WORK RELATED MUSCULOSKELETAL DISORDERS OF THE UPPER LIMBS AMONG STEEL INDUSTRY POPULATIONS

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Abstract- For high occurrences of upper extremity disorders in working populations and in order to compare the occurrence of musculoskeletal alterations due to ergonomic risk factors such as highly force exertion, repetition, awkward posture between exposed and non-exposed groups, the research was carried out in Tabarestan steel industry. All 526 male workers (316 as exposed group : 132 aged 20-35 years, 184 aged >35 years; 210 as Non-exposed group: 89 aged 20-35 years, 121 aged > 35 years) performing tasks exposed / not exposed to risk factors for $WMSD_S$ of the upper limbs underwent a clinical examinations as well as completing standardized Nordic Musculoskeletal Questionnaires. The anamnestic cases were defined on the basis of pain, paraesthesia, hyposthenia, and vegetative disorders during previous months. Mean age of exposed and non- exposed groups were obtained 36.3 years (SD= 5.9) and 37.9 years (SD = 7.3) respectively. There were distinguished differences in occurrences of $WMSD_S$ of upper limbs between two mentioned groups. The major occurrence was found for the right and left hands. Nocturnal and diurnal paraesthesia obtained an occurrence of about 54% and 53% respectively. Data bears witness to the greater occurrence of affected individuals in exposed group, with a non- exposed / exposed ratio of 1:7.2. The greater occurrences of affected individuals in exposed group ($P = 0.006$) and in subjects>35 years ($P = 0.002$) were significant. Structural, organizational and educational measures can be applied to prevent $WMSD_S$ or diminish the relative effects to acceptable limit.

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Key words: Work-related musculoskeletal disorders, Nordic musculoskeletal questionnaire, upper extremity disorders, ergonomic risk factors, force exertion, repetition, awkward posture

INTRODUCTION

Musculoskeletal diseases of the upper limbs that are considered to be 'work-related' ($WMSD_S$) are generally multi-factorial in character (1). Work may significantly contribute to the onset of these diseases, but there may be other triggering causes (1).

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There is substantial evidence that neck and upper limb musculoskeletal disorders and back disorders are a significant problem with respect to ill health and associated costs within the workplace (2). It is likely that the size of the problem will increase because workers are becoming more exposed to work risk factors for these disorders (2). The importance of the musculoskeletal problem is confirmed by a recent review on work-related neck and upper limb musculoskeletal disorders by the European Agency for Safety and Health at Work in Bilbao, Spain (2). Combating musculoskeletal disorders is also a top health and safety priority for

the European Trade Union Confederation (2). Work-related musculoskeletal disorders arise when exposed to work activities and work conditions that significantly contribute to their development of exacerbation, but not acting as the sole determinant of causation (2). Disorders of the neck and upper limb are common problems in the general population as well as among industrial workers (3). The most common type of neck and upper limb disorders in the Scandinavian countries is pain in the neck/shoulder region with or without neck stiffness and with tenderness over the descending part of the trapezius muscle(3). The other most common disorder in the worker population are probably tendinitis (inflammation of the muscle tendon of which rotator cuff, supraspinate, biceps tendinitis, medial and lateral epicondylitis, and De Quervain's diseases), Nerve entrapments (pressure or mechanical friction on a nerve of which cervical nerve-root compression, neurogenic thoracic outlet syndrome, and carpal tunnel syndrome), and degenerative joint disease and osteoarthritis (3, 4). In order to highlight the presence and effects of various occupational risk factors producing work-related musculoskeletal disorders ($WMSD_S$) and prevent from inducing such disorders among workers populations (5), the corresponding research was carried out with the aim of comparing the prevalence rate of $WMSD_S$ between case and control groups of working populations performing various jobs in the relative steel industry. Thereby, the final purpose of the research was solely the study of diseases of the upper limbs for which evidence of correlation to work-related repetitive movements and suggestion of engineering designing solutions and corrections for controlling or eliminating various ergonomic risk factors (1).

MATERIAL AND METHODS

All 526 male workers occupying in Tabarestan steel industry were selected and surveyed as the target population sample (1). Of 526 sampled male employees, 316 male workers working in nine various jobs (include: melting scrap metals, foundry, removing impurities, steel tempering, moulding, thickness meter, steel–cutting, steel handling and storing, and loading on trailer) were selected as populations exposed to ergonomic risk factors (include: force exertion, repetition, awkward posture, duration of repetitive task, speed of repetitive task, recovery periods, and additional elements), and 210 remainder male workers per forming five various jobs (contain: supplying department, staff department, safety and protection unit, kitchen unit, and gardening unit) were selected as populations not exposed to any mentioned risk factors (1, 6). On the one hand, all 526 employees were referred to the corresponding medical clinic to be examined and screened by medicine specialists and occupational medicine physicians for carrying out periodic examinations (mainly for doing radiography and electromyography and detecting musculoskeletal disorders) (1).On the other, the standardized Nordic Musculoskeletal Questionnaires (NMQ) were also used and completed by all 526 employees with assistance of occupational hygienist to be obtained the required information and data about musculoskeletal disorders (7). Since 1987, the Nordic Questionnaire was established by Kuornika and his colleagues in institute for occupational health of Scandinavian countries with the aim of determining the occurrence rate of musculoskeletal disorders resulted from the ergonomic risk factors (7, 8).

The NMQ is one of the most commonly used standardized symptom questionnaire that suits health surveillance purpose well (8). Also the ascertaining the health outcome is inexpensive and data acquisition is quick and easy by using symptoms obtained from NMQ method (8). In the research, the NMQ method was utilized as a confirming and complementary method as well as clinical tests and examinations to detect ‘anamnestic cases’ and occurrences of upper extremity musculoskeletal disorders ($UEMSD_S$) (7, 8). The gained results are divided by two group categories (populations exposed /non-exposed to occupational ergonomic risk factors) and into two age groups (1). The division point between two age groups was established at 35 years according to pilot studies and preliminary analysis, which showed an increase in the occurrence of disorders and diseases after 35 years of age (1).

Table 1. Subdivision of the working populations samples by group categories and age groups

		Age groups					
		25-30 years		> 35 years		Total	
Group categories	**Job categories**	**N**	**%**	**N**	**%**	**N**	**%**
Exposed group	Melting scrap metals	13	4.1	25	7.9	38	12
	Foundry	18	5.7	18	5.7	36	11.4
	Removing impurities	15	4.7	20	6.3	35	11.1
	Steel tempering	13	4.1	16	5.1	29	9.2
	Moulding	12	3.8	23	7.3	35	11.1
	Thickness meter	14	4.4	18	5.7	32	10.1
	Steel- cutting	16	5.1	21	6.6	37	11.7
	Steel handling & storing	17	5.4	20	6.3	37	11.7
	Loading on trailer	14	4.4	23	7.3	37	11.7
	Total	132	41.8	184	58.2	316	100
Non-exposed group	Supplying department	26	12.4	46	21.6	72	34.3
	Staff department	23	11.0	49	23.3	72	34.3
	Safety & protection unit	14	6.7	10	4.8	24	11.4
	Kitchen unit	11	5.2	7	3.3	18	8.6
	Gardening unit	15	7.1	9	4.3	24	11.4
	Total	89	42.4	121	57.6	210	100

Also the individuals were classified as being 'anamnestic cases' on the basis of the following criteria: presence of pain or paraesthesia over the past 12 months, with a duration of least 1 week, or at least once a month, and without previous acute traumas (1). The obtained results and extracted data were analyzed by using SPSS/9 statistical software and also the occurrences of musculoskeletal disorders between two population groups (exposed and non-exposed groups) was surveyed by Chi-square (χ^2) statistical tests (9).

RESULTS

All 526 male employees working in Tabarestan steel industry including 316 male subjects as exposed population group (comprising 132 male workers aged 20-35 years; 184 male workers aged > 35 years) and 210 male subjects as non-exposed population group (consisting 89 male employees aged 20-35 years; 121 male workers aged > 35 years) were studied (t Table 1). Mean age of exposed population group was gained 36.3 years (SD = 5.9 years); and mean age of non- exposed population group was obtained 37.9 years (SD = 7.3 years). The exposed population group contains nine jobs (include: melting scrap metals, foundry, removing impurities, steel tempering, moulding, thickness meter, steel–cutting, steel handling and storing, and loading on trailer) ;and the non-exposed population group consists of five jobs (involve: supplying department, staff department, safety and protection unit, kitchen unit, gardening unit) (Table 1).

Table 1 also shows distribution of various male employees performing different jobs in two mentioned age groups. The non- exposed population/ exposed population ratio was 1:1.5. As it was mentioned before, all surveyed populations (of two aforementioned populations were male.

Table 2 submits the prevalence rates of pain, paraesthesia, hyposthenia and vegetative disorders by two aforesaid groups categories and two age groups.

Table 2. Occurrence of different types of upper limb disorders by group categories and age groups

Group categories	Age groups		Disorders types			
			Pain	Paraesthesia	Hyposthenia	Vegetative disorders
Exposed group	20-35 years	N	106	115	108	110
		%	80.3	87.1	81.8	83.3
	> 35 years	N	140	155	169	163
		%	76.1	84.2	91.8	88.6
	Total	N	246	270	277	273
		%	77.8	85.4	87.7	86.4
Non-exposed group		N	15	13	18	14
	20-35 years	%	16.9	14.6	20.2	15.7
	> 35 years	N	18	16	22	17
		%	14.9	13.2	18.2	14
	Total	N	33	29	40	31
		%	15.7	13.8	19	14.8

The data simply refer to the presence of the problem, with no additional assessment concerning frequency and duration. As it was considered, there was distinguished difference between exposed and non- exposed groups in occurrence of various disorders. Hyposthenia was reported more frequently by non- exposed group, while the exposed group had a higher occurrence of hyposthenia, vegetative paraesthesia, and pain disorders. Also it was observed that the occurrence rates of the aforesaid disorders in the older group were obtained higher than those of the younger group. Table 3 shows the occurrence of 'anamnestic cases' by sample group categories and age groups. The occurrence rate was significantly different by group categories, and was also about trebled in the older age group. The anamnestic threshold criterion was deployed carefully with joint pain in different sites, and with paraesthesia as a symptom, dividing paraesthesia into diurnal and nocturnal. The occurrences of anamnestic cases for exposed and non- exposed group were obtained 91.8% and 13.3% respectively. Table 4 and 5 report the occurrence of individuals with disorders exceeding the anamnestic threshold, divided by sample group categories, age groups, sites, and affected limbs. The occurrences of pain, paraesthesia, hypothenia, and vegetative disorders above the threshold were generally very high. The major occurrence rate was found for the right and left hands, for the left and right wrist, and for the left elbow among exposed group with both age groups. No non- exposed groups with both age groups exceeded the threshold for joint, vegetative, paraesthesia, and pain disorders.

Table 3. Occurrence of 'anamnestic cases' by group categories and age groups

Group categories	Age groups					
	25-30 years		> 35 years		Total	
	N	%	N	%	N	%
Exposed group	119	90.2	171	92.9	290	91.8
Non-exposed group	12	13.5	16	13.2	28	13.3
Total	131	59.3	187	61.3	318	60.5

Table 4. Occurrence of subjects with joint disorders in right and left upper limbs, which exceeded the anamnestic threshold at the various sites, divided by group categories and age groups*

	Shoulder		Elbow		Wrist		Hand	
Age Group	**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**
Exposed Group								
20-35 years	89 (67.4)	103 (78)	101 (76.5)	106 (80.3)	110 (83.3)	113 (85.6)	123 (93.2)	119 (90.2)
>35 years	120 (65.2)	127 (69)	123 (66.8)	129 (70.1)	125 (67.9)	133 (72.3)	148 (80.4)	146 (79.3)
Total	209 (66.1)	230 (72.8)	224 (70.9)	235 (74.4)	235 (74.4)	246 (77.8)	271 (85.6)	265 (83.9)
Non-exposed Group								
20-35 years	9 (10.1)	6 (6.7)	2 (2.2)	0 (0)	3 (3.4)	1 (1.1)	4 (4.5)	2 (2.2)
>35 years	4 (3.3)	2 (1.7)	11 (9.1)	8 (6.6)	5 (4.1)	2 (1.7)	6 (5)	0 (0)
Total	13 (6.2)	8 (3.8)	13 (6.2)	8 (3.8)	8(3.8)	3 (1.4)	10 (4.8)	2 (1)

Abbreviations: R, right; L, left.
*Data are given as number (percent).

Paraesthesia above the threshold that were reported most often by exposed groups with both age groups were nocturnal, with occurrence in excess of about 54% for both limbs.

Diurnal paraesthesia disorders also obtained a occurrence of about 53% for both limbs. The occurrences of any disorders were obtained the rates below the threshold by non- exposed group and both age groups. The all paraesthesia reported always involved the hands. Table 6 shows the objective occurrence of diseases of the upper limbs, and gives the total number of the various diagnoses, and-wherever possible-details concerning the occurrence of the single clinical types.

In the case group, the occurrences were all relatively high: the highest occurrences corresponded to those diseases that are notoriously more frequent, such as left periarticular calcifications (12.1%), right trapezium- metacarpal arthrosis (12.1%), left Guyon syndrome (11.4%), and right and left De Quervain's syndrome (9.8% for each of them separately) in 20-35 years and as right and left periarticular calcifications (9.8% and 8.7% respectively), right trapezium- metacarpal arthrosis (9.2%), right tendonitis of the wrist-hand (9.2%), right and left Guyon syndrome (10.3% and 8.7% correspondingly), and right and left Duplay's syndrome (7.6% and 8.7% respectively) in > 35 years).

Table 5. Occurrence of subjects with diurnal and nocturnal paraesthesia exceeding the threshold

			Nocturnal Paraesthesia		Diurnal Paraesthesia	
Group categories	**Age Group**		**R**	**L**	**R**	**L**
Exposed group	20-35 years	N	121	117	107	105
		%	91.7	88.6	81.1	79.5
	>35 years	N	117	101	98	89
		%	63.6	54.9	53.3	48.4
	Total	N	238	218	205	194
		%	75.3	69	64.9	61.4
Non- exposed groups	20-35 years	N	8	6	10	7
		%	9	6.7	11.2	7.9
	>35 years	N	11	5	9	3
		%	9.1	4.1	7.4	2.5
	Total	N	19	11	19	10
		%	9	5.2	9	4.8

Abbreviations: R, right; L, left.

Table 6. Occurrence of upper limb diseases in the samples examined, by group categories, age groups, and limbs involved

		Group categories											
		Exposed group						Non- exposed group					
		25-30 years		>35 years		Total		25-30 years		>35 years		Total	
Diagnoses		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Thoracic outlet	R	8	6.1	12	6.5	20	6.3	3	3.4	4	3.3	7	3.3
syndrome	L	9	6.8	9	4.9	18	5.7	0	0	0	0	0	0
	T	17	12.9	21	11.4	38	12	3	3.4	4	3.3	7	3.3
Scapulo-humeral	R	11	8.3	10	5.4	21	6.6	0	0	0	0	0	0
periarthritis	L	7	5.3	11	6	18	5.7	0	0	1	0.8	1	0.5
	T	18	13.6	21	11.4	39	12.3	0	0	1	0.8	1	0.5
Duplay ’s syndrome	R	13	9.8	14	7.6	27	8.5	2	2.2	3	2.5	5	2.4
	L	8	6.1	16	8.7	24	7.6	1	1.1	0	0	1	0.5
	T	21	15.9	30	16.3	51	16.1	3	3.3	3	2.5	6	2.9
Medial & lateral	R	10	7.6	10	5.4	20	6.3	1	1.1	0	0	1	0.5
epicondylitis	L	9	6.8	10	5.4	19	6	0	0	1	0.8	1	0.5
	T	19	14.4	20	10.8	39	12.3	1	1.1	1	0.8	2	1
De Quervain’s	R	13	9.8	10	5.4	23	7.3	1	1.1	3	2.5	4	1.9
syndrome	L	13	9.8	9	4.9	22	7	0	0	1	0.8	1	0.5
	T	26	19.7	19	10.3	45	14.3	1	1.1	4	3.3	5	2.4
Periarticular	R	9	6.8	18	9.8	27	8.5	2	2.2	1	0.8	3	1.4
calcifications	L	16	12.1	16	8.7	32	10.1	1	1.1	2	1.7	3	1.4
	T	25	18.9	34	18.5	59	18.6	3	3.3	3	2.5	6	2.8
Trapezium- metacarpal	R	16	12.1	17	9.2	33	10.4	3	3.4	1	0.8	4	1.9
arthrosis	L	9	6.8	12	6.5	21	6.6	0	0	1	0.8	1	0.5
	T	25	18.9	29	15.8	54	17	3	3.4	2	1.6	5	2.4
Tendonitis of the	R	8	6.1	17	9.2	25	7.9	0	0	0	0	0	0
wrist-hand	L	6	4.5	1.3	7.1	19	6	0	0	0	0	0	0
(Tendinous cyst)	T	14	10.6	30	16.3	44	13.9	0	0	0	0	0	0
Guyon syndrome	R	9	6.8	19	10.3	28	8.9	2	2.2	1	0.8	3	1.4
	L	15	11.4	16	8.7	31	9.8	0	0	0	0	0	0
	T	24	18.2	35	19	59	18.7	2	2.2	1	0.8	3	1.4
Carpal tunnel	R	8	6.1	11	6	19	6	0	0	1	0.8	1	0.5
syndrome(CTS)	L	9	6.8	8	4.3	17	5.4	0	0	1	0.8	1	0.5
(With other entrapment	T	17	12.9	19	10.3	39	11.4	0	0	2	1.6	2	1
neuropathies)													
Total $WMSD_S$	R	105	33.2	138	43.6	243	76.8	14	6.6	14	6.7	28	13.3
(for group categories	L	101	32	120	38	221	70	2	1	7	3.3	9	4.3
and age groups)	T	206	65.2	258	81.6	464	146.8	16	7.6	21	10	37	17.6
Total $WMSD_S$	R	243			76.9			28			13.3		
(for group categories)	L	221			70.3			9			4.3		
	T	464			146.8			37			17.6		

Abbreviations: R, right; L, left; T, total.

Table 7. Occurrence of affected individuals, by disorders, group categories and age groups

	Group categories											
	Exposed group						Non- exposed group					
	25-30 years		> 35 years		Total		25-30 years		> 35 years		Total	
Disorders	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Thoracic outlet syndrome	6	4.5	12	6.5	18	5.7	1	1.1	2	1.7	3	1.4
Scapulo-humeral periarthritis	7	5.3	14	7.6	21	6.6	0	0	1	0.8	1	0.5
Duplay's syndrome	10	7.6	13	7.1	23	7.3	1	1.1	2	1.7	3	1.4
Medial & lateral epicondylitis	8	6.1	10	5.4	18	5.7	1	1.1	1	0.8	2	1
De Quervain's syndrome	11	8.3	13	7.1	24	7.6	1	1.1	2	1.7	3	1.4
Periarticular calcifications	9	6.8	10	5.4	19	6	2	2.2	1	0.8	3	1.4
Trapezium-metacarpal arthrosis	12	9.1	12	6.5	24	7.6	1	1.1	1	0.8	2	1
Tendonitis of the wrist-hand (Tendinous cyst)	8	6.1	14	7.6	22	7	0	0	0	0	0	0
Guyon syndrome	12	9.1	13	7.1	25	7.9	1	1.1	1	0.8	2	1
Carpal tunnel syndrome (CTS) (with other entrapment neuropathies)	11	8.3	12	6.5	23	7.3	0	0	1	0.8	1	0.5

In non- exposed group, the occurrences were all very low in both age groups. On the one hand, it seemed to indicate that the occurrence of these diseases was very low indeed among non- exposed group (not-exposed individuals) and on the other, it appeared to show that the occurrence of these diseases were very high.

Table 6 also shows the totals for all diseases fond, obtained by summing the two limbs. The occurrences of diseases found in the age group of > 35 years were 1.25 times higher than that of 20-35 years for both sample group categories. In the exposed group, some subjects had concurrent differences or bilateral disorders. The occurrences of total $WMSD_S$ of the upper limbs were calculated on the number of limbs examined, equal to the number of subjects multiplied by 2. Thereby, the occurrences of total $WMSD_S$ of the upper limbs in 20-35 years and > 35 years of age groups were obtained 65.2% and 81.6% respectively for exposed group, while for the non- exposed group, these occurrences were gained very low (7.6% in 20-35 years of age and 10% in > 35 years of age).

It must be pointed out that all the subjects with right hand diseases were associated with left hand diseases. Table 7 shows the occurrence of affected individuals, by sample group categories and age groups. Table 8 illustrates the occurrence of individuals suffering from at least one of the $WMSD_S$. Data reported in table 9 bears witness to the greater occurrence of affected individuals in the sample exposed group against non- exposed group, with a non- exposed group/ exposed group ratio of 1:7.2. The greater occurrence of affected individuals in the exposed group was significant using the Chi-square test (χ^2=7.33; P = 0.006).

The greater occurrence found in subjects >35 years was also significant using the Chi-square test, both for exposed and non- exposed groups (exposed group: χ^2 = 8.53, P = 0.002; non- exposed group: χ^2 = 4.79, P = 0.015).

Table 8. Occurrence of affected individuals by group categories and age groups

	Age groups					
	25-30 years		>35 years		Total	
Group categories	**N**	**%**	**N**	**%**	**N**	**%**
Exposed	94	71.2	123	66.8	217	68.7
Non-exposed	8	9	12	9.9	20	9.5
Total	102	46.2	135	44.3	237	45.1

DISCUSSION

The results of the research showed that on the one hand there was a very high occurrence of the diseases analyzed among exposed group (workers who do perform tasks with repetitive movements of the upper limbs, particularly in the older age range), on the other, there was a very low occurrence of the diseases analyzed among control group (workers not exposed to any occupational risk factors) (1, 6).

Considering the high occurrence of $WMSD_S$ in exposed individuals, it is possible to conclude that it could be a sign of the presence of especially occupational risk factors (1). Preventive measures aimed at minimizing the occurrence of work-related musculoskeletal disorders of the upper limbs ($WMSD_S$) associated with repetitive tasks can be divided into three categories: structural, organizational and educational (10). Structural measures involve optimizing the layout of the work area and furnishings, and the 'ergonomic' properties of work tools and equipment (10). Such measures serve to alleviate the problems caused by the use of excessive force and awkward postures (10). Organizational measures essentially relate to job design (i.e. distribution of tasks, speeds and pauses)(10). They serve to alleviate problems connected with highly repetitive and frequent actions, excessively lengthy tasks and inadequate recovery periods (10). Educational and training programs for the workers and supervisors made it possible to identify a suitable plan and schedule of measures taking into due consideration the impact of the plan on production levels and costs (10). Analysis and re-design of tasks and training, matching tasks with $WMSD_S$, timetable for returning WMSD- affected workers to the work force, and enhancing worker awareness can steer us to prevent $WMSD_S$ of the upper limbs and the relative subsequent effects on working populations and to enhance worker efficiency, productivity and healthy (11).

Therefore, knowledge about the epidemiology of the upper limb disorders is important for different types of prevention as well as for handling medical issues (11, 12). In primary prevention, there is a need to know the occupational risk factors for the neck and upper limb disorders to design workplaces and work systems that promote health for the worker (12). By using epidemiological method, there is taken into consideration the risk factors and their magnitude that can be used for prioritization of where initiation and implementation of change at work (12, 13). In secondary prevention, there is a need to screen and diagnose the injured workers. In third prevention (treatment of injured worker to full recovery) involves early workplace rehabilitation where knowledge of the prognosis of different neck and upper limb disorders is important (11-13). To accommodate the injured worker with impaired function at the workplace knowledge of factors that prevents disability is necessary (11, 13). The following recommendations and measurements can be suggested:

- The jobs that they need to serve a lot of forces for doing them, the number of human forces exposed to incidence risk of distal upper extremity musculoskeletal disorders should be diminished by designing suitable handling carts, ergonomic designing of processes, automatizing and mechanizing process, and etc.(6).
- By rotating the jobs or workers, the workers who are doing the repetitive works in static positions for a long term have an opportunity for performing actions and movements and thereby preventing accumulation of Lactic acid much more in muscles and avoiding acute tiredness and fatigue (6, 14).
- By taking into consideration rest or recovery intervals between work periods or task times ,we can prevent from intervention of blood stream and avoid from fatigue of arm or forearm (Radio – ulnar) muscles (6,15). This problem is observed at populations doing jobs exposed to various occupational ergonomic risk factors (1, 14).
- The rectification of the work – shift program at the in industry and a proper planning according to the human physiology system (in the weekly work–shift, i.e. morning, evening, and night shifts respectively) will effectively be deducted in mental and physiological stress resulted from the works (6, 15).

- As most of the work presented in this in industry (especially jobs placed in exposed groups) has been allocated based on the physical ability of the young persons, therefore, it seems to be necessary to apply anthropometric principles in designing hand tools and work stations and also employ young workforces for doing these jobs to prevent from upper extremity musculoskeletal disorders (6, 14).
- By designing the chair, work- table, the proportion of the work type to its height, and the ergonomic interventions in some jobs embarking on transportation by hand, will considerably be reduced the occurrence of musculoskeletal disorders (6, 16).
- A periodic educational program as well as daily body practice can play a main role reducing the musculoskeletal disorders resulted from the work positions and postures or gestures (6, 14).

Conflict of interests

The authors declare that they have no competing interests.

REFERENCES

1. Battevi N, Menoni O, Vimercati C. The occurrence of musculoskeletal alterations in worker populations not exposed to repetitive tasks of the upper limbs. Ergonomics. 1998 Sep; 41(9):1340-1346.
2. Lagerlof E. Significant ill heath problem. In: Violante F, Armstrong T, Kilbom A, editors. Occupational ergonomics work-related musculoskeletal disorders of the upper limb and back. 1st Ed. London & New York, UK & US: Taylor & Francis Publishing; 2000. P. vi-x.
3. Hagberg M. Epidemiology of neck and upper limb disorders and work-place factors. In: Violante F, Armstrong T, Kilbom A, editors. Occupational ergonomics work-related musculoskeletal disorders of the upper limb and back. 1st Ed. London & New York, UK & US: Taylor & Francis Publishing; 2000. P. 20-28.
4. Buckle PW, Devereux JJ. The nature of work-related neck and upper limb musculoskeletal disorders. Appl Ergon. 2002 May; 33(3):207-217.
5. Occhipinti E. OCRA: a concise index for the assessment of exposure to repetitive movements of the upper limbs. Ergonomics. 1998 Sep; 41(9):1290-1311.
6. Grieco A. Application of the concise exposure index (OCRA) to tasks involving repetitive movements of the upper limbs in a variety of manufacturing industries: preliminary validations. Ergonomics. 1998 Sep; 41(9):1347-1356.
7. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, Andersson G, Jørgensen K. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987 Sep; 18(3):233-237.
8. Riihimäki H. Methodological issues in epidemiologic studies of musculoskeletaldisorders. In: Violante F, Armstrong T, Kilbom A, editors. Occupational ergonomics work-related musculoskeletal disorders of the upper limb and back. 1st Ed. London & New York, UK & US: Taylor & Francis Publishing; 2000. P. 1-10.
9. Dunn OA, Clark VA. Applied statistics: analysis of variance and regression. New York: Wiley; 1974.
10. Bergamasco R, Girola C, Colombini D. Guidelines for designing jobs featuring repetitive tasks. Ergonomics. 1998 Sep; 41(9):1364-1383.
11. Battevi N, Bergamasco R, Girola C. Criteria for the reintegration in the workforce of workers with musculoskeletal disorders of the upper limbs, based on preliminary practical experience. Ergonomics. 1998 Sep; 41(9):1384-1397.
12. Armstrong TJ. Analaysis and design of jobs control of work-related musculoskeletal disorders (WMSDS). In: Violante F, Armstrong T, Kilbom A, editors. Occupational ergonomics work-related musculoskeletal disorders of the upper limb and back. 1st Ed. London & New York, UK & US: Taylor & Francis Publishing; 2000. P. vi.x.
13. Genaidy AM, al-Shedi AA, Shell RL. Ergonomic risk assessment: preliminary guidelines for analysis of repetition, force and posture. J Hum Ergol (Tokyo). 1993 Jun; 22(1):45-55.
14. Karwowski W, Marras WS. The occupational ergonomics handbook. Florida: CRC Press; 1997.
15. Bernard BP. Musculoskeletal disorders and workplace factors. Cincinnati, Ohio: DHHS (NIOSH) Publication, national institue for occupational safety and Health; 1997. P. 141-145.

16. Pheasant S. Body space: anthropomentry, ergonomics and design of the work. Florida: 2nd ed. CRC 1996.