

SUBJECTIVE ASSESSMENT OF THE FATIGUE OF FOREST WORKERS BASED ON JAPANESE QUESTIONNAIRE

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Abstract. In order to evaluate the fatigue of forest workers, the authors used a Japanese questionnaire. The investigations included workers employed on 30 workstations in silviculture, forest protection and forest utilization. Workers filled the questionnaire three times during the workday. The frequency of the symptoms of tiredness from the group concerning reduced activity reported by workers before the beginning of work was small and increased in the course of work reaching the highest values after finishing work. Symptoms of reduced motivations were reported by workers sporadically, with the exception of operators of harvester and forwarder where they dominated. The frequency of the occurrence of fatigue symptoms (ABC) before work amounted, on average, to 1.9%, during the break – to 8.5%, whereas after the termination of work – to 13.1%. The group of symptoms of physical fatigue was characterised by the highest frequency and scale of intensity. The most frequently reported symptoms included: thirst, back pain and stiff neck and shoulders. For the distinct majority of the examined operations, a $C > A > B$ type of fatigue characteristic for physical jobs was observed and the only exception was the job of operators of harvester and forwarder which was characterised by the $B > C > A$ pattern of fatigue.

Key words: fatigue, subjective methods, Japanese questionnaire, forestry

INTRODUCTION

Subjective assessment methods of fatigue by work are simple and easy to apply and, simultaneously, allow differentiating the compared workstations with regard to the level of workload irrespective of the fact whether these stations are similar or differ from one another with respect to the character of the performed operations. There is a correlation between changes of physiological parameters and the results of the subjective fatigue measurements [Grandjean 1980]. Many researchers, among others: Sprusińska [1984, 1988], Dudek and Makowska [1986], Dudek and Koniarek [1995] emphasise the

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usefulness of subjective methods of investigating fatigue which employ various questionnaires and multi score scales. One of the most popular methods is the subjective scale of fatigue (Japanese questionnaire) used in Japan since 1970. In Poland, the method was employed rarely in industry as well as in investigations of tiredness of school children [Paluch 1985].

In forestry, the above-mentioned Japanese questionnaire was used by Giefing and Mana [1996] to evaluate the fatigue of forest workers during beech pre-felling harvesting. The evaluation of subjective fatigue was also carried out for tree pruning [Giefing 1999, Hołota and Szaban 1996].

The investigations presented below aimed at comparing the degree of tiredness across a wide section of works carried out in forestry.

MATERIAL AND RESEARCH METHODS

The performed experiments comprised 30 workstations in three principal sectors of forest economy: silviculture – 12, forest protection – 4 and forest utilization – 14. The analysed jobs were carried out by men with the following parameters: height 165-185 (174.9 ± 4.82) cm, body weight 60-91 (78.0 ± 7.13) kg, age 18-52 (37.7 ± 8.52) years, work experience in forestry 0-30 (8.64 ± 6.65) years.

The subjective assessment of fatigue was carried out by the worker himself by answering a set of questions concerning his general physical and mental condition. For this purpose, the authors used a modified Japanese questionnaire which comprises 30 symptoms of complaints divided into three groups (Table 1) [Paluch 1985]. The evaluation of the worker's current general physical and mental condition on the basis of the Japanese questionnaire was conducted three times during the workday: before beginning work, during the main break and directly after finishing work. The employed scale contains five categories of opinions:

- definitely not (1),
- rather not (2),
- it is difficult to say (3),
- rather yes (4),
- definitely yes (5).

Later, the authors determined the percentage frequency of the occurrence of fatigue symptoms in individual symptom groups (A, B, C) as well as cumulatively (ABC) and determined the type (pattern) of tiredness [Yoshitake 1978].

RESULTS

The frequency of fatigue symptoms from the group concerning reduced activity reported by workers before the beginning of work was small and increased in the course of work reaching its peak after work. Symptoms of reduced motivation were reported by workers sporadically, with the exception of operators of harvester and forwarder, where they dominated. The group of symptoms of physical fatigue was characterised by the highest frequency and scale of intensity. The most frequently reported symptoms included:

Table 1. List of fatigue symptoms [Paluch 1985]
Tabela 1. Lista symptomów zmęczenia [Paluch 1985]

A – a group of questions concerning activities A – grupa pytań dotycząca aktywności	B – a group of questions concerning motivation B – grupa pytań dotycząca motywacji	C – a group of questions concerning physical fatigue C – grupa pytań dotycząca zmęczenia fizycznego
I would like to lie down Chciałbym się położyć	I am impatient Jestem zniecierpliwiony	My shoulders feel stiff Mam zeszywniałe barki
I feel sleepy Czuję się senny	I am indecisive Jestem niezdecydowany	My eyelids tremble Drżą mi powieki
I am muddle-headed Mam zamęt w głowie	I cannot concentrate Nie mogę skupić uwagi	My limbs shiver Odczuwam drżenie kończyn
I have tired eyes Mam zmęczone oczy	I am indifferent Jestem zubożniały	I feel out of breath Mam krótki oddech
I feel ponderous Czuję się ociężały	I am slow in thinking Odczuwam powolność w myśleniu	I feel dizzy Odczuwam zawrót głowy
I feel fatigue in my legs Czuję zmęczenie w nogach	I am absent-minded Czuję się roztrągniony	I have a headache Boli mnie głowa
My movements are clumsy Jestem niezręczny w ruchach	My concentration is distracted Moja uwaga jest rozproszona	My voice is hoarse Mój głos staje się ochrypły
I feel uncertain when I stand Stojąc czuję się niepewnie	I feel anxiety Odczuwam niepokój	I feel thirsty Odczuwam pragnienie
I am heavy-headed Mam ociężałą głowę	Speaking makes me feel tired Męczy mnie mówienie	I have a back pain Odczuwam ból w plecach
I yawn Ziewam	I feel edgy Jestem podenerwowany	My neck is stiff Czuję usztywnioną szyję

thirst, pain in the back, stiff neck and shoulders. The frequency of the occurrence of fatigue symptoms (ABC) before work was, on average, 1.9%, during the break – 8.5% and after work – 13.1%. For the distinct majority of the examined works, a C > A > B type of fatigue, characteristic for physical jobs, was observed and the only exception was the job of operators of harvester and forwarder which was characterised by the B > C > A pattern of tiredness typical for mental activities.

Silviculture

Workers performing silvicultural works began work with slightly reduced level of activities. Symptoms were reported by half of the workers with the frequency of 11.7%, while the remaining workers did not report symptoms of reduced activity. After finishing work, the frequency of symptom occurrence increased significantly reaching, on average, 19.6% in all the examined workers. Workers did not report symptoms of reduced motivation before work and in the course of work as well as after work, symptoms of this group were reported sporadically.

Slight symptoms of physical fatigue before the beginning of work were reported only by three workers but the frequency of reporting them increased, on average, to 21.7% during the break and 40.0% after work and occurred in all workers.

The highest intensity of psychosomatic symptoms occurred during planting with a dibble and planting with a spade. The frequency pattern of fatigue symptoms assumed, for all the examined workstations, the form of $C > A > B$ (Table 2). On average, the occurrence frequency of the fatigue symptoms (ABC) reached 2.0% before work, 5.7% during the break and 12.9% – after work.

Table 2. Frequency of fatigue symptoms in individual groups of symptoms and the fatigue pattern in silviculture

Tabela 2. Częstość występowania objawów zmęczenia w poszczególnych grupach symptomów oraz wzór zmęczenia w pracach z zakresu hodowli lasu

Workstation or type of work Stanowisko lub rodzaj pracy	Before work Przed pracą				During break Podczas przerwy				After work Po pracy				Fatigue pattern Wzór zmęczenia
	A	B	C	ABC	A	B	C	ABC	A	B	C	ABC	
Planting using a standard dibble Sadzenie pod kostur IBL													
– worker kosturujący	10	–	5	2.5	–	10	30	6.7	35	10	40	14.2	$C > A > B$
– helper with seedlings pomocnik z sadzonkami	–	–	–	–	10	–	20	5.0	10	–	45	9.2	$C > A > B$
Planting using a Getinga dibble Sadzenie pod kostur Getynga													
– worker kosturujący	10	–	–	1.7	–	–	40	6.7	20	–	50	11.7	$C > A > B$
– helper with seedlings pomocnik z sadzonkami	–	–	–	–	10	–	15	4.2	20	–	35	9.2	$C > A > B$
Planting using a Huffa dibble Sadzenie pod kostur Huffa													
– worker kosturujący	10	–	–	1.7	–	–	35	5.8	15	–	50	10.8	$C > A > B$
– helper with seedlings pomocnik z sadzonkami	10	–	–	1.7	10	–	10	3.3	25	–	40	10.8	$C > A > B$
Manual preparation of spots Ręczne wykonywanie talerzy	20	–	–	6.7	–	–	30	10.0	–	–	40	13.3	$C > A > B$
Planting using a spade Sadzenie pod szpadel													
– worker szpadlowy	–	–	20	3.3	15	–	30	7.5	35	5	45	14.2	$C > A > B$
– helper with seedlings pomocnik z sadzonkami	–	–	–	–	5	–	10	2.5	15	–	35	8.3	$C > A > B$
Manual scything of weeds Ręczne wykaszanie upraw	–	–	–	–	10	–	30	13.3	30	–	40	23.3	$C > A > B$
Motor-manual cutting of weeds Mechaniczne wykaszanie upraw	10	–	–	3.3	–	–	10	3.3	10	–	40	16.7	$C > A > B$
Early cleaning Czyszczenie wczesne	–	–	10	3.3	–	–	–	–	20	–	20	13.3	$C > A > B$

The most frequently reported symptoms included: leg fatigue (75.0%), tired eyes (66.7%) as well as sleepiness and a feeling of ponderousness (58.3% each). As to the symptoms of physical fatigue, the following ones were reported: thirst – 100%, pain in the back and neck stiffness (91.7% each) and stiff shoulders 83.3%. The symptoms intensity in the A and C symptom groups before work were negligible. It increased during the main break (after about 3 working hours), primarily, in the area of physical tiredness (mean value – 1.39). After work, a significant increase was observed in the fatigue score assessment in groups A and C (by 1.38 and 2.09, respectively). Figure 1 a-c presents mean evaluation values in individual groups of symptoms in the course of a workday.

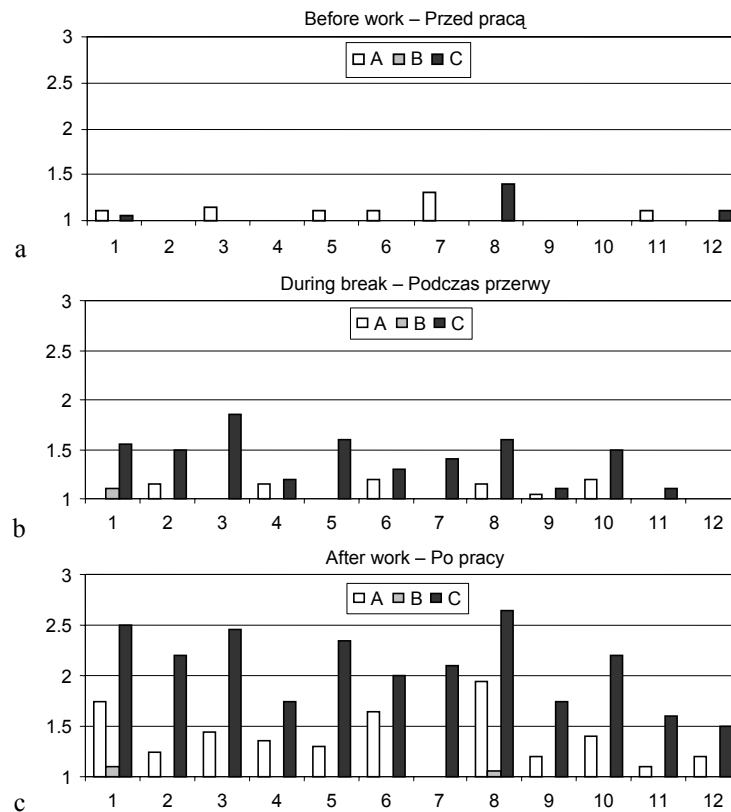


Fig. 1 a-c. Mean assessment values in individual groups of fatigue symptoms on comparable workstations in silviculture: planting using a standard dibble: 1 – worker, 2 – helper with seedlings; planting using a Geting dibble: 3 – worker, 4 – helper with seedlings; planting using a Huffa dibble: 5 – worker, 6 – helper with seedlings, 7 – manual preparation of spots; planting using a spade: 8 – worker, 9 – helper with seedlings, 10 – manual scything of weeds, 11 – motor-manual cutting of weeds, 12 – early cleaning

Rys. 1 a-c. Wartości średnie ocen w poszczególnych grupach symptomów na porównywanych stanowiskach w pracach z zakresu hodowli lasu: sadzenie pod kostur IBL: 1 – kosturujący, 2 – pomocnik z sadzonkami; sadzenie pod kostur Getynga: 3 – kosturujący, 4 – pomocnik z sadzonkami; sadzenie pod kostur Huffa: 5 – kosturujący, 6 – pomocnik z sadzonkami, 7 – ręczne wykonywanie talerzy; sadzenie pod szpadel: 8 – szpadlowy, 9 – pomocnik z sadzonkami, 10 – ręczne wykaszanie uprawy, 11 – mechaniczne wykaszanie uprawy, 12 – czyszczenie wczesne

Forest protection

When analysing works concerning the forest protection, the authors found a decrease in the activity before starting work of small intensity only in the case of a worker who did some fencing and it continued also during the break and receded after work. Workers did not report symptoms characterising a decline in their motivation during the whole workday. The frequency of reporting physical fatigue symptoms during the break amounted to 27.5% and to 37.5% after work. The highest intensity of symptoms of physical fatigue was recorded in a worker who did some fencing and in a worker who was hanging boxes for birds – 50% in each case. The determined pattern $C > A > B$ of the frequency of fatigue symptoms in the activities associated with forest protection is characteristic for operations involving a high level of physical activities (Table 3). The frequency of fatigue symptoms (ABC) before work averaged 1.7%, during the break – 13.3% and after work – 12.5%.

Table 3. Frequency of fatigue symptoms in individual groups of symptoms and the fatigue pattern in forest protection

Tabela 3. Częstość występowania objawów zmęczenia w poszczególnych grupach symptomów oraz wzór zmęczenia w pracach z zakresu ochrony lasu

Workstation or type of work Stanowisko lub rodzaj pracy	Before work Przed pracą				During break Podczas przerwy				After work Po pracy				Fatigue pattern Wzór zmęczenia
	A	B	C	ABC	A	B	C	ABC	A	B	C	ABC	
Fencing of forest plantation Grodzenie uprawy													
main worker pracownik główny	20	–	–	6.7	30	–	50	26.7	–	–	50	16.7	$C > A > B$
helper pomocnik	–	–	–	–	–	–	10	3.3	–	–	20	6.7	$C > A > B$
Guarding stumps against fungus Zabezpieczanie pniaków	–	–	–	–	–	–	30	10.0	–	–	30	10.0	$C > A > B$
Hanging boxes for birds Wywieszanie budek dla ptaków	–	–	–	–	20	–	20	13.3	–	–	50	16.7	$C > A > B$

The decreased activity of the examined persons manifested itself in the frequency of reporting leg fatigue (100%) and yawning declared by 75.0% workers. The most frequent symptoms of physical fatigue included: thirst and pain in the back (100% each) and trembling of hands (75.0%). Mean score assessments in the individual groups of symptoms during workday are shown in Figure 2 a-c. An increase in the intensity scores of symptoms from 1.45 points during the break to 1.67 after work was observed only in the group of symptoms of physical fatigue. The highest score points during the entire workday were recorded in the case of a worker carrying most of his work fencing plantation.

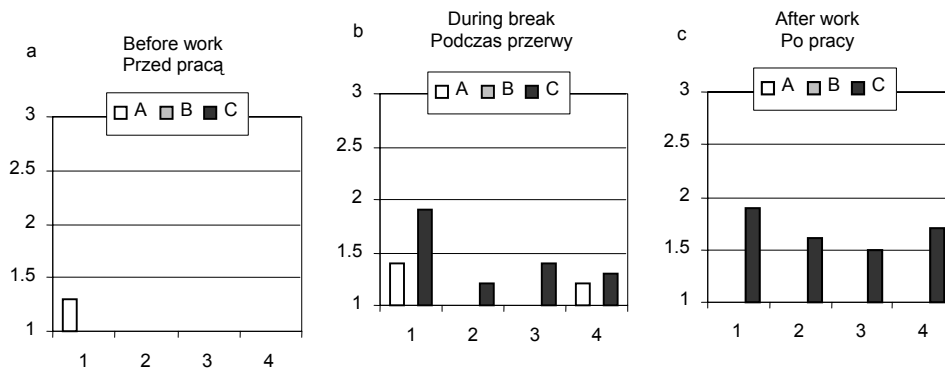


Fig. 2 a-c. Mean assessment values in individual groups of fatigue symptoms on comparable workstations in forest protection: fencing of forest plantation; 1 – main worker, 2 – helper; 3 – guarding stumps against fungus; 4 – hanging boxes for birds

Rys. 2 a-c. Wartości średnie ocen w poszczególnych grupach symptomów na porównywanych stanowiskach w pracach z zakresu ochrony lasu: 1 – grodzenie uprawy, pracownik główny, 2 – grodzenie uprawy, pomocnik, 3 – zabezpieczanie pniaków, 4 – wywieszanie budek

Forest utilization

Symptoms concerning a decline in the activities in workers carrying out timber harvesting were registered sporadically before the beginning of work and during work and reached 5.0% of the frequency of reports submitted after work. Symptoms associated with the decline of motivation were recorded only in operators of harvester and forwarder. Before work, the occurrence frequency of these symptoms reached 15.0% and they were reported by 3 out of 4 of the examined workers but it decreased to 7.5% (1 worker) in the course of the break. After work, symptoms of the decline of motivation occurred in all the examined workers with the average frequency of 22.5%. The frequency of physical fatigue symptoms in the course of the break averaged 15.0% for all experiment subjects and it reached 30.7% after work. The $C > A > B$ pattern of fatigue, characteristic for physical workers, occurred on all workstations with the exception of operators of harvester and forwarder, where the $B > C > A$ type of fatigue was recorded (Table 4). The frequency of fatigue symptoms (ABC) before work averaged 1.9% increased to 6.4% during the break and reached 14.0% after work.

The most frequent complaints in the field of the decline in activity was leg fatigue (28.6%), whereas in the case of complaints associated with the decline in motivation – the most frequent complaints included: apathy and failure to focus attention (21.4% each). As to symptoms associated with physical fatigue, the dominant ones included: thirst (71.4%), pain in the back (64.3%) as well as stiff shoulders and trembling hands (57.1% each). The intensity of symptoms during the day became most apparent in the group of symptoms concerning physical fatigue (C) and, to a lesser degree, in the group of decreased activity (A). The mean score assessment in group C in the course of the break amounted to 1.41 and reached 2.06 points after work (Fig. 3a-c). The mean point evaluation after work in group A reached 1.12.

Table 4. Frequency of fatigue symptoms in individual groups of symptoms and the fatigue pattern in forest utilization

Tabela 4. Częstość występowania objawów zmęczenia w poszczególnych grupach symptomów oraz wzór zmęczenia w pracach z zakresu użytkowania lasu

Workstation or type of work Stanowisko lub rodzaj pracy	Before work Przed pracą				During break Podczas przerwy				After work Po pracy				Fatigue pattern Wzór zmęczenia
	A	B	C	ABC	A	B	C	ABC	A	B	C	ABC	
Late cleaning Czyszczenie późne	10	-	10	6.7	-	-	40	13.3	10	-	50	20.0	C > A > B
Early thinning Trzebież wczesna													
- feller drwal	-	-	-	-	-	-	20	6.7	10	-	30	13.3	C > A > B
- feller's assistant pomocnik drwala	-	-	-	-	-	-	30	10.0	10	-	40	16.7	C > A > B
- skidder-driver of farm tractor zrywkarz (ciągnik C-330)	-	-	-	-	20	-	20	13.3	30	-	60	30.0	C > A > B
Late thinning – motor- manual Trzebież późna – t. ręczno-maszynowa													
- feller drwal	-	-	-	-	-	-	20	6.7	-	-	60	20.0	C > A > B
- feller's assistant pomocnik drwala	-	-	-	-	10	-	20	10.0	-	-	50	16.7	C > A > B
- skidder-driver of LKT zrywkarz (LKT)	-	-	-	-	-	-	20	6.7	10	-	10	6.7	C > A > B
- horse skidder (carter) zrywkarz konny	-	-	-	-	-	-	20	6.7	-	-	40	13.3	C > A > B
Late thinning – mechanized Trzebież późna – t. maszynowa													
- operator of harvester operator harwestera	-	-	-	-	-	-	-	-	-	10	-	3.3	B > C > A
- operator of forwarder operator forwardera	-	10	-	3.3	-	-	-	-	-	30	10	13.3	B > C > A
Late thinning – mechanized with midfield Trzebież późna – t. maszynowa z międzyplonem													
- operator of harvester operator harwestera	-	40	-	13.3	-	30	-	10.0	-	40	-	13.3	B > C > A
- operator of forwarder operator forwardera	-	10	-	3.3	-	-	-	-	-	10	-	3.3	B > C > A
- feller drwal	-	-	-	-	-	-	10	3.3	-	-	70	23.3	C > A > B
- feller's assistant pomocnik drwala	-	-	-	-	-	-	10	3.3	-	-	10	3.3	C > A > B

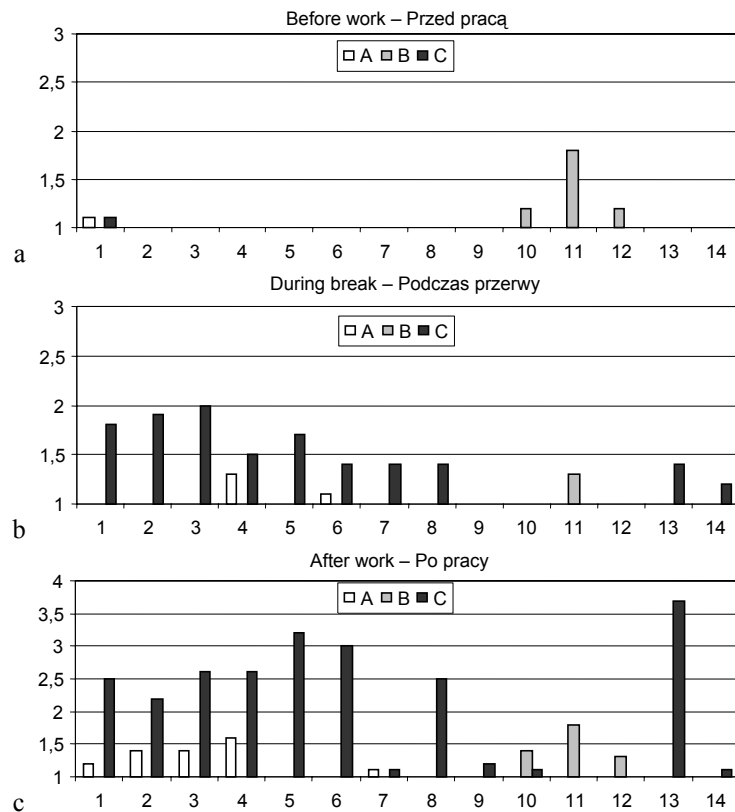


Fig. 3 a-c. Mean assessment values in individual groups of fatigue symptoms on comparable workstations in forest utilization: 1 – late cleaning; early thinning: 2 – feller, 3 – feller's assistant, 4 – skidder-driver of farm tractor; late thinning – motor-manual technology: 5 – feller, 6 – feller's assistant, 7 – skidder-driver of LKT, 8 – horse skidder (carter); late thinning – mechanized technology: 9 – operator of harvester, 10 – operator of forwarder; late thinning – mechanized technology with midfield: 11 – operator of harvester, 12 – operator of forwarder, 13 – feller, 14 – feller's assistant

Rys. 3 a-c. Wartości średnie ocen w poszczególnych grupach symptomów na porównywanych stanowiskach w pracach z zakresu użytkowania lasu: 1 – czyszczenie późne; trzebież wczesna: 2 – drwal, 3 – pomocnik drwala, 4 – zrywkarz (ciągnik C-330); trzebież późna technologia ręczno-maszynowa: 5 – drwal, 6 – pomocnik drwala, 7 – zrywkarz (LKT), 8 – zrywkarz konny; trzebież późna technologia maszynowa: 9 – operator harwestera, 10 – operator forwardera; trzebież późna technologia maszynowa z międzypolem: 11 – operator harwestera, 12 – operator forwardera, 13 – drwal, 14 – pomocnik drwala

DISCUSSION

Analysing the results of the fatigue subjective assessment it was found that works carried out in forestry are of physical character (fatigue pattern $C > A > B$). The intensification frequency of arduousness symptoms increased together with the passage of time of the work shift. The greatest symptoms intensity was observed in the group of

symptoms which characterise physical fatigue and degree of activity. The motivation level remained high throughout the workday. A similar interrelation was reported by Giefing and Mana [1996] during thinning, Hołota and Szaban [1996] as well as Giefing [1999] during tree pruning. In the majority of cases workers began work with reduced activity which can be attributed to the high physiological costs of forest works. In addition, many workers employed in forests also have their own small farms or take up additional employment and, therefore, the night's rest fails to provide full regeneration of strength. The fatigue symptoms reported most frequently included: fatigue in legs, pain in the back and stiff shoulders confirming a high load proportion of the musculoskeletal system resulting from forced positions and high physical effort in forest works [Grzywiński 2005 a, b].

The fatigue pattern ($B > C > A$) determined in the case of harvester and forwarder operators is characteristic for workstations with the predominance of mental effort. Yoshitake [1978] reported this type of fatigue on workstations occupied, among others, by helicopter pilots, air traffic controllers, bank clerks where the level of psychological load is very high. The domination of symptoms of the motivation decline on workstations of harvester and forwarder operators can be the result of a high level of psychological loads (especially in operators of harvester) as well as of high monotony of the performed operations, condition invariability of the work environment in cabins and isolation from outside stimuli, which can easily lead to the feeling of weariness and speed up the onset of tiredness.

CONCLUSIONS

1. The frequency of symptoms associated with reduced activity and physical fatigue before work was low and increased during work reaching the highest values after work.
2. Symptoms of reduced motivation were reported by workers sporadically with the exception of operators of harvester and forwarder, where they were dominant.
3. The highest frequency and scale of intensity was observed in the group of symptoms of physical fatigue. The most frequently reported symptoms included: thirst, pain in the back, neck stiffness and stiff shoulders.
4. The occurrence frequency of fatigue symptoms (ABC) before work averaged 1.9%, during the break – 8.5% and after work – 13.1%.
5. The majority of the examined works was characterised by the $C > A > B$ type of fatigue, typical for physical jobs. The only exceptions were observed in the case of operators of harvester and forwarder where the appropriate fatigue pattern was $B > C > A$, typical for mental works.

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SUBIEKTYWNA OCENA ZMĘCZENIA ROBOTNIKÓW LEŚNYCH NA PODSTAWIE KWESTIONARIUSZA JAPOŃSKIEGO

Streszczenie. Ocena subiektywna jest prostą metodą wartościowania zmęczenia. Jest nią odpowiedź pracownika dotycząca poziomu obciążenia pracą na stanowisku roboczym. Do oceny zmęczenia robotników leśnych zastosowano kwestionariusz japoński, składający się z 30 pytań podzielonych na trzy grupy dolegliwości dotyczących aktywności, motywacji i zmęczenia fizycznego. Badaniami objęto pracowników na 30 stanowiskach roboczych, wykonujących różnorodne prace z zakresu hodowli, ochrony i użytkowania lasu. Robotnicy wypełnili kwestionariusz trzykrotnie w ciągu dnia roboczego: przed rozpoczęciem pracy, w trakcie głównej przerwy i bezpośrednio po zakończeniu pracy. Częstość objawów zmęczenia z grupy dotyczącej obniżenia aktywności zgłaszanych przez robotników przed rozpoczęciem pracy była niewielka i rosła w trakcie pracy, osiągając najwyższe wartości po jej zakończeniu. Symptomy obniżonej motywacji były zgłaszane przez pracowników sporadycznie, z wyjątkiem operatorów harwestera i forwardera, u których dominowały. Częstość występowania objawów zmęczenia (ABC) przed pracą wynosiła średnio 1,9%, w trakcie przerwy 8,5%, natomiast po zakończeniu pracy 13,1%. Najwyższą frekwencją i skalą nasilenia odznaczała się grupa symptomów zmęczenia fizycznego. Do najczęściej sygnalizowanych objawów należały: pragnienie, ból w plecach, usztywniona szyja i zeszywniała barki. Zdecydowanej większości prac towarzyszył typ zmęczenia $C > A > B$, charakterystyczny dla prac fizycznych. Wzór zmęczenia w postaci $B > C > A$, typowy dla prac umysłowych, dotyczył jedynie pracy operatorów wielooperacyjnych.

Słowa kluczowe: zmęczenie, metody subiektywne, kwestionariusz japoński, leśnictwo

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