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Diagnosis of the physical strain at the truck operator's workstation

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SUMMARY

The occupation of a truck driver may involve excessive physical effort, long hours of sitting in a forced posture (uncomfortable seat) and exposure to prolonged general vibrations. As a result of this type of occupational exposure, pain in the musculoskeletal system may develop over a shorter or longer period of time. In order to counteract the adverse effects of strenuous physical activity, it is recommended to measure and reduce it to a safe level, as recommended by physiologists and ergonomists. The aim of this study is to assess the physical strain on the stand of a truck operator according to the Lehmann method.

Keywords: ergonomics, work safety, work load assessment

Introduction

In order to exercise the profession of a road carriage operator, the driver must be licensed as a road carriage operator [1]. The truck operator starts his work from preparing the truck for work, then collecting and transporting, to merging and storing loads, keeping records of equipment control and maintaining the equipment in good condition of the handling equipment. He performs his work both in closed rooms (halls, warehouses), as well as in the open air, during unloading or loading of other means of transport (road, rail, sea). It often transports very large and heavy loads using auxiliary equipment [2]. The tasks assigned to the truck operator may involve excessive physical effort at work, long hours of sitting in a forced posture (uncomfortable seat) and prolonged vibrations resulting in prolonged spine, back, arm and arm pain.

In studies conducted by Suterski, Miedziarek and Tytyk, it was found that in this occupational group more severe ailments are felt in the neck, lower back, buttocks, right knee, feet and left wrist [3]. As ¾ (75%) of all work-related health problems in Poland are musculoskeletal disorders, measures should be taken to reduce the risk of their development (Fig. 1). [4] Therefore, this is a serious problem not only within the profession of a wheelchair operator, but also for the entire population working in Poland. The first step in prevention is to assess the physical exertion burden at the workplace [5].

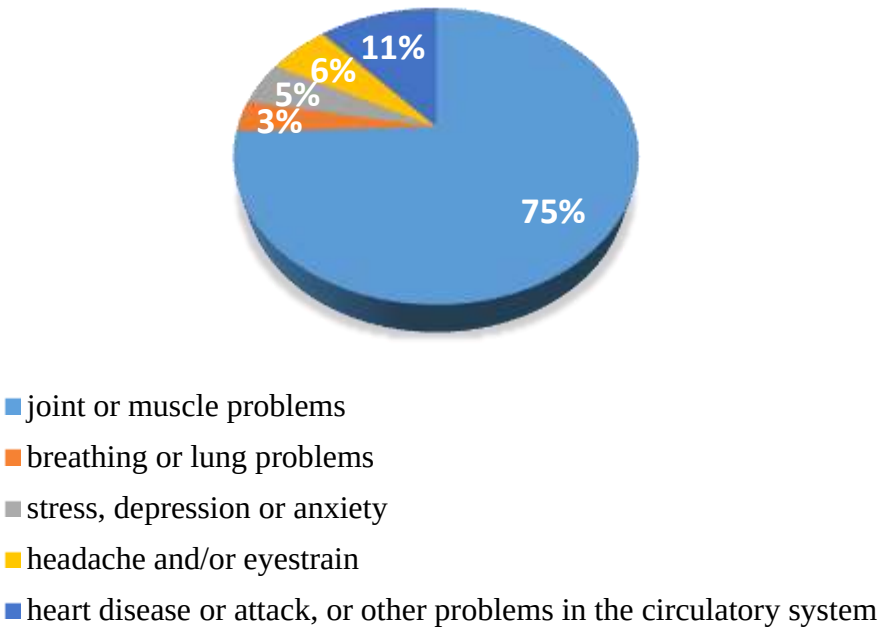

Fig. 1. Structure of work-related health problems in Poland [%].

Effective counteraction to the development of musculoskeletal system diseases may protect the employer from the consequences of the diagnosis of an occupational disease in an employee. In the current list of occupational diseases there are two items which relate to the subject in question: item No 19 'Chronic diseases of the locomotor system caused by the way of work' and item No 20 'Chronic diseases caused by the way of work'. "Chronic diseases of the peripheral nervous system caused by the way of work'. [6].

The aim of this study is to assess the physical strain on the stand of a truck operator according to the Lehmann method.

Characteristics of the method for assessing the burden of physical activity

Introduction

The following components are taken into account to assess the physical exertion nuisance using the Lehmann estimation-table method:

a) energy expenditure [kJ/8h], which expresses the mechanical work (dynamic effort) carried out during work activities,

b) static exercise, associated with constant muscle tension when working in a forced posture,

c) repeatability of motions, which describes the inconvenience of working due to one-sided strain on the muscular system as a result of monotonous, monotonous motions (e. g. on a mounting strap).

This method consists of the following steps:

a) the compilation of a 'working day photo',

b) a calculation of energy expenditure,

c) assessment on a point scale of the successive nuisance components,

d) a summary and assessment of the total inconvenience of the physical work concerned.

The Lehmann energy expenditure can be estimated for medium-heavy and heavy work with an accuracy of 10%, which is sufficient to assess the risk of musculoskeletal stress in the workplace.

Notes for use of the Lehmann method:

a) minor interpolations of the values in the tables are acceptable,

b) breaks in work shall be included, taking into account only the position of the body in which the worker spends the breaks,

c) the accuracy of estimates of energy expenditure decreases when periods of operation are separated by long breaks.

d)

Working day photo

Before commencing the assessment, a summary of all work activities carried out by the employee during the 8-hour shift must be drawn up. Such a list is called a photograph of a working day.

Symbols:

a) *t* - duration of the work activity [min],

b) *wa* - energy expenditure by torso position [kJ/min],

c) *wb* - energy expenditure due to limb work [kJ/min],

d) *wc* - energy input for the work activity [kJ], calculated as

$$wc = (wa+wb)* t$$

The values wa and wb to the formula are to be read from Tables 1 and 2.

The total energy expenditure in [kJ/8h] is calculated by summing up the energy expenditure in all activities during an 8-hour shift.

The calculated amount of energy expenditure should be within a range:

a) up to 3500 kJ/8h - for light work,

b) from 3500 to 6500 kJ/8h - for medium-heavy works,

c) from 6500 to 10000 kJ/8h - for heavy work.

For people with average physical strength abroad, the permissible expenditure is assumed to be approx:

a) 8400 kJ/8h for men,

b) 7100 kJ/8h for women,

c) for the optimal range for both sexes 3300-6500 kJ/8h.

d)

Table 1: Energy expenditure *wa* due to the position of the torso.

BODY POSITION	*wa* [kJ/min]
Sitting	1,2
Kneeling	2,1
Standing	2,5
Stand inclined	4,2
Walking	7,2-14,8
Unladen walking on a 10° slope	3,5/metre of elevation

Table 2: Energy expenditure *wb* due to the work of the limbs.

TYPE OF WORK		*wb* [kJ/min]
Hand and forearm work	easy medium hard	1,2 - 2,5 2,5 - 3,8 3,8 - 5,2
One arm work	easy medium hard	3,0 - 5,0 5,0 - 7,2 7,2 - 9,3
Both arms work	easy medium hard	6,3 - 8,4 8,4 -10,5 10,5-12,6
Whole body work	easy medium hard very hard	10,5-16,8 16,8-25,1 25,1-35,6 35,6-48,2

Scoring of nuisance

After calculating the amount of energy expenditure, further components of the physical effort should be estimated on a point scale:

Tab. 3: Cumulative assessment of nuisance.

COMPONENT OF THE EFFORT	APPRAISAL	
	score	verbal
Energy expenditure kJ/8h		
Static loads		
Repeatability of movements		
	Σ .....pkt.	endeavor.....

The scoring is determined from Table 4, Table 5, Table 6.

The verbal assessment is determined from Table 7.

Table 4: Evaluation of energy expenditure at physical work.

ENERGY EXPENDITURE [kJ/8h]	ASSESSMENT OF ENERGY EXPENDITURE	
	Verbal	score
up to 1260	very small	0
1260 - 3350	small	1 - 25
3350 - 6300	medium	25 - 50
6300 - 8400	large	51 - 75
over 8400	very large	76 - 100

Table 5: Evaluation of static load.

Assessment of the static load degree Verbal/score		Working posture	Examples
SMALL 1-30	1-10	unforced seating	most of the office work
	11-20	standing upright with the possibility of periodical change to seated	locksmith, carpenter
	21-30	seated or standing upright alternately with walking	technical supervision, librarian
MEDIUM 31-60	31-40	forced seating, not inclined or slightly inclined	typing, operation of mechanical presses
	41-50	standing upright, without the possibility of changing the sitting position periodically	operation of some machine tools, painting, varnishing, salesman's work
	51-60	forced standing, not inclined, with the possibility of changing periodically to a seated position	motorcycle, overhead travelling crane
LARGE 61-90	61-70	seated, forced, very inclined	shoemaker, watchmaker
	71-80	standing forced, not inclined without the possibility of changing periodically to a seated position	sandblasting, operation of certain machine tools
	81-90	forced standing, inclined, regardless of the possibility of repositioning.	mining, woodworking
VERY LARGE 91-100	91-100	kneeling, squatting and other non-natural positions	manual molding, mining, flooring, automotive locksmith

Table 6: Evaluation of the degree of physical work inconvenience due to repetitive movements.

NUMBER OF REPETITIONS OF STEREOTYPICAL MOVEMENTS PER SHIFT		NUISANCE	
Force exerted		Verbal	Score
up to 100 N	over 100 N		
up to 800	up to 300	Little	1 – 30
800-1600	300 – 800	Medium	31 - 60
over 1600	over 800	Large	61 - 100

Table 7: Summary assessment of physical workload on a point scale.

EFFORT ASSESSMENT	SCORE
VERY LITTLE	1 - 30
LITTLE	31 - 70
MEDIUM	71 - 120
LARGE	121 - 190
VERY LARGE	191 - 300

Analysis of the components of stressful physical activity

After completion of the calculation, it shall be determined:

a) which of the components of the physical workload contributes most to its discomfort,

b) indicate which work activities are the most energy-intensive and onerous.

Working methods and technical and organisational improvements should be proposed with a view to:

a) a reduction in energy expenditure,

b) general reduction of physical workload on the examined position [7-8].

The results of the lehmann method of examination of physical exertion inconvenience

Working day photo

Employee: male			t	wa	wb	wc
L.p.	Action		[min]	[kJ/min]	[kJ/min]	[kJ]
1.	Preparation for work		5	2,5	3	27,5
2.	Preparation of the forklift truck, checking individual systems and mechanisms (6 min)	Checking the steering system.	1	1,2	2,5	3,7
3.		Checking the brake system.	1	1,2	2,5	3,7
4.		Checking the drive train.	1	1,2	2,5	3,7
5.		Checking the lifting mechanism.	1	1,2	2,5	3,7
6.		Checking the control mechanism.	1	1,2	2,5	3,7
7.		Verification of indications of control and measurement devices, signalling and protections.	1	1,2	2,5	3,7
8.	Unloading goods from a lorry (71 min)	Driving with a forklift from the parking place to the inside of the truck trailer.	1	1,2	2,5	3,7
9.		Operating the trolley in order to load goods on it.	2*12=24	1,2	2,5	88,8
10.		Transport of pallets using a forklift truck from a tira semi-trailer to a storage yard.	2*12=24	1,2	2,5	88,8
11.		Return to the tira semi-trailer with an unladen forklift truck	2*11=22	1,2	2,5	81,4
12.	Replacement of tyres in a truck (5pcs*34min=165 min)	Manual loading of the tyre on a pallet.	2*5=10	10	36	460
13.		Transport of the pallet by means of a forklift truck from the storage point to the workshop.	1*5=5	1,2	2,5	18,5
14.		Unscrew the wheel bolts using hand tools.	10*5=50	4,2	8	610
15.		Remove the wheel that has been unscrewed.	2*5=10	4,2	12	162
16.		Manual transfer of the unscrewed wheel to the work table.	3*5=15	14,8	45	897
17.		Remove the tyre and attach a new one.	4*5=20	4,2	12,6	336
18.		Manual transfer of the wheel from the table to the car.	3*5=15	14,8	45	897
19.		Tighten the wheel with hand tools.	5*5=25	4,2	8	305
20.		Manually load the tyre on a pallet.	2*5=10	10	36	460
21.		Transport of pallets using a forklift truck from the workshop to the storage yard.	1*5=5	1,2	2,5	18,5
22.	Park, switch off and secure the forklift truck.		2	1,2	5	12,4
23.	Passage on foot to the social room		4	7,2	10,5	72

24.	Break (30 min)	Washing hands, preparing a meal.	10	4,2	3	72
25.		Eating a meal.	20	1,2	1,2	48
26.	Cleaning and maintenance of tarpaulins		90	2,5	8	942
27.	Minor truck repairs, maintenance		65	4,2	8	793
28.	Finishing tasks, cleaning the workplace, getting ready for the exit		22	4,2	10	312,4
	TOTAL:		460	108	281,3	6728,2
			Energy expenditure We=6728,2			

Summary assessment of the physical workload

Effort component	Assessment	
	Score	Verbal
Energy expenditure 6 728,2 kJ/8h	53	Large
Static load	41	Medium
Repeatability of movements	31	Medium
Cumulative assessment :	∑ 125	

Final result: physical work at the analyzed workplace is a heavy-duty work.

Analysis of the components of stressful physical activity

On the basis of the analysis carried out, it should be concluded that the most onerous component of physical workload was energy expenditure (We=6 728. 2 kJ/8h).

One of the most energy-intensive activities during a shift:

a) Manual transfer of wheel from table to car (897 kJ/8h),

b) Cleaning and maintenance of tarpaulins (942 kJ/8h)

Proposals for technical and organisational changes at the workplace

Key conclusions on the basis of comparative assessments of the strain on the body:

Performing works on the analyzed position is connected with energy expenditure at the level of 6 728. 2 kJ/8h. This result is within acceptable standards. The aim should be to maintain the result at a similar level.

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