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Characteristics of the workplace of harvester operators in Poland

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Abstract: The objective of the presented research was to create an average image of a harvester operator in Poland and to identify factors influencing the degree of mental workload. We used a survey of environmental assessments of workload. The creation of an electronic survey and the support of a company that indirectly employs operators (State Forests) made it possible to reach a large group of surveyed people. The respondents indicated the occurrence of ailments typical of sedentary work at the researched workstation. These included mainly monotony, back pain and numbness in the upper limbs. Stress at work was felt by the majority of respondents; hence the analyses of mental stress, which also translates into other diseases, should indicate key responses to questions regarding comprehensive ergonomic assessments at the researched workstation.

Keywords: ergonomics; harvesting; mental workload; survey research

Most of the work related to harvesting is considered particularly dangerous (Chojnicki 2013). This applies especially to hand-machine technologies in which chainsaws are used. Such work is characterised by high nuisance and generates a high level of accidents (Kapral 2004; Sowa et al. 2007; Grzywiński 2010; Nowacka, Moskalik 2012, 2013; Szewczyk et al. 2012; Grzywiński et al. 2019). The widely discussed postulate of minimising workload in forestry has led to the gradual introduction of specialised, safer and more efficient work methods using harvesters.

The idea of machine harvesting, with the full mechanisation of tree felling and then delimbing and sawing the wood to the desired length comes from the United States (Hakkila 1989; Pulkki 2004). The dynamic increase in the number of harvesters in recent years indicates the multi-faceted profitability of their use. According to Bodył (2022), in 2019, machine harvesting accounted for 37.4% of the total annual harvest volume, in 2020 for 41.8% and in 2021 for 46.2%.

Independence from weather conditions, continuity of work, reduced accident rate, low energy consumption, limited risk to hearing, social ennoblement and high work autonomy undoubtedly constitute the advantages of this job. On the other hand, however, new, unprecedented loads have appeared (Heinimann 2007; Moskalik 2009; Sowa 2014): monotony of work, forced automation of movements, static effort, exposure to long-term vibrations, intellectual challenges (knowledge of operators not only in forestry), stress and a feeling of loneliness. Men-

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tal loads became visible: making decisions in a short time, the complexity of performed activities, concentration, and wide range of attention (Grzywiński et al. 2008; Nowacka 2009; Nowacka 2012; Nowacka et al. 2017; Szewczyk et al. 2020; Szewczyk et al. 2021; Naskrent et al. 2022). The fatigue and stress that occur among harvester operators make them exhausted, their reactions slow and they are not sufficiently focused. As a result, work efficiency decreases, and there is a significant risk of accidents (Sullman, Gellerstedt 1997; Berger 2003). From typical workloads, what comes to the fore are not physical but mental elements as well as organisational elements. Recognition of the psychological loads of contractors, especially in difficult environmental conditions, is the starting point for designing safe and efficient technological systems.

Survey research, which is a subjective method of determining fatigue, is often used instead of measurement methods requiring expensive equipment. The survey allows access to a large, diverse group of respondents in a short time. The advantages of this method include simplicity, repeatability, anonymity and standardisation (Witaszek 2007). The most popular subjective procedures for measuring mental workload include the Cooper-Harper scale (Cooper, Harper 1969), the Bedford Scale (Roscoe 1987; Roscoe, Ellis 1990), and SWAT (Subjective Assessment Technique) (Reid, Nygren 1988). In forestry, the Japanese questionnaire (Japanese Fatigue Feeling Scale) is used, in which the subject self-assesses their degree of fatigue before and after work (Paluch 1985).

Survey research including, among others, subjective methods of measuring fatigue, has been used in forestry for years (Grzywiński 2010). Surveys conducted among forest workers involved, among others, determination of the impact of fatigue on the number of accidents and on the occurrence of musculoskeletal diseases (Lilley et al. 2002; Gallis 2006). In the study by Skonieczna and Grzywiński (2016), surveys were used to examine the occurrence of work-related stress in the State Forests. Grzywiński and Hołota (2006) conducted similar research among harvester operators, indicating the dominant mental load. The psychological load of harvester operators was also examined using survey methods by Spinelli et al. (2020). They used the NASA Task Load Index (NASA-TLX) simulation method. NASA-TLX ratings are calculated by combining ratings of mental workload: mental, physical, and time demands, frustration, effort, and performance. The described method is repeatable, easy to implement, and sensitive to changes in mental workload (Schick, Hahn 1987; Hart, Steveland 1988; Rubio et al. 2004). In forestry, this method was only used by Dvořák et al. (2011) and Spinelli et al. (2020) on harvesting simulators; therefore, the results obtained require confrontation with field conditions.

The objective of our research was to define the characteristics of an average harvester operator in Poland and to determine their mental workload.

MATERIAL AND METHODS

We have created an electronic survey divided into four groups of questions: professional experience, health and attitude to work, further plans and job evaluation, and information about yourself (Kaden 2008). In the first group of questions, the respondents were asked about their experience in the forestry industry, the structure of the working day, including the length and number of breaks, the ability to operate forestry machines (not only multi-operational ones), training received, and place of work. The 'health and attitude to work' group included questions about emotions accompanying work, career ambitions, stress at work, typical ailments related to the discussed job, including monotony, loneliness, back pain, numbness in limbs, the impact of the stand of trees on workload, burnout, addictions. Further plans and work evaluation dealt with satisfaction and willingness to change work, the influence of external conditions – work organisation and type of trees, with an indication of elements that interfere with work. The 'information about yourself' section constituted a standard demographic element in the survey. The respondents were asked about their gender, age, education, marital status, and place of residence. The entire survey contained 35 open, closed single and multiple choice questions. Completing the survey took no more than 15 minutes. The survey was designed and sent electronically via the company commissioning forestry work. The survey was anonymous with the possibility of leaving contact details for the respondents. Survey data was collected from over 100 operators. According to Mederski et al. (2016) and Bodył (2022), there are currently approximately 700 harvesters working in Poland. Our research, therefore, includes a representative group of respondents that can indicate the general trends in the level of mental workloads of forest machine operators.

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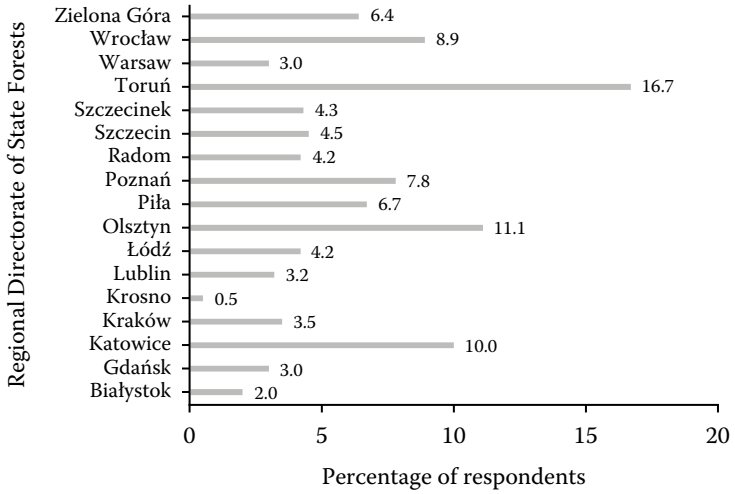

Figure 1. Place of work of machine operators

RESULTS

The survey reached forest machine operators working throughout Poland. We received responses from 102 respondents.

Figure 1 presents the respondents' workplace. Most of the respondents worked in the Regional Directorates of the State Forests in Toruń (17%), Olsztyn (11%) and Katowice (10%). The smallest share consisted of employees from the Regional Directorates of State Forests in Krosno (1%), Białystok (2%), Lublin (3%), and Szczecinek (3%).

Figure 2 presents the spectrum of types of forest machines operated by the respondents. The respondents could select multiple responses. A similar number of respondents operating felling and thinning harvesters may suggest that they are the same persons.

In Figure 3, we compare the results regarding the experience of harvester and forwarder operators and work in the forest. The largest group of respondents were people with six to seven years of experience. Noteworthy is the large participation of operators with less experience, which indicates continued interest in working in this profession.

The preferences of the respondents regarding the stands in which they can work best are presented in Figure 4. Most people responded that, in their opinion, low-land, single-species and single-storied stands were the most suitable for the operation of machines. The surveyed operators were also much more inclined to work in felling compared to thinning stands. Mountain-specific, multi-storied, multi-species stands were suitable for only 5% of operators.

Figure 5 presents the number of operators who have received specialised training and where they received it. The vast majority of them completed training that was conducted in Poland. The supplementary questions show that training for the position of a harvester operator lasts approximately 120 hours, most

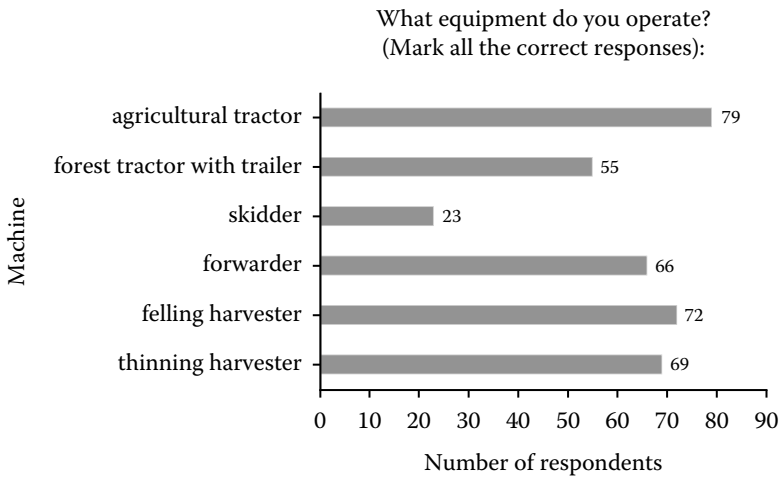

Figure 2. Forestry machines operated by the respondents while harvesting wood

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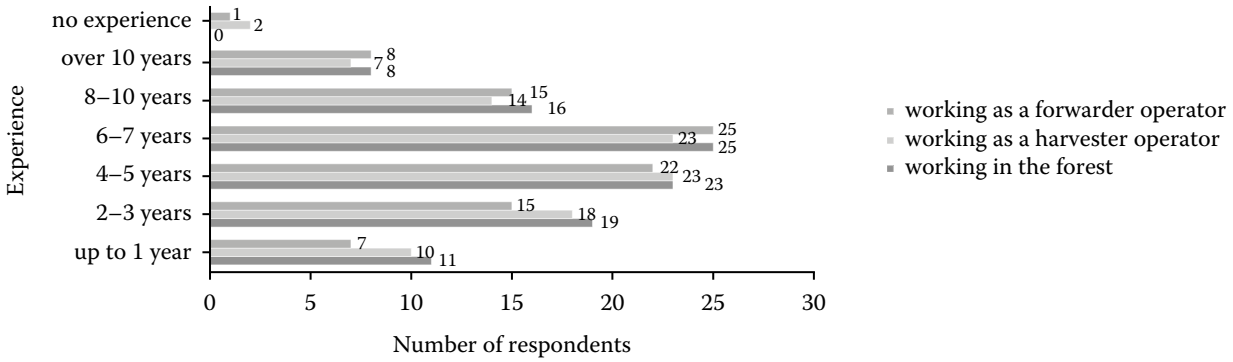

Figure 3. Length of professional experience of the respondents

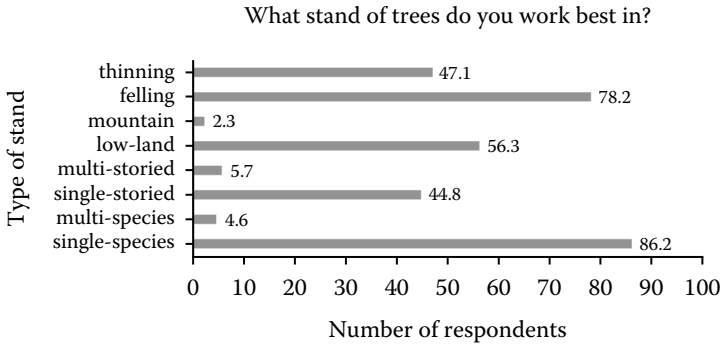

Figure 4. Preferences of the respondents regarding stands optimal for machines

of which are practical classes. In addition to training for the positions of operators of multi-operational forest machines, the respondents also indicated participation in training in working with loading cranes and in operating a petrol chainsaw.

When asked about average working hours, the respondents replied that they most often worked eight to ten hours a day, six days a week (Figure 6). This means that most of the respondents worked a minimum of 48 hours a week, which is inconsistent with the Labor Code. In an open question about breaks during work, the respondents most often responded that they had two breaks during the day, 15 minutes each.

Figure 7 presents the frequency of work of the respondents at night and at dusk. The response 'never' and 'rarely', i.e. a few times a month, was given by the majority, i.e. 65% of the respondents. The rest responded 'sometimes' (25%) and 'often' (10%).

When asked about their self-assessment of their health, the majority of the respondents responded that they felt good (55%) or very good (17%). Only 5% of the respondents rated their health as poor and unsatisfactory (Figure 8).

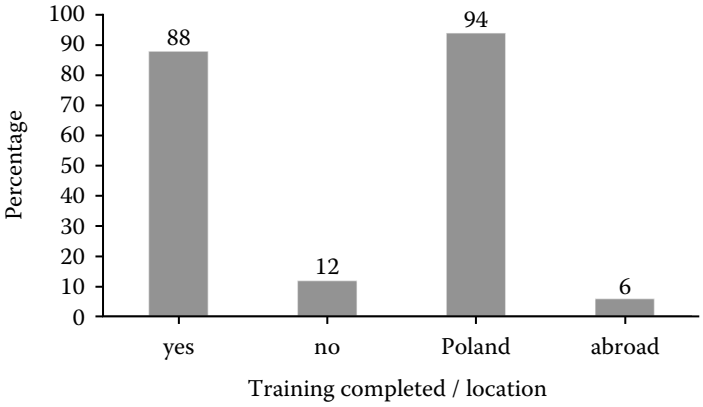

Figure 5. Completion of operator training and training location (%)

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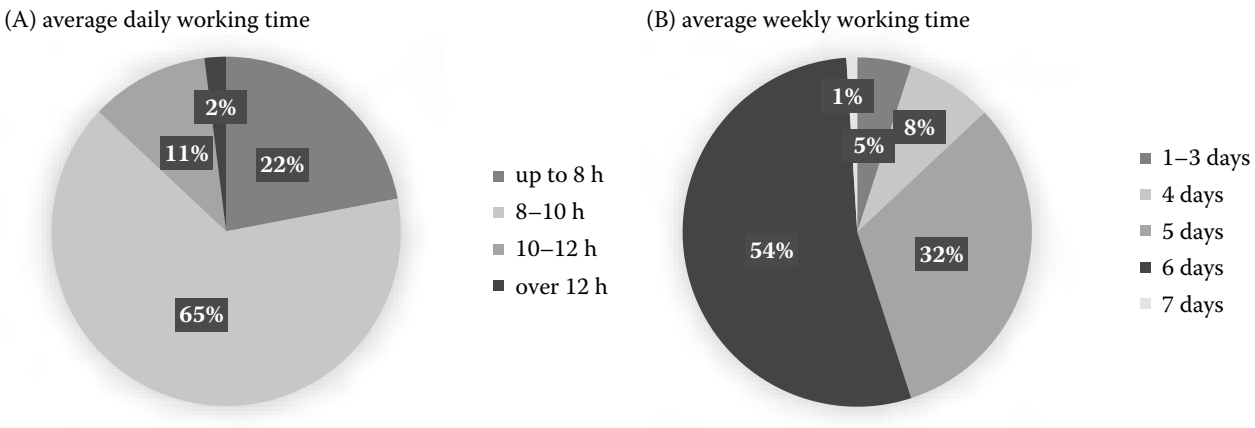

Figure 6. Average (A) daily and (B) weekly working time

Figure 9 presents the incidence of some common ailments among harvester operators. The survey results indicate that the most troublesome ailments among the respondents include boredom/monotony, the feeling of loneliness, and back pain. The least severe symptoms in the group of respondents were lack of concentration, insomnia and numbness in the lower limbs.

Before commencing work, the respondents felt mainly content, which may suggest satisfaction with

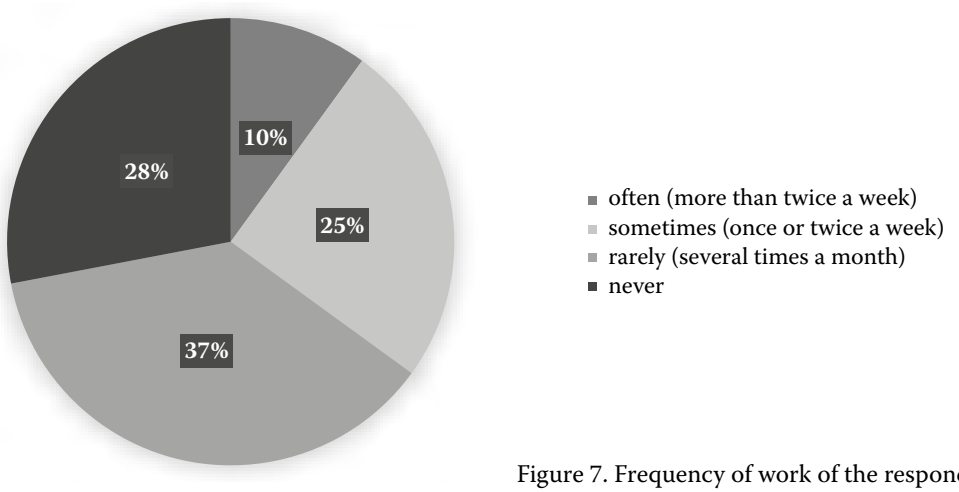

Figure 7. Frequency of work of the respondents at night and at dusk

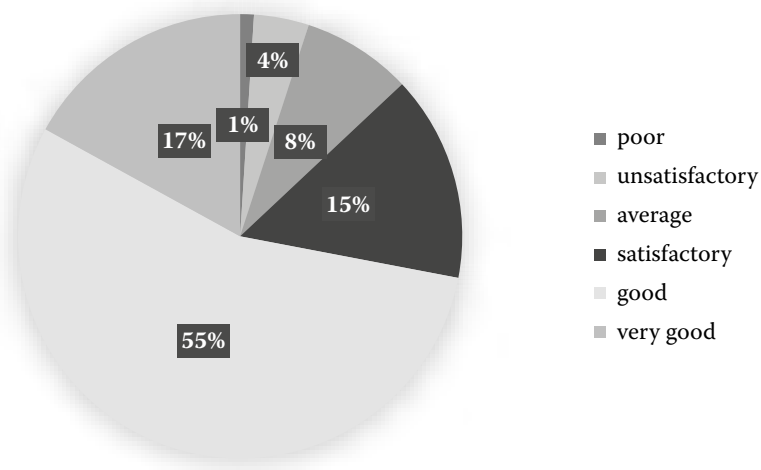

Figure 8. Self-assessment of health

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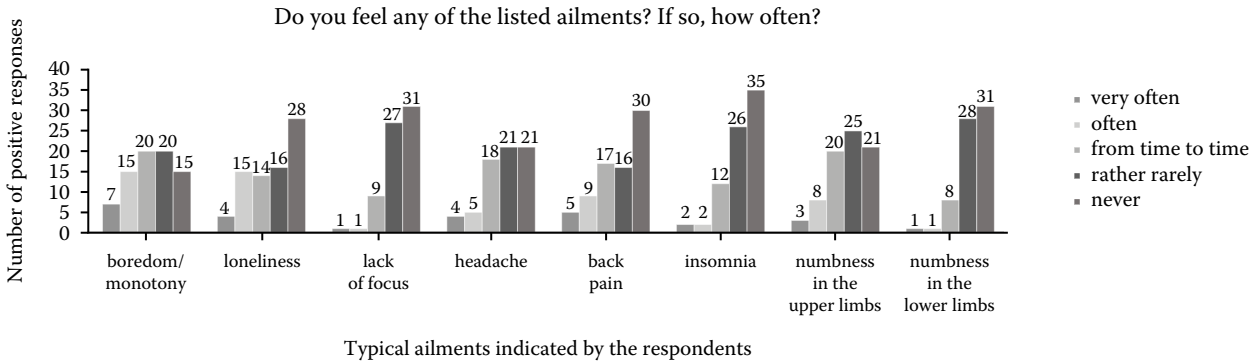

Figure 9. Frequency of occurrence of some typical ailments in the respondents working as operators of multi-operational forest machines

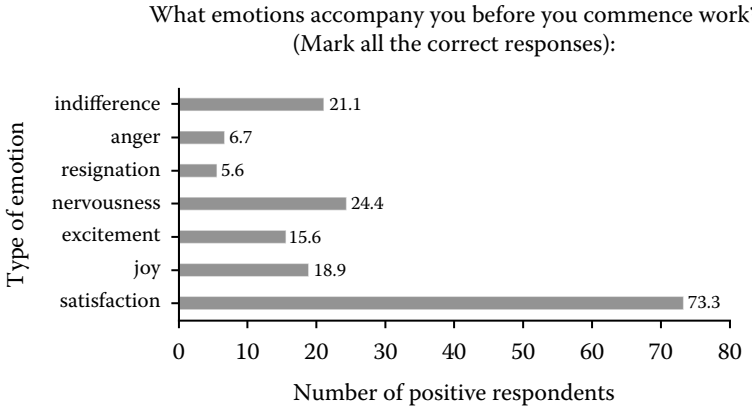

Figure 10. Attitude towards work – Emotions of the respondents before commencing work

the tasks undertaken (Figure 10). The respondents ranked nervousness, indifference and joy at a similar level. In turn, negative emotions such as resignation and anger characterised the work of the respondents to the least extent.

When asked about addictions, the respondents mentioned nicotine – over 30% of the respondents marked this response. Physical activity turned out to be very important, over 55% of those responding to the questions chose active rest as their preferred activity. Swimming, fishing and cycling were indicated by the respondents as the main sports disciplines practised. The respondents also indicated a great desire for contact with other people as a way to relax after work. When asked about exercising during breaks at work, over 90% responded that they did not do it, which suggests taking up physical activity after work. Considering the very long working hours mentioned above, practicing sports probably takes place on weekends.

Monotony of work was a characteristic determinant of the assessment for 35% of the respondents. The respondents justified this response by the constant repetition of the same activities, the unchanging environment and the lack of presence of other people. At the same time, they indicated the presence of stress in their work (Figure 11).

Figure 12 presents the respondents' subjective opinion on the influence of work experience. As ex-

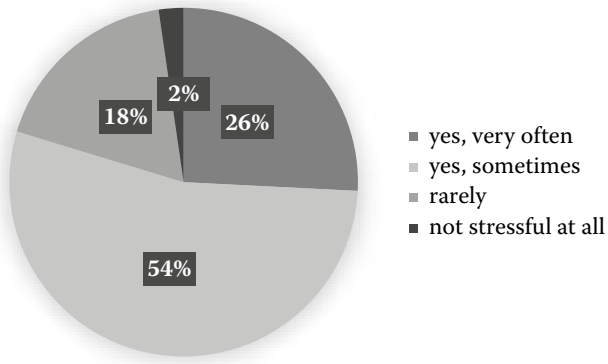

Figure 11. Assessment of the respondents' frequency of feeling stress at work

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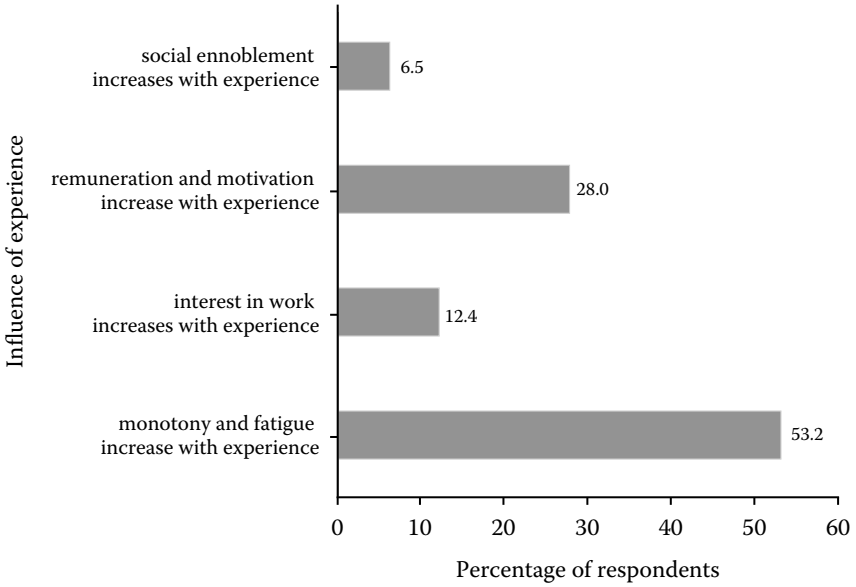

Figure 12. Subjective assessment of the respondents regarding the correlation between experience and workload

perience increases, fatigue and the feeling of monotony increase, and interest in work decreases. To a small extent, experience translates into motivation and an increase in remuneration. According to the respondents, work experience has no impact on social recognition. In response to the question about their willingness to change jobs, the respondents replied that most of them had no such plans due to job security.

The predominant form of remuneration for the work of the respondents was piecework, which accounted for 76% of the settlement methods (Figure 13). This means that the dominant factor in job evaluation was efficiency, not quality.

Figure 14 presents the age groups of the respondents. The largest group were people aged 31–40 and then 26–30. The group of respondents over 50 years of age constituted the smallest group (2% of respondents).

The majority of respondents had basic vocational and technical secondary education. 12% of respondents declared higher education (Figure 15).

The forest services market is dominated by men, which is also confirmed by the results of the survey.

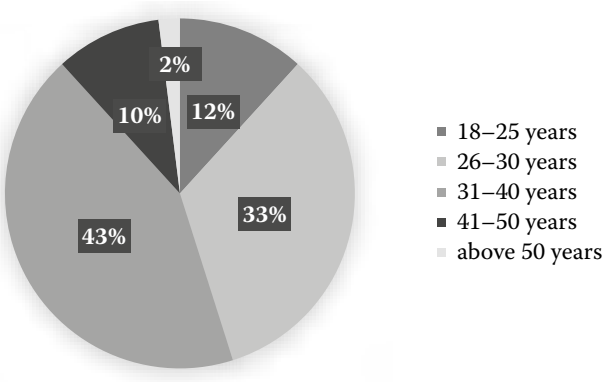

Figure 14. Share of specific age groups among the respondents

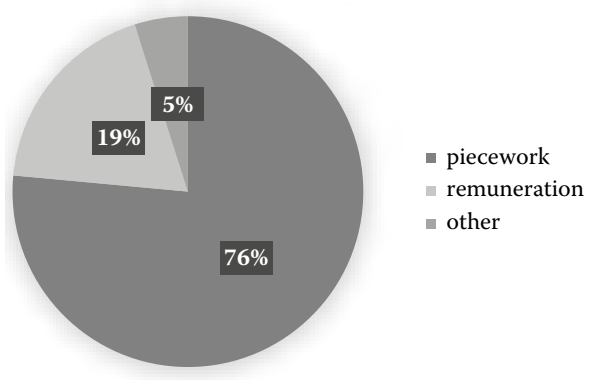

Figure 13. Forms of payment for work among the respondents

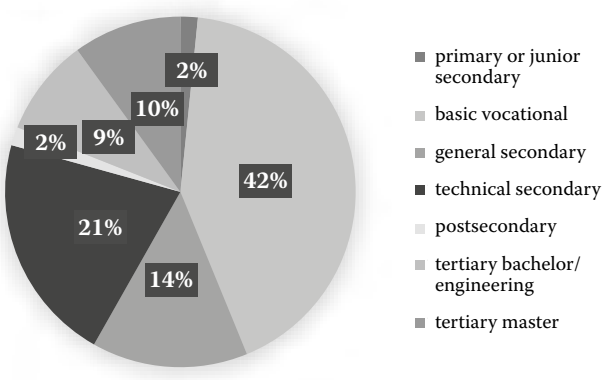

Figure 15. Education of the respondents

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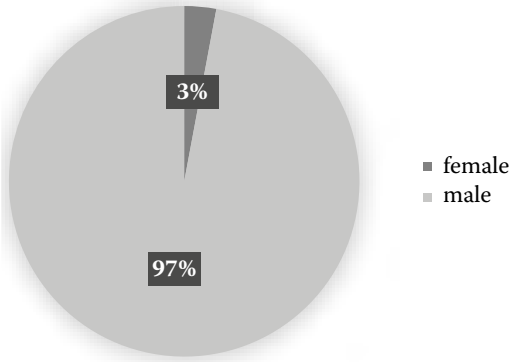

Figure 16. Gender of the respondents

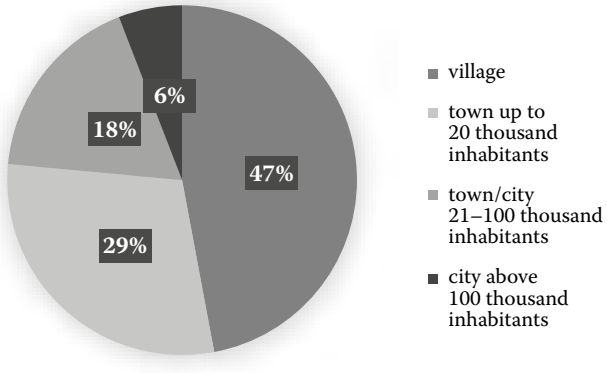

Figure 18. Place of residence of the respondents

The majority of the respondents (97%) were men (Figure 16), who were married – 53% (Figure 17).

Figure 18 presents the place of residence of the respondents. Villages and towns with up to 20 thousand inhabitants were the main locations indicated by the respondents, which is certainly related to the location of larger forest complexes in which harvesting works are carried out on a larger scale at the machine level of technology.

The collected survey results helped to create an image of an average harvester operator in Poland. Most often, it was a man aged 31–40 with basic vocational education, living in a village and assessing his health as good. Most operators liked their job and felt satisfied before commencing it, but at the same time, they indicated that they felt stressed at work. The respondents confirmed that boredom and monotony occurred frequently and constituted the main ailments at work. The surveyed operators usually had 6–7 years of work experience. Due to the prevailing piecework, single-species felling in flat terrain constituted the preferred stands. Approximately 50% fewer respondents would prefer to work in thinning stands.

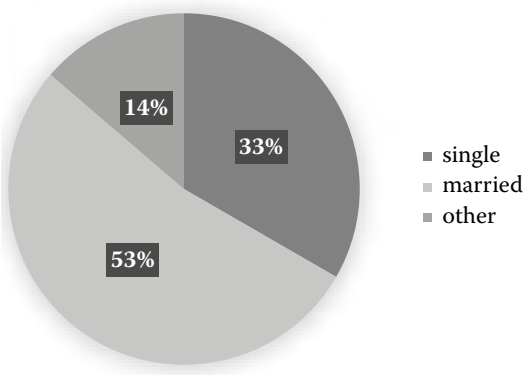

Figure 17. Marital status of the respondents

The respondents strongly rejected working in stands with varied structures, typical of mountains. Most operators completed professional specialist training and worked 8–10 hours, 6 days a week. While working, they took two 15-minute breaks.

DISCUSSION

Preventive measures in the form of training, also mentioned by Gallis (2006), would potentially find a large group of recipients also in Poland. In the research, 12% of the respondents reported a lack of training. Assuming that there are currently approximately 600 harvesters and one employee per machine, this gives a group of 72 persons requiring training. Greater knowledge and health awareness could contribute to improving working conditions among Polish harvester operators. Taking into account not only the possibility of catching up on training but also the fact of the constantly developing forest machinery market (not only harvesters), the need for operator training is estimated at up to 700–1 000 new employees (Nowacka, Moskalik 2012).

Skonieczna and Grzywiński (2016) described the stress level in most positions as medium and high. In the conducted research, forest machine operators did not specify the level of stress, but 26% of them responded that they felt stress very often and 54% sometimes. Nevertheless, when asked about their attitude towards work and emotions before commencing it, in most cases, they responded that they felt satisfied. However, the subsequent response revealing their nervousness at work suggests increasing mental tension during the working day.

Grzywiński and Hołota (2006), in their study of harvester operators' fatigue, prove the predominance

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of mental loads during work. Symptoms of reduced motivation were reported by harvester and forwarder operators also surveyed in the course of this research – only 28% of the respondents stated that remuneration and motivation increased with experience. Slightly over 37% of the respondents noticed a lack of focus while working, of which most of the positive responses stated that its frequency was quite rare.

According to Berger (2003) and Sullman and Gellersted (1997), operators' fatigue varies at different times of the day. Moreover, the author highlighted the influence of field conditions and time pressure during piecework on the degree of fatigue. The research results presented in this study show that the operators' preferences regarding conditions of stands of trees are clear: single-storied, single-species, low-land stands and felling. 35% of operators declared that they worked at dusk and at night several times a week, and 28% replied that they had never worked in such conditions. The vast majority of the respondents (76%) declared piecework payment, which, according to Berger (2003), causes stress and greater fatigue at work.

According to Nowacka and Moskalik (2012), the main barriers to the development of the labour market in question are: lack of certainty and stability of employment, pay inadequate to commitment, lack of a development path, improper organisation of work and too much mental load. Similar results were also obtained in the course of the presented research. Operators pointed out the lack of good cooperation with forest managers, problems with machine repairs and service, not using logistics in planning work areas, short-term contracts with PGL LP (State Forest Holding), and the high cost of purchasing machines. The respondents stated that social ennoblement and interest in work do not increase with experience. The work of a harvester operator is mainly associated with mental effort and mental stress is at a very high level. Operators experience forms of fatigue typical of mental work, characterised by reduced concentration and motivation, emotional and thinking disorders, slower reaction time and weakened perception. Greater knowledge and health awareness could contribute to improving working conditions among Polish harvester operators. Due to the fact that the market for forestry machines (not only harvesters) is constantly developing, the need for operator training is indicated. Enriching course materials with information on mental fatigue during work should facilitate rational planning of the working day by machine operators, e.g. the structure of work breaks.

CONCLUSION

The presented research results of other authors were, to some extent, reflected in this study. In the described research, machine operators, when asked about typical ailments in their position, noted back pain, headaches and numbness in the upper limbs. Only slightly over 1/3 of the respondents reported health problems related to their lower limbs. The reported feelings are very interesting. The vast majority of the respondents felt monotony at work and almost half felt loneliness. Moreover, just over half of the surveyed operators stated that the feeling of fatigue and monotony at work increased with experience. The risk of injuries at work related to fatigue and length of work is also reflected here. Only about 1/5 of the respondents work up to 8 hours a day and over half reported working 6 days a week. This means that an average operator in Poland can work up to 60 hours a week.

In the conducted research, the respondents' opinions were divided regarding the type of work performed in the stand of trees and their work experience. The respondents confirmed the results of research conducted by other authors regarding the occurrence of typical ailments in this position. These include monotony, back pain and numbness in the upper limbs. The search for important factors of the work environment affecting the mental load of harvester operators focused on the type of work performed in the stand of trees and work experience. It was in these sections that the differences in the respondents' opinions were large. Stress at work was felt by 80% of the respondents; hence, the analysis of mental stress, which also translates into other diseases, should indicate key responses to questions regarding comprehensive ergonomic assessments concerning the position. The influence of other factors shown in the surveys is in no way denied a priori, but their importance in the current reality of harvesting in Poland is less important, e.g. mechanised harvesting in mountain conditions or night work. This knowledge is also of great importance for the development of training programs and the transfer of information between operators.

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