

Ergonomics and its role in reducing risks during the practice of education and training in industrial secondary schools in Egypt

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Abstract – The study sought to apply human factor engineering in a number of industrial secondary school workshops in Egypt, such as furniture and blacksmithing carpentry workshops in two different schools. The research sample consisted of 35 students in each department. The misfit between the researched human factor applications and the physical characteristics of the employed individuals has negative consequences on the health, safety and productivity of the workers. The study conducted Ergonomics applications in the maintenance workshop of diesel engines for Egypt railway. The misfit between the Ergonomics applications and physical body dimensions of the employees in the factory reflected negative consequences on the health of the workers and their safety, and also on their productivity. It was found a set of conclusions and recommendations such as the Ergonomics. It considered as the entrances to design the work systems and achieve the coordination between employees according to their physical, and structural specifications of their work Environment. Another recommendation encourage the establishment of a governmental commission engage with Ergonomics as well as the establishment of an organizational unit specialized with Ergonomics, which provide the training material and physical requirements for studied factory.

Key Words: Ergonomics, Environments Work study, sounds - noise - light - heat – ventilation, worker ability.

1.INTRODUCTION

Ergonomics or human factors engineering is the science that the world has dedicated to bring, evaluate, process and display data related to the human body and its relationship to product design, conditions and working environments. This science is known as the amount of information on human capabilities, obstacles to movement and other human characteristics related to design. The term ergonomic design is also known as the application of this amount of information in the design of tools, machines, systems, tasks, functions and environments for efficient, safe and comfortable use.

That the musculoskeletal injuries associated with daily work practices are among the major health problems that workers within the industrial organization are exposed to during the handling of manual circulation and transport

activity. That cause muscular and structural disorders which cannot be avoided due to how it operates. To reduce these injuries, criteria should be established in order to assess these risks in an environment the work. So the goals of human factors engineering were to design machines and equipment and the work environment so that they fit the physical and mental capabilities of the worker in order to improve the performance of the individual worker within the industrial organization by increasing the performance speed with high accuracy and ensuring worker safety.

Also, it reduces human organ consumption and human stress by introducing automation of some production processes or automating the entire production line and this is evaluated using the “rapid evaluation of the upper end RULA” method. It is used to assess work risks resulting from wrong practices of manual activities and results in lower back, neck and upper limb injuries.

Therefore, reducing these injuries reduces absence and sick leave among workers within the organization and provides a safe work environment free from stress.

A person is not in the power of the machine or in the speed and accuracy of a computer. A person is in need of sleep and also prone to disease and the occurrence of a sudden accident or making mistakes or work without obtaining a suitable rest. Also, machines and vehicles cannot repair themselves and machines cannot modify themselves to an unexpected situation. Ergonomics or human factors are used to achieve the best-balanced performance between weaknesses and strengths between man and machine. Some people refer to human engineering or what is sometimes called human factors engineering in improving productivity and performance indicators through designing work sites, hand tools and tools in addition to machines and equipment that take into account the physical capabilities of a person [2].

Summarizing previous studies on the need to adhere to the science of ergonomics in all areas with the need to train workers on how to adhere to the science of ergonomics to reduce the industrial risks to which the worker is exposed. The study agrees with the previous studies as follows:

1. The necessity of introducing the science of ergonomics and its damages and providing an information base that would raise awareness to protect from its dangers.
2. The necessity of knowing the science of ergonomics and not neglecting them so that we can reduce musculoskeletal injuries.
3. Emphasizing on workers the need to adhere to the science of ergonomics to reduce the industrial risks to which they are exposed.

The research also benefited from the previous studies as follows:

1. Strategies dealing with the science of ergonomics to benefit from them to reduce the risks of ergonomics, methods of data analysis and methods and methods of reducing the risks of ergonomics mentioned in the results and recommendations, all the previous mechanism has been taken into account.
2. Methods of monitoring the risks of not applying the rules of human engineering in the workplace and their negative effects on workers and the need to adhere to applying these standards to avoid musculoskeletal injuries on workers.

2. THEORETICAL PROCEDURES

Ergonomics is a term derived from the Greek words Ergos and Nomos in the sense of the natural laws of action, a term that also indicates the fact that ergonomics is a systematic science and scope that has recently extended to all considerations related to human life. Ergonomics means compatibility, suitability and conformity. The harmony between humans, the things they use, the things that they do, and the environment in which they work and move around, and even that they have fun and play in. If this compatibility and well-being are achieved, the pressure on humans decreases. They will feel more comfortable, will be able to do their tasks faster and easier, and will make fewer mistakes. And the Ergonomic Design means the body's application of knowledge to design the workstation (work assignments, equipment, environment) to secure and adequately use by workers and that good design for human engineering works on:

However; human engineering is defined as the scientific study of the engineering relationship between man and his work environment. The work environment represents the conditions in which the individual lives and the machinery, equipment and materials he uses in work sites. As for the engineering relationship, it means compatibility and harmony between the standards of the human body and its muscular and sensory capabilities and the machinery, equipment and materials that it uses in order to adapt everything that surrounds the human body to its standards and capabilities as an integrated production unit, [1].

Some people refer to human engineering or what is sometimes called human factors engineering in improving

productivity and performance indicators through designing work sites, hand tools and tools in addition to machines and equipment that take into account the physical capabilities of a person [2].

Physical working conditions

Sitting for long hours may cause back stiffness, numbness of the hands and feet, as well as fatigue and nerve infections in the wrist. The severity of these symptoms increases with time and usually appears after several years of persistence in these actions and in order to avoid such injuries. Iso 6385 specifies a set of guidelines when designing as follows;

1. That the best angle for resting the eye while looking is the angle that ranges from (15-30) degrees towards the bottom, then the head must be in a position that reduces the pressure force on the neck muscles to the lowest possible extent, and that the head extends slightly forward, Also, the head should not be raised to the top, as raising the head to the top would strain the neck muscles.
2. The angle between the torso and thigh must exceed 95 degrees, preferably between (115-120) degrees, which reduces the pressure of the intervertebral disc and movement of the muscles in the back and works to straighten the spine.
3. The back of the chair should be supportive of the lower back lumbar spine.
4. The height of the chair should be adjustable in the sitting position
5. The base of the chair must be with five legs to provide maximum stability.
6. That the low seat be large enough to provide support to the thighs and buttocks, in order not to put pressure on the back of the knees.
7. Easily adjustable low slope seat.

Safety Instructions

1. Take regular break times and not stay in a seated position for a long period of time.
2. Doing exercises to overcome the tension of the muscles of the body, especially after sitting for several hours.
3. Adjusting lighting in the workplace to the level that provides comfort.
4. Shifting the direction of the computer screen to avoid glare and reflections of light.

Work productivity does not depend on improving the working methods and good design of its locations, but also on improving the physical conditions surrounding the worker, such as lighting, heat, and noise, which are specified by Iso10075;

1- Lighting

Good lighting is an essential ingredient in the efficiency and health of workers, and high productivity often

depends on speed of visual perception and accuracy in distinguishing between parts. Individual requirements for lighting vary according to age, for a person who is (60) years old needs (10) times what a person who is (20) years old needs, and the degree of backlighting must not be less than (50fc) candle / foot (foot candles)), So that the lighting is distributed uniformly.

2- Noise

It is an unwanted annoying sound that causes inconvenience, stress and possibly deafness, as it accompanies productive and manufacturing processes in general noise whose intensity varies according to the nature and quality of these operations and affects high levels of noise working in tension in its simplest cases and may lead to professional deafness and may lead to any death in the worst cases The limits of hearing are (85) decibel (db) in laboratories and (65) decibels in office work. The sound becomes disturbing when its intensity is (90) decibels or more. On the eardrum.

3- humidity and temperature

The intense heat that exceeds the normal rates borne by the bodies of workers leads to tension and loss of fluids from the body, and the extreme cold that the working individual loses the ability to focus in the work and necessitates wearing thick clothes that hinder the movement of the worker. And the rules of human engineering in this matter require that the degree in the work sites not be less than (20) degrees in winter and not more than (35) degrees in summer in the indoor places in general, while the levels of humidity acceptable in the office work ranges between (40-60) degrees Celsius .

Ergonomics goals and factors that aspire in product design

1. Products, tasks, workplace and tools are designed taking into account differences and differences in size, muscle strength, endurance and the ability to receive, perceive and deal with things and information for a large sector of users.
2. Reducing mistakes and working to reduce the chances of their occurrence, especially those that lead to serious risks.
3. Raising the level of safety and reducing accidents, stress and various pressures on individuals.
4. Improving performance, improving and enhancing the effectiveness and efficiency with which industrial and administrative tasks are accomplished.
5. Achieving suitable works, tools and environments for its users and designing jobs that suit individuals.
6. Improving the work environment. Maximizing the human ability to interact with products, tools and work environments
7. Reducing boredom and monotony (working with one pattern and frequency).

8. Increasing worker acceptance and satisfaction with work, its environment and its various conditions.
9. Reducing waste of time and equipment consumption.

The role of human factors in preventing work-related injuries

The neglect of the application of human factors principles in the design of tools and workplaces has resulted in many injuries in the devices supporting the bodies of workers, from shocks and wounds to severe lower back pain (LBD) at costs exceeding \$ 100 billion in the United States of America. For example, traumatic lesions (CTD) today constitute about 11% of all work-related injuries in the United States, and have caused many individuals to stop working temporarily, for long periods, or even permanently. The high rate of work injury in the past decades is attributed to many factors, the most important of which is the high production rates, which compels workers to perform frequent work thousands of times every day, in addition to the proliferation of the keyboard for computers, in addition to increasing the awareness of individuals of these injuries. NIOSH mainly works to increase awareness of the dangers arising from specific practices and offers some solutions in designing work environments.

3. EXPERIMENTAL PROCEDURES

Through the direction of research procedures to answer his questions and then achieve his goals, some criteria have been identified for selecting study cases, namely:

1. The research aimed at diversity in the selected industrial activities to more than one reality monitors the risks of agronomics.
2. Selecting departments whose activities depend on the operations in which manual transfer work is carried out.
3. Choosing departments in which complaints of musculoskeletal strikes are increasing.
4. Targeting institutions that believe in scientific research in addressing the risks of musculoskeletal strikes to ensure effective assistance.

4- Reality monitoring method for Rula analysis

It consists of 15 boundary items divided into tables A, B, c and the final result: 1: 2 = acceptable; 3: 4 investigation more; 5: 6 investigation more and change soon; 7 investigation and change immediately.

From No. 1 to No. 8 in Table A depends on the analysis of the arms and the palm of the hand.

From No. 9 to No. 11 depends on the analysis of the neck, back and torso.

From No. 12 to No. 15:

No. 12 cares about the general condition of the body.

No. 13 is concerned with the rate of muscle use, either in a fixed position or in a moving position at a rate of four movements per minute.

No. 14 is concerned with the use of strength and the load is divided into less than 2 kg or from 2:10 kg or more than 10 kg.

No. 15 is responsible for adding the previous scores to the numbers 12,13,14.

Then the final grades RULA are set by searching in table C with the results of step number 8 with step 15 to find the final grade of table C and the final score is subject to comparison with the following criteria from 1: 2 = acceptable.

It is 4: 3 investigation more.

It is 6: 5 more investigation and change soon.

And number 7 change immediately.

5- RESULTS AND DISCUSSIONS

The practical application of the first sample "blacksmith workshop at Giza Electrical High School"

The activity inside this workshop is based on the manufacture of some iron bars, tables, and gloves using the electric welding method. This method leads to high temperatures, humidity, and noise, which indicates that the work environment is not appropriate for health workers, where there is a permanent complaint from students of the emergence of general muscle and physical fatigue, which leads The workflow is affected.

It is clear from the following table No. (1) that the gravity levels of the arm and firm are higher than the gravity levels of the neck, trunk, and leg for the neck, trunk, leg for all students in the various work stages of cutting, cutting, and welding. As for the formation stage, the degree of gravity of the neck, trunk and leg is higher than the arm and firm and this indicates that Workers are susceptible to musculoskeletal injuries to the arm and wrist * wrist * arm is higher than for the neck, torso and leg, as the gravity levels of the arm and wrist are between 5: 7, while the gravity levels of the neck, trunk and leg range between 4: 9, indicating that musculoskeletal injuries occur to students in these departments.

The rula analysis for student No. 1 in the formation phase shows that the degree of risk for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60

degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a long time And repeated work.

As for the degree of severity of the neck, torso, and leg, it is 8 degrees, where the angle of inclination of the neck is more than 20 degrees, and the angle of inclination of the trunk is more than 60 degrees, with the feet bent during work and standing for long periods, and where the work is done consistently for long periods and carrying a weight of more than 10 kg, and from these two The two degrees show us that the final grade in the analysis of the Rolla that the student gets from the table is 7 and this means stopping these daily practices and changing immediately.

- The rula analysis for student No. 1 in the welding stage shows that the risk degree for the wrist and arm is 6 as the angle of the arm's tilt from 20 degrees to 45 degrees, the location of the lower arm from zero to 60 degrees, the wrist tilt angle from zero to 15 degrees with standing for long periods and repeated work.

As for the degree of severity of the neck, torso, and leg, it is 5 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. 6 This means changing these daily practices soon.

- The rula analysis of student No. 1 in the cutting stage shows that the degree of danger for the wrist and arm is No. 7 where the angle of the inclination of the arm from 20 degrees to 45 degrees, the location of the lower arm from zero to 60 degrees and the angle of the wrist inclination from zero to 15 degrees with the bending of the wrist and standing for a long time And repeated work.

As for the degree of severity of the neck, torso and leg, it is 5 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. From these two degrees, it becomes clear to us that the final degree in the analysis of the rollers that the student gets from the table is 7 This means stopping these daily practices and changing immediately.

- The rula analysis of student No. 1 in the shear phase shows that the severity of the wrist and arm is 5, where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60 degrees, and the wrist's tilt angle is zero where the action is repeated 4 times per minute.

As for the degree of severity of the neck, torso and leg, it is 4 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. 5 This means changing these daily practices soon.

Table-1 shows the Rolla analysis of the work of “cutting, cutting, welding and forging” in the Blacksmithing Department at Giza Electrical School.

No of workers	A) Wrist arm score				B) Neck, trunk, leg score				C) Final score			
	Forming	Welding	Cutoff	Shorn	Forming	Welding	Cutoff	Shorn	Forming	Welding	Cutoff	Shorn
1	7	6	7	5	8	5	5	4	7	6	7	5
2	7	6	7	5	8	6	4	4	7	7	6	5
3	7	6	7	5	9	4	4	4	7	6	6	5
4	7	6	7	5	8	4	4	4	7	6	6	5
5	7	6	7	5	8	6	4	4	7	7	6	5
6	7	6	7	5	8	4	5	4	7	6	7	5
7	7	6	7	5	9	4	4	4	7	6	6	5
8	7	6	7	5	8	4	5	4	7	6	7	5
9	7	6	7	5	8	4	4	4	7	6	6	5
10	7	6	7	5	9	4	4	4	7	6	6	5
11	7	6	7	5	8	4	4	4	7	6	6	5
12	7	6	7	5	8	4	4	4	7	6	6	5
13	7	6	7	5	9	4	4	4	7	6	6	5
14	7	6	7	5	8	4	4	4	7	6	6	5
15	7	6	7	5	8	4	4	4	7	6	6	5
16	7	6	7	5	8	4	4	4	7	6	6	5
17	7	6	7	5	8	4	4	4	7	6	6	5
18	7	6	7	5	8	4	4	4	7	6	6	5
19	7	6	7	5	9	4	4	4	7	6	6	5
20	7	6	7	5	8	4	4	4	7	6	6	5
21	7	6	7	5	8	4	4	4	7	6	6	5
22	7	6	7	5	8	4	4	4	7	6	6	5
23	7	6	7	5	8	4	5	4	7	6	6	5
24	7	6	7	5	9	4	4	4	7	6	6	5
25	7	6	7	5	8	4	4	4	7	6	6	5
26	7	6	7	5	8	4	4	4	7	6	6	5
27	7	6	7	5	8	4	4	4	7	6	6	5
28	7	6	7	5	9	4	4	4	7	6	6	5
29	7	6	7	5	8	4	4	4	7	6	6	5
30	7	6	7	5	8	4	4	4	7	6	6	5
31	7	6	7	5	8	4	4	4	7	6	6	5
32	7	6	7	5	8	6	4	4	7	6	6	5
33	7	6	7	5	8	4	4	4	7	6	6	5
34	7	6	7	5	8	4	4	4	7	6	6	5

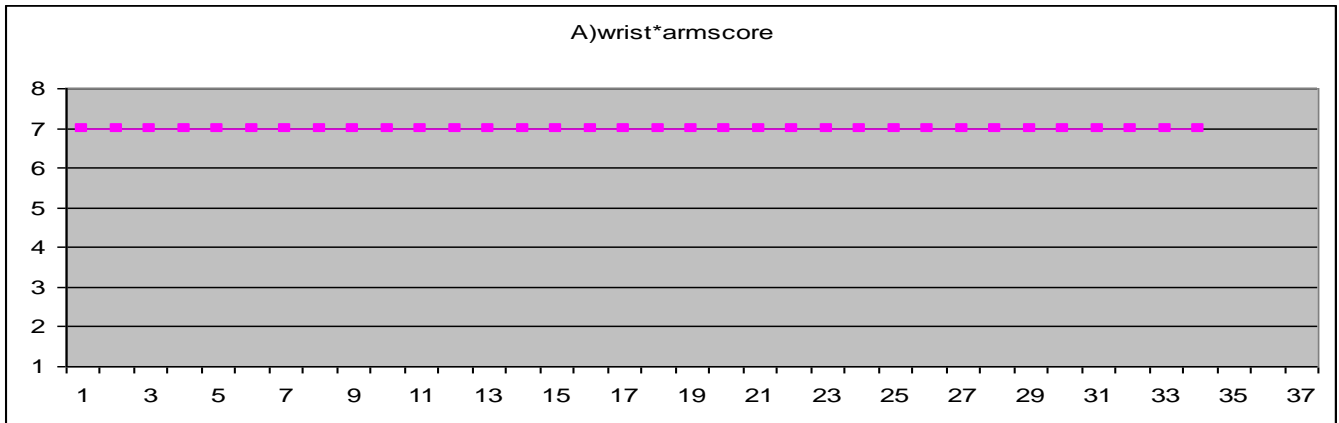


Figure No. 2 shows the degree of gravity of the wrist and arm of workers for students of the Giza Electrical School in the formation stage

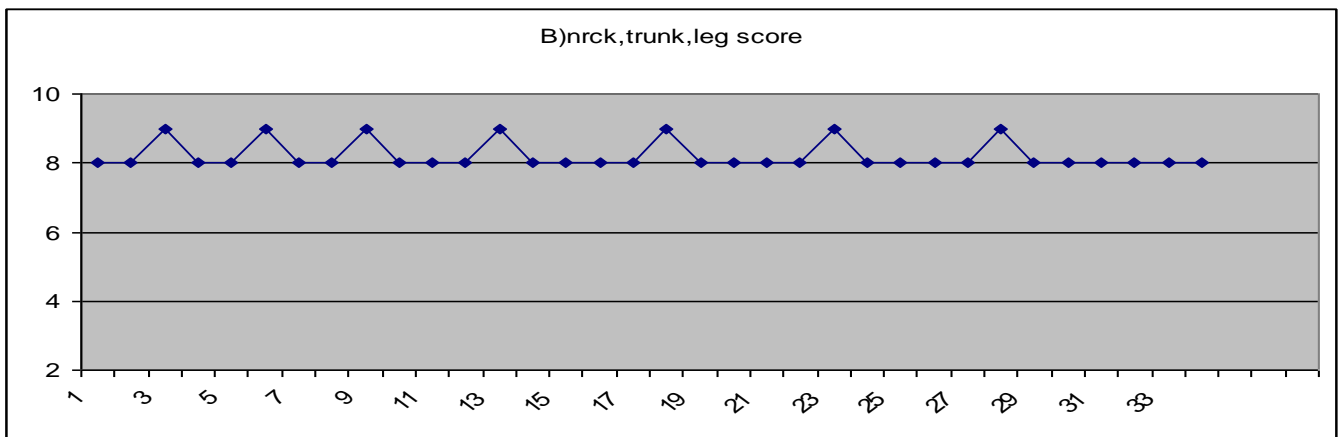


Figure 3 shows the degree of severity of the neck, torso and leg of workers of Giza Electric School students in the formation phase

The practical application of the second sample (blacksmithing workshop in Imbaba High School):

The activity inside this workshop is based on manufacturing iron doors, tables, and gloves using the electric welding method. This method leads to high temperatures, humidity, and noise, which indicates that the work environment is not appropriate for health students, as there is a permanent complaint from students of the emergence of general muscle and physical fatigue, which leads to Workflow affected.

It is clear from the following table that the degrees of risk for the arm and firm are higher than the risk levels for the neck, trunk and leg for all students. This indicates that students are subject to musculoskeletal injuries to the arm and firmly higher ones than for the neck, trunk and leg, as the degree of risk for the arm and firm is between 7: 5 degrees while the risk levels for the neck The trunk and leg

range from 4: 7, which indicates the occurrence of musculoskeletal injuries to students.

- The rula analysis for student No. 1 in the formation phase shows that the degree of risk for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60 degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a long time And repeated work. As for the degree of severity of the neck, torso and leg, it is 6 degrees, where the angle of inclination of the neck is more than 10: 20 degrees with the curvature of the neck and the angle of the torso of 60:20 degrees with bending of the feet during work and standing for long periods, and where the work is done consistently for long periods and carrying more weight From 10: 2 kg, and from these two degrees, it becomes clear to us that the final degree in the analysis of the rolls that a student gets from the schedule is 7, and this means stopping these daily practices and changing immediately.

- The Rula analysis of Student No. 1 in the welding stage shows that the degree of risk for the wrist and arm is 6 as the angle of the arm's tilt from 20 degrees to 45 degrees, the location of the lower arm from zero to 60 degrees, the wrist tilt angle from zero to 15 degrees with standing for long periods and repeated work.

As for the degree of severity of the neck, torso, and leg, it is 5 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. 6 This means changing these daily practices soon.

Table -2: The Rolla analysis of the work of “cutting, cutting, welding and forging” in the blacksmithing department of Imbaba Secondary School

No of workers	A) Wrist arm score				B) Neck, trunk, leg score				C) Final score			
	Forming	Welding	Cutoff	Shorn	Forming	Welding	Cutoff	Shorn	Forming	Welding	Cutoff	Shorn
1	7	6	7	5	6	5	5	4	7	6	7	5
2	7	6	7	5	6	5	6	4	7	6	7	5
3	7	6	7	5	7	5	5	4	7	6	7	5
4	7	6	7	5	7	5	6	4	7	6	7	5
5	7	6	7	5	7	5	6	4	7	6	7	5
6	7	6	7	5	7	5	6	4	7	6	7	5
7	7	6	7	5	7	5	6	4	7	6	7	5
8	7	6	7	5	7	5	6	4	7	6	7	5
9	7	6	7	5	7	5	6	4	7	6	7	5
10	7	6	7	5	7	5	6	4	7	6	7	5
11	7	6	7	5	7	5	6	4	7	6	7	5
12	7	6	7	5	7	5	6	4	7	6	7	5
13	7	6	7	5	7	5	6	4	7	6	7	5
14	7	6	7	5	7	5	6	4	7	6	7	5
15	7	6	7	5	7	5	6	4	7	6	7	5
16	7	6	7	5	7	5	6	4	7	6	7	5
17	7	6	7	5	7	5	6	4	7	6	7	5
18	7	6	7	5	7	5	6	4	7	6	7	5
19	7	6	7	5	7	5	6	4	7	6	7	5
20	7	6	7	5	7	5	6	4	7	6	7	5
21	7	6	7	5	7	5	6	4	7	6	7	5
22	7	6	7	5	7	5	6	4	7	6	7	5
23	7	6	7	5	7	5	6	4	7	6	7	5
24	7	6	7	5	7	5	6	4	7	6	7	5
25	7	6	7	5	7	5	6	4	7	6	7	5
26	7	6	7	5	7	5	6	4	7	6	7	5
27	7	6	7	5	7	5	6	4	7	6	7	5
28	7	6	7	5	7	5	6	4	7	6	7	5
29	7	6	7	5	7	5	6	4	7	6	7	5
30	7	6	7	5	7	5	6	4	7	6	7	5
31	7	6	7	5	7	5	6	4	7	6	7	5
32	7	6	7	5	7	5	6	4	7	6	7	5
33	7	6	7	5	7	5	6	4	7	6	7	5
34	7	6	7	5	7	5	6	4	7	6	7	5
35	7	6	7	5	7	5	6	4	7	6	7	5

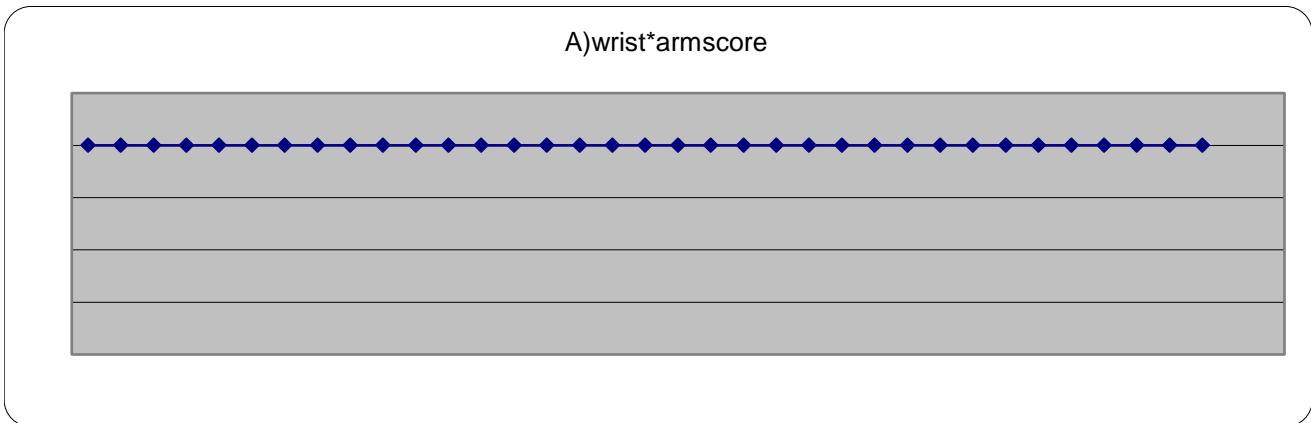


Figure 4 shows the degree of severity of the wrist and arm of workers for Imbaba High School students in the formative stage.

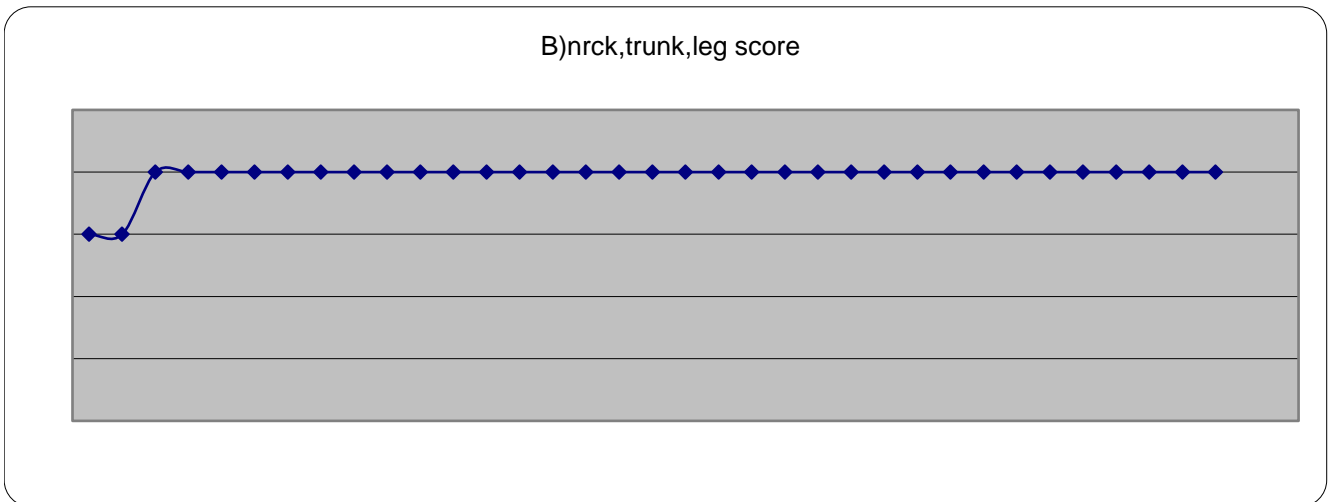


Figure No. 5 shows the degree of severity of the neck, torso and leg of workers of Imbaba High School students in the formative stage

The rula analysis for student No. 1 in the cutting stage shows that the degree of danger for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60 degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a long time And repeated work.

As for the degree of severity of the neck, torso and leg, it is 5 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. From these two degrees, it becomes clear to us that the final degree in the analysis of the rollers that the student gets from the table is 7 This means stopping these daily practices and changing immediately.

- The rula analysis of student No. 1 in the shear phase shows that the severity of the wrist and arm is 5, where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60 degrees, and the wrist's tilt angle is zero where the action is repeated 4 times per minute.

As for the degree of severity of the neck, torso and leg, it is 4 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. 5 This means changing these daily practices soon.

The practical application of the third sample, "Carpentry workshop, furniture, Giza Electric High School"

The activity inside this workshop is based on manufacturing doors, bedrooms, offices and school benches using cutting, clicking, thickness and assembly machines, which causes noise, which indicates that the work environment is not appropriate for health students, as there is a permanent complaint from students of the emergence of general muscle and physical fatigue, which leads to the impact Workflow.

It is clear from Table No. 3 that the degrees of risk for the arm and firm are less than the risk levels for the neck, trunk and leg for all students. This indicates that students are subject to musculoskeletal injuries to the neck, trunk and leg higher than the arm and firm as the degree of risk for the arm and firm ranges between 5: 7 degrees while the degrees of risk The neck, torso and leg range from 4: 9 degrees, which indicates the occurrence of musculoskeletal injuries to students with this workshop. The neck, trunk and leg are higher than the implants and the firm.

- The rula analysis for student No. 1 in the thickness control stage shows that the degree of risk for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20: 45 degrees, the location of the lower arm is from zero to 60 degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a while Long and repetitive work.

As for the degree of severity of the neck, trunk and leg, it is 9 degrees, where the angle of inclination of the neck is more than 20 degrees, and the angle of inclination of the trunk of 60:20 degrees with the curvature of the trunk and bending the feet during work and standing for long periods, and where the work is done consistently for long periods and carry a weight of more than 10 One kilogram and from these two degrees, it becomes clear to us that the final degree in the analysis of the Rolla that the student gets from the table is 7, and this means stopping these daily practices and changing immediately.

- The rula analysis for student No. 1 of the click stage shows that the degree of risk for the wrist and arm is No. 7 where the angle of the inclination of the arm is from 20:45 degrees, the location of the lower arm is from zero to 60 degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a long time And repeated work.

As for the degree of severity of the neck, torso and leg, it is 7 degrees, where the angle of inclination of the neck is more than 20 degrees, the angle of the tilt of the torso from 20: 0 degrees, bending the feet during work and standing for long periods, and where the work is done consistently for long periods and carrying a weight of 2: 10 kg and from these two The two degrees show us that the final grade in the

analysis of the Rolla that the student gets from the table is 7 and this means stopping these daily practices and changing immediately.

- The rola analysis for Student No. 1 in the assembly and finishing stage shows that the degree of risk for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20:45 degrees, the location of the lower arm is from zero to 60 degrees and the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a while Long and repetitive work.

As for the degree of severity of the neck, torso and leg, it is 8 degrees, as the angle of inclination of the neck is more than 20 degrees, and the angle of inclination of the trunk is from 20 to 60 degrees, with feet bent during work and standing for long periods, and where the work is done consistently for long periods and carrying a weight of more than 10 kg. These two degrees show us that the final level in the analysis of the Rolla that the student gets from the table is 7 and this means stopping these daily practices and changing immediately.

- The rula analysis of student No. 1 in the shear phase shows that the severity of the wrist and arm is 5, where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60 degrees, and the wrist's tilt angle is zero where the action is repeated 4 times per minute.

As for the degree of severity of the neck, torso and leg, it is 4 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. 5 This means changing these daily practices soon.

Table -3: shows the Rula analysis of the work of "cutting, assembling, clicking and thickness" in the carpentry department at Giza Electric School

No of workers	A) Wrist arm score				B) Neck, trunk, leg score				C) Final score			
	Bladder	Tapping	Aggregation	Cutoff	Bladder	Tapping	Aggregation	Cutoff	Bladder	Tapping	Aggregation	Cutoff
1	7	7	6	5	9	7	7	4	7	7	7	5
2	7	7	6	5	9	7	7	4	7	7	7	5
3	7	7	6	5	9	7	8	4	7	7	7	5
4	7	7	6	5	9	7	7	4	7	7	7	5
5	7	7	6	5	9	7	7	4	7	7	7	5
6	7	7	6	5	9	7	7	4	7	7	7	5
7	7	7	6	5	9	7	7	4	7	7	7	5
8	7	7	6	5	9	7	7	4	7	7	7	5
9	7	7	6	5	9	7	8	4	7	7	7	5
10	7	7	6	5	9	7	8	4	7	7	7	5
11	7	7	6	5	9	7	7	4	7	7	7	5
12	7	7	6	5	9	7	7	4	7	7	7	5
13	7	7	6	5	9	7	7	4	7	7	7	5
14	7	7	6	5	9	7	7	4	7	7	7	5
15	7	7	6	5	9	7	7	4	7	7	7	5
16	7	7	6	5	9	7	8	4	7	7	7	5
17	7	7	6	5	9	7	7	4	7	7	7	5
18	7	7	6	5	9	7	7	4	7	7	7	5
19	7	7	6	5	9	7	7	4	7	7	7	5
20	7	7	6	5	9	7	7	4	7	7	7	5
21	7	7	6	5	9	7	7	4	7	7	7	5
22	7	7	6	5	9	7	7	4	7	7	7	5
23	7	7	6	5	9	7	8	4	7	7	7	5
24	7	7	6	5	9	7	7	4	7	7	7	5
25	7	7	6	5	9	7	7	4	7	7	7	5
26	7	7	6	5	9	7	7	4	7	7	7	5
27	7	7	6	5	9	7	7	4	7	7	7	5
28	7	7	6	5	9	7	7	4	7	7	7	5
29	7	7	6	5	9	7	8	4	7	7	7	5
30	7	7	6	5	9	7	8	4	7	7	7	5
31	7	7	6	5	9	7	7	4	7	7	7	5
32	7	7	6	5	9	7	7	4	7	7	7	5
33	7	7	6	5	9	7	7	4	7	7	7	5
34	7	7	6	5	9	7	7	4	7	7	7	5
35	7	7	6	5	9	7	7	4	7	7	7	5

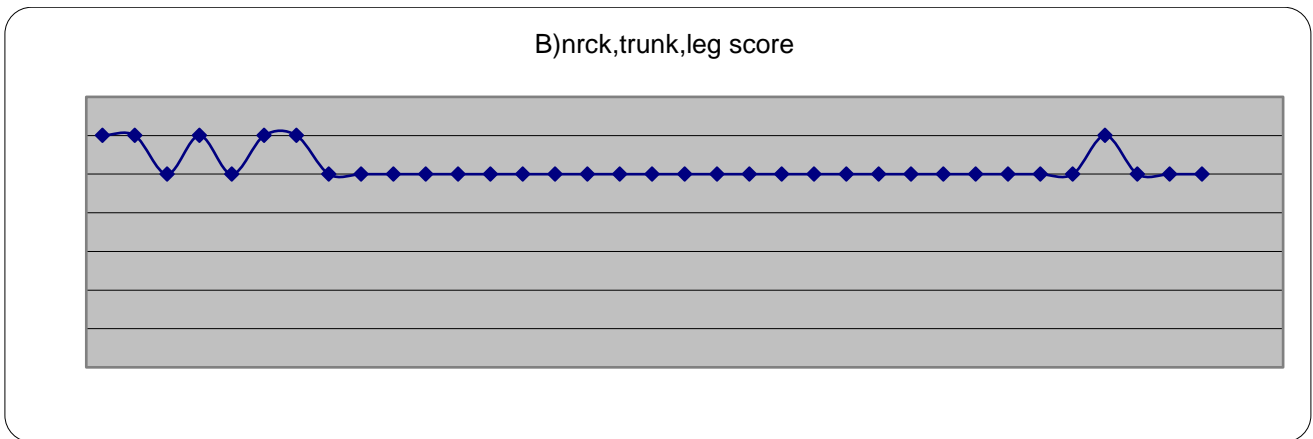


Figure 6 shows the degree of severity of the wrist and arm for students of the Carpentry Department of the Giza Electric School

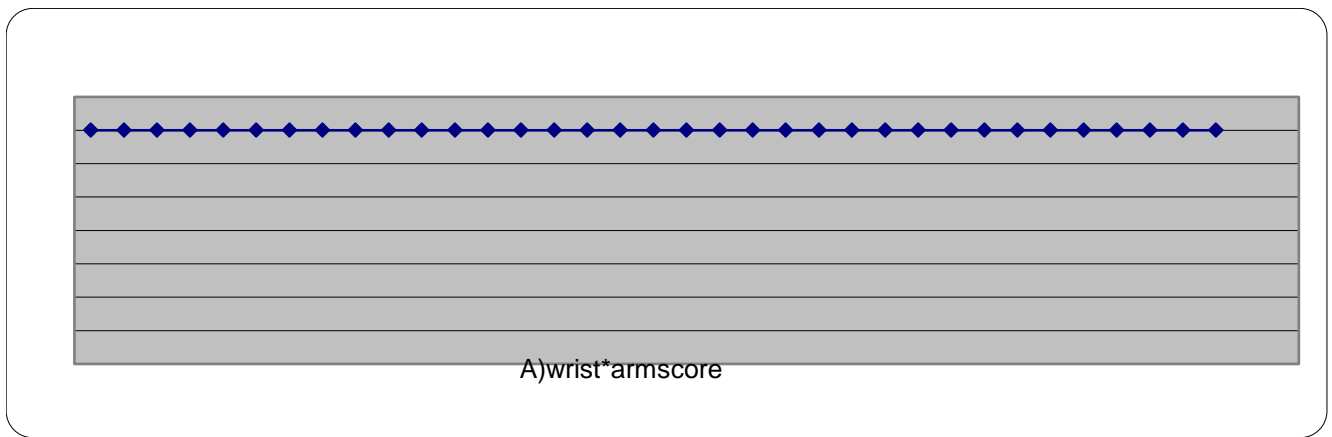


Figure 7 shows the degree of severity of the neck, torso and leg for students of the Carpentry Department of the Giza Electric School.

The practical application of the fourth sample (carpentry workshop, Imbaba High School):

The activity in this workshop is based on manufacturing doors, bedrooms, offices, and school benches using cutting, clicking, rapes, and assembly machines, which creates noise, which indicates that the work environment is not appropriate for health students, as there is a permanent complaint from students of the emergence of general muscle and physical fatigue, which leads to the impact Workflow. It is clear from Table No. 4 that the degree of risk for the arm and firm is less than the risk levels for the neck, torso and leg for all students. This indicates that students in this section are subject to musculoskeletal injuries to the neck, torso, and leg higher than the arm and firm as the degree of risk for the arm and firm ranges from 5: 7 degrees While the degrees of severity for the neck, trunk and leg range from 4: 8, which indicates the occurrence of musculoskeletal injuries to students in this section.

- The rula analysis for student No. 1 in the thickness control stage shows that the degree of risk for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20: 45 degrees, the location of the lower arm is from zero to 60 degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a while Long and repetitive work.

As for the degree of severity of the neck, trunk and leg, it is 9 degrees, where the angle of inclination of the neck is more than 20 degrees, and the angle of inclination of the trunk of 60:20 degrees with the curvature of the trunk and bending the feet during work and standing for long periods, and where the work is done consistently for long periods and carry a weight of more than 10 One kilogram and from these two degrees, it becomes clear to us that the final degree in the analysis of the Rolla that the student gets from the table is 7, and this means stopping these daily practices and changing immediately.

Table -4: The Rolla analysis of the work of "cutting, assembling, clicking and thickness" in the carpentry department at Imbaba High School.

No of workers	A) Wrist arm score				B) Neck, trunk, leg score				C) Final score			
	Bladder	Tapping	Aggregation	Cutoff	Bladder	Tapping	Aggregation	Cutoff	Bladder	Tapping	Aggregation	Cutoff
1	7	7	7	5	8	7	8	4	7	7	7	5
2	7	7	7	5	8	7	8	4	7	7	7	5
3	7	7	7	5	8	7	8	4	7	7	7	5
4	7	7	7	5	8	7	8	4	7	7	7	5
5	7	7	7	5	8	7	8	4	7	7	7	5
6	7	7	7	5	8	7	8	4	7	7	7	5
7	7	7	7	5	8	7	8	4	7	7	7	5
8	7	7	7	5	8	7	8	4	7	7	7	5
9	7	7	7	5	8	7	8	4	7	7	7	5
10	7	7	7	5	8	7	8	4	7	7	7	5
11	7	7	7	5	8	7	8	6	7	7	7	5
12	7	7	7	5	8	7	8	4	7	7	7	5
13	7	7	7	5	8	7	8	4	7	7	7	5
14	7	7	7	5	8	7	8	4	7	7	7	5
15	7	7	7	5	8	7	8	6	7	7	7	7
16	7	7	7	5	8	7	8	4	7	7	7	5
17	7	7	7	5	8	7	8	4	7	7	7	5
18	7	7	7	5	8	7	8	6	7	7	7	7
19	7	7	7	5	8	7	8	4	7	7	7	5
20	7	7	7	5	8	7	8	4	7	7	7	5
21	7	7	7	5	8	7	8	4	7	7	7	5
22	7	7	7	5	8	7	8	6	7	7	7	7
23	7	7	7	5	8	7	8	4	7	7	7	5
24	7	7	7	5	8	7	8	4	7	7	7	5
25	7	7	7	5	8	7	8	4	7	7	7	5
26	7	7	7	5	8	7	8	4	7	7	7	5
27	7	7	7	5	8	7	8	4	7	7	7	5
28	7	7	7	5	8	7	8	4	7	7	7	5
29	7	7	7	5	8	7	8	6	7	7	7	7
30	7	7	7	5	8	7	8	4	7	7	7	5
31	7	7	7	5	8	7	8	4	7	7	7	5
32	7	7	7	5	8	7	8	4	7	7	7	5
33	7	7	7	5	8	7	8	4	7	7	7	5
34	7	7	7	5	8	7	8	4	7	7	7	5
35	7	7	7	5	8	7	8	4	7	7	7	5

- The rula analysis for student No. 1 of the click stage shows that the degree of risk for the wrist and arm is No. 7 where the angle of the inclination of the arm is from 20:45 degrees, the location of the lower arm is from zero to 60 degrees, the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a long time And repeated work.

As for the degree of severity of the neck, torso and leg, it is 7 degrees, where the angle of inclination of the neck is more than 20 degrees, the angle of the tilt of the torso from 20: 0 degrees, bending the feet during work and standing for long periods, and where the work is done consistently for long periods and carrying a weight of 2: 10 kg and from these two The two degrees show us that the final grade in the analysis of the Rolla that the student gets from the table is 7 and this means stopping these daily practices and changing immediately.

- The rula analysis for Student No. 1 in the assembly and finishing stage shows that the degree of risk for the wrist and arm is No. 7 where the angle of the arm's tilt is from 20:45 degrees, the location of the lower arm is from zero to 60 degrees and the angle of the wrist tilt from zero to 15 degrees with the wrist bent and standing for a while Long and repetitive work.

As for the degree of severity of the neck, torso and leg, it is 8 degrees where the angle of inclination of the neck is more than 20 degrees and the angle of the tilt of the torso from 20 to 60 degrees with bending of the feet during work and standing for long periods, and where the work is done consistently for long periods and carrying a weight of 2: 10 kg and from these two The two degrees show us that the final grade in the analysis of the Rolla that the student gets from the table is 7 and this means stopping these daily practices and changing immediately.

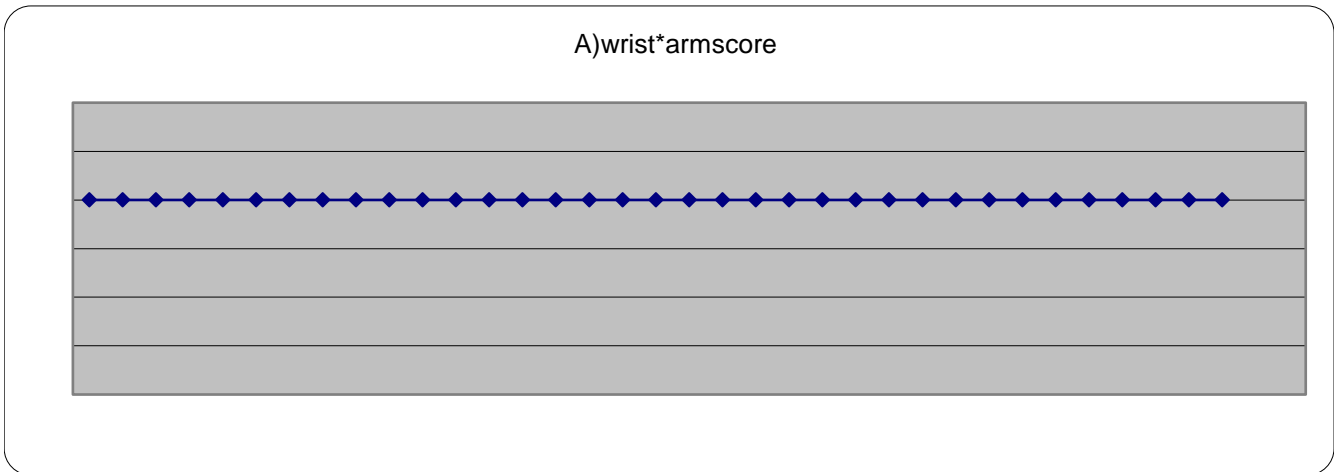


Figure 8 shows the degree of severity of the wrist and arm for students of the Carpentry Department of the Imbaba Secondary School

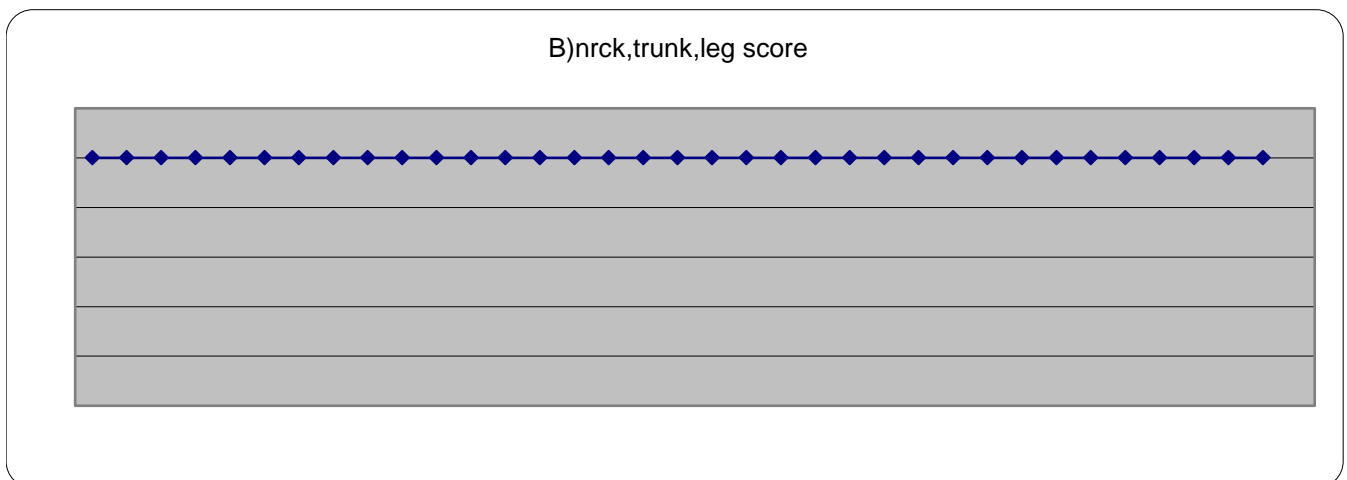


Figure No. 9 shows the degree of severity of the neck, torso and leg for students of the carpentry department at Imbaba Secondary School

- The rula analysis of student No. 1 in the shear phase shows that the severity of the wrist and arm is 5, where the angle of the arm's tilt is from 20 degrees to 45 degrees, the location of the lower arm is from zero to 60 degrees, and the wrist's tilt angle is zero where the action is repeated 4 times per minute.

As for the degree of severity of the neck, torso and leg, it is 4 degrees, as the angle of inclination of the neck is from 10 to 20 degrees, the angle of inclination of the trunk from zero to 20 degrees, and the legs and feet supported and parallel. 5 This means changing these daily practices soon.

6. CONCLUSIONS

From the results of the present study, the important conclusions are as follows:

- 1- The multiplicity of human engineering terms presented in the literature according to the multiplicity of science and knowledge intertwined with human engineering such as psychology, medicine, engineering, anatomy and physiology, science specialized in human body measurements (anthropometry), science and management, and three main terms have emerged:
- 2- Human factors and engineering Human factors and human engineering In light of the overlap and interdependence between the terms as well as the development and history of the use of the term it was found that the term human engineering is the most common and used and an indication of the fields of human engineering and its dimensions.
- 3- Human engineering is characterized by its wide applications in the field of achieving harmonization between working individuals according to the characteristics of their muscular and intellectual physical specifications and their work environment in general, where human engineering is an entry point for designing work systems that follow, the system becomes easier for working individuals and more difficult to move those approaches away from design.
- 4- Weak experiences and informing individuals working in the laboratory in the field of study about the benefits of applications of the concept of human engineering, whether at the individual level or their productivity.
- 5- The process of mismatch between the variables of the human engineering research and the physical characteristics and specifications of working individuals leads to negative consequences for the health and safety of the working individual, especially musculoskeletal injuries on the one hand, and their productivity on the other.

7. Recommendations:

First / general recommendations:

1- Work to form an organizational unit in the workshops at the level of a department or division called (the Human Engineering Unit) whose mission is to apply and follow up the application of human engineering principles and rules in workplaces, including health and safety of the working individual.

2- Establishing human engineering training programs for teachers, students, and school workers in a manner that increases their knowledge and practical ability in this field using the expertise of external specialists.

3- Providing material variables (chairs, tables, machines and tools) that are compatible with the nature of the specifications of the student's body working in blacksmithing and carpentry workshops, noting that it was not given appropriate importance to that matter which led to an increase in cases of occupational injuries and diseases.

4- Securing the physical and appropriate conditions in terms of temperature, humidity, lighting, vibration and noise, according to the standards approved internationally and locally.

5- Developing the technical, administrative, and medical capabilities and staff in the blacksmithing and carpentry workshops responsible for occupational health and safety activities and not considering them as a separate entity from production, marketing and other activities because of their mutual impact.

Second / recommendations for research samples:

1- In the (blacksmithing workshop at Giza Electrical High School), it is recommended that the formation stage be mechanized with modern machines to train students to keep up with the job market.

- Make suitable ventilation hoods in the workshop to withdraw the smoke from welding operations.

- Raising the level of the existing viscosity regarding the formation of minerals to prevent students from bending while working on them.

2- In the (blacksmithing) workshop at Imbaba Industrial Secondary School, it is recommended to mechanize the formation stage with modern machines to train students to keep up with the job market.

- Work appropriate ventilation suction in the workshop to withdraw the smoke from welding operations.

- To warn students not to wear loose clothes to keep them safe.

3- In the workshop (carpentry furniture at Giza Electric High School) it is recommended to raise the level of the machine for controlling the thickness of wood to fit with the

body of the student so as not to bend the students during work.

- Using an automatic wood beak instead of the existing manual.

- Introducing modern workshop machines to train students in keeping pace with the job market.

4- In the workshop (carpentry furniture at Imbaba Industrial Secondary School) it is recommended to raise the level of the machine for controlling the thickness of wood to fit with the body of the student so as not to bend the students during work.

- Using an automatic wood beak instead of the existing manual.

- Introducing modern workshop machines to train students in keeping pace with the job market.

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