

Risk Assessment of Weight Lifting at McMaster DBAC: A REBA and NIOSH Analysis

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Part 1: Work Environment Selection & Observation

DBAC Overview/What is Located in the DBAC?

The David Braley Athletic Centre (DBAC) is a health and recreation building at McMaster University that offers multiple recreational areas, health education activities, workout equipment, etc. The building is open to the McMaster and local Hamilton community, and it has been a significant space dedicated for sports, medicine and health (*David Braley*, n.d.). After observing an employee's role at the DBAC, I performed various assessments and identified numerous hazards and risks that could potentially contribute to musculoskeletal disorders.

What Job Roles Does the DBAC Provide?

The DBAC offers various job roles. This includes front desk staff, facility maintenance staff, fitness instructors, janitors, lifeguards, game officials, sports coordinators, safety management, customer service, and health administrators, to name a few (*David Braley*, n.d.). A lot of jobs, such as Front desk staff, game officials, and sports conductors, are more verbal and communication-based. Other jobs, such as facility maintenance staff, janitors, and lifeguards, require more physical attention. This does not mean that a job is tied to only communication or physical aspects. Most of these jobs need a balance of both. The job observed in this report is from a facility maintenance staff.

The Scenario Observed in the DBAC

The scenario observed at my time in DBAC revolved around an employee who is assigned to keep the gym clean and safe. This included sterilizing equipment, arranging weights, and keeping workout areas safe and clean. Their duty is critical in maintaining a clean atmosphere and eliminating any hazards by keeping the gym areas organized and uncluttered. Furthermore, their efforts immediately benefit the users' overall safety, as cleanliness and organized environments help lessen the probability of injuries for gym users and musculoskeletal injuries (*David Braley*, n.d.).

The Specific Task Observed

One specific task that I observed involved the employee constantly moving through different parts of the gym. They moved between various stations, lifting weights and returning them back to their weight stations. The tasks they completed involved repeated arm and shoulder movements. It required the employee to bend over to reach lower areas of the equipment frequently. The employee periodically lifted and returned weights or other equipment to their designated locations, which increased the physical workload of the job. Overall, the task required

a lot of bending, repeated arm and leg movements, and heavy lifting. This can potentially cause strain on muscles, bones, and tendons, leading to short-term pain or long-term musculoskeletal issues.

Part 2: Hazard Identification & Risk Assessment

Methods

The Rapid Entire Body Assessment (REBA) from the MSD Prevention resource was used to conduct a preliminary risk assessment of the facility maintenance employee. The REBA is split into two primary sections. Section A assesses the posture of the neck, trunk, and legs and gives an evaluation based on the results (Hignett & McAtamney, 2000). Section B assesses the posture of the arms and wrists (Hignett & McAtamney, 2000). The way the REBA tool works is by analyzing various physical motions, the frequency of the task, and the amount of force used by the individual. Each section is assigned a number based on its risk and the total risk is calculated by combining the scores (Refer to **Table I**, **Table II**, and **Table III**) (Hignett & McAtamney, 2000). Larger numbers indicate a higher chance of injury, and lower numbers indicate a lower chance of injury (Refer to **Table I**, **Table II**, and **Table III**) (Hignett & McAtamney, 2000). The REBA was used as a preliminary assessment tool because it provides a quick and general evaluation of whole-body postures and associated risks without requiring highly detailed measurements (See Appendix B). The REBA also requires zero calculations. The REBA was used as it offered a broad overview of potential bodily risks. It was not used for the detailed risk assessment because it does not specify which section of the body it is targeting. Rather, it targets the entire body, making it less precise than more detailed tools like the NIOSH Lifting Equation.

The NIOSH Lifting Equation from the MSD Prevention resource was used to conduct a detailed risk assessment of the facility maintenance employee. Through the use of multiple factors, including the weight lifted, load transported, vertical movements, horizontal movements, angle of asymmetry, and coupling factors (Refer to **Figure 1**), this tool is directly intended to evaluate the risk of lifting and its relationship with musculoskeletal disorders. To conduct the assessment, measurements of the load's origin and destination were taken. Then, the horizontal and vertical location of the employee was taken before and after returning misplaced weights to their original location. The angle of asymmetry was measured at both the lift's starting and ending points. Then, the coupling quality of the weights was assessed. The analysis considered both the frequency and length of the lifts (Refer to **Table VI**). Measurements were done using a measuring tape and a protractor to obtain values in inches and degrees, respectively. After all variables were assessed, the NIOSH Lifting Equation formula was used to calculate the recommended weight limit (RWL), frequency index RWL (FIRWL), lifting index (LI), and frequency index lifting index (FILI) (Refer to **Table VII**). The formula for the NIOSH Lifting

Equation is: $RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$. The NIOSH Lifting Equation values were then multiplied to achieve final results.

Limitations

One limitation of the REBA tool is that it provides a broad and generalized assessment, which does not account for specific joint or muscle movements. The REBA assessment tool is an excellent place to start when determining body posture concerns in workplaces such as the DBAC. However, the tool lacks the accuracy required to evaluate specific body areas that may be subjected to more significant physical strain when performing actions like lifting weights. Due to this, it is helpful for basic knowledge and the overall impact on the body, but it is insufficient for a thorough examination. The NIOSH Lifting Equation, on the contrary, is a much more detailed and comprehensive assessment tool that takes into account a variety of variables that are specifically tailored towards lifting objects. The NIOSH Lifting Equation uses various factors such as the load's weight or lifting frequency. However, the NIOSH Lifting Equation is not perfect. Both the preliminary and detailed risk assessment tools are limited by observing one person. They are not impacted by biological characteristics between workers, such as sex, which might affect the overall results. Men and women have various biological traits that can cause differences in their levels of strength and physical endurance (Tosi et al., 2024). This can cause some occupations to be seen as more suitable for one over the other. This can result in an uneven distribution of physically demanding tasks. The time constraint is another limitation. The employee only worked at the weight stations for approximately 45 minutes. The employee does various tasks in his shifts, including cleaning locker rooms and maintaining a good appearance in the facility. This short time frame is a limitation as it only gave a glimpse of what was being done. This brief window may not capture the entire scope of labor or the accumulated stress that employees endure throughout longer shifts. Various factors may change, including critical factors such as the maximum weight lifted. Due to this, the data gathered is limited to what was noted during that little time, and it is possible that long-term concerns were not adequately considered in the assessment. Due to the short observation time and the physically demanding aspects of the job, it would be difficult to apply a psychological risk assessment method like the Job Strain Model in this analysis. The Job Strain Model is a model that focuses on work demands and social interactions. The analysis would take much more time because assessing mental strain is done over time. To better capture stress factors in a manner that is more useful for the workplace, short surveys or brief interviews could be used at the end of shifts to gather real feedback from workers on job stress. This would allow for an immediate assessment of psychosocial risks.

Part 3 : Risk Assessment Report

Summarizing the Risk Assessment Results

In Section A of the REBA assessment, the neck scored 1 (slight forward tilt), the trunk scored 2 (bending), and the legs scored 2 (frequent crouching), with an additional 2 points for lifting 25 lbs. The total score for Section A was 7. In Section B, the upper arm scored 2, the lower arm 2, the wrist 1 (slight twisting), with 1 additional point for a tight grip. The total score was 7. After using **Table V**, the final score was 9, indicating moderate risks of musculoskeletal injuries. The NIOSH Lifting Equation calculated a Recommended Weight Limit (RWL) of 39.78 lbs at the origin and 42.19 lbs at the destination. With an observed load of 25 lbs, the Lifting Index (LI) was 0.63 at the origin and 0.59 at the destination. This indicates a low risk of musculoskeletal injuries.

Hazards and Risk Factors in the DBAC

Two key hazards were identified during the task observation at DBAC. Mechanical wiring near the treadmill area was identified as a tripping hazard. Fatigued individuals are at a higher risk of tripping over these wires. Narrow areas to get to gym equipment are a hazard because the likelihood of hitting people and/or equipment is high. Risk factors include lifting weights beyond body threshold and constant bending, causing discomfort in the spinal area. Lifting heavy weights often can lead to muscle strain and tiredness. Constantly bending or twisting during tasks can lead to bodily injuries.

Next Steps Going Forward

After observing the hazards and risks associated with the task, the DBAC along with other workplaces should implement several key changes going forward. First, recreational and sports workplaces should create a scheduled system for regularly checking and clearing weights and equipment from the floor to prevent tripping hazards. Adding clear and visible floor signs to incentivize gym users to re-rack their weights would also help minimize injuries. Additionally, increasing the space between gym equipment in crowded areas would reduce the likelihood of collisions. This reduces the amount of injuries caused in the work environment.

Considerations/Recommendations

Some recommendations that can be given to DBAC and other similar workplaces include simple training for gym users and gym staff on proper lifting techniques. Additionally, creating more space or renovating the gym to allow better traffic flow between gym users will minimize the chances of collisions. This will improve the safety of both staff and gym users.

References

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Appendix

Appendix A: Observed Notes

- The employee often took moments to fix their posture after bending down to get weights. This may show signs of discomfort.
- When moving weights such as the 25 lbs weights back to their station, the employee seemed like they were out of breath after putting the weights back to their stations.
- All the weights were moved by hand. There were no visible marks on the employees hands, but the front of the hand appeared slightly red.

Appendix B: REBA Analysis

Table I: Section A of the Rapid Entire Body Assessment (REBA), Scoring the Neck, Trunk, and Leg Posture. This table displays the posture scores for the neck, trunk, and legs of the facility maintenance employee at the David Braley Athletic Centre (DBAC).

Body Part	Score	Reason
Neck	1	Slight forward tilt
Trunk	3	Bending and turning
Legs	2	Frequent crouching and bending of the knees
Load & Force Application	2	Lifting 25 lbs per arm (over 22 lbs)
Total Score	7	

Table II: Section B of the Rapid Entire Body Assessment (REBA), Scoring the Arm, Wrists, and Grip Posture. This table displays the posture scores for the arm, wrist, and grip of the facility maintenance employee at the David Braley Athletic Centre (DBAC).

Body Part	Score	Reason
Upper Arm	2	Lifting items between 45-90°
Lower Arm	2	Pressure on forearms
Wrist	2	Slight twisting
Grip Application	1	Decent grip on weights
Total Score	7	

Table III: REBA's Neck, Trunk, and Leg Posture Scoring Table. This table displays the scoring numbers for the neck, trunk, and leg postures. The scores are calculated by cross-referencing the trunk, leg, and neck postures to obtain a single number.

Table III	Neck												
		1				2				3			
	Legs												
		1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table sourced from Highnett & McAtamney (2000), (Hignett & McAtamney, 2000).

Table IV: REBA's Arm and Wrist Posture Scoring Table. This table displays the scoring numbers for the lower arm, upper arm, and wrist postures. The scores are calculated by cross-referencing the lower/upper arm values, with the wrist values to obtain a single number.

Table IV	Lower Arm						
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table sourced from Highnett & McAtamney (2000), (Hignett & McAtamney, 2000).

Table V: REBA's Final Scoring Table. This table combines the posture scores from **Table III** and **Table IV** to help assess the overall ergonomic risk of the employee's job at the David Braley Athletic Centre (DBAC). This gives the final REBA risk score.

Score from Table III	Table V											
	Score from Table IV											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table sourced from Highnett & McAtamney (2000), (Hignett & McAtamney, 2000).

Appendix C: NIOSH Lifting Equation Assessment

Table VI: A NIOSH Lifting Equation Assessment for Employee Working at DBAC. This table displays the input parameters, including the horizontal and vertical location, travel distance, angle of asymmetry, coupling, frequency load, and duration for both the origin and destination positions of the weight lifting task.

Input	Origin (inches)	Destination (inches)
Horizontal Location	10	10
Vertical Location	0	30
Travel Distance	0	30
Angle of Asymmetry	0°	20°
Coupling	Good	Good
Frequency	≤0.2	≤0.2
Avg. Load	15	15
Max Load	25	25
Duration	Short (≤1 hr)	Short (≤1 hr)

(NIOSH, n.d.)

Table VII: Weight Limit and Lifting Index for Weight Lifting Task at DBAC. This table displays the recommended weight limit (RWL), frequency-independent RWL (FIRWL), lifting index (LI) and the frequency-independent lifting index (FILI) for the weight-lifting task at DBAC.

Input	Origin	Destination
Recommended Weight Limit (RWL)	39.78 lb(s)	42.19 lb(s)
Frequency Ind. RWL (FIRWL)	39.78 lb(s)	42.19 lb(s)
Lifting Index (LI)	0.38	0.36
Frequency Ind. Lifting Index	0.63	0.59

(NIOSH, n.d.)

Table VIII: The NIOSH Lifting Equation Multipliers for Weight Lifting Task at DBAC.

This table displays the horizontal, vertical, distance, asymmetry, coupling, and frequency multipliers for the NIOSH Lifting Equation for the task observed at DBAC.

Input	Origin	Destination
Horizontal Multiplier (HM)	1.00	1.00
Vertical Multiplier (VM)	0.78	1.00
Distance Multiplier (DM)	1.00	0.88
Asymmetry Multiplier (AM)	1.00	0.94
Coupling Multiplier (CM)	1.00	1.00
Frequency Multiplier (FM)	1.00	1.00

(NIOSH, n.d.)

Appendix D: Image analysis of the NIOSH Lifting Equation

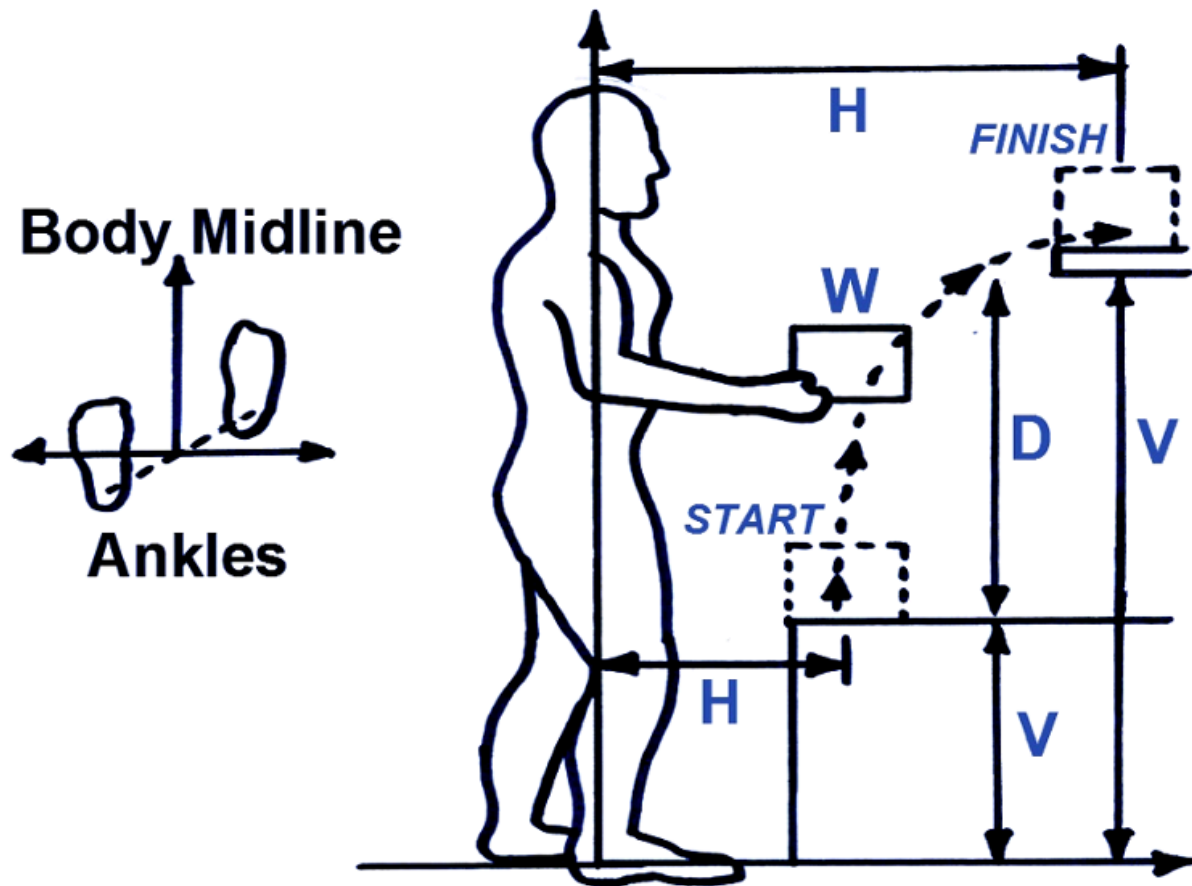


Figure 1: NIOSH Lifting Equation Procedure. This image displays the overall process for evaluating a lifting task using the NIOSH Lifting Equation method. The “W” stands for weight, the “D” stands for distance, the “H” stands for horizontal, and the “V” stands for vertical.

(Jesús, 2021)