



# Subjective Mental and Physical Assessments of Workload and Its Correlation with Wrist Disorders of Workers in the Assembly Line Workers of a Porcelain Company

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## Abstract

**Objectives:** This study aimed at measuring the mental and physical workload and its association with the prevalence of wrist disorders.

**Methods:** This cross-sectional study was conducted on 120 female workers working in the assembly line of a porcelain company. The mental and physical workloads and also the prevalence of wrist disorders were measured using the National Aeronautics and Space Administration-Task Load Index (NASA-TLX) questionnaire, the OCRA method, and the Nordic musculoskeletal questionnaire for wrists and hands, respectively.

**Results:** The results showed that 63.3% of the participants had discomfort in their wrist and hands. The Mann-Whitney test results showed that OCRA risk levels were significantly higher in those with wrist pain than those without. The NASA-TLX results revealed that the physical demands and effort ( $78.79 \pm 19.562$  and  $78.37 \pm 20.002$ , respectively) had the higher scores among the 6 subscales of NASA-TLX, which were significantly higher in those with wrist pain.

**Conclusions:** The findings suggested a high rate of physical and mental workloads and also the wrist disorders in the assembly line workers of the porcelain company. It seems that mental workload is one of the risk factors associated with the incidence of MSDs. Therefore, the high amount of mental workload should be considered as a risk factor.

**Keywords:** Mental Workload, Physical Workload, Assembly Line, Musculoskeletal Wrist Disorders

## 1. Background

Global competition in the manufacturing sector has brought about an environment for developing the methods to enhance capacities, improve operations continuously and reduce the costs. However, investing in these aspects requires paying much more attention to workforce health factors (1), of which ergonomic risk factors at workstations are more important due to work-related musculoskeletal disorders (WMSDs) (2). Musculoskeletal disorders (MSDs) are conditions, in which nerves, tendons and muscles are affected (3). They are sometimes known as ergonomics-related injuries and disorders (4). These disorders are commonly occurred in the occupations with high physical and psychological demands and can cause muscle discomfort and pains. Performing repeated tasks and/or performing an activity in an inappropriate physical condition are the causes of such disorders (5). Force, repetition, and awkward posture are among the primary risk factors for WMSDs (6). WMSDs usually are associated with symptoms, such as pain, sensitivity, vulnerability, swelling and numbness in various organs (7), which can cause huge damage to the organization by affecting the quality of products and services (8). WMSDs are widely seen in assembly line jobs, because most of the tasks in these jobs are repetitive and need precision. Assembly line workers suffer from physical and psychological workload (9). The Occupational Repetitive Actions (OCRA) method can be used to assess the risk factors of MSDs (10).

In addition to physical demands, workstations are currently associated with more cognitive demands for operators (11, 12). Thus, the concept of subjective mental workload (SMWL) depends on the kind of profession, in which the operator is working. SMWL is one of the most widely used concepts in ergonomics and human factors (13). It can be defined as the amount of mental effort made by a per-

son while performing his task along with using his mental capacity in receiving and processing information and also making decisions (14). Physical factors and workplaces are not the only causes of WMSDs. Eatough et al. (15) revealed that psychological factors can also be effective in the incidence of these disorders. Studies on WMSDs have shown a direct or indirect relationship between physical and psychological risk factors and individual characteristics with the prevalence of MSDs (16). They also have reported the effect of mental workload on muscles (17). Paying more attention to SMWL is currently one of the main goals of ergonomics to achieve convenience, satisfaction, productivity and safety in the workplace. For this reason, many studies have been recently conducted on SMWL, operators' performance level, their feelings, and abilities to perform tasks, their tasks' complexities and the time needed for their tasks (13, 18, 19). There are several tools to measure mental workloads, among which the National Aeronautics and Space Administration-Task Load Index (NASA-TLX) is one of the most popular self-report measures dealing with cognitive tasks (20).

The role of physical activity, work environment factors, and workstations as the leading causes of MSDs has been widely considered. However, limited numbers of studies has reported the relationship between psychological factors and the prevalence of MSDs in workplaces (21). Considering the need for conducting relevant studies and the high prevalence of MSDs in assembly line workers and also the fact that women suffer from MSDs much more than men (22), this study aimed at investigating the prevalence of MSDs to take the necessary measures to control the workload with a higher index and also its consequences among the affected group.

## 2. Methods

### 2.1. Study Design and Participants

This cross-sectional study was conducted on 120 female workers employed in the assembly line of a porcelain manufacturing company in 2018. All participants signed a written informed consent form before participating in this study. The ethics committee of the Isfahan University of Medical Sciences reviewed and approved the research protocol.

The mean age and work experience of the participants were  $33.16 \pm 6.80$  and  $7.06 \pm 5.35$  years, respectively. The descriptive statistics of the qualitative variables and demographic information of the subjects are presented in Table 1.

**Table 1.** Descriptive Statistics of the Participants' Qualitative Variables

Qualitative Variables, Category	Frequency (%)
<b>Education</b>	
Diploma	88 (73.3)
AD	13 (10.8)
BS	18 (15.0)
MSc	1 (0.8)
<b>Marital status</b>	
Single	18 (15.0)
Married	102 (85.0)
<b>Exercise program</b>	
Yes	15 (12.5)
No	105 (87.5)
<b>Dominant hand</b>	
Right	106 (88.3)
Left	14 (11.7)

Abbreviations: AD, associate degree; BS, bachelor of science; MSc, master of science.

### 2.2. Assessment of the Mental Workload by NASA-TLX

A NASA-TLX questionnaire was used to measure the workload of the position. It is a reliable tool for measuring mental workloads and has been widely used in the studies on human performance and performance levels (23). It is also a multi-dimensional approach that provides a total score of workload, based on the weighted average of six subscales, including mental and physical demands, temporal demands, effort, performance, and frustration (24). NASA-TLX consists of two parts. The first part deals with the total workload in an activity divided into six subscales. The user must first read the description of each subscale before scoring it. Its result is a score ranging from low to high, except for the performance and efficiency subscales that are measured from good to poor levels. In this questionnaire, subscales are rated for each task within a 100-points range with 5-point steps. At the end, the selected values are set in the TLX. In the second part, these subscales are compared two by two making the participants able to select the scale with the most impact on her work. The scale is available in the paper and electronic versions, which its electronic version was used in this study. The reliability and validity of this questionnaire were confirmed by the Cronbach's alpha coefficient of 0.83 by Kazemi et al. (25).

### 2.3. Assessment of the Physical Workload by OCRA

The status of the body was assessed by OCRA. This method is suggested to analyze the various health risk factors in upper limbs in workers with daily repetitive tasks

(26). It is also developed to determine the level of exposure of the workers to the repeated tasks and the risks due to the WMSDs (27). The OCRA method assesses four risk levels ranging from low to high. An OCRA score of 1 or less means low-risk level (or no risk) and is placed in the green zone (risk level of 1). An OCRA score of between 1 and 2 is considered as negligible risk and is placed in the green/yellow zone (risk level of 2). An OCRA score of between 2 and 4 represents a moderate risk located in the yellow zone (risk level of 3). An OCRA score of over 4 shows severe risk level, which is seen in the red zone (risk level of 4). In a study by Colombini and Occhipinti (28) in 2004, OCRA was used for risk and impairment assessment in workers exposed to repetitive strain and movement of the upper limbs in various occupations, including assembly line workers, electrical appliances manufacturers, workers in the cleaning industry, and meat processing employees. The results were divided into four levels of risk-free, low risk, moderate risk and high risk.

#### 2.4. Assessment of Wrist Disorders

The prevalence of wrist disorders in the participants was assessed using the Nordic Musculoskeletal Questionnaire for wrists and hands. It is a standard questionnaire that includes multiple-choice questions assessing the discomfort and severity of pain in 9 musculoskeletal areas during the past year. The questions can be answered either by interviewing the workers or by the subjects. This questionnaire consists of two parts, including a general part and a specific part. The general part evaluates the general examination of the symptoms in whole body organs, whereas the specific part deals with a deeper analysis of these symptoms in nine specific areas of the body, such as lumbar, neck, and shoulders. It was first designed by Kuorinka et al. in 1987, and then reviewed by Dickinson in 1992 (29).

#### 2.5. Study Stages

The subjects ( $n=300$ ) were fully informed about the research objectives, of whom 225 participants were voluntarily participated in a training session to be informed about the study process. A total of 120 participants were then selected based on the inclusion criteria, including the lack of the following problems: occupationally-related surgery, osteoporosis, hand fractures, hand disorders, a stroke due to unexpected events for hands, psychological disorders, pregnancy and diseases, such as diabetes. In the second stage, needed data were collected from the participants' demographic information. The prevalence of MSDs was measured by the Nordic Musculoskeletal Questionnaire for wrists and hands and also interviews with the participants. The electronic version of NASA-TLX questionnaire

was then distributed among the subjects in their working hours and the results were recorded for further analysis. In order to confirm the workload scores obtained from the subjective mental evaluation, the musculoskeletal load of the upper limb caused by repetitive tasks and the risk of MSDs were evaluated using the OCRA method. Seventy-seven tasks were identified by observation and then divided into the related activities. Each activity was then divided into its related motions, which were finally subjected to the required examinations. The information derived from the OCRA method was collected in the checklist and evaluated through the ErgoIntelligence UEA Software (version 1.4b). Finally, the results of the three measurement tools were analyzed by SPSS version 20.0 using the appropriate statistical tests (Mann-Whitney test and Spearman correlation coefficient).

### 3. Results

The results of the Nordic questionnaire showed that 76 participants (63.3%) had discomfort in their wrist and hands. The severity of their experienced pain is presented in Table 2. An Independent *t*-test was conducted to examine significant differences between two groups (with and without pain) in terms of their age and work experience. The relationship between age and work experience and pain intensity was measured using the Spearman correlation coefficient, which was significant ( $P = 0.001$ ).

In addition to the pain intensity reported in Table 2, further information was collected regarding the wrist pain in the affected individuals using the Nordic questionnaire. This information included the details on the duration of wrist problem over the past 12 months, the possible effect of the participants' wrist lesions on their occupational or leisure activities, the length of the lost work time, and whether the affected person had referred to a specialist or other physicians for her wrist or hand discomfort. The collected data are summarized in Table 3.

In this study, the Wilcoxon test was used to compare the risk levels of the OCRA index for both hands among 120 participants. The results showed that the risk index

**Table 2.** The Severity of Pain Experienced by Workers with Discomfort ( $N = 120$ )

Intensity of Pain	Frequency (%)
No pain	44 (36.7)
Moderate	20 (16.7)
Intense	46 (38.3)
Very intense	10 (8.3)
Total	120 (100)

**Table 3.** Duration and Consequences of the Wrist and Hand Problems

The Subjects with Wrist and Hand Problems, Category	Percentage
<b>Total duration of the problem over the past 12 months</b>	
0 days	0
1-7 days	25.8
8-30 days	22.5
> 30 days, but not Every day	12.5
Every day	2.5
<b>Reducing work activities over the past 12 months</b>	53.3
<b>Reducing leisure activities over the past 12 months</b>	31.7
<b>Total duration of the regular work avoided over the past 12 months</b>	
0 days	0.8
1-7 days	36.7
8-30 days	23.3
> 30 days	2.5
<b>Consultation with a physician or other health professionals over the past 12 months</b>	21.7

of the right hand was significantly higher than that of the left hand ( $P = 0.001$ ). Also, the mean OCRA index in the right and left hands was  $3.92 \pm 2.92$  and  $1.92 \pm 1.45$ , respectively. The results of the Paired  $t$ -test also showed that the mean OCRA index in the right hand was significantly higher than that of the left hand ( $P = 0.001$ ). The results of the physical workload measurement using OCRA method are given in Table 4. This table shows that the highest level of risk for the right hand was risk level 3 (low risk) and the highest level of risk for the left hand was risk level 1 (risk aversion). Generally, the assembly of the large pieces, like platter food, soup dishes, and plates with complex design structures is associated with the higher risk for the assembly line workers of a porcelain company. According to the classification of risk levels, no action is required to deal with the risk levels 1 (no risk) and 2 (trivial or insignificant risk), whereas corrective action is required for the risk level 3 (low risk), and for the risk level 4 (significant risk) corrective action is necessary and even task redesigning is needed, as well.

Regarding the dominant hand, 88.3% of the subjects were right-handed and 11.7% were left-handed. The Mann-Whitney test was used to measure compare the right handed and left handed participants in terms of OCRA risk index. The results showed that the score of OCRA index for the right hand in right-handed participants was significantly more than the left-handed subjects and the same pattern was observed in the left-handed individuals ( $P = 0.001$ ; Table 5).

**Table 4.** The Risk Levels of the Left and Right Hands and Comparison of the Two Hands

Category	Right Hand (N = 120)	Left Hand (N = 120)	P Value
<b>Risk level, %</b>			0.001 <sup>a</sup>
Green	2.5	35.0	
Green-yellow	24.2	30.8	
Yellow	40.0	25.8	
Red	33.3	8.3	
Total	100	100	
<b>OCRA index</b>			0.001 <sup>b</sup>
Mean	3.92	1.92	
Standard deviation	2.92	1.45	
Min	0.65	0.48	
Max	15.43	7.41	

<sup>a</sup>Wilcoxon test<sup>b</sup>Paired  $t$ -test**Table 5.** Comparison of the Frequency of OCRA Risk Levels in the Right-Handed and Left-Handed Participants

Category	Handedness, %		Mann-Whitney Test
	Right-Handed	Left-Handed	
<b>Right-OCRA</b>			P = 0.001
Green	0.0	21.4	
Green - yellow	18.9	64.3	
Yellow	44.3	7.1	
Red	36.8	7.1	
<b>Left-OCRA</b>			
Green	36.9	0.0	
Green - yellow	34.0	7.1	
Yellow	23.6	42.9	
Red	2.8	50.0	

The Mann-Whitney test was used to compare two groups (with and without wrist pain) in terms of OCRA risk level (Table 6). The results showed that the OCRA risk levels were significantly higher in those with wrist pain than those without ( $P = 0.001$ ). As OCRA levels increased, the pain and discomfort of the subjects with wrist disorders also increased.

The obtained data from the six SMWL subscales using the NASA-TLX software are shown in Table 7. The physical (78.79) and effort (78.37) were found as the highest, and the performance (40.25) was announced by the workers as the lowest scores among the six SMWL subscales.

The correlation between six SMWL subscales and wrist pain is presented in Table 8. The Independent  $t$ -test results showed that the mean physical activity, effort, and overall

**Table 6.** The Relationship Between OCRA Risk Levels and Wrist Pain

Category	With Wrist Pain (N = 76), %	Without Wrist Pain (N = 44), %	Mann-Whitney Test
<b>Right-OCRA</b>			P = 0.001
Green	3.9	0.0	
Green - yellow	9.2	50.0	
Yellow	34.2	50.0	
Red	52.6	0.0	
<b>Left-OCRA</b>			
Green	23.7	54.5	
Green - yellow	31.6	29.5	
Yellow	32.9	13.6	
Red	11.8	2.3	

mental workload in the participants with wrist pain were significantly higher than those without pain ( $P < 0.05$ ). Also, the mean of performance in those without wrist pain was significantly higher than those with wrist pain ( $P = 0.001$ ). In other cases, no significant difference was observed.

In this study, the relationship between the severity of wrist pain and the OCRA risk index and the NASA-TLX were also measured. The results of Spearman correlation coefficient showed a direct relationship between the severity of the wrist pain and the OCRA risk index in both hands ( $P = 0.001$ ), and also the total score of NASA ( $r = 0.232$ ,  $P < 0.05$ ).

#### 4. Discussion

Women due to their physiological characteristics are more likely to be affected by problems associated with performing repetitive tasks in assembling jobs (carpal tunnel syndrome (CTS) instances observed in women are 5 times more than men (30)). Several studies have been carried out on musculoskeletal problems in female assemblers. Considering the need for examining the prevalence of MSDs in assemblers in the relevant studies, the aim of this study was to measure the mental and physical workload and its association with the prevalence of wrist disorders in assembly line workers in a porcelain manufacturing company.

The results of the present study indicated that workers in assembly line of the porcelain manufacturing industries are exposed to wrist disorders, due to the type and nature of their tasks.

In this study, the Wilcoxon test was used to compare the risk factors of the OCRA index in both hands and the difference between the right and left hands was significant ( $P = 0.001$ ).

After examining the assembly process of different pieces as well as determining the risk level of the workers' right and left hands, it was found that the mean OCRA index of the right hand was greater than that of the left hand. This can be due to the fact that most of the participants were right-handed.

Another finding was the role of the shape and design of the pieces in the ergonomic risks of the workers' left and right hands, since they caused the assembly process as well as the needed physical postures and hands to be more involved in repetitive movements. The larger pieces with more complex design structures needed more repetitive movements and also more wrist involvement.

Generally, the highest risk of the right hand was at risk level 3 (the low risk that needs corrective action) and the highest risk of the left hand was at risk level 1 (risk aversion). In this study, Wilcoxon test was used to compare the risk factors of the OCRA index in both hands, and the difference between the right and left hands was significant ( $P = 0.001$ ). Also, Mann-Whitney test was applied to measure two groups (with and without wrist pain) in terms of OCRA risk levels. The results revealed that OCRA risk levels were significantly higher in those with wrist pain than those without wrist pain ( $P = 0.001$ ). As OCRA levels increased, the pain and discomfort of people with wrist disorders also increased. Furthermore, an Independent *t*-test was used to examine the correlation between age and work experience and wrist pain, and also Spearman coefficient was employed to evaluate the correlation between age and work experience and the severity of wrist pain and the results of both tests were statistically significant ( $P = 0.001$ ). These results were consistent with the results of other studies (31-33). Habibi et al. (27) examined the ergonomic risk factors through the OCRA index in an assembly company. The results showed that most complaints by assembly line workers was about their pain experienced in their wrists and fingers. They concluded that the OCRA method can be used as one of the most effective methods for measuring the risk of upper limb MSDs in such occupations. Furthermore, the results of Jansen et al. study (1) conducted on 37 female assembly workers with MSDs, showed that they felt pain more on their neck, lower back and right wrist. Veronesi Junior et al. (34) reported that rapid and repetitive movements were associated with the development of MSDs and repetitive strain injuries (RSI).

Psychologically, the existence of a certain amount of stress and workload is common in each occupation and the workers' behavior, performance, and efficiency are affected by psychological stress. Several studies have acknowledged the role of psychological factors in the incidence and prevalence of MSDs (21, 35). Moreover, it has been revealed that various factors, such as constant

**Table 7.** Results of NASA-TLX in the Assembly Workers (N = 120)

Statistics <sup>a</sup>	Mental Demands	Physical Demands	Performance	Temporal Demands	Effort	Frustration	Overall Workload
<b>Rating</b>							
Mean	63.17	78.79	40.25	74.54	78.37	64.08	69.7847
Standard deviation	22.398	19.562	19.304	19.370	20.002	25.421	12.32226
<b>Weight</b>							
Mean	0.13354	0.23341	0.12461	0.18803	0.21129	0.11689	-
Standard deviation	0.100334	0.085929	0.087058	0.087122	0.080360	0.107256	-
<b>Tally</b>							
Mean	1.93	3.51	1.87	2.82	3.18	1.68	-
Standard deviation	1.320	1.290	1.306	1.307	1.207	1.426	-

Abbreviation: NASA-TLX, National Aeronautics and Space Administration-Task Load Index.

<sup>a</sup>Rating, out of 100; Weight, out of 1; Tally, out of 15.

**Table 8.** The Associations Between the Weighted Average of Ratings on Six Subscales and Musculoskeletal Outcomes

Subscales	Study Size (N = 120)	With Wrist Pain (N = 76)	Without Wrist Pain (N = 44)	P Value
<b>Mental demands</b>	63.17 ± 22.3	62.83 ± 24.8	63.75 ± 17.72	0.83
<b>Physical demands</b>	78.79 ± 19.2	81.05 ± 18.5	74.89 ± 20.04	0.045
<b>Performance</b>	40.25 ± 19.3	35.92 ± 18.5	47.73 ± 18.37	0.001
<b>Temporal demands</b>	74.54 ± 19.3	74.93 ± 20.6	73.86 ± 17.18	0.77
<b>Effort</b>	78.38 ± 20.0	80.72 ± 18.4	74.32 ± 22.06	0.046
<b>Frustration</b>	64.08 ± 25.4	65.66 ± 26.4	61.36 ± 23.51	0.37
<b>Overall workload</b>	69.78 ± 12.3	71.54 ± 13.0	66.74 ± 10.50	0.039

and monotonous activities, task requirements (concentration, attention, and effort), fatigue (due to the physical pressures, environmental factors (sound, vibration, etc.)), and interpersonal relationships can lead to an increase in SMWL (36). In this regard, the findings of the present study, in which workload was measured using the NASA-TLX method, showed a high level of workload in the assembly workers (69.78%), and also the subjects suffered from the pressures caused by SMWL. Physical pressure and effort subscales showed the higher scores in the participants, because assembly line workers are involved in a great deal of physical activities and efforts while working to meet the expected outcome (in terms of the number of units to be assembled) determined by the industries. In addition, the performance subscale was ranked with the lowest score by the participants among the six SMWL subscales. The results of Independent *t*-test showed that the mean of physical pressure and effort scales and also the overall workload in the participants with wrist pain were significantly higher than those without pain ( $P < 0.05$ ). Also, the mean score of performance scale in those without wrist pain was significantly higher than those with

pain ( $P = 0.001$ ). This suggests the important role of workload as a risk factor to cause physical and psychological stress in workers and subsequently, ergonomic concerns and problems, which indicate the necessity of examining workload. Therefore, the necessary measures should be taken to control and reduce the workload as well as its consequences. In this study, the relationship between the severity of the wrist pain and the OCRA risk index, and the NASA-TLX were also investigated. The results of the Spearman correlation coefficient showed that there was a direct correlation between the severity of the wrist pain and the OCRA risk index in both hands ( $P = 0.001$ ), and also the total score of NASA ( $r = 0.232$ ,  $P < 0.05$ ). In this regard, Keir and Brown (37) have reported that high repetition, high force, and gripping are important factors in the development of MSDs. In Mazloumi et al. study (38), entitled "workload assessment of workers in the assembly lines of a car manufacturing company" in 2014, the workload assessment using the NASA-TLX index showed that the participants measured the performance and the physical demands with the scores of 89.23 and 86.92, respectively, as the most important subscales, whereas they determined mental de-

mands (49.23) as the least significant one. The results of this study suggested a high level of workload in the assembly line workers, which was confirmed by observational assessment. Hughes et al. (39) in a study on the workload of assemblers using the NASA-TLX method showed that physical demands and effort had the highest scores, whereas mental demands showed the lowest scores. In Darvishi et al. study (40) on the relationship between mental workload with MSDs in the employees of a bank by NASA-TLX method, a significant correlation was found between the overall mental workload score and the subscales of SMWL and MSDs. Yeung et al. (41) revealed a relationship between the protective and risk characteristics of acting and experienced workload experienced by MSDs and concluded that there was a significant correlation between workload and MSDs. Khandan et al. (42) using the NASA-TLX method, evaluated the employees of a heavy metal company. The results demonstrated that the two subscales, including mental demands and physical demands had the highest scores among different subscales. In 2012, Borner et al. (43) examined the assembly line workers' workload in the car industry using the NASA-TLX method. The results indicated that the temporal demands and physical demands subscales were the most important ones from the subjects' point of view. In addition, previous studies have also reported a correlation between individual workload and MSDs (44-46).

In conclusion, the factors affecting the occurrence and outbreak of MSDs can also be involved in SMWL. As a result, these factors simultaneously lead to the incidence and prevalence of MSD in workers (40, 47-49).

#### 4.1. Limitations and Future Studies

The present study faced the following limitations: (1) this research had a cross-sectional design, in which the cause and effect relationship can not be established, since the results may be influenced by other variables; (2) the used research tools also affected the results. For example, the NASA-TLX and Nordic musculoskeletal questionnaires are self-reported instruments and the self-reported answers may be exaggerated or vice versa; (3) moreover, the sample included assembly line workers of a porcelain company in Iran, who may not be representative of all assemblers. In different companies, assembly line workers have different working demands and conditions. Accordingly, the results can not be generalized to other subjects. Further studies can address the different preventive and intervention strategies to reduce SMWL, prevent the incidence of MSDs, and improve workers' performance. Also, ergonomic guidelines for workstations can be used in the future studies to decrease SMWL. They include regular work - rest patterns and regulate environmental condi-

tions, and most importantly, design workplace according to the macro-ergonomics approaches.

#### 4.2. Conclusions

In general, the results of the present study indicated the high physical and mental workload of the assembly line workers of the porcelain company, and the resulted wrist disorders in the subjects. In addition, the highly repetitive tasks in the assembly line workers of the porcelain industry is the major factor in increasing the OCRA risk level and also the prevalence of wrist disorder. It can be concluded that the overall SMWL score may be effective in the incidence of MSDs. In other words, the prevalence and percentage of MSD were higher in those with a higher SMWL score. In fact, identification of the risk factors associated with development of MSDs, especially psychological factors, seems crucial. MSDs have become a major health issue for industries and communities, and relevant investigations can be helpful for occupational health professionals to provide preventive and controlling strategies. It seems that SMWL scales can be one of these risk factors. Consequently, the mental workload should be measured and evaluated as a risk factor for the incidence of MSD.

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