Analysis of RWL and designing safe load for the workers to reduce lifting related injury in a Bangladeshi Brick Industry: A Case Study

Abdun Noor*, Md. Rubel Miah, J. Akram, Md. Shohel Parvez, Sudipta Saha, Prof. Dr. Tarapada Bhowmick

Abstract— Manual Handling of Loads (MHL) includes lifting, holding, putting down, pushing, pulling, carrying and moving a load. If these tasks are performed repeatedly or over long periods of time, they can lead to fatigue and injury. Majority of the workers in our country suffer same type of overexertion injury or ergonomically problems per year. Approximately most of these overexertion problems involve lifting. As a result productivity is decreased. So it is necessary to know the anthropometric measurement of a worker and their respective lifting Capacity to have an idea about which position of the work is best suited for the worker. Scientific evidence shows that effective ergonomic interventions can lower the physical demands of manual material handling work tasks, thereby lowering the incidence and severity of the musculoskeletal injuries they can cause. Applying Recommended Weight Limit (RWL) workers can easily overcome ergonomically problems. Though it seems reducing efficiency, but in bird view in increases efficiency for long run.

Index Terms— RWL, MHL, LI, Anthropometric measurement, NIOSH, LBP, Productivity

1 Introduction

Most of the industry in Bangladesh, workers are done repeated work in various situation and they suffer into ergonomically problems like back injuries. Back injuries result from damage, wear, or trauma to the bones, muscles, or other tissues of the back. Common back injuries include sprains and strains, herniated disks, and fractured vertebrae. The lumbar is often the site of back pain. The area is susceptible because of its flexibility and the amount of body weight it regularly bears. It is estimated that low-back pain may affect as much as 50 to 70 percent of the general population in the United States. Most of the organizations in the developing country especially like Bangladesh; most of the workers lift loads beyond their limit. Although top level management think is as an increase of productivity, but for long term period consideration it is a great physical damage to the worker. By applying RWL for the people, according to their anthropometric measurements, it is easily possible to recommend a maximum weight limit to the person which is comfortable to work for a long term. Thus it will also reduce back pain and other physical injuries related to lifting operations and ensure workers safety.

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2 Literature review

The ergonomic consultation is part of a broader package of services intended to prevent work loss among people with inflammatory arthritis (the Making It Work Program). Thus, is it not intended to address every issue associated with the workplace, but rather to focus on ergonomic issues such as work postures and work demands (Backman, Village & Lacaille 2008) [1]. Low-back pain (LBP) is often the result of incorrect lifting methods and posture. Much of the LBP people experience is thought to be caused by unfavorable working conditions putting too much strain on the lower back. These tasks can include (but are not limited to) lifting, twisting, carrying, pushing, and pulling. Not only is LBP an unpleasant experience for employees, but also an expensive liability for employers. The Sept. 26, 1989, issue of The Wall Street Journal, in a front-page article on low back pain, said that LBP accounts for about one-quarter of all lost workdays in the United States and costs $15 billion to $20 billion annually in medical expenses and lost earnings. When you consider that roughly 80 percent of all people, at some point in their lives, are afflicted with low back pain, it is easy to see that this is a significant problem that concerns us all (Cherie and Allen, 2008)[2].

The word "anthropometry" is derived from the Greek word "anthropo" meaning "human" and the Greek word "metron" meaning "measure". The field of anthropometry encompasses a variety of human body measurements. Weight, stature (standing height), recumbent length, skin fold thicknesses, circumferences (head, waist, limb, etc.), limb lengths, and breadths (shoulder, wrist, etc.) are examples of anthropometric measures. Anthropometric data using in ergonomics to indicate the physical dimensions of work spaces, equipment, furniture etc. (Bridger, 1995 [3]; Kayis and Ozok, 1991 [4]; Jeong and Park, 1990 [5]). Anthropometry in design improves the health, comfort, safety and reduces injury (Pheasant, 1998 [6]; Barroso et al., 2005 [7]). Several indexes and ratios can be derived from anthropometric measurements [8]. Ergonomic as-

sessment and recommendations may help people with arthritis maintain employment; however, most ergonomic tools are designed to assess injury risk in the general population and are not specific to the needs of people with inflammatory arthritis (Catherine, Judy and Diane, 2008)[9].

The National Institute for Occupational Safety and Health (NIOSH) Lifting Equation is a method to assess risk of low-back disorders in jobs with repeated lifting. It consists of two primary products, the recommended weight limit (RWL) and the lifting index (LI). LI values >1 indicate increased risk (Waters 2006) [10]. LI is limited to jobs with similar lifting tasks. For jobs with multiple tasks, procedures have been proposed to compute the composite lifting index (CLI) (Tolbert 2007) [11] or the sequential lifting index (SLI) (Waters 2007) [12] for the overall job. The computation of the Revised NIOSH Lifting Equation (RNLE) CLI can be difficult and confusing for more than three or four tasks. In its current form, the RNLE CLI can take over an hour to compute manually (without a computer program) for only five tasks, which does not include time used for data collection and data entry (Jennifer and Richard 2005) [13]. Tasks may vary because of differences in age, physical condition, strength, gender, stature, and other factors [14]. Guide for Manual Lifting in 1981 to assist safety and health practitioners in evaluating lifting and lowering jobs in the sagittal plane. Because the 1981 equation could only be applied to a limited number of lifting jobs, it was revised in 1991. The objective is to prevent or reduce the occurrence of lifting and lowering overexertion injuries and low back pain among workers (Garg 1995) [15]. The equation is used for industry workers (Wang 1998) [16], warehouse workers (Markin 1999) [17], industry workers and office workers (Waters et al. 1999) [18], construction workers (Van Der beak 2005) [19].

3 RESEARCH METHODOLOGY

In this chapter, the anthropometry measurements, method of determining RWL, different multiplier, revised NIOSH lifting equation and lifting task limitations have been discussed.

3.1 ANTHROPOMETRY MEASUREMENTS

Anthropometric measurements are considered as the key basis for calculating RWL. Thus, following various anthropometric measurements have considered for calculating RWL in this study.

Stature Height: The vertical distance from the floor to top of the head, when standing. In Fig.1 numbers 1 indicates stature height.

Shoulder Height, Standing: The vertical distance from the floor to the tip of the shoulder, when standing. In Fig.1 numbers 3 indicates Shoulder Height.

Elbow Height, Standing: The vertical distance from the floor to the lowest point of the right elbow, when standing. In Fig.1 numbers 4 indicates Elbow Height.

Hip Height, Standing: The vertical distance from the floor to the trochanter landmark on the upper side of the right thigh, when standing. In Fig.1 numbers 5 indicates Hip Height.

Finger Tip height, Standing: The vertical distance from the floor to the tip of the index figure of the right hand, when standing. In Fig.1 numbers 7 indicates Finger Tip Height.

Shoulder-Elbow length: The vertical distance from the underside of the right elbow to the right acromion, with the elbow fixed at 90 degrees and upper arm hanging vertically. In Fig.1 numbers 22 indicates Shoulder-Elbow length.

Elbow-Finger Tip length: The distance from the back of the right elbow to the tip of the middle figure, with the elbow fixed at 90 degrees. In Fig.1 numbers 23 indicates Elbow-Finger Tip length.

Hand length: The length of the right hand between the crease of the wrist and the tip of the middle figure, with right hand flat. In Fig.1 numbers 28 indicates Hand length.

Hand Breadth: The breadth of the right hand across the knuckles of the four fingers. In Fig.1 numbers 29 indicates Hand length.

The required body dimensions for the work are as shown in Fig.1: [20]

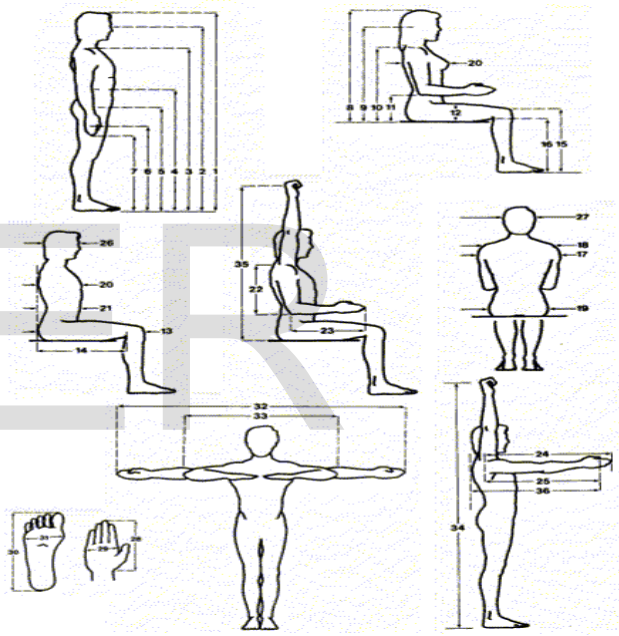

Fig. 1. Anthropometry Measurements

3.2 GROUPING OF HUMAN

According to anthropometry measurement all the human workers are grouped into different groups. In this work six groups were done based on the stature height.

3.3 RECOMMENDED WEIGHT LIMIT (RWL)

The RWL is defined for a specific set of task conditions as the weight of the load that nearly all healthy workers could perform over a substantial period of time (up to 8 hours) without an interested risk of developing lifting-related low back pain. It is calculated as a product of the weight that is considered safe for an ideal lift (i.e. load constant equal To 23 Kg) and six weighted task variables, which include the:(1)horizontal distance of the load from the worker (H); (2) vertical height of the lift (V); (3) vertical displacement during the lift (D);angle of

asymmetry (A); (5) frequency (F) and duration of lifting and and,(6) quality of the hand to object coupling.

RWL = LC * HM * VM * DM * AM * FM * CM

3.4 Lifting Index (LI)

The LI is a term that provides a relative estimate of the level of physical stress associated with a particular manual lifting task. The estimate of the level of physical stress is defined by the relationship of the weight of the load lifted and the recommended weight limit. The LI is defined by the following equation:

$$LI = \frac{\text{Load Weight}}{\text{Recommended Weight Limit}} = \frac{L}{RWL}$$

3.5 Terminology and Data Definitions

The following list of brief definitions is useful in applying the revised NIOSH lifting equation. For detailed descriptions of these terms, refer to the individual sections where each is discussed. Methods for measuring these variables and examples are provided. Lifting defined as the act of manually grasping Task an object of definable size and mass with two hands, and vertically moving the object without mechanical assistance.

Load Weight (L): Weight of the object to be lifted, in pounds or kilograms, including the container.

Horizontal Location (H): Distance of the hands away from the mid-point between the ankles, in inches or centimeters (measure at the origin and destination of lift) as shown in Fig.2.

Vertical Location (V): Distance of the hands above the floor, in inches or centimeters (measure at the origin and destination of lift) as shown in Fig.2.

Vertical Travel Distance (D): Absolute value of the difference between the vertical heights at the destination and origin of the lift, in inches or centimeters as shown in Fig.2.

Asymmetry Angle (A): Angular measure of how far the object is displaced from the front (mid-sagittal plane) of the worker's body at the beginning or ending of the lift, in degrees (measure at the origin and destination of lift). The asymmetry angle is defined by the location of the load relative to the worker's mid sagittal plane, as defined by the neutral body posture, rather than the position of the feet or the extent of body twist.

Neutral Body Position: Describes the position of the body when the hands are directly in front of the body and there is minimal twisting at the legs, torso, or shoulders.

Lifting Frequency (F): Is average number of lifting per minute over 15 minute periods.

Lifting Duration: Three-tiered classification of lifting duration specified by the distribution of work-time and recovery-time (work pattern). Duration is classified as either short (1 hour), moderate (1-2 hours), or long (2-8 hours), depending on the work pattern.

Coupling Classification: Classification of the quality of the hand-to-object coupling (e.g., handles, cut-out, or grip). Coupling quality is classified as good, fair, or poor.

3.6 Lifting Task Limitations

The Revised NIOSH Lifting Equation does not apply if any of the following occur:

- Lifting/lowering with one hand.
- Lifting/lowering for over 8 hours.
- Lifting/lowering while seated or kneeling.
- Lifting/lowering in a restricted work space.
- Lifting/lowering unstable objects.
- Lifting/lowering while carrying, pushing or pulling.
- Lifting/lowering with wheelbarrows or shovels.
- Lifting/lowering with high speed motion (faster than about 30 inches/second).
- Lifting/lowering with unreasonable foot/floor.
- Coupling (< 0.4 coefficient of friction between the sole and the floor).

Lifting/lowering in an unfavorable environment (i.e., temperature significantly outside 66-79° F (19-26° C) range; relative humidity outside 35-50% range) For those lifting tasks in which the application of the revised lifting equation is not appropriate, a more comprehensive ergonomic evaluation may be needed to quantify the extent of other physical stressors, such as prolonged or frequent non-neutral back postures or seated postures, cyclic loading (whole body vibration), or unfavorable environmental factors (e.g., extreme heat, cold, humidity, etc.). Any of the above factors, alone or in combination with manual lifting, may exacerbate or initiate the onset of low back pain.

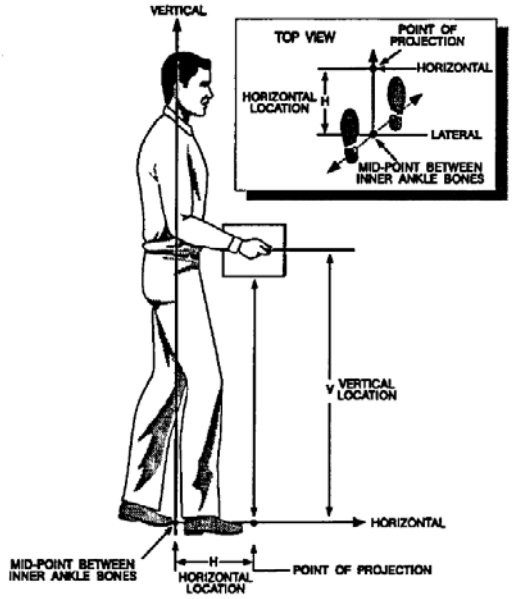

Fig. 2. Graphical representation of hand location

3.7 The Equation and Its Function

The revised lifting equation for calculating the Recommended

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Weight Limit (RWL) is based on a multiplicative model that provides a weighting for each of six task variables. The weightings are expressed as coefficients that serve to decrease the load constant, which represents the maximum recommended load weight to be lifted under ideal conditions. The RWL is defined by the following equation:

RWL = LC * HM * VM * DM * AM * FM * CM

The term and meaning are shown in Table 1.

TABLE 1
Term and meaning of RWL

TERM	MEANING	METRIC
LC	Load Constant	23 kg
HM	Horizontal Multiplier	HM (25/H)
VM	Vertical Multiplier	1-.003(V~75)
DM	Distance Multiplier	.82 + (4.5/D)
AM	Asymmetric Multiplier	1-(.0032A)
FM	Frequency Multiplier	From Appendix E
CM	Coupling Multiplier	From Appendix F

The term task variables refers to the measurable task descriptors (i.e., H, V, D, A, F, and C); whereas, the term multipliers refers to the reduction coefficients in the equation (i.e., HM, VM, DM, AM, FM, and CM). Each multiplier should be computed from the appropriate formula, but in some cases it will be necessary to use linear interpolation to determine the value of a multiplier, especially when the value of a variable is not directly available from appendix. For example, when the measured frequency is not a whole number, the appropriate multiplier must be interpolated between the frequencies values in the table for the two values that are closest to the actual frequency.

4 COMPUTATIONAL DETAILS

For this work data has been collected from several industries and workstations. MS Excel spreadsheet has been used for ease of calculation and fast computation. An analysis sheet has been developed with excel where it is easy to check and analysis different multiplier for RWL that is comfortable for a worker.

4.1 GROUPING

Grouping done based on stature height at 85 percentile are shown in Table 2.

TABLE 2
Grouping of data

Group	Stature Height
Group: 1	Below 155
Group: 2	155 – 160
Group: 3	160 – 165
Group: 4	165 – 170
Group: 5	170 – 175
Group: 6	Above 175

4.2 RWL SHEET FOR COLLECTED DATA

By using MS Excel RWL is calculated that are shown in Table 3.

TABLE 3
RWL calculation sheet

Serial	Stature Height	Object Weight		Hand Location				Vertical Dist. (m)	Assemetry Angle		Frequency	Frequency Multiplier		Time	Object Coupling	CM Coupling Multiplier	CM Coupling Multiplier	LC Load Constant	HM		VM		DM	AM		RWL		Lifting Index	
		Average	Maximum	Origin H	Origin V	Destination H	Destination V	D	Origin Degree	Destination Degree	Lifts/min F	Origin FM	Destination FM	Hours	C	Origin	Destination	kg	Origin	Destination	Origin	Destination		Origin	Destination	Origin	Destination	Origin	Destination
1	162.5	10.6	11	22	35	77.5	84.5	49.5	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.62	3.65	0.78	2.90
2	167.6	10.2	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.75	2.91
3	172	10.2	11	22	35	82	90	55	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.76	3.04
4	168	11	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.81	3.13
5	165.9	11	11	22	35	77	85	50	0	45	2	0.65	0.65	3	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.60	3.67	0.81	3.00
6	173.2	10.2	11	22	35	82	90	55	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.76	3.04
7	164.3	11	11	22	35	78	84	49	0	45	2	0.65	0.65	3	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.64	0.81	3.02
8	166	10.6	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.78	3.02
9	170.6	10	11	22	35	82	90	55	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.74	2.98
10	160.2	11	11	22	35	78	84	49	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.64	0.81	3.02
11	178	9.5	11	22	35	86	95	60	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.71	3.04
12	171.7	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
13	165.3	10.5	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.78	2.99
14	171.3	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
15	174	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
16	169.3	9.4	11	22	35	86	95	60	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.70	3.00
17	163.6	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
18	168.3	10.6	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.78	3.02
19	173	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	3	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
20	170.6	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	5	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01

table 3. (continued)

21	160.5	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
22	168.2	10.6	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.78	3.02
23	173.5	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
24	169.7	10.6	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.78	3.02
25	163.2	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	3	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
26	173.2	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
27	175	9.4	11	22	35	86	95	60	0	45	2	0.65	0.65	5	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.70	3.00
28	171.3	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
29	176.9	9.4	11	22	35	86	95	60	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.70	3.00
30	162.3	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
31	177	9.5	11	22	35	86	95	60	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.71	3.04
32	164	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
33	174	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
34	170	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01
35	179.2	9.4	11	22	35	86	95	60	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.70	3.00
36	167.1	10.6	11	22	35	79	88.7	53.7	0	45	2	0.65	0.65	8	Good	1	1	23	1.14	0.32	0.88	0.96	0.90	1.00	0.86	13.51	3.51	0.78	3.02
37	163.6	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	2	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
38	180	9.5	11	22	35	86	95	60	0	45	2	0.65	0.65	4	Good	1	1	23	1.14	0.29	0.88	0.94	0.90	1.00	0.86	13.38	3.13	0.71	3.04
39	163.3	11.1	11	22	35	77	84	49	0	45	2	0.65	0.65	3	Good	1	1	23	1.14	0.32	0.88	0.97	0.91	1.00	0.86	13.63	3.69	0.81	3.01
40	175.2	10.1	11	22	35	82	90	55	0	45	2	0.65	0.65	5	Good	1	1	23	1.14	0.30	0.88	0.96	0.90	1.00	0.86	13.48	3.36	0.75	3.01

5 RESULTS AND FINDINGS

Data is analyzed in order to determine the limit of two factors (horizontal and vertical position of destination) in determining the RWL as these two factors plays major role in determining RWL. Other factors assumed constant as this can be call as an ideal condition in our work. In this ideal condition RWL is determined for each group of people which is safe for lifting.

5.1 Recommended Weight for Each Group

Recommended weights for six groups are shown in Table 4.

TABLE 4
Grouping and respective weight limit

Group	Stature Height (cm)	Maximum Horizontal position of Destination (cm)	Maximum Vertical position of Destination (cm)	Safe Load (kg)
Group: 1	Below 155	70	78.5	10
Group: 2	155 – 160	75	81	10.2
Group: 3	160 – 165	77.5	84.5	10.4
Group: 4	165 – 170	79	88.7	10.7
Group: 5	170 – 175	82	90	10.8
Group: 6	Above 175	86	95	11

From Table 4 it is found that maximum weight limit does not very significantly for each group in ideal conditions. So it can summarized that, in ideal conditions the weight limit is 10 kg to 11 kg for each human worker to avoid back pain and other lifting related injuries.

5.2 RWL Calculator

In this work, finally a RWL calculator is developed with Microsoft Excel where the value of H and V for destination is determined automatically when the stature height is put in the stature height column. A drop down menu is included for object coupling option and coupling multiplier value taken automatically from dropdown menu. After putting other conditions the calculator show RWL, LI and ultimately it indicates while the conditions are safe or unsafe for the worker. This calculator also helps to analysis all conditions of a workstation. A sample calculation with RWL is shown in figure 3.

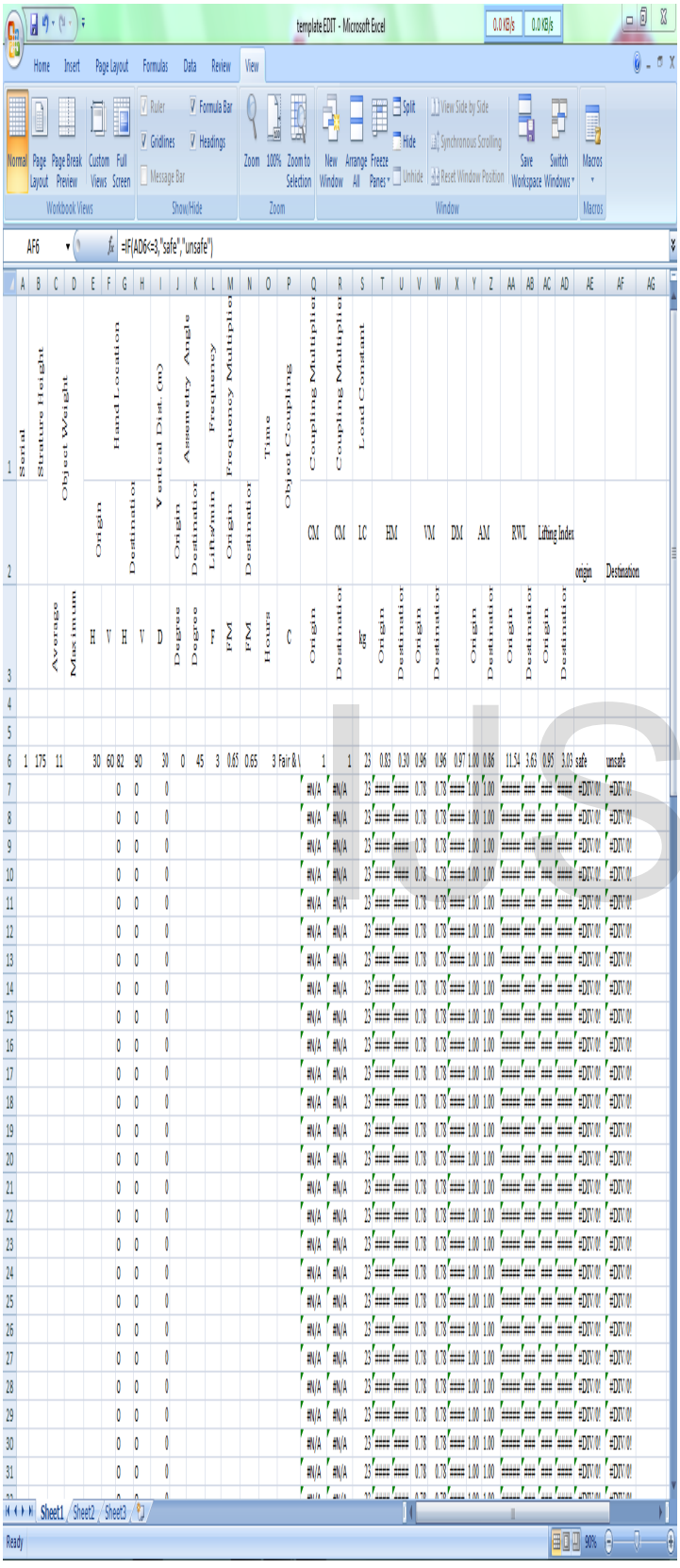

Fig. 3. Screen shot of RWL Calculator

6 Conclusion and Discussion

Lifting weights more that limit have a long term impact on workers. Many of them suffer in low back pain and other long term injuries. So it is really very important to determine the limit of load that a worker can safely lift. It is also important to assign right person to the right workstation in order to lift the right load which is safe for him. For this reason in this work a weight limit is determined for 5 groups of people who are grouped according to their anthropometric measurement. First the workers are classified into 5 groups according to their anthropometric measurement. Then RWL is calculated individually for each worker for each group from the raw data that is gathered from different sources. Then the data is further analyzed in order to determine the limit of two factors (horizontal and vertical position of destination) in determining the RWL as these two factors plays major role in determining RWL. The all other factor assumed constant as this can be call as an ideal condition in our work. In this ideal condition RWL is determined for each group of people which is safe for lifting. At last a RWL calculator is prepared in order to calculate RWL in all condition.

Future Recommendation

1. A safe work station can be designed with the limit of two factors that has been determined in this work. Thus it is possible to assign a worker into a workstation for lifting work which is safe for them.
2. Worker turnover is one of the recent problems that has been faced by our industries. This turnover not only causes huge economical loss for the company but also the company loss their skilled and experienced personnel. As over lifting causes the long term injuries for the workers, it regarded as one of the major cause of employee turnover. Thus by determining a safe load for the worker this rate of turnover can be minimized.

APPENDIX

APPENDIX A: Horizontal Multiplier

H(cm)	HM
≤25	1.00
28	.89
30	.83
32	.78
34	.74
36	.69
38	.66
40	.63
42	.60
44	.57
46	.54
48	.52
50	.50

52	.48
54	.46
56	.45
58	.43

APPENDIX B: Vertical Multiplier

V (cm)	VM
0	.78
10	.81
20	.84
30	.87
40	.90
50	.93
60	.96
70	.99
80	.99
90	.96
100	.93
110	.90
120	.87
130	.84
140	.81
150	.78
160	.75
170	.72
175	.70
>175	.00

APPENDIX C: DISTANCE MULTIPLIER

D (cm)	DM
≤25	1.00
40	.93
55	.90
70	.88
85	.87
100	.87
115	.86
130	.86
145	.85
160	.85
175	.85
>175	0

APPENDIX D: Asymmetric Multiplier

A (degree)	AM
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	0

APPENDIX E: Frequency Multiplier Table (FM)

Lifting frequency F, (lifting actions/min)	Duration of lifting work: <= 1 hour		>1 but <= 2 hours		> 2 but <=8 hours	
	V < 75 cm	V >75 cm	V < 75 cm	V >75 cm	V < 75 cm	V >75 cm
<= 0.2	1	1	0.95	0.95	0.85	0.95
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.8	0.8	0.6	0.6	0.35	0.35
6	0.75	0.75	0.5	0.5	0.27	0.27
7	0.7	0.7	0.42	0.42	0.22	0.22
8	0.6	0.6	0.35	0.35	0.18	0.18
9	0.52	0.52	0.3	0.3	0	0.15
10	0.45	0.45	0.26	0.26	0	0.13
11	0.41	0.41	0	0.23	0	0
12	0.37	0.37	0	0.21	0	0

APPENDIX F: Coupling Multiplier

Coupling Type	Coupling Multiplier: V< 30 inches (75 cm)	V > 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

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