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FATIGUE AT WORKERS EXPOSED TO JUTE DUST, WOOD DUST, CHEMICALS AND OFFICE WORKERS

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Abstract. Aim: Screening study was focused on the assessment of fatigue in workers exposes to organic dust (jute and wood) and chemicals. **Material end methods**: The group exposed to jute dust consisted in 110 workers (98 females) in the following workplaces: squashing, carding, laminating, spinning, twisting, starching, rolling, where there are: fibers and dust of jute, noise, adverse microclimate (at starching). The group exposed at wood dust consisted in 57 workers (33 females), in workplaces of manual and mechanical brush sections, where there are fibers and dust of wood (species: oak, beech tree, fir-tree, lime-tree, poplar, nut-tree, cherry-tree, ash-tree). The group exposed to chemicals (organic solvents and dyes) consisted in 56 workers (53 females) in the following workplaces: finishing and dying sections. Control group consisted in 92 (35 females) office workers. **Results and discussion**: mean values for age was 39.6±9 years in the investigated groups; mean total work length was 20±8 years. Multidimensional checklist individual strength (CIS20R) questionnaire with 20 items self reported questionnaire that referred to fatigue experienced during the previous two weeks has been administered. It consisted of four dimensions: the subjective feeling of fatigue, and motivation reduction, activity diminution and concentration reduction. By adding the four dimensions a CIS total score can be calculated. Higher scores indicate a higher degree of fatigue, more concentration problems, reduced motivation and less activity. Statistical differences were noted in exposed groups *vs.* controls ($p < 0.001$). Total scores (%) were: 76.53 for workers exposed to jute dust, 75.38 for workers exposed to wood dust, 83.22 for workers exposed to chemicals, 44.1 in controls. Test *sensibility*: 72.59% (in workers exposed to jute dust), 57.95% (in workers exposed to wood dust), 59.34% (in workers exposed to chemicals). In the absence of gold standard for fatigue, CIS were able to discriminate adequately between fatigued and non-fatigued employees in occupational exposure to organic dust (jute and wood), chemicals and office workers. **Conclusions**: Differences of subscales of fatigue (dimensions of fatigability) were noted by categories of exposure (levels and noxious agents).
Key words: fatigue, jute, wood, chemicals, occupational exposure

Rezumat. Scop: Studiul de tip screening urmăreşte să evidenţieze oboseala la muncitori expuşi la pulberi organice (iută şi lemn) şi noxe chimice. **Material şi metodă**: Grupul expus la pulberi de iută este constituit din 110 muncitori (98 femei) care lucrează în următoarele sectoare: zdrobire (preparaţie), cardare, laminare, tors, răsucire, poliere, ghemuire, unde se găsesc: fibre şi pulberi de iută, zgomot, microclimat nefavorabil (la poliere). Grupul expus la pulberi de lemn este alcătuit din 57 muncitori (33 femei) care muncesc în sectoarele de şlefuit manual şi mecanic unde se lucrează cu esenţe de stejar, fag, brad, tei, plop, nuc, cireş, frasin. Grupul expus la noxe chimice este alcătuit din 56 muncitori (53 femei) din sectoarele de

finisaj şi băiţuire unde se lucrează cu solvenţi organici şi vopsele. Grupul martor este alcătuit din 92 funcţionari(35 femei). **Rezultate şi discuţii**: vârsta medie a subiecţilor investigaţi a fost de 39,6±9 ani iar vechimea profesională medie este de 20±8 ani. S-a completat un chestionar de evaluare a rezistenţei individuale (CIS) cu 20 de întrebări care se referă la oboseala resimţită de subiect în timpul ultimilor două săptămâni anterior examinării. Chestionarul conţine patru categorii de oboseală şi anume: oboseala resimţită subiectiv, scăderea motivaţiei, scăderea activităţii fizice şi scăderea concentrării. Prin sumarea celor patru dimensiuni se calculează un scor total. Cu cât scorul este mai mare, cu atât oboseala este mai accentuată, cu atât sunt mai mari problemele de concentrare, motivaţia şi activitatea fizică sunt mai scăzute. S-au constatat diferenţe semnificative statistic între loturile expuse profesional la pulberi şi solvenţi comparativ cu lotul martor ($p < 0,001$). Scorurile totale (%) au fost: 76,53 pentru muncitorii expuşi la pulberi de iută, 75,38 pentru muncitorii expuşi la pulberi de lemn, 83,22 pentru muncitorii expuşi la noxe chimice, 44,1 la funcţionari. Sensibilitatea testului a fost de 72.59% la muncitorii expuşi la pulberi de iută, 57,95% la muncitorii expuşi la pulberi de lemn, 59,34% la muncitorii expuşi la noxe chimice. **Concluzii**: În absenţa unui chestionar „*gold standard*" pentru oboseală, chestionarul CIS s-a dovedit capabil să diferenţieze în mod satisfăcător muncitorii obosiţi de cei neobosiţi în expunerea profesională la pulberi organice (iută şi lemn), noxe chimice şi la funcţionari. Au fost notate diferenţe ale dimensiunilor oboselii în funcţie de categoriile expunerii şi nivelurile acestora.

Cuvinte cheie: oboseala, iută, lemn, noxe chimice, expunere profesională

INTRODUCTION

Study of fatigue is in our attention in the context of assessment of various occupational exposures. The goal of this screening study was to emphasize the utility of a standard questionnaire in quantification of fatigue and it's peculiarities at various categories and levels of noxious occupational agents.

The implication of nervous system in occupational medicine is large discussed in literature (1-4).

Occupational health interest in fatigue arises from the adverse consequences that are attributed to fatigue in the more serious acute or chronic forms, and when there is insufficient opportunity for recover. Bad performance, impaired quality of services and products, and dropout of personnel may be adverse consequences. For employees, feelings of professional incompetence, accidents, and fatigue's disruptive effects on private social life are serious outcomes (5). Fatigue is a common complaint in the working population, with a reported prevalence of 22% (6). Other surveys have reported prevalence rates of fatigue varying from 7% to 45%, depending on the instruments used and the applied cut off points (5). When fatigue becomes severe and persistent, it may lead to long-term sick leave and work disability (6). Epidemiological methods concerning the effect upon nervous system in occupationally exposure to organic solvents are well known in literature (1,7-15). Principles and methods for the assessment of neurotoxicity associated with exposure to chemicals are presented in various communications and publications (2,3, 4,16,17). Fatigue was defined as "the change in the psychophysiological control mechanism that regulates task behavior, resulting from preceding

mental and/or physical efforts which have become burdensome to such an extent that the individual is no longer able to adequately meet the demands that the job requires of his or her mental functioning; or that the individual is able to meet these demands only at the cost of increasing mental effort and the surmounting of mental resistance." This definition principally implies that fatigue in itself is not an adverse effect but rather a physiological adaptation or safety mechanism of the individual confronted with the risk of overstrain or exhaustion. Physiological fatigue can be seen as a feedback mechanism that will reduce drive and motivation in instances where exhaustion can lead to adverse mental or physical effects. Finally, in quite a number of mental disorders including burnout, adjustment disorders, and neurasthenia, prolonged or chronic fatigue is one of the core symptoms. The presence of many other related terms and definitions such as nervous exhaustion, nervous breakdown, and overwork refers to the confusion related to the concepts of a number of psychological syndromes and minor psychiatric disorders, which are closely related to fatigue. The wide range of frequently used terms and concepts also reflects the relevance of the topic. Most extensively used scales to measure fatigue or related entities within the research program are the Checklist Individual Strength (CIS). Effects may be so serious that workers can experience disability leading to long term or even indefinite absenteeism from work (3-5). Fatigue is a general term used to describe a wide variety of conditions. Acute fatigue can be divided into mental fatigue due to mental overload or underload (associated with monotony and boredom) and physical fatigue has been noted in heat exhaustion and attribute to several possible physiological disturbances: hyperthermia, circulatory strain, due to excessive call on cardiac output to deal with hyperthermia and/or reduced circulating volume due to dehydratation, sweat gland fatigue, depleted muscular glycogen concentration and muscle soreness due to overuse (18,19). There are certain papers focused on fatigue at work in various conditions as physiological responses to different levels of heat stress as fatigue at worker in a steel plant, prevalence of fatigue among employees in different work schedules (day work, three-shift, five-shift, and irregular shift work; investigates whether different work schedules are related to increasing fatigue over time, while taking into account job title characteristics; studies fatigue among shift workers were matched on job title (3,20,21;). Swaen G M H showed that fatigue and need for recovery are independent risk factors for being injured in an occupational accident (22). Ahsberg E. offered a slightly revised model for perceived fatigue, still with five dimensions: lack of energy, physical exertion, physical discomfort, lack of motivation and sleepiness, based on a rating profiles describing fatigue states differed between five occupations; on the basis of results, a revised version of the Swedish Occupational Fatigue Inventory is presented (23). Unusual tiredness is noted in other literature

data in occupational exposure to organic dust (7,24,25). Fatigue as a problem of modern society is discussed by Weber A (26).

MATERIAL AND METHOD

A screening study focused on the assessment of fatigue in workers there were exposed to organic dust (jute and wood) and chemicals was performed. The method was structured as follows:

a) studied groups;
b) exposure evaluations;
c) fatigue assessment by the CIS20R questionnaire (27).

a) *Studied groups*

Three exposed groups and a control group were examined.

The characteristics of groups are shown in tables 1 and 2.

Table 1. Characteristics of studied groups

Work places	No workers			Age (years)		Total length of work (years)		Length of actual work place (years)	
	No	M	F	Average	Limits	Average	Limits	Average	Limits
Squashing	6	0	6	41.33	32÷51	21.33	14÷28	15.5	6÷25
Carding	18	8	10	34.21	27÷48	14.52	4÷30	9.89	1÷24
Laminating	9	0	9	44	32÷49	24.22	11÷30	12	5÷23
Spinning 1	23	0	23	37.60	29÷50	17.95	11÷31	13.08	4÷27
Spinning 2	16	0	16	38.5	33÷50	18.25	4÷27	14	4÷27
Twisting	16	0	16	39.53	30÷53	18.41	10÷27	10.94	1÷26
Starching	11	4	7	37.08	31÷44	16.75	10÷24	11.5	1÷26
Rolling	11	0	11	37.18	27÷47	18	5÷27	8.45	1÷27
JUTE DUST EXPOSED	110	12	98	38.68	27÷53	18.68	4÷31	11.92	1÷27
Manual brushing	9	3	6	34.77	20÷44	14.14	1÷23	13.88	1÷23
Mechanical brushing	48	21	27	41.85	21÷53	22.52	2÷35	21.14	2÷31
WOOD DUST EXPOSED	57	24	33	38.31	19÷52	18.33	1÷35	17.51	1÷31
Finishing workers	30	3	27	38.97	29÷50	19.97	10÷30	19.97	10÷30
Dying workers	17	0	17	40.76	32÷50	22.29	15÷32	22.29	15÷32
CHEMICALS EXPOSED	56	3	54	39.51	29÷50	20.67	10÷32	20.67	10÷32
CONTROL GROUP	92	57	35	41.07	24÷55	20.78	0.4÷37	14.81	0.4÷37

Table 2. Studied group distribution (number of workers)

Length of work (years)	Exposed to jute dust	Exposed to wood dust	Exposed to chemicals	Office workers	Total
1-19	63	21	15	42	141
Ovr 20	47	36	41	50	174
Total number	110	57	56	92	315

- ***Group exposed to jute dust*** consisted in 110 workers (98 females); length of work: 1-19 years: 63; over 20 years: 47. Workplaces of squashing, carding, laminating, spinning, twisting, starching, rolling were investigated. The noxious agents were: fibers and dust of jute, noise and adverse microclimate (table 1).
- ***Group exposed at wood dust*** consisted in 57 workers (33 females); length of work: 1-19 years: 21; over 20 years: 36. The investigated workplaces were: manual and mechanical brush sections. Noxious agents were: fibers and dust of wood (species: oak, beech tree, fir-tree, lime-tree, poplar, nut-tree, cherry-tree, ash-tree) (table 1).
- ***Group exposed to chemicals*** consisted in 56 workers (53 females); length of work: 1-19 years: 15; over 20 years: 41. The investigated workplaces were: finishing and dying sections. Noxious agents were: organic solvents, dyes and wood dust (table 1).
- ***Control group*** consisted in 92 (35 female) office workers; length of work: 1-19 years: 42; over 20 years: 50 (table 1).

- The mean values for the 315 subjects for age were 39.6±9 years and work length were 20±8 years respectively.

b) Levels of exposure

The study has shown that at squashing were the dustiest place of work both at the first hour in the morning (72.4 mg/m^3) and at the middle of the work shift (30.8 mg/m^3) when determines the ventilation system reduction of the exposure (table 3).

An intermediated place of work, laminating process, when the activity was rich in the middle of the work shift, was also noted with big levels of dust, both in the morning (12.2 mg/m^3) and to the end of the day (30.4 mg/m^3). The permissible values were overfull-filled almost in all the workplaces [Thresholds Limits Values (TLW): 2 mg/m^3; 4 mg/m^3] (table 3).

Table 3. Exposure levels of jute dust (mg/m^3) (Thresholds Limits Values: 2 mg/m^3; 4 mg/m^3)

Work places	Daytime	
	7.00-10.00 a.m	10.00 am-1.00 pm **
	Dust levels (mg/m^3)	Dust levels (mg/m^3)
Squashing	72.4	30.8*
Carding	6.8	6.8
Laminating	12.2	30.4
Spinning 1	3.38	5.38
Spinning 2	9.16	15.1
Twisting	10.2	4.5
Starching	2.4	2.4
Rolling	6.3	8.4

* Exposure is diminished

** Ventilation system is started

The levels of dust were overfulfilled at mechanical brush section (35.6 mg/m^3; TLW is 10 mg/m^3) (table 4).

Cumulus index exceeded the value of 1 (table 5).

Table 4. Exposure levels of wood dust (mg/m^3) (Thresholds Limits Values: 10 mg/m^3)

	Daytime			
Work places	7.45-11.30		10.15-12.45	
	Dust levels (mg/m^3)		Dust levels (mg/m^3)	
Manual brush section	8			
Mechanical brush section			35.6	

Table 5. Exposure levels of chemicals

Work places		Daytime	Level (mg/m^3)	Thresholds Limits Values (mg/m^3)	
				Average	Ceiling
Finishing	Acetone	9.35	26.8	200	500
	Butylacetate	9.35	79.8	300	400
Dying	Ammonia	12.35	59.9	15	30

c) Fatigue evaluation

In order to evaluate fatigue dimensions a *multidimensional checklist individual strength (CIS20R) questionnaire* with 20 items self reported questionnaire that refers to fatigue experienced during the previous two weeks has been administered (27). The questionnaire consists of four dimensions: the subjective feeling of fatigue, motivation reduction, physical activity diminution and concentration reduction. By adding the four dimensions a CIS total score was calculated. Higher scores indicate a higher degree of fatigue, more concentration problems, reduced motivation and less activity.

RESULTS AND DISCUSSION

Many aspects could be discussing fatigue. Results are present as follows: by occupational exposure and sections, by length of work and by sex.

- Table 6 shows *fatigue scores in workers exposed to jute dust* are different in various work sections. The highest general score (%) being noted at laminating (95.33), were the level of dust exposure are constantly increased all the dayshift, followed by scores (%) noted for the workers in squashing (84.17) and spinning 2 section (84.06), where the dust level are also, increased. Observationally, the scores follow nearly the level of exposure (table 3).

Table 7 related to length of work, show that there were higher values, for subscale "*subjective feeling of fatigue*", for the group over 20 years (40.51), that is expressed also in general score (82.40).

Table 6. Scores noted at the exposed to jute dust on different sections (%)

Work places	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
Squashing	**42.17**	18.67	13	**10.33**	**84.17**
Carding	30.06	18.50	10.56	9.83	68.94
Laminating	**48.11**	**20.33**	**16.22**	**10.67**	**95.33**
Spinning 1	29.00	10.00	8.00	7.00	54.00
Spinning 2	**39.81**	19.75	14.25	**10.25**	**84.06**
Twisting	32.94	**20.44**	8.31	8.63	70.31
Starching	32.18	15.82	12.09	8.91	69.00
Rolling	33.18	19.00	9.45	8.55	70.18

Table 7. Repartition of dimensions of fatigue by length of work at workers exposed to jute dust (%)

Length of work (years)	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
1-19	31.62	18.41	11.02	9.6	70.65
over 20	**40.51**	19.81	12.36	9.72	**82.40**
Total	36.07	19.11	11.69	9.66	76.53

o ***Fatigue scores* (%) *in workers exposed to wood dust***, as is showed in table 8, were more increased at the manual brushers (86.33) those physical efforts were increased, compared to mechanical brushers (71.97), although the level of dust was overfull-filled only at the mechanical sections (table 4). There were no important differences between groups by length of work in workers exposed to wood dust (table 9).

Table 8. Scores noted at the exposed to wood dust on different sections (%)

Work places	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
Manual brushers	39.42	22.92	12.59	11.42	86.33
Mechanic brushers	33.40	18.68	10.29	9.61	71.97

Table 9. Repartition of dimensions of fatigue by length of work at workers exposed to wood dust (%)

Length of work (years)	Subjective feeling of fatigue	Concentration	Motivation	Physical activity	GENERAL score
1-19	34.38	20.05	10.9	9.29	74.62
over 20	35.36	19.17	10.92	10.69	76.14
Total	34.87	19.61	10.91	9.99	75.38

o ***Fatigue scores* (%) *at workers exposed to chemicals*** were increased in dyers (92.35) compared to finishing workers (82.97) (table 10). At dyeing section there were increased values of noxious agents (table 5). There were higher values of fatigue scores (%) in the group with over 20 years length of work (88.83) compare to the first group of length of work (77.6) (table 11).

Table 10. Scores noted at the exposed to chemicals on different sections (%)

Work places	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
Finishing sections	42.23	19.9	10.85	10	82.97
Dyeing sections	47.24	19.88	12.94	12.29	**92.35**

Table 11. Repartition of dimensions of fatigue by length of work at workers exposed to chemicals (%)

Length of work (years)	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
1-19	39.73	19.07	10.8	8	77.6
over 20	45.22	20.2	11.73	11.68	**88.83**
Total	42.48	19.64	11.27	9.84	83.22

o ***Fatigue scores at office workers (controls)*** are greatest in the group with over 20 years length of work (48.00) compared to the group of length of work 1-19 years (40.19) as the table 12 shows.

Table 12. Repartition of dimensions of fatigue by length of work at office workers (controls) (%)

Length of work (years)	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
1-19	16.93	9.38	8.4	5.48	40.19
over 20	21.98	11.44	8.92	5.66	48.00
Total	19.46	10.41	8.66	5.57	44.1

❖ ***Repartitions of dimensions of fatigue by sex*** were feasible for the exposed to wood dust and controls. In workers exposed to wood dust, general score (%) is higher at females workers (88.28) compared to male workers (70.02), as table 13 shows. In the office workers, females were, generally, more fatigued (47.63%) compared to males (42.47%) while mans were more physically fatigued (5.86%) compared to females (5.21%), as table 14 shows.

Table 13. Repartition of dimensions of fatigue by sex at workers exposed to wood dust (%)

Length of work (years)	Subjective feeling of fatigue	Concentration reduction	Motivation diminution	Physical activity reduction	GENERAL score
Females	**40.77**	**21.55**	**13.59**	**12.38**	**88.28**
Males	32.05	20.05	9.29	8.64	70.02

Table 14. Repartition of dimensions of fatigue by sex at office workers (controls) (%)

Length of work (years)	Subjective feeling of fatigue	Concentration	Motivation	Physical activity	GENERAL score
Females	**22.03**	**11.71**	8.77	5.21	**47.63**
Males	18.23	9.75	8.63	**5.86**	42.47

- **Fatigue subscales values in the studied groups**
  - ***Generals scores* (%)** were: 76.53 for workers exposed to jute dust; 75.38 for workers exposed to wood dust; **83.22** for workers exposed to **chemicals**; 44.1 in controls. *Test sensibility* in workers exposed to jute dust *vs.* control: 72.59%; 57.95% in workers exposed to wood dust; 59.34% in workers exposed to chemicals.
  - ***Scores of subjective feeling of fatigue* (%)** were: 36.07 for workers exposed to jute dust; 34.87 for workers exposed to wood dust; **42.48** for workers exposed to **chemicals**; 19.46 in controls. *Test sensibility* in workers exposed to jute dust: 69.77%; 56.67% in workers exposed to wood dust; 58.06% in workers exposed to chemicals.
  - ***Scores of concentration reduction* (%)** were: 19.11 for workers exposed to jute dust; 19.61 for workers exposed to wood dust; 19.64 for workers exposed to chemicals; 10.41 in controls. *Test sensibility* in workers exposed to jute dust: 67.86%; 43.32% in workers exposed to wood dust; 54.55% in workers exposed to chemicals.
  - ***Scores of motivation diminution* (%)** were: 11.69 for workers exposed to jute dust; 10.91 for workers exposed to wood dust; 11.27 for workers exposed to chemicals; 8.68 in controls. *Test sensibility* in workers exposed to jute dust: 67.27%; 50.68% in workers exposed to wood dust; 53.25% in workers exposed to chemicals.
  - ***Scores of physical activity reduction* (%)** were: 9.66 for workers exposed to jute dust; **9.99** for workers exposed to **wood** dust; 9.84 for workers exposed to chemicals; 5.57 in controls. *Test sensibility* in workers exposed to jute dust *vs.* control: 68.91%; 47% in workers exposed to wood dust; 55.42% in workers exposed to chemicals.
- The greatest values for *general score of fatigue*, *subjective feeling of fatigue*, *concentration reduction*, were noted in the workers exposed to chemicals, nervous system being target for many chemicals in direct or indirect ways. Test sensibility for the workers exposed to jute dust highlighted the

utility of this questionnaire in that kind of occupational exposure.

➢ The greatest values for *motivation reduction* are noted at workers exposed to jute dust with a *sensibility of test* of 67.27%.

➢ The values of scores of *physical activity reduction* were proximate for the exposed groups. The sensibility of test was 68.91% for the exposed to jute dust.

❖ ***Fatigue subscales and general scores* (%) *out of studied groups*** are presented in figure 1.

All noxious agents in the studied population as table 15 shows induced fatigue.

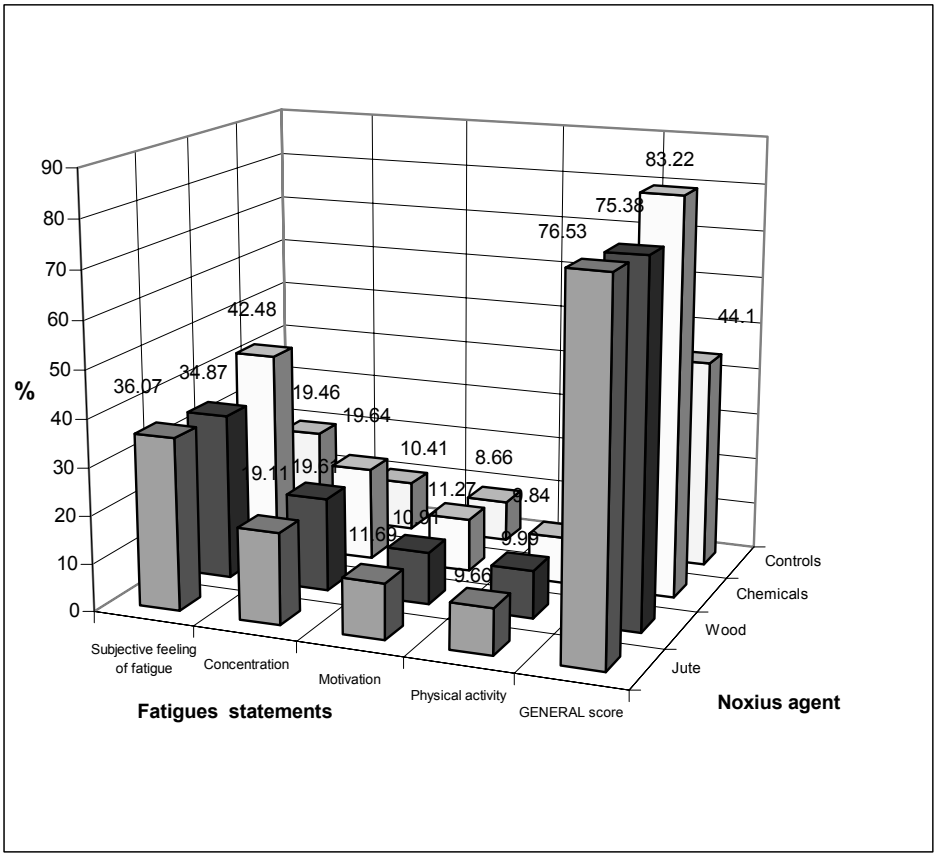

Fig. 1 Fatigue subscales out of studied groups

Tabel 15. OR values and 95% confidence intervals for the combinations between the exposed groups and controls; test sensibility

Scales of fatigue	Noxious agent	p	OR(95%CI)	Test sensibility (%)
GENERAL SCORE	Jute	<0.001	12.14(5.55-27.04)	72.59
	Wood	<0.001	12.64(4.6-36.61)	57.95
	Chemicals	<0.001	26.79(7.28-116.19)	59.34
Subjective feeling of fatigue	Jute	<0.001	6.12(3.09-12.19)	69.77
	Wood	<0.001	11.55(4.21-33.4)	56.67
	Chemicals	<0.001	24.46(6.67-108.07)	58.06
Concentration reduction	Jute	<0.001	6.61(3.19-13.88)	67.86
	Wood	<0.1	-	42.32
	Chemicals	<0.001	18.8(5.14-81.34)	54.55
Motivation diminution	Jute	<0.001	3.2(1.72-5.95)	67.27
	Wood	0.003	2.88(1.37-6.07)	50.68
	Chemicals	<0.001	3.99(1.85-8.69)	53.25
Physical activity reduction	Jute	<0.001	4.35(2.3-8.3)	68.91
	Wood	<0.001	0.26(0.12-0.57)	47
	Chemicals	<0.001	6.22(2.69-14.66)	55.42

CONCLUSIONS

- In the absence of gold standard for fatigue, CIS20R were able to discriminate adequately between fatigued and non-fatigued employees in various occupational exposure;
- Occupational exposure to jute dust, wood dust, chemicals and office workers showed different degrees of fatigue;
- Differences of subscales of fatigue (dimensions of fatigability) were noted by categories of exposure (levels and noxious agents);
- Assessments of subscales of fatigue are useful because the nervous system is differently involved in different levels and kinds of occupational exposure.

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