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ERGONOMIC STUDY TO EVALUATE RISK FACTORS IN PACKAGING LINE AT FOOD PRODUCTION INDUSTRY

Thabet M. Elrabei

Department of Industrial and Manufacturing Systems Engineering,
Faculty of Engineering, University of Benghazi, Libya
E-mail: thabet.elrabei@uob.edu.ly

الملخص

تهدف الدراسة الحالية الى دراسة وتقييم عوامل الخطر للأعمال المرتبطة باضطراب الجهاز العضلي الهيكلي (WMSD) في خط التعبئة لشركة إنتاج مواد غذائية. اوضاع العمل الغير مريحة والمناولة اليدوية للأحمال الثقيلة والحركات المتكررة هي عوامل الخطر المشتبه بها والتي تؤدي الى اضطراب الجهاز العضلي الهيكلي (WMSD). تتأثر إنتاجية العمال باضطرابات الجهاز العضلي الهيكلي (WMSD) مما يحد من حركة العمال اثناء تأدية العمل. تعتبر البيئة الارجونومية (Ergonomic) المريحة لظروف مكان العمل المريح أمرًا هامًا لمنع حدوث اضطراب الجهاز العضلي الهيكلي (WMSD). تم اجراء تقييم عوامل الخطر وتحليلها باستخدام أداة التقييم السريع للطرف العلوي لجسم الانسان (RULA) وأداة التقييم السريع للجسم بأكمله (REBA) مع استخدام معادلة نياش (NOISH) لرفع الاحمال (المعهد الوطني للسلامة والصحة المهنية) للتوصية ببيئة العمل المريحة للعمال اثناء تأدية العمل استنادا إلى حالة الدراسة الحالية. ومن النتائج، تبين لنا بان العمال يتعرضون إلى اوضاع غير مريحة اثناء تأدية العمل والتي تؤدي بدورها إلى حدوث الاضطرابات العضلية الهيكلية (WMSD). وبالتالي هناك حاجة إلى تدخل الارجونوميك (Ergonomic) للحد من خطر تعرض العمال للعوامل المساهمة في اضطراب الجهاز العضلي الهيكلي (WMSD) في خط التعبئة لشركات انتاج مواد غذائية.

ABSTRACT

The objectives of the present study were to investigate and evaluate the risk factors of Work-related Musculoskeletal Disorder (WMSD) in packaging line at food production company. Awkward postures, manual handling of heavy loads, repetitive movements are the suspected risk factors for WMSD. The productivity of the workers is affected by WMSD which limits the movement of the workers. The ergonomic environment of comfort workplace condition is important to prevent the occurrence of the WMSD. The risk factors were evaluated and analyzed using Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) using NIOSH (National Institute for Occupational Safety and Health) lifting equation to recommend the ergonomic workplace environment based on the study condition. From the results, it is observed that the workers are exposed to the awkward postures that lead to Work-Musculoskeletal disorders (WMSDs). Ergonomic intervention is needed to eliminate the risk of exposure to factors contribution to WMSDs in packaging line of food production.

KEYWORDS: WMSD; RULA; REBA; NIOSH; Packaging Line.

INTRODUCTION

In terms of safety and health, controlling ergonomic hazards at a workplace is one of the main responsibilities related to protecting workers that organizations have. Improper workplace design can lead to many ergonomic hazards such as work-related musculoskeletal disorders (WMSDs) and fatigue. This, in turn, can lead to low productivity, injuries and lost workdays [1]. In the food manufacturing sector, poor of workstation design in the workplace leads to awkward postures such as bending the back, over-bending the neck forward and torso twisting while performing a task with highly repetitive motions (i.e., assembly tasks and inspections), which leads to a significant impact on the worker's back, arms, neck and legs, which causes musculoskeletal disorders (MSD) symptoms to appear and poor productivity to occur [2,3].

In food production industry many tasks are dependent on manual activity rather than automated systems, especially in the packaging process, assembly and inspection tasks. In terms of ergonomic control measures, engineering controls are significantly effective techniques in reducing MSDs compared to other control measures such as changing of work methods (e.g., using ergonomic mechanical aids); [4,5]. Also, it has been proven that ergonomic interventions are useful not only for reducing MSDs but also for improving the psychological perception of the workers toward their task [6,7].

To improve the productions for higher profit, employee productivity is important [8]. Work productivity as an indicator has been a general subject for examination in several studies on musculoskeletal disorders that influence the worker's condition [9]. If the workers are facing the health problem, it indicates that the losses faced by the company [10]. Heavy lifting and awkward work postures are the physical work condition that related to sick-leave [11]. As the condition of the workers affects the productivity, hence the worker needs to have a comfortable workplace that is ideally free from hazards.

The comfortable workplace is known as the proper ergonomic working environment. Ergonomics are the information concerned to the behavior, limitation, and capacity of human. Which applies on the machines, designs of tools, tasks, and environment for secure, comfort and beneficial for human use [12]. A bad worksite design leads to the difficulties for the workers such as fatigue and injuries. Besides, the injuries related to the low productivity of the workers are increased the cost of the company. Also, the workers are needed to a rest and the company need to bear the losses [13]. In the study of the occupational risks, there are few ergonomics analysis tools available to determine the risks of the worker at the workplace. These methods are identified and classified the risks into several parts which are self-reports, observational methods and direct measurements [14]. In this study, the ergonomic tools used to identify the occupational risks on the workers are Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) with using NOISH (National Institute for Occupational Safety and Health) lifting equation to assess the manual material handling risks associated with lifting and lowering tasks in the workplace [15,16]. The selection of the RULA and REBA with NIOSH lifting equation are based on the tasks doing by the workers. These are awkward postures, repetitive work and involves the entire body parts.

The objective of the present study is carried out to investigate and evaluate the risk factors of Work-related Musculoskeletal Disorder (WMSD) in packaging line at food production company.

METHODOLOGY

This study was conducted at a factory involved in the production of food located in Libya. The first step for this research was to study the process flow of the food processing by assessing the overall working areas. Then, by doing interview sessions and observations, the critical workplace was identified. The chosen subjects were from the packaging line stage of final products. The packaging line group consisted of four people aged from 24 to 35 years as shown in Figure (1). Employees were informed about the study and participated in it as volunteers.

Figure 1: Actual side posture for packaging line.

The packaging line consisted of four tasks, the first task is lifting the product (12 pieces of 0.45 kg for each) from pallet placed on the floor to a table by first worker. The second task is wrap the product using nylon bag by second worker. The third task are moves the wrapped carton (5.4 kg) to a third worker who's pushing the carton inside the shrink packaging machine. The final task is lowering and lifting the packaged product from packaging machine conveyor to a pallet placed on the floor by fourth worker

Next, the workers are required to conduct their work cycles as usual and the pictures and videos of the process were taken. The postures that were repetitive and awkward were chosen. Later, the RULA and REBA and NIOSH lifting equation analysis were performed to assess the posture level of discomfort for fourth worker.

RULA is a method in postural targeting for estimating the risk of work related upper limb disorders. While REBA is focusing on the risk of work related entire body disorders estimation. Both assessment gives quick and systematic evaluation of the complete body postural risk to a worker, then these ergonomics tools end up with score mark.

The NIOSH equation is a tool which used by occupational health and safety professionals to assess the manual material handling risks associated with lifting and lowering tasks in the workplace. This equation considers job task variables to determine safe lifting practices and guidelines. The RULA and REBA employee assessment worksheet was used, which is modified by Alan Hedge, Hignett, and McAtamney respectively as shown in Figure (2) and Figure (3).

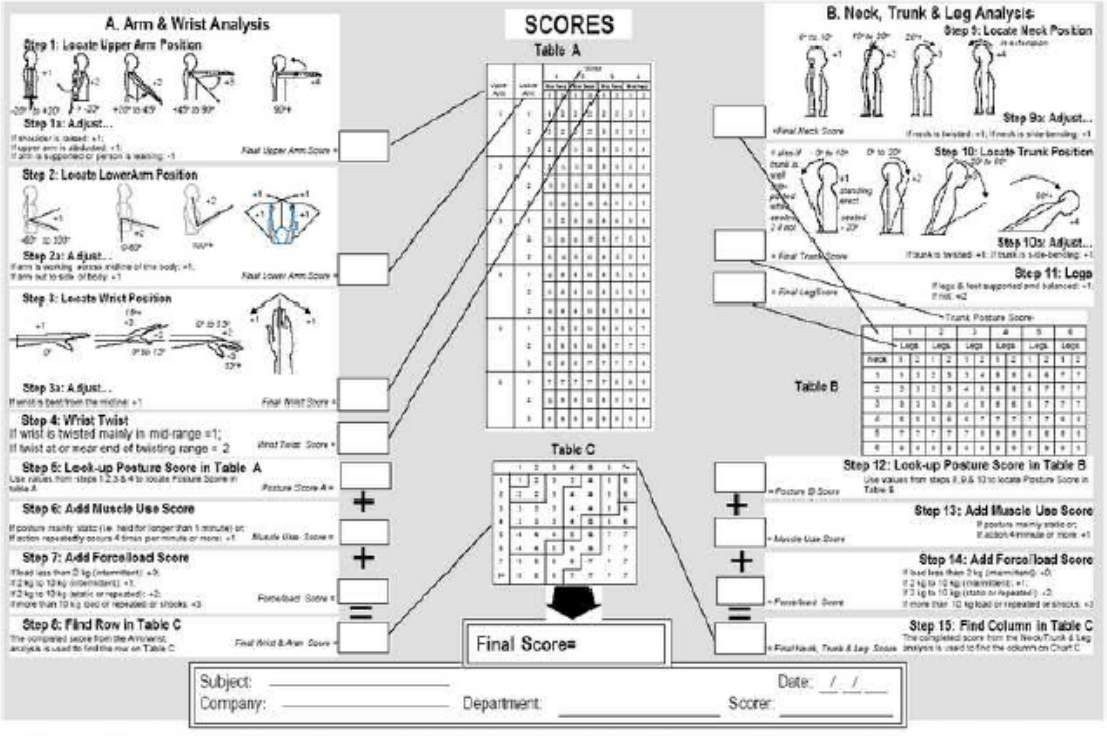

Figure 2: RULA employee assessment worksheet [15].

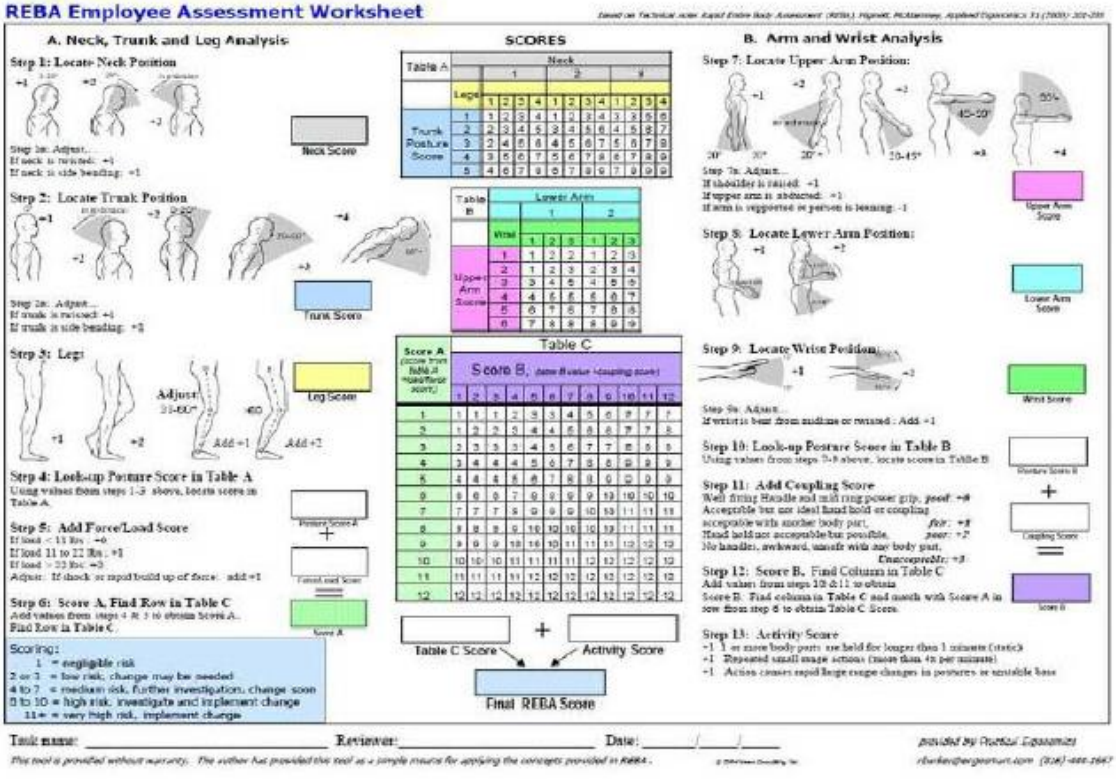

Figure 3: REBA assessment worksheet [16].

The movements of the fourth worker were divided into two different positions, which is Posture one (lowering) and Posture two (lifting). Posture one is the position where the worker is lowering the wrapped products from the packaging machine conveyor to the pallet placed on the floor as shown in Figure (4).

Figure 4: Posture 1 (lowering position).

While the position where the worker is lifting the products to vertical location (destination) on the pallet is called Posture two as shown in Figure (5).

Figure 5: Posture 2 (lifting position).

RESULTS AND DISCUSSION

Rapid Upper Limb Assessment (RULA)

Figure (6) shows the RULA's comparison score between lowering and lifting posture. According to RULA approach, the lower score value shows the better posture condition.

The results for the RULA grand score as shown in Figure 6 for postures one and two, it shows that worker is exposed to the same level in the high risks that need to be changed immediately as the score valued 7. The results for RULA assessment reveal that worker is in the high risks for both postures. The change is needed immediately to prevent the worker from MSD.

Rapid Entire Body Assessment (REBA)

The REBA's comparison score between lowering and lifting posture is shown in Figure (7). The REBA approach is resembled with RULA whereby the lower score value shows the better posture condition. Based on the score results, as well as RULA. It is

found that worker at position one is exposed in the medium risks that need implement change in the near future as the score valued 6. While the worker at posture two is in very high risks as the score valued 9. The Posture two is really dangerous to worker and needs the implementation of the changes immediately. The results for REBA assessment divulge that worker at posture two is in the high risks. The change is needed to be implemented immediately to ensure that the worker is free from MSD.

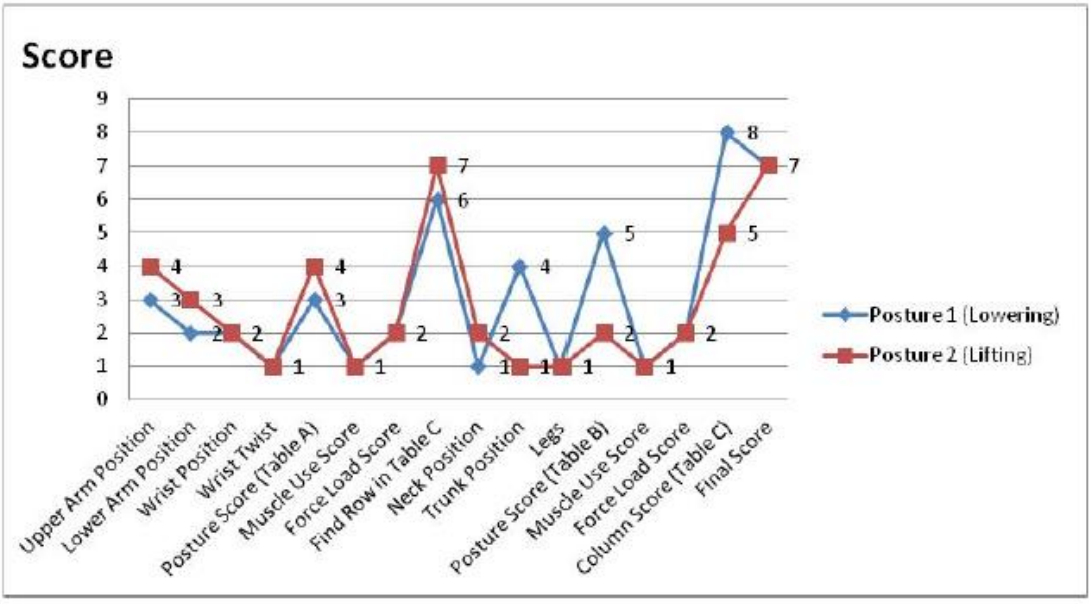

Figure 6: The graphical RULA's score summary.

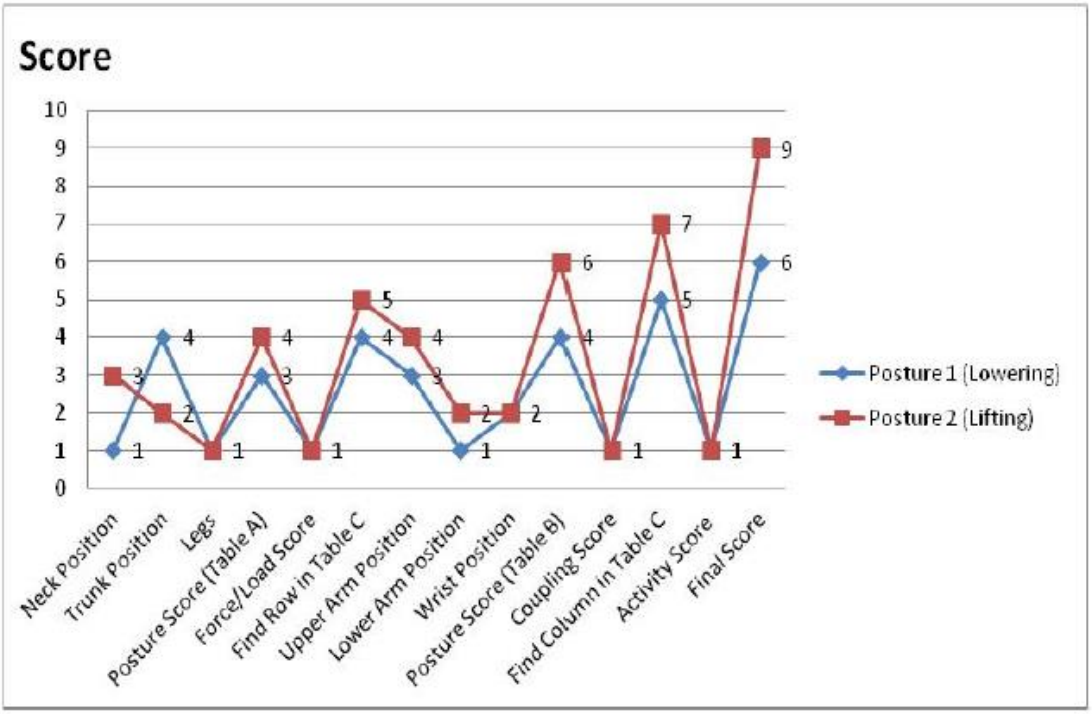

Figure 7: The graphical REBA score summary.

The comparison between the RULA and REBA are made in Figure 8. The graph indicates that the worker at posture two is always in the awkward condition as compared to the posture one as the grand scores are higher than 6, which represents the medium to high risks states.

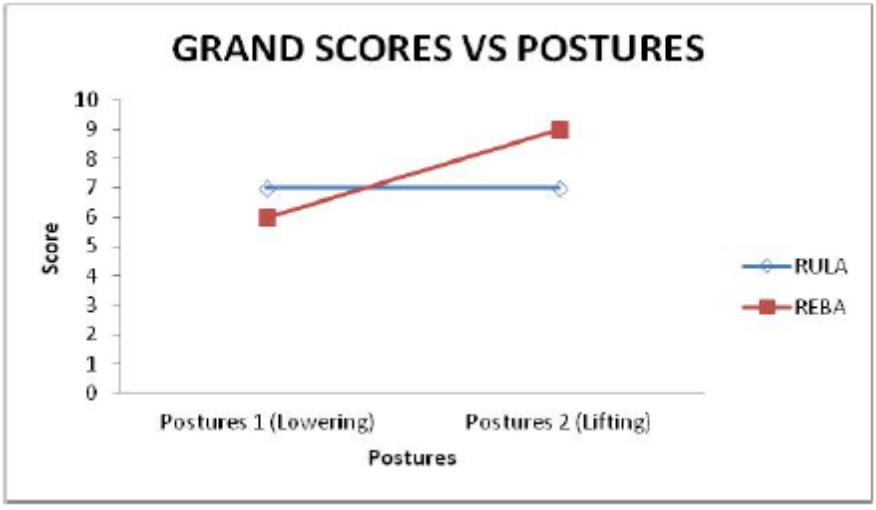

Figure 8: Grand scores versus postures.

NIOSH Lifting Equation by Ergo Intelligence Application

The primary product of the NIOSH equation is the Recommended Weight Limit (RWL), which defines the maximum acceptable weight (load) that nearly all healthy employees could lift over the course of an eight hours shift without increasing the risk of musculoskeletal disorders (MSD) to the lower back. In addition, a Lifting Index (LI) is calculated to provide a relative estimate of the level of physical stress and MSD risk associated with the manual lifting tasks evaluated.

NIOSH Equation [17]:

$$\mathbf{LC \times HM \times VM \times DM \times AM \times FM \times CM = RWL} \quad \mathbf{(1)}$$

The Task variables which needed to calculate the RWL are shown in Table (1):

Table 1: NIOSH lifting variables.

	NIOSH lifting variables input
LC: Load Constant	23 Kg
The appropriate job duration	30 min, short (≤1 hr.)
Weight	5.4 kg
C: Coupling (Grip)	Fair
F: Frequency	10 lifts/min.
A: Asymmetric angle (deg.)	origin=25°, destination=20°
H: Horizontal location (cm)	origin=45, destination=35
V: Vertical location (cm)	origin=87, destination=153

Table (2) shows the results of NIOSH lifting equation by using Ergo application program [18]. From the program, it is found that recommended weight limit is 4.5 kg. Also, a Lifting Index (LI) was calculated to provide a relative estimate of the level of physical stress and MSD risk associated with manual lifting tasks. It is found to be 1.1 indicates a risk of overexertion injury.

Table 2: Results of NIOSH lifting equation.

NIOSH Lifting Calculation--Single Task

INPUT:				
Weight				
average	5.40	kg	11.90	lb
maximum	8.00	kg	17.63	lb
Average lifts per min	10.00	lifts/min		
Origin				
X	45.00	cm	17.71	in
Y	87.00	cm	34.25	in
angle	25.00	degree		
Destination				
X	35.00	cm	13.77	in
Y	153.00	cm	60.23	in
angle	20.00	degree		
Control is needed	only at origin			
Lifting duration/recovery	short-duration			
Grasping classification	fair			
RESULTS:				
Origin RWL	4.5	kg		
Origin lifting index	1.1			

CONCLUSIONS AND RECOMMENDATIONS

This paper presented the approach to find out the occupational risk of the workers at food production company. Three types of analysis tools were selected namely, RULA, REBA, and NIOSH lifting equation are used in this study. These tools are able to determine the condition of the worker at the critical areas, that are not ergonomically designed. The results demonstrated that the exposure level to risk factors for musculoskeletal disorders was high in target workplace. Awkward postures, manual handling of heavy loads and repetitive movements are the suspected risk factors for WMSD. Any ergonomic intervention program in the workplace should focus on eliminating awkward postures and manual handling of heavy loads and implementing job rotation.

RECOMMENDATIONS:

- Use height-adjustable hydraulic lifts table to eliminate lowering and lifting handles.

- Develop an appropriate system of breaks in the work.
- Design a system of employee positions rotation.

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