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Evaluation of Upper Limb Musculoskeletal Loads due to Posture, Repetition, and Force by Rapid Upper Limb Assessment in a Textile Factory

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ABSTRACT

Background*:* In the last 15 or 20 years, upper extremity musculoskeletal disorders have been recognized as a cause of major medical problems among industrial workers.

Objectives: The aim of this study was conducted to assess risk factors for upper limb musculoskeletal disorders on workers performing various tasks in a textile factory. Ergonomic interventions and solutions may be developed on the basis of the assessment results.

Patients and Methods: Rapid Upper Limb Assessment (RULA) was used to evaluate upper limb musculoskeletal loads, and the Nordic Musculoskeletal Questionnaire (NMQ) was used to measure the prevalence of upper limb disorders in workers at the Qaem Shahr textile factory. A target population sample included 566 subjects (404 males [71.4%] aged 23–51 years, mean age 32.9 [SD = 6.3 years]; 161 females [28.6%] aged 21–37 years, mean age 25.6 [SD = 8.6 years]).

Results: Prevalence data on disorders to the upper arms, lower arms, wrists, neck, trunk, and legs were obtained in 497 (87.8%), 255 (45.1%), 318 (56.2%), 383 (67.7%), 436 (77%), and 163 (28.8%) workers, respectively. Recommended action as a result of the assessment varied according to prevalence and severity of the disorders. Tasks involving spinning, direct wrapping, pirn wrapping, Gard machine operating, yarn combing, weaving, and fold counting were revealed to be the most hazardous. The results of the NMQ confirmed the results of the RULA.

Conclusions: Preventive measures at the structural, organizational, and personnel levels must be taken for the safety of industrial workers performing tasks categorized as action levels 2–4 in this study. RULA is a useful and practical tool for evaluation of musculoskeletal disorders resulting from working in a textile factory.

▸ *Implication for health policy/practice/research/medical education:*

This article pays attention to the application of an ergonomic risk factors assessment technique so-called "Rapid Upper Limbs Assessment (RULA)" for evaluation of the upper limb musculoskeletal loads due to posture, repetition and force in textile factory. It introduces a practical topic in ergonomics field that can be useful for ergonomists, occupational hygienists, occupational therapists, industrial designers, physiotherapists, rehabilitation specialists, and anthropologists.

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1. Background

Musculoskel *et al.* disorders are among the most prevalent occupational ailments in industrialized and industrializing countries. These disorders are common in industrial jobs requiring awkward postures, repeated motion, and heavy lifting. Work-related musculoskeletal disorders (WMSDs) arise when work activities and conditions contribute significantly to their development or ex-

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acerbation, but are not the sole determinant of causation (1). WMSDs are mainly caused by poor workplace conditions. WMSDs are responsible for a large number of disability and workers' compensation claims (2). Therefore, ergonomically challenging situations must be identified that may contribute to these disorders which so negatively affect workers' productivity and performance.

The possible mechanisms of injury to specific tissues in WMSDs vary. Generally, injuries associated with various manual tasks may be characterized as either acute or cumulative. Acute injuries are associated with relatively short exposure to loads which exceed the tissue tolerance level (3, 4). Cumulative injuries, as the term suggests, occur as a consequence of relatively long-term exposure to such loads. In the latter case, the mechanism of injury is generally believed to be an accumulation of microdamage which exceeds the tissue's capacity for repair (3, 5). Injuries may also occur as a combination of both mechanisms: a history of cumulative loading leads to reduced tissue tolerance, and that tolerance level is then exceeded by short-term exposure to a relatively high-intensity load (3, 6). For preventing these injuries, the cause of load exposure and those aspects of the task or job that should be redesigned must be identified in order to eliminate or at least reduce that exposure (7), with consideration of the various possible risk factors involved. The relation between musculoskeletal disorders and ergonomic risk factors (including prolonged exposure to forceful exertions, awkward and static posture, vibration, and repetition) has been strongly confirmed. Certain injuries and disorders are particularly associated with exposure to multiple ergonomic risk factors (3, 8). For example, strong epidemiological associations have been found between individual risk factors of vibration and forceful exertion (8).

Sex differences also play a role in susceptibility to risk factors, although associations with workplace risk factors are generally found to be stronger than gender factors. Several epidemiological studies have found that women are at higher risk for work-related neck and upper limb disorders (8, 9). The importance of gender differences and their implications for work system design requires more study (3, 9, 10). In order to avoid injury to and impaired function of workers in the workplace, knowledge about ergonomic risk factors is important (3).

2. Objectives

The aim of this study was conducted to assess risk factors for upper limb musculoskeletal disorders on workers performing various tasks in a textile factory. Ergonomic interventions and solutions may be developed on the basis of the assessment results.

2. Materials and Methods

This study included 566 workers performing 34 different tasks in the textile factory in Qaem Shahr, northern Iran. Tasks required of these workers put them at risk for injury to the upper extremities. The workers were surveyed for assessment of risk factors for WMSDs of the upper limbs using the Nordic Musculoskeletal Questionnaire (NMQ) and the Rapid Upper Limb Assessment (RULA) (10, 11). With the NMQ method, anamnestic cases were examined on the basis of pains, discomforts, or disorders present for at least 1 week during the previous 12 months, or appearing at least once a month, and not attributable to acute trauma (1, 3). The results were subdivided by gender (11). Using the RULA method, the 34 aforementioned tasks were evaluated in terms of their propensity to expose workers to upper limb disorders (neck, shoulder, upper and lower arms, and wrist).

2.1. Nordic Musculoskeletal Questionnaire (NMQ)

Using postal questionnaires or interviews asking about symptoms is an inexpensive, quick, and easy way to ascertain information and acquire data about health outcome (3, 11). The survey method is particularly suitable for large studies and, in principle, standardization is easy (3, 11). One of the most commonly used standardized symptom questionnaires is the NMQ, which was developed by Kuorinka and colleagues in 1987 (11). This questionnaire is good for surveillance purposes (11). It can also be used for determining incidence, prevalence, occurrence rate, and epidemiology of musculoskeletal disorders in different body regions resulting from ergonomically undesirable work conditions and awkward postures (3, 11). Inter- and intra-observation validity and reliability of this questionnaire have strongly been confirmed in previous studies (11).

2.2. Rapid Upper Limb Assessment (RULA)

The RULA tool provides a relatively simple means of assessing the risk of developing upper limb disorders associated with a task (10). RULA was proposed by McAtamney and Corlett in 1993 as a practical method for analysis of working postures (10). The tool provides rapid assessment of musculoskeletal loads on workers due to posture, repetition, and force (3, 10). It aids in evaluating jobs or tasks that may expose workers to risk of developing upper limb disorders (neck, shoulder, upper and lower arms, and wrist) (3, 10), incorporating scores for postures across different body regions and ratings of exertion using a 4-point scale. Scores are then combined to produce a single score between 1 and 7 (3, 10). Advantages of RULA include its applicability to the complete range of manual tasks, its prioritization of tasks, incorporation of suggested action thresholds with an acceptable level of precision, and ease of use with minimal training and equipment (3, 10). While RULA is a relatively simple tool, allowing rapid assessment of upper limb risk while integrating posture and exertion, it does not incorporate consideration of other risk factors (i.e., repetition, duration, and vibration) (3, 10). In addition, the RULA tool fails to provide an integrated assessment of biomechanical risk factors or facilitate effective targeting of controls by providing an indication of the relative severity of different risk factors within a task (3, 10).

RULA has been used in the assessment of risk factors (repetition, force, awkward postures) to upper body regions in various types of work, including assembly work, production work, sewing, janitorial maintenance, meatpacking, grocery store work, telephone operating, ultrasound operating, and dental work. High sensitivity and efficiency of the results have been demonstrated (3, 10). It is a pen and paper-based observational method that requires very little time to set up.

The RULA method entails five steps: studying work processes, conducting interviews, recording observations, measuring, and assessing. All body parts are classified into two groups: Group A (upper arms, forearms, wrists, and wrist twist); and Group B (neck, trunk, and legs) (10). A total score based on evaluation of risk factors is calculated corresponding to four action levels: acceptable if not maintained or repeated for long periods (score: 1 or 2), requiring further investigation, possible changes required (score: 3 or 4), requiring change in the near future (score: 5 or 6), and requiring immediate change (score: 7) (10).

3. Results

The sample population consisted of 566 subjects, of whom 404 (71.4%) were males (age: 23–51 years, mean age: 32.9 years, SD = 6.3 years) and 161 (28.6%) were females (age: 21–37 years, mean age: 25.6 years, SD = 8.6 years). The minimum, maximum, and mean ages of the sample population were 21, 51, and 30.4 years, respectively. The male/female ratio was 1:2.5 (*Table 1*). A list of the 34 tasks assessed in this study using both the RULA and NMQ assessment tools is provided in (*Table 2*). Mean ages and gender distribution of workers for each task are also listed. Male workers were older than female workers. Three tasks were performed by male workers only: bale storing, bale handling, and textile fabric loading. Female workers dominated the spinning and weaving, and in bobbin dyeing and textile cutting, male and female workers were equal in number. Disorders were reported in the upper arms, lower arms, wrists, neck, trunk, and legs (*Table 3*). Data were obtained for upper arm, lower arm, wrist, neck, trunk, and leg disorders in 497 (87.8%), 255 (45.1%) 318 (56.2%), 383 (67.7%), 439 (77%), and 163 (28.8%) workers, respectively. The highest (4.8%) and lowest (1.8%) prevalence of upper arm disorders corresponded to the spinning and precision wrapping tasks, respectively. The highest (2.8%) and lowest (0.5%) prevalence of lower arm disorders corresponded to the spinning and full webbing tasks, respectively. The highest (3.2%) and lowest (0.9%) prevalence of wrist disorders corresponded to the tasks of spinning and hank handling, respectively. The highest (3.7%) and lowest (1.2%) prevalence of neck disorders corresponded to the spinning and precision wrapping tasks, respectively. The highest (3.9%) and lowest (1.6%) prevalence of trunk disorders was associated with the spinning and precision wrapping tasks, respectively. The highest (1.9%) and lowest (0.2%) prevalence of leg disorders was associated with the tasks of weaving and operating the dryer machine, respectively. The prevalence of upper arm disorders was higher than that of disorders in other body regions (trunk, neck, wrist, lower arm, and legs, in that order). Highest scores on the RULA assessment were reported for the upper arm region, followed by the scores for the trunk, neck, wrist, lower arm, and leg regions. The highest and lowest scores in these body regions were related to the tasks with the highest and lowest prevalence of injury in the same body regions.

Table 1. Subdivision of the Population Sample by Gender and Age

Gender	Workers, NO. (%)	Min. Age, y	Max. Age, y	Mean ± SD
Male	404 (71.4)	23	51	32.9 ± 6.3
Female	161 (28.6)	21	37	25.6 ± 8.6
Total	566 (100)	21	51	30.4 ± 9.4

Table 4 displays total scores, action levels, and recommendations for further action to be taken in order to correct the work situations and various tasks examined in this study. The highest posture A score was found in the spinning task, and the lowest posture score was related to the tasks of bobbin dyeing and textile cutting. The highest posture B score corresponded to the spinning task, and the lowest posture B scores were found for the tasks of bale storing, bale tapping, skeining, hank handling, full webbing, precision wrapping, bobbin wrapping, dryer machine operating, setting of knitting needles, textile cutting, and textile handling. The highest final scores for wrists, arms, neck, trunk, and legs corresponded to the spinning task. As shown in Table 4, 3 tasks, including bale trapping, precision wrapping, and textile cutting, were categorized as action level 1; 19 tasks were categorized as action level 2; 5 tasks, including bale handling, bale opening, cotton feeding, roll handling, and textile designing, were categorized as action level 3; and 7 tasks, including spinning, direct wrapping, pirn wrapping, Gard machine operating, yarn combing, weaving, and fold counting, were categorized as action level 4. The last column of Table 4 recommends further action for all tasks in action levels 2–4.

4. Discussion

This study of WMSDs used the RULA and NMQ methods to reveal significant risks associated with repetitive and/or strenuous movements of the upper limbs in various work environments in a textile factory. Specific measures for redesigning tasks and procedures must be implemented to address these risks. Such measures are often urgent and complex (12, 13). Their efficacy depends on three types of coordinated and simultaneous actions: structural modifications, organizational changes, and

Table 2. List of Tasks Assessed using the RULA and NMQ Methods

Task Type	Code	Workers, No			Mean Age	
		Male	Female	Total	Male	Female
Bale storing	T_1	14	0	14	24.8	0
Bale handling	T_2	16	0	16	25.6	0
Bale weighing	T_3	9	8	17	26.7	24.7
Bale opening	T_4	9	7	16	29.5	25.6
Bale tapping	T_5	8	6	14	37.3	30.7
Cotton feeding	T_6	10	6	16	25.9	34.2
Cotton mixing	T_7	12	4	16	31.3	31.3
Roll handling	T_8	13	4	17	36.8	34.1
Skeining	T_9	11	4	15	30.8	28.2
Hank handling	T_{10}	13	1	14	32.3	29.9
Spinning	T_{11}	11	17	28	35.4	31.2
Half webbing	T_{12}	12	4	16	30.9	28.6
Full webbing	T_{13}	11	3	14	36.3	25.1
Doubling	T_{14}	9	7	16	33.7	23.7
Manifolding	T_{15}	8	6	17	28.9	24.1
Direct wrapping	T_{16}	9	10	19	35.6	25.9
Precision wrapping	T_{17}	10	4	14	31.3	22.3
Pirn wrapping	T_{18}	11	7	18	38.2	25.6
Stretching	T_{19}	9	8	17	35.1	25.1
Bobbin wrapping	T_{20}	12	3	15	30.2	22.4
Yarn hauling	T_{21}	13	4	17	37.4	28.1
Gard machine operating	T_{22}	10	8	18	32.1	26.6
Bobbin dyeing	T_{23}	8	8	16	39.3	27.1
Dryer machine operating	T_{24}	10	4	14	40.1	25.3
Textile designing	T_{25}	11	6	17	38.5	29.2
Setting of knitting needles	T_{26}	9	6	15	35.4	31.6
Yarn combing	T_{27}	11	7	18	30.7	26.7
Weaving	T_{28}	10	16	26	33.5	28.3
Textile cutting	T_{29}	7	7	14	26.9	34.2
Textile measuring	T_{30}	9	7	16	30.1	25.7
Fold counting	T_{31}	13	5	18	34.4	31.2
Textile controlling	T_{32}	9	8	17	31.6	29.3
Textile handing	T_{33}	8	7	15	38.2	34.5
Textile fabric loading	T_{T34}	16	0	16	35.2	0

personnel training (12, 13). While structural measures are almost universally accepted and widely recommended, actions involving organizational changes do not always gain unanimous consent (2, 12, 13). Often when specific risk and injury assessments show the need for preventive action, a wide range of assorted measures is implemented (2, 12, 13).

Structural measures involve optimizing the layout of work areas and equipment, and evaluating the ergonomic properties of work tools and equipment. Such measures may alleviate problems caused by use of excessive force and awkward postures (12, 13). Organizational measures essentially relate to job design (i.e., distribution of tasks, work pace, and breaks) (12, 13). They serve to alleviate problems connected with highly repetitive and frequently performed actions, excessively lengthy tasks and inadequate recovery periods (12, 13). Training and educational measures may be implemented following development of a suitable plan and schedule. The impact of the plan and schedule on production levels and costs must be considered (12, 13). Training programs must guide both workers and their supervisors.

The objective of these preventive measures is to lower to acceptable limits the frequency of certain repetitive tasks performed using the upper limbs for the purpose of preventing WMSDs (12, 13). Knowledge about the epidemiology of upper limb disorders is important for different types of prevention and in handling medical issues (2, 14). In primary prevention, the risk factors for neck and upper limb disorders must be considered during work-

Table 3. Prevalence of Disorders in Upper Extremity Region by Task Type

Task Type	Upper Extremity Disorders						
	Upper Arms, No. (%)	Lower Arms, No. (%)	Wrist, No. (%)	Neck, No. (%)	Trunk, No. (%)	Legs, No. (%)	P [a]
Bale storing	2.3 (13)	1.1 (6)	1.4 (8)	1.8 (10)	1.9 (11)	0.5 (3)	0.012
Bale handling	2.7 (15)	1.6 (9)	1.8 (10)	2.3 (13)	2.3 (13)	0.9 (5)	0.041
Bale weighing	2.5 (14)	1.1 (6)	1.4 (8)	1.8 (10)	2.1 (12)	0.5 (3)	0.007
Bale opening	2.5 (14)	1.2 (7)	1.8 (10)	2.1 (12)	2.3 (13)	0.7 (4)	0.016
Bale tapping	1.9 (11)	1.2 (7)	1.4 (8)	1.4(8)	1.8 (10)	1.1 (6)	0.011
Cotton feeding	2.5 (14)	1.6 (9)	1.9 (11)	1.9 (11)	2.3 (13)	0.9 (5)	0.038
Cotton mixing	2.3 (13)	1.1 (6)	1.6 (9)	1.6 (9)	1.9 (11)	0.5 (3)	0.022
Roll handling	2.7 (15)	1.1 (6)	1.4 (8)	1.8 (10)	2.3 (13)	0.7 (4)	0.011
Skinning	2.3 (13)	1.2 (7)	1.2 (7)	1.9 (11)	1.9 (11)	0.9 (5)	0.001
Hank handling	2.1 (12)	0.9 (5)	0.9 (5)	1.4 (8)	1.8 (10)	0.4 (2)	0.023
Spinning	4.8 (27)	2.8 (16)	3.2 (18)	3.7 (21)	3.9 (22)	1.8 (10)	0.031
Half webbing	2.3 (13)	1.8 (10)	1.8 (10)	2.1 (12)	2.3 (13)	1.4 (8)	0.013
Full webbing	1.9 (11)	0.5 (3)	1.1 (6)	1.6 (9)	1.8 (10)	0.5 (3)	0.034
Doubling	2.7 (15)	1.2 (7)	1.6 (9)	2.1 (12)	2.5 (14)	0.7 (4)	0.012
Manifolding	3 (17)	1.6 (9)	1.8 (10)	2.3 (13)	2.7 (15)	1.2 (7)	0.039
Direct wrapping	2.8 (16)	1.4 (8)	1.9 (11)	1.9 (11)	2.5 (14)	1.1 (6)	0.012
Precision wrapping	1.8 (10)	1.1 (60	1.1 (6)	1.2 (7)	1.6 (9)	0.5 (3)	0.040
Pirn wrapping	3 (17)	1.8 (10)	2.3 (13)	2.7 (15)	2.8 (16)	1.4 (8)	0.007
Stretching	2.8 (16)	1.4 (8)	1.8 (10)	1.9 (11)	2.3 (13)	0.9 (5)	0.016
Bobbin wrapping	2.3 (13)	0.9 (5)	1.2 (7)	1.8 (10)	1.9 (11)	0.5 (3)	0.031
Yarn hauling	2.7 (15)	1.1 (6)	1.6 (9)	1.9 (11)	2.3 (13)	0.5 (3)	0.038
Gard machine operating	2.8 (16)	1.2 (7)	1.8 (10)	2.1 (12)	2.5 (14)	0.5 (3)	0.027
Bobbin dyeing	2.5 (14)	0.9 (5)	1.2 (7)	1.6 (9)	1.8 (10)	0.4 (2)	0.011
Dryer machine operating	2.3 (13)	1.1 (6)	1.6 (9)	1.8 (10)	2.1 (12)	0.2 (1)	0.0001
Textile designing	2.5 (14)	1.1 (6)	1.4 (8)	1.9 (11)	2.1 (12)	0.9 (5)	0.023
Setting of knitting needles	2.3 (13)	1.4 (8)	1.8 (10)	1.8 (100)	2.1 (12)	0.9 (5)	0.031
Yarn combing	2.8 (16)	1.8 (10)	2.3 (13)	2.7 (15)	2.7 (15)	1.4 (8)	0.013
Weaving	4.1 (23)	2.7 (15)	2.8 (16)	3.2 (18)	3.5 (20)	1.9 (11)	0.034
Textile cutting	2.1 (12)	1.1 (6)	1.6 (9)	1.8 (10)	2.1 (12)	0.9 (5)	0.012
Textile measuring	2.3 (13)	1.2 (7)	1.4 (8)	1.6 (9)	1.8 (10)	0.7 (4)	0.026
Fold counting	2.7 (15)	1.4 (8)	1.8 (10)	2.3 (13)	2.5 (14)	0.9 (5)	0.012
Textile controlling	2.8 (16)	1.6 (9)	1.9 (11)	2.3 (13)	2.7 (15)	1.2 (7)	0.013
Textile handing	2.3 (13)	1.2 (7)	1.4 (8)	1.9 (11)	2.1 (12)	0.7 (4)	0.007
Textile fabric loading	2.7 (15)	0.9 (5)	1.1 (6)	1.4 (8)	1.9 (11)	0.5 (3)	0.016
Total	87.8 (497)	45.1 (255)	56.2 (318)	67.7 (383)	77 (436)	28.8 (163)	0.013

[a] Significance level was set at $P < 0.05$.

place design, and work systems must be developed that promote worker health (2). This epidemiological information about these risk factors and their magnitude can inform the initiation and implementation of changes in the workplace (2, 15). Secondary prevention involves treatment of injured workers to the point of full recovery, followed by early workplace rehabilitation. In this process, knowledge of the prognosis of different neck and upper limb disorders is important (2, 15, 16). To accommodate injured workers with impaired function in the workplace, knowledge of factors that prevent disability is necessary (2, 16).

The results obtained from the RULA tool in this study conform to those gained using the NMQ method. This demonstrates that the RULA tool is a useful, successful, and applicable method for assessment of risk factors and loads inducing upper limb disorders in workers in the textile factory examined in this study. In addition, the validity and reliability of the RULA tool have been verified and confirmed by similar results obtained from the NMQ (10, 11, 16). Thus, RULA is useful as a primary survey tool.

Many changes recommended in this study to the workplace and performance of work in the textile factory will be straightforward and obvious; however, the results of

Table 4. Determination of Grand Score, Action Level, and Further Actions for Correcting Various Tasks

Task Type	Posture A Score	Posture B Score	Muscle Use Score	Force/Load Score	Final Wrist And Arms Score	Final Neck, Trunk, And Legs Score	Total Score	Action Level	Comments
Bale storing	3	1	0	0	3	1	3	2	Investigate further
Bale handling	4	2	1	1	6	4	6	3	Investigate further and change soon
Bale weighing	2	2	1	1	4	4	4	2	Investigate further
Bale opening	4	2	1	1	6	4	6	3	Investigate further and change soon
Bale tapping	2	1	0	0	2	1	2	1	Acceptable
Cotton feeding	4	2	1	1	6	4	6	3	Investigate further and change soon
Cotton mixing	4	2	0	1	5	3	4	2	Investigate further
Roll handling	4	2	1	1	6	4	6	3	Investigate further and change soon
Skeining	4	1	0	0	4	1	3	2	Investigate further
Hank handling	3	1	0	0	3	1	3	2	Investigate further
Spinning	9	9	1	3	13	13	7	4	Investigate further and change immediately
Half webbing	4	2	0	1	5	3	4	2	Investigate further
Full webbing	3	1	0	0	3	1	3	2	Investigate further
Doubling	4	2	0	1	5	3	4	2	Investigate further
Manifolding	2	2	0	1	3	3	3	2	Investigate further
Direct wrapping	4	5	1	2	7	8	7	4	Investigate further and change immediately
Precision wrapping	2	1	0	0	2	1	2	1	Acceptable
Pirn wrapping	4	6	1	2	7	9	7	4	Investigate further and change immediately
Stretching	3	3	0	1	4	4	4	2	Investigate further
Bobbin wrapping	5	1	0	0	5	1	4	2	Investigate further
Yarn hauling	3	2	0	1	4	3	3	2	Investigate further
Gard machine operating	4	7	1	2	7	10	7	4	Investigate further and change immediately
Bobbin dyeing	1	2	1	1	3	4	4	2	Investigate further
Dryer machine operating	3	1	0	0	3	1	3	2	Investigate further
Textile designing	3	2	1	1	5	4	5	3	Investigate further and change soon
Setting of knitting needles	4	1	0	0	4	1	3	2	Investigate further
Yarn combing	6	7	1	2	9	10	7	4	Investigate further and change immediately
Weaving	7	8	1	3	11	12	7	4	Investigate further and change immediately
Textile cutting	1	1	0	0	1	1	1	1	Acceptable
Textile measuring	3	2	0	1	4	3	3	2	Investigate further
Fold counting	6	7	1	2	9	10	7	4	Investigate further and change immediately
Textile controlling	3	2	0	1	4	3	3	2	Investigate further
Textile handing	3	1	0	0	3	1	3	2	Investigate further
Textile fabric loading	3	2	0	1	4	3	3	2	Investigate further

this study indicate that more detailed investigation is required for certain tasks. Some changes can be made immediately and for very little cost, while others may be more difficult, requiring time and money. Further investigation should be conducted where recommended to determine necessary changes for tasks categorized in action levels 2–4. RULA should be used again after the changes have been implemented to track improvement and allow workers to describe their experiences of changes at work (17).

The RULA technique is accessible to relatively unskilled personnel after modest training. Many ordinary workers have been trained in its use, who have then gone on to improve their workplaces. Computerization of the procedure has made it available to all workers in a company, facilitating easy and quick assessment of their own work situations and conditions using the most recent version of the RULA. When workers have completed their assessments, scores are shown and suggestions for improvement are offered (10, 17). Combined with other techniques, methods engineers may find RULA a valuable tool that does not increase the time needed to investigate working methods. It is also useful in the design and planning of new workplaces to avoid creation of unsuitable work situations, ensuring that newly developed workplaces will suit all users (10, 17).

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Authors work equally.

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