height is of particular importance, since these are aspects of special risk for workers' health which
367 could lead to accidents with severe injuries. These results evidence that there is a need to regulate
368 chainsaw operator training. With this study, a first step has been taken towards the identification of
369 mandatory minimum competences for chainsaw workers. So, minimum compulsory training contents
370 should be developed for workers who use chainsaws as work equipment, regardless of the industry they
371 work in. Consequently, a training manual should be developed including all of these contents to be used
372 as a reference document. This would be a significant improvement for the protection of chainsaw
373 operators' health and safety.

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381 **Conflicts of Interest**

382 The authors declare no conflict of interest.

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