Increasing Productivity and Controlling of Work Fatigue in Forest Operations by Using Prescribed Active Pauses: a Selective Review

Christos Gallis

Abstract – Nacrtak

This paper presents and discusses a selective review of the current work/rest schedule bibliography, and provides a theoretical model to be used to create work-rest schedules for forest workers. Forest machine and manual motor tool operators expose themselves to a variety of factors that may cause work fatigue. Prolonged fatigue may produce a variety of musculoskeletal disorders, decrease performance, and cause health problems. Pauses at work may provide time for physical recovery and for reduction of health hazards. Prescribed active pauses at work may help forest machine and manual motor tool operators to increase their net working time and to decrease commonly existing spontaneous and disguised pauses. Ten-minute active pauses may relieve forest operators from fatigue effects, provide time for recovery and maintain adaptation to work. The use of electromyography (EMG) accompanied by the use of the Checklist of Individual Strength questionnaire (CIS) would be the methodology for determining the validity and assessing the results of the above mentioned work/rest schedules in mechanized and motor-manual forest operations.

Keywords: work fatigue, health problems, prevent accidents, electromyography, productivity, work pauses, forest operators, work/rest schedules

1. Introduction – *Uvod*

In spite of increasing mechanization and automation of many forest operations, there is still a need for muscular power and activity to operate hand tools and machines (Gallis 1992). Muscular power cannot be maintained for prolonged work because fatigue sets in and muscular power is reduced. In practice, forest machine and manual motor tool operators work very intensively during a work day, with a limited number of pauses, and are exposed to a variety of working conditions, which affect their working capabilities and may cause work fatigue, health problems, musculoskeletal problems, lower performance, and increase working errors, injuries, and accidents (Herberts et al. 1980; Axelsson and Ponten 1990; Harstela 1990; Gallis 1992; Gellerstend 1993; Kirk 1998; Gallis 2006). Even if performance has not declined, the subjective sensations of fatigue are a very important aspect of human work. Fatigability as an objective inability to sustain power and performance can be measured electro physiologically, but it is not necessarily related to the subjective sensation of fatigue (May and Kline 1988). Work fatigue related musculoskeletal disorders of the neck and upper limb continue to be of interest to individual forest worker, forest organizations and researchers. This is due to significant disability, time lost from work, increasing worker's compensation and increasing number of cases coming before the courts that can be associated with them (Ong 1992; Barker 1995; Stock et al. 1996). Fatigue at work is a normal everyday experience. However, in the case of severe fatigue, it may affect the person's performance both at work and home. Moreover, severe long term fatigue may lead to sick leave and work disability (Beurskens et al. 2000). Work fatigue would be categorized as acute and long term fatigue. Acute fatigue is characterized by reversibility, task specificity, and the functional use of compensation mechanisms (Lewis and Wessely 1992). Acute fatigue is a normal phenomenon that disappears after a period of rest, when tasks are switched,

or when particular strategies are used – for example, working at a slower pace. By contrast, long term fatigue is irreversible, not task specific, and the compensation mechanisms that were useful in reducing acute fatigue are no longer effective (Beurskens et al. 2000).

The factors that may affect fatigue and deteriorate work performance may be grouped into three categories: environmental factors (noise, vibration, temperature, humidity), human factors (age, sex, health, motivation, fitness, capabilities, training, emotional stability) and task factors (complexity, duration, skills, physical, mental or sensorimotor tasks). The impact of each of the environmental factors depends upon the value it deviates from acceptable levels and the duration of exposure. There is also a limitless number of possible combinations of all environmental factors, which may alter stressfulness at higher levels. The situation becomes more complex with the interaction of human, task, and environmental factors. Ergonomic factors that showed the highest association with neck and shoulder problems occurred when the forest operator was only sitting operating a forest machine and using small control levers, machine keyboards and display units. Arm and hand problems were associated with the use of hand control levers and forest machine keyboard position. Organizational factors showed that limited or extensive peer contacts were associated with work-related musculoskeletal disorders, and limited rest break opportunity appeared to be a major factor for several muscular problems. Time pressures at work and the work-rest schedules were also shown to be associated with work related musculoskeletal disorders in a Brazilian study of a group involved in telephone-computer tasks (Ferreira et al. 1997).

It is almost impossible to define the contribution of each of these factors to fatigue and deterioration of performance, especially in the »unmanaged« working conditions in the forest (Gallis 1992). To manage this complex situation, and to prevent fatigue, improvement in work organization and management of the overall working conditions with job redesign, breaks, and physical activation of workers is required. When doing physical work, humans need adequate resting periods to recover from the physiological consequences of exertion (Beyon et al. 2000).

Work pauses are needed to maintain the working performance and efficiency required by work and to avoid or decrease fatigue effects (Janaro and Bechtold 1985; Henning et al. 1997; Koparadeker and Mital 1994).

The aim of this paper is to propose and discuss as follows:

⇒ review both past and current literature,

⇒ underline and discuss the importance of work pauses by introducing a properly designed work/rest schedule, which will help forest workers to recover from fatigue during the working day, to decrease the effects of fatigue, and to reduce time exposure to environmental factors,

⇒ present a theoretical model that can be used to create work-rest schedules for forest workers, i.e. a work/rest schedule for forest harvesting machine and chainsaw operators, by providing prescribed active ten (10) minute pauses after every fifty minutes of work.

2. Work pauses and their effect on fatigue and productivity – *Prekidi rada i njihov utjecaj na umor i proizvodnost*

Forest machine operators usually work very intensively during a workday with a limited number of pauses (Staaf and Wiksten 1984; Gallis 1992; Byers 1997; Kirk 1998). Such a mode of work is unacceptable since physical exhaustion can be caused by extended periods of strain. The capacity of muscles to perform either severe or prolonged work is ultimately limited by a variety of physiological changes, which decrease performance by producing a variety of symptoms called fatigue (Chaffin 1973). Prolonged muscle fatigue may produce a variety of musculoskeletal disorders. Muscular fatigue can seriously affect the safety of workers, as well as their health and performance (Herberts et al. 1980).

Although most mechanized tasks in forest operations demand smaller oxygen intake and cabin environment is generally improved, muscular fatigue due to repetitive tasks and the static posture imposed by manipulative tasks results in localized tenderness (soreness in a specific muscle when it is touched), occupational hazards, and repetitive strain injuries (Ferguson 1976; Onishi et al. 1977; Axelsson and Porten 1990; Harstela 1990; Nakata et al. 1992; Veiersted 1996; Byrne 2000). Porten (1990) reported that 50% of forest machine operators in Sweden complained of injuries to the neck, arm and cervical spine. In his study on Norwegian forestry workers, Hagen (1997) found that 87.7% of the forest machine operators and 86.0% of manual motor tool forest workers reported musculoskeletal disorders in at least one body part during the previous 12 months. The lower-back, neck and shoulders were the three most common sites. Pauses (breaks) are needed for physical recovery and for reduction of health hazards (i.e. noise, vibration, and

temperature) (Simonson 1971; Staaf and Wiksten 1984; Gallis 1997; Bovenzi et al. 1998; Giannini et al. 1999; Ising et al. 1999). The positive preventive effect of breaks on muscle restoration has been stated in the literature by several authors (Basmajan and DeLuca 1985; Sundelin and Hagberg 1992; Veiersted 1995; Westgaard and DeLuca 1999).

People at work are used to taking different kinds of pauses under various circumstances: prescribed pauses, which are rest breaks at work laid down by the management; spontaneous pauses, which are the obvious rest pauses that workers take on their own initiative; disguised pauses, which are times when workers occupy themselves with easier tasks; work-conditioned pauses, which are interruptions arising either from the operation or the machines or the organization of work; and active pauses, which are short pauses during which workers are not passive but either use other muscle groups or the same muscle groups with or without light loads, or walk or perform gymnastic exercises (Grandjean 1988; Laporte 1966; Simonson 1971).

Disguised, active, and spontaneous pauses are often used by workers to avoid excessive fatigue and to relieve from fatigue symptoms. The use of these pauses explains why old workers, with small work capacities and little resistance to fatigue, can stay at work in heavy tasks in forestry and farming.

Rest pauses are very important for maintaining working performance and the required work efficiency, and for avoiding or decreasing fatigue effects. In general, the important reasons for having rest pauses during work are (Grandjean 1988; Simonson 1971; Karpovich and Sinning 1971): to restore the balance of oxygen and nutrients to the muscles and to remove waste products, particularly lactic acid, to avoid a low level of blood sugar by spreading out the intake of food and to pay oxygen debt. Additionally, according to the above-mentioned authors, the effect of pauses is rapid restoration of blood concentration in the legs and feet and decrease of blood pressure in veins. A replacement of water losses is regularly possible through a cooling down of the body. Pauses seem to limit exposure time of vibration, noise, temperature, and humidity. Additionally, pauses break down the monotony of work and provide time for social contacts. Prevention of musculoskeletal disorders as well as prevention of errors and accidents caused by fatigue is also made possible.

For most occupations, pauses of less than one or two minutes are not practical. Therefore, this information is concerned with pauses of several minutes to half on hour or one hour. Generally, the effect of pauses on work performance is favorable, more so for shorter (about 10 minutes) than for prolonged pauses (Rohmert 1965; Simonson 1971; Zwahlen et al. 1984; Janaro and Bechtold 1985; Swanson et al. 1989; Henning et al. 1997).

The energy requirement is the highest at the beginning of work and decreases until a steady state is reached. Occasionally it even continues to decrease with continuation of work, as a result of removal of part of the oxygen (O_2) debt accumulated at the beginning of work (Simonson 1971). If the work is continued to the point of fatigue, the energy requirement increases again, largely because motor coordination deteriorates and biochemical processes change.

Physiological and psychological adaptation to work is a fundamental process involved in all occupations. The adaptation to work is the basis of the warm-up period, as practiced in athletics. Previous exercise of the same or even of a different type increases performance capacity for subsequent maximum exercise. The basis for adaptation is complex, involving cardiovascular, metabolic, muscular, and nervous functions (Rohmert 1973; Sundelin and Hagberg 1989). The adaptation to work is gradually lost on the recovery but outlasts the recovery of the O_2 debt within ten minutes, and adaptation disappears within thirty minutes (Simonson 1971). Thus, both the exponential course of the recovery of O_2 debt and related cardiovascular functions and the loss of adaptation favor short rest pauses. The favorable effect of short pauses may be the reason why a surprisingly high number of older workers, in spite of decreased capacity of oxygen intake, remain in physically heavy jobs such as forestry and farming (Astrand and Rodahl 1986).

The question of rest breaks and determination of their duration has been the subject of several studies. In their study on telephone directory assistants, Koparadekar and Mital (1994) determine the preferable work-rest schedule. The schedules examined were: 30 minutes work followed by a 5 minute break; 60 minutes followed by a ten minute break; 120 minutes without any break reported that performance did deteriorate when the work duration was increased from 30 minutes to 60 minutes by 11% more errors. If no rest was provided performance deterioration became great, with errors increasing by almost 80% during 120 minutes of continuous work. The deterioration in performance was halted after a rest break.

Dul et al. (1991) developed a model to find the optimum work-rest schedule for static work. The model predicted that for a given total time and total rest time, many short-rest periods are better than fewer long work-rest cycles, and this model showed relatively

good agreement with the actual measurements. In order to decrease fatigue of repetitive work, Kogi (1982) recommended brief intra-work pauses where the muscles are rested from static load, and a break after a period of continuous work.

Rohmert (1965) suggested that the reduction of fatigue by intermittent pauses is the most effective way of maintaining or increasing work performance. Graf (1954) reported that short breaks have shown an increase in net working time and a decrease in spontaneous and disguised pauses (Fig. 1). Rest breaks, taken by workers at their own initiative, decrease the net working time, while short breaks that are laid down by the management have favorable effects on net working time (Fig. 1). Henning et al. (1997) aimed to determine whether frequent, short rest breaks (three of 30-s and one of 3-min) from computer work each hour, in addition to conventional rest breaks, had a positive influence on workers' productivity and well-being in processing of insurance claims at two sites. They reported that there was an improvement in productivity, eye, leg and foot comfort when the short breaks included stretching exercises. These results provide evidence that frequent short breaks from continuous computer-mediated work can benefit worker productivity and well-being when the breaks integrate with task demands.

Dababneh et al. (2001) studied the impact of frequent short rest breaks on the productivity and well being of a group of 30 workers in a meat-processing plant. Two rest break schedules were tested, both of which provided 36 min of extra break time over the regular break schedule (30-min lunch and two 15-min breaks). In the first experimental rest break schedule, workers were given 12 3-min breaks evenly distributed over the workday (3-min break for every 27 min of work). In the second schedule, workers were given four 9-min breaks evenly distributed over the workday (9-min break every 51 min of work). Results showed that neither of the two experimental rest break schedules had a negative effect on production, and the 9-min break schedule improved discomfort ratings for the lower extremities. The workers in the study mostly preferred the 9-min rest break schedule, indicating that workers in general might not as readily accept fragmentation of break time into short, frequent breaks. With respect to work breaks within a sift, it is generally accepted that additional short breaks (5–10 min each hour) are beneficial for physical as well as mental work (Graf 1954), resulting in improved physical and mental well-being and reduced discomfort together with unchanged or even improved performance (Galinsky et al. 2000; Debabneth et al. 2001; McLean et al. 2001; Faucett et al. 2007).

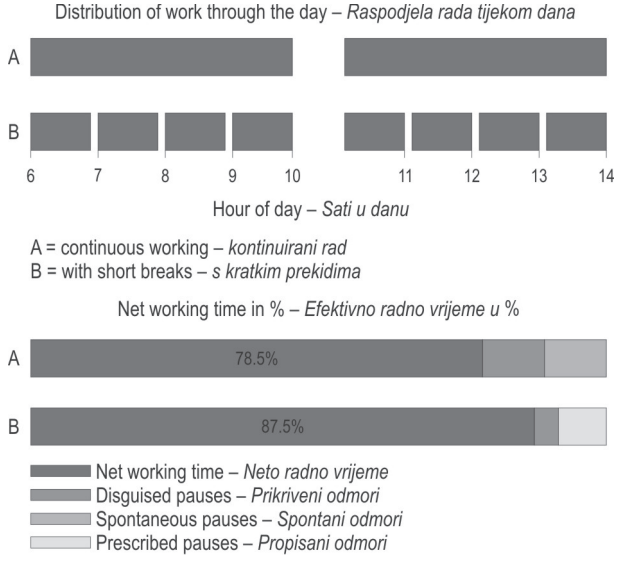

Fig. 1 Effects of short breaks on net working time (Modified from Graf 1954)

Slika 1. *Utjecaj kratkih odmora na efektivno radno vrijeme (prilagođeno prema Graf 1954)*

The past and current literature seems to support frequent and short rest pauses at work. It is worth mentioning here that the main problem with introducing these pauses is that there may be a disruption from tasks, resulting in loss of adaptation to work (Rohmert 1965; Henning et al. 1989). On the other hand, in his fundamental work on fatigue, Simonson (1971) argues that the adaptation to work is not disrupted if 10 minute pauses are introduced.

3. Rest breaks with active pauses – *Prekidi rada s aktivnim odmorom*

Active pauses have been used, particularly by Russian workers, to reduce fatigue and to maintain work performance (Simonson 1971). The favorable results of pauses in occupational work are in large measure due to the effect of active pauses (Simonson 1971; Genaidy et al. 1995).

Marschak (1933), in his pioneer historical work, found that for restoring work capacity after fatigue of finger muscles (load 4–5 kg) or hand muscles (load 9–10 kg), the effect of active pauses of thirty seconds, with intermittent moderate work of other or the same muscle groups without load, was better than the effect of passive pauses ranging from 18.5 to 51%. Muratov (1967) reported that active pauses had a favorable effect on the reaction of pulse rate and blood pressure,

particularly in older people. Gisolfi et al. (1966) in their experiments, with the subjects running at 19.3–20.9 km/hour at 2.0–2.5 degrees to exhaustion on the treadmill, and with recovery from thirty-five to fifty minutes with running at 6.4–10.5 km/hour at 0 degree to 5 degrees grade, found that O_2 debt was decreased by 1 to 2 litters. The rate of lactate removal was considerably faster when aerobic work was performed during recovery, as compared with values observed when the subjects rested during recovery. It appears that the favorable effect of active pauses on recovery may also be found in strenuous work at or near maximum VO_2.

4. Prescribed work/rest schedules for forest operators and the application of Electromyogram – *Propisani rasporedi rada i odmora rukovatelja šumskim strojevima i primjena elektromiograma*

Theoretical examples of managed work/rest scheduling for forest operations are illustrated in Figs. 2 and 3. Due to the advantages of having short breaks distributed through the day, a work/rest schedule involving more frequent short breaks might be proposed. Also, a set policy of prescribed pauses, as supported by Janaro and Bechtold (1985), increases the work output and total rest time compared to when workers control their own rest-work schedule.

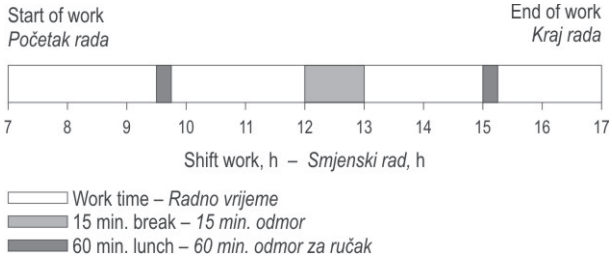

Fig. 2 Current work/rest schedule for forest operators

Slika 2. *Postojeći raspore rada i odmora za rukovatelje šumskim strojevima*

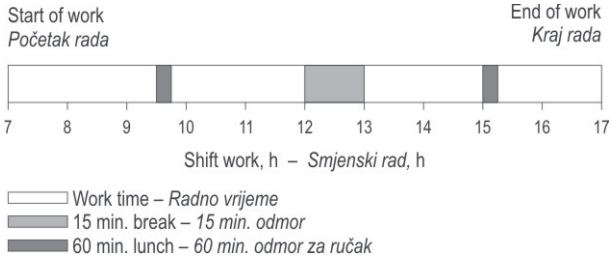

Fig. 3 Proposed work/rest schedule for forest operators

Slika 3. *Predloženi raspored rada i odmora za rukovatelje šumskim strojevima*

The proposed work/rest schedule would consist of an approximate ten-minute active rest pause after every fifty minutes of work. The ten-minute rest break will help the operators to recover from fatigue effects (Rohmert 1965; Simonson 1971), to maintain work capacity, performance and efficiency, and to maintain their adaptation to work (Rohmert 1973; Sundelin and Hagberg 1989; Gallis 1992).

Also, ten-minute rest pauses may increase the net working time because workers may avoid taking spontaneous and disguised pauses (Graf 1954; Grandjean 1988). It will also decrease exposure time to vibration, noise, and climate effects. Active pauses during working time, on the other hand, will improve the restoration of work capacity, and may have favorable effects on localized muscle fatigue (Genaidy et al. 1995; Gisolfi et al. 1966; Laporte 1966; Marschak 1933; Simonosn 1971).

With this proposed work/rest schedule, workers would have more meal breaks as well as the lunch breakdown into two ten-minute periods (Fig. 3). Several meal breaks would help the workers to avoid overloading their digestive organs from having only one heavy meal by spreading food intake during the day (Gallis 1992).

The effects of this proposed work/rest schedule on the physiological parameters of workers' bodies, and on net working time and productivity would be evaluated by future research. Time studies are a valuable and useful tool to determine productivity and net working time (Magagnotti and Spinelli 2012). The use of an electromyogram (EMG) from the muscle group that is involved in a task may be a useful tool to indicate muscular fatigue and to determine appropriate design work/rest schedules (Gallis 1997; Kogi 1982; Sundelin 1993). Myosignals are the »picture« of the physiological status of muscles, both for fatigue and recovery. The electromyography could be used as a tool to determine the duration of work pauses for each individual operator working at a specific task. The shift of the distribution of EMG signal power from a high frequency band toward low frequencies can be used to monitor muscle fatigue (Lindstrom et al. 1977; Basmajan and DeLuca 1985). Since median and mean frequencies have been observed to increase toward their initial values during rest, the recovery time can be indicated by the EMG (Sabbahi et al. 1979; Merletti et al. 1984).

In mechanized forest operations, EMG has been used to define risks for musculoskeletal disorders

among forest machine operators. Østensvik et al. (2009) used surface electromyography to study the association between numbers of long periods of sustained low-level trapezius muscle activity and neck pain among forest machine operators by using EMG. The results of this study show that the exposure to several long periods (> 8 min) with sustained low-level muscle activity in the right upper trapezius muscle increase the risk of pain in the neck and shoulder. The authors of the study argue for a possible causal relationship between these long periods and neck pain. In another study, Østensvik et al. 2008 recorded EMG of the right upper trapezius and extensor digitorum muscles during a whole working day (7.5–8 h per operator). The study was performed to analyze potential risk factors for upper extremity disorders in two groups of forest machine operators driving harvesting vehicles and performing equal tasks in France and Norway. In Finland, Asikainen and Harstela (1993) studied the Influence of Small Control Levers of forest grapple loader on muscle strain of forest operators. Electromyograms (EMG) of the trapezius muscle were analyzed using the root mean square (RMS – EMG) method. The trapezius muscle was chosen as the object of the study because it is the biggest muscle in the shoulder-arm system and the pain reported by operators focusing on this system is, generally, the most severe in this muscle. The EMG value for the maximum voluntary constriction was measured every morning and the results were calculated as relative values of these maximum values (%MVC). Working with mini levers, as compared to conventional levers, leads to lesser muscle constriction in the trapeziums muscle as measured by RMS – EMG.

The use of EMG may be limited by the fact that muscles, other than those EMG is recording, may undergo great strain. Thus, there may be some practical limits on monitoring all the muscles involved in field forest tasks (Gallis 1997). EMG should, therefore, be accompanied by the use of the multidimensional Checklist Individual Strength questionnaire (CIS). The application of CIS has been proved to be able to discriminate between fatigued and non-fatigued employees. The CIS seems to be an appropriate instrument for measuring the overall fatigue of an operator (Beurskens et al. 2000). The CIS questionnaire 7–11 was used to measure chronic fatigue and it consists of four dimensions: the subjective experience of fatigue and reduction in motivation, reduction in activity, and reduction in concentration. This would be the methodology for determining the validity and assessing the results of the above mentioned work/rest schedules in mechanized and motor-manual forest operations.

5. Conclusions – *Zaključci*

It is concluded that, despite some concerns about the manner of the integration of short pauses into the task, the literature supports the idea that short active pauses at work enhance work productivity, comfort, and health, if they are managed and well integrated into the task. Thus, managing work fatigue by using prescribed work/rest schedules would relieve operators from fatigue effects and increase their work performance. Net working time may be increased by avoiding worker disguised and spontaneous pauses. In forest operations, ten minute active pauses may provide time for recovery, maintain adaptation to work, and restore work capacity. Active pauses may be an effective method of workload reduction and prevention of musculoskeletal injuries and discomfort among forest operators. The fact that it may not be at the expense of productivity is also an important issue for forest and logging managers, supervisors and crew bosses.

Further research should be focused on determining the type of active pauses (i.e. manner and rate of gymnastics, stretching, time for lunches) required for each specific task and workload in various types of forest work.

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Sažetak

Povećanje proizvodnosti i kontrola radnoga umora pri šumskim radovima primjenom propisanih aktivnih odmora: odabrani pregled

U članku se donosi odabrani pregled postojeće literature o rasporedu rada i odmora te raspravlja o teoretskom modelu koji se može primijeniti u određivanju odmora pri radu za šumske radnike. Rukovatelji šumskim strojevima i ručno-strojnim alatima izloženi su mnogim čimbenicima koji mogu uzrokovati umor pri radu. Unatoč povećanju mehaniziranosti i automatizacije u velikom broju šumskih poslova još uvijek je potrebna mišićna snaga i aktivnost za rukovanje mnogim ručnim alatima i strojevima. Mišićna se snaga ne može održati kod dugotrajnoga rada jer se pojavljuje umor i smanjuje snaga mišića. U praksi rukovatelji šumskim strojevima i ručno-strojnim alatima rade vrlo intenzivno tijekom radnoga dana, s ograničenim brojem odmora, i izloženi su raznovrsnim radnim uvjetima koji djeluju na njihovu radnu sposobnost i koji mogu uzrokovati umor, zdravstvene probleme, mišićno-skeletne probleme, slabu učinkovitost, učestalije pogreške pri radu, ozljede i nesreće. Čak ako se i ne smanjuje radni učinak, subjektivan je osjećaj umora važan aspekt ljudskoga rada. Umor je objektivna nemogućnost stjecanja snage i izvođenja rada, što se može izmjeriti elektrofiziološki. Umor je normalna svakodnevna pojava, no u slučaju ozbiljnoga i teškoga umora može utjecati na čovjekovu izvedbu i u profesionalnom i u privatnom okruženju. Štoviše, ozbiljan dugotrajan umor uzrok je bolovanja i radne nesposobnosti. S umorom povezani mišićno-skeletni poremećaji vrata i gornjih udova i dalje su u središtu interesa šumskih radnika, šumskih organizacija i istraživača. Tomu pridonosi značajna nesposobnost rada, gubitak radnoga vremena, povećanje naknada radnicima i sve veći broj s tim povezanih sudskih postupaka.

Čimbenici koji djeluju na umor i umanjuju radni učinak mogu se svrstati u tri kategorije: okolišni čimbenici (buka, vibracije, temperatura, vlaga), ljudski čimbenici (dob, spol, zdravlje, motivacija, sposobnosti, utreniranost, emocionalna stabilnost) i čimbenici zadatka (složenost, trajanje, fizički, mentalni ili senzomotorički zadaci). Utjecaj svakoga okolišnoga čimbenika ovisi o stupnju u kojem odstupa od prihvatljive razine i trajanju njegova djelovanja. Također su moguće bezbrojne kombinacije svih okolišnih čimbenika, a situacija postaje još složenija s interakcijom ljudskih, okolišnih i čimbenika zadatka.

Odmori pri radu mogu pružiti vrijeme potrebno za fizički oporavak i za smanjenje zdravstvenih rizika. Pri fizičkom radu čovjeku su nužna odgovarajuća razdoblja odmora radi oporavljanja od fizioloških posljedica radnoga napora. Prekidi rada, tj. odmori, omogućuju zadržavanje traženoga stupnja izvršenosti i učinkovitosti u radu te izbjegavanje ili umanjenje utjecaja umora. S tim u vezi ciljevi su ovoga rada:

⇒ dati pregled prošle i sadašnje literature,

⇒ naglasiti i raspraviti važnost prekida rada uvođenjem ispravno oblikovanoga rasporeda rada i odmora,

⇒ prikazati teoretski model koji se može primijeniti u određivanju rasporeda rada i odmora za šumske radnike.

Obično se pri radu uzimaju različiti oblici odmora i pod različitim okolnostima: propisani odmori, koje je prekide rada utvrdilo vodstvo; spontani odmori, koji su očiti prekidi rada koje radnici uzimaju na vlastitu inicijativu; prikriveni odmori, koji predstavljaju trenutke kada se radnici bave lakšim zadacima; radom uvjetovani odmori, koji predstavljaju prekide rada zbog šumskih operacija, strojeva ili organizacije rada; aktivni odmori, koji su kratki prekidi rada tijekom kojih radnici nisu pasivni već koriste druge mišićne grupe ili iste mišićne grupe s lakšim opterećenjem ili bez opterećenja, ili hodaju ili obavljaju gimnastičke vježbe. Prikriveni, aktivni i spontani odmori često se koriste da bi radnici izbjegli pretjerano umaranje i oslobodili se simptoma umora. Glavni razlozi uzimanja odmora tijekom rada su: uspostava ravnoteže kisika i hraniva u mišićima, odstranjivanje otpadnih tvari, posebno mliječne kiseline, izbjegavanje niske razine šećera u krvi. Dodatno, odmori omogućuju brzi povratak koncentracije krvi u nogama i stopalima, smanjenje krvnoga tlaka u venama, nadoknadu gubitka vode hlađenjem tijela, ograničavanje izloženosti vibracijama, buci, vlazi, temperaturi, razbijaju monotoniju rada, omogućuju socijalne kontakte i dr.

U literaturi se podržavaju česti i kratki prekidi rada. Pri uvođenju takvih odmora kao glavni problem mogu se pojaviti poremećaji u zadatku koji rezultiraju gubitkom prilagodbe na rad. S druge strane, smatra se da se pri uvođenju kratkih 10-minutnih odmora ne narušava prilagodba na rad. U članku se predlaže takav raspored rada i odmora koji bi se sastojao od približno 10-minutnih aktivnih odmora nakon svakih 50 minuta rada. Odmor od 10 minuta pritom pomaže da se rukovatelj oporavi od djelovanja umora, da zadrži radni kapacitet, stupanj izvedbe i učinkovitost te da zadrži svoju prilagodbu na rad. Također, 10-minutni bi odmori mogli povećati efektivno radno vrijeme jer radnici mogu izostaviti spontane i prikrivene odmore. Isto se tako smanjuje trajanje izloženosti vibracijama, buci i klimatskim učincima. S druge strane, aktivni će odmori poboljšati obnavljanje radnoga kapaciteta i mogu imati povoljan učinak

na lokalizirani mišićni umor. S predloženim rasporedom rada i odmora radnici dobivaju više pauza za obroke te raspodjelu ručka u dvije 10-minutne pauze. Više prekida za obroke tijekom dana može pomoći radnicima da ne opterete svoj probavni sustav kao u slučaju jednoga teškoga obroka.

*Učinke predloženoga rasporeda rada i odmora na fiziološke parametre radnika i na efektivno radno vrijeme i radnu učinkovotost potrebno je ispitati u budućim istraživanjima. Primjena elektromiografije (EMG) popraćena s »kontrolna lista individualne snage« (*Checklist Individual Strength questionnaire*) pritom se smatra odgovarajućom metodologijom za utvrđivanje valjanosti i procjenu rezultata navedenoga rasporeda rada i odmora pri mehaniziranim i ručno-strojnim šumskim radovima. Daljnja se istraživanja također trebaju usmjeriti na određivanje vrste aktivnih odmora (oblik i stupanj vježbi, istezanje, vrijeme obroka) za svaki specifični zadatak i radno opterećenje u različitim vrstama šumskoga rada.*

Ključne riječi: umor pri radu, zdravstveni problemi i ozljede, elektromiografija, proizvodnost, prekidi rada, rukovatelji šumskim strojevima, raspored rada i odmora

Authors' address – *Autorova adresa:*

Christos Gallis, PhD.
e-mail: cgalis@fri.gr
Forest Research Institute
GR-57 006, Vassilika
Thessaloniki
GREECE

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