

Faculty of Engineering and Architectural Science

Department of Mechanical and Industrial Engineering

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Course Title	Industrial Ergonomics
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Instructor	Patrick Neumann
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Report No.

3

Report Title	Final Report
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Group No.	7
Submission Date	April 13th 2021
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MAIN MESSAGE

The workplace group 7 has chosen to analyze and apply human factors knowledge and methods to a small family run pharmacy known as Westwood Pharmasave. The study aims at improving the overall wellbeing of the pharmacy technicians at the location to assist in accomplishing the pharmacies main goals.

PROBLEM

The pharmacy describes its goals as fulfilling prescriptions, handling customer transactions, assisting customers, maintaining cleanliness, and providing quick and efficient service. The following report will focus primarily on the tasks that the pharmacy technicians perform during the pharmacy's operational hours, and more specifically the process by which they fill prescriptions. The group noticed that there are numerous instances where the workers find themselves over exerting, or experiencing stress and the group aims to find ways to remedy, and develop possible solutions.

CONTEXT:

Background:

Westwood Pharmasave is a small pharmacy adjacent to a medical clinic in the suburbs of Guelph, Ontario. The pharmacy is a very small operation, with a total of 4-5 workers present at time. Upon initial conversation with the owner the pharmacy estimates to serve on average 40-50 customers a day and fill upwards of 90-110 prescriptions a day. The pharmacy remains operational 6 days of the week, while being open 9:30am- 7:00 pm weekdays, and open 10:00 am-4:00pm Saturdays. The pharmacy is fairly new, having opened the spring of 2019, and a new doctors clinic opening next door also provides an influx of patients and customers further busying the location.

System:

The system being analyzed in this scenario focuses specifically on the filling of prescriptions by the pharmacy technicians. This process involves a variety of steps, including using a computer for processing prescriptions for new or old customers, then reaching for the paperwork and medication on certain elevations on a shelf, moving the medication to the work area, filling the medication into the appropriate containers, packaging the medication with paperwork, and delivering the medication to the pharmacist or patient.

METHODS:

Redesigns were created for the workers that are currently working at the pharmacy based on the surveys, WATBAK, and analysis. This was done to improve their everyday work environment, lower their overall stress levels and physical pain they experience. The solutions that were decided were adding sit-stand stools and anti fatigue mats for workers who complained about standing, lowering the counter height with an adjustable desk, removing a hole in the desk and adding ergonomic chairs for workers to get closer and have better back positions while on the computer, and moving heavy objects off very low shelves. JACK models and WATBAK

were the primary source to simulate the workers' tasks. The information that was gathered was from the pharmacy pictures that showed the key areas where the workers complained. The surveyed then helped locate the specific areas on the worker that were being affected. In JACK, vision, RULA and spine and shoulder forces were measured for each task. These procedures were then expanded to account for the widest range of potential employees who could work at the pharmacy in the future.

RESULTS:

There were two qualitative surveys conducted which addressed both physiological and psychological aspects of the job. Four different workers were asked to fill out the survey and each held a different responsibility within the workplace. These workers varied in age, height, weight and gender.

Physiological survey:

Worker 1 is 64 year old, and 163 cm who works long hours (7+ per day) .She works as a pharmacy technician which means she is in charge of medication which includes labeling, delivering, mixing, measuring and many more. She complains about sitting and standing for long periods of time. Her pain that is caused by her work is mostly targeted on her neck, upper back, lower back and shoulders meaning she is looking down in order to complete her tasks. It can also be observed that she experiences pain on her right knee, right thigh/hip and ankles. She also experiences slight pain in her wrist area due to manipulating pills.

Worker 2 is a 53 year old male and works as a pharmacist. He prepares and dispenses the medication while ensuring that each dose is correct. The results from his survey indicate that he feels pain when sitting in place for long periods of time. He also noted that the chairs within the pharmacy slack back support which causes extra strain placed on the neck and upper shoulder. He is on his feet for prolonged periods of time and often has to look down when preparing the medication for the customers. Doing this frequently has caused him to feel pain in the left knee as well as the lower back.

Worker 3 is a 53 year old female who works as a pharmacy assistant. Some of her roles include gathering the customer's information and prescription details through computerized systems, preparing and packaging the prescription medications. Doing these tasks daily has caused her to experience pain in certain areas such as the right hip and right knee. She also experiences slight discomfort in her neck, left thigh and left knee when switching from sitting to standing. The strain placed on her neck comes from looking at the computer screen for most of the day and also looking downwards when counting pills during her shift.

Worker 4, a 28 year old pharmacy student, is currently working as an assistant. He does similar tasks as the pharmacy technician and is also in charge of cleaning. He says he experiences discomfort while cleaning and dusting the lowest self which is approximately 2 inches off the floor. His pain is mostly targeted in his neck, upper back, lower back which comes from standing for hours and the awards positions from cleaning. Unlike other workers he is not often tired at work (once or twice a week) and experiences less discomfort.

Psychological survey:

Based on the results, it can be concluded that each position is mentally challenging due to its long work days, fast pace, dealing with customers and from the surveys it can be observed that all workers do experience stress caused by work. The stress experienced within their job comes from the daily duties they have to carry out. For instance, worker 3 experiences headaches from staring at computer screens for hours which can be irritating and can lead to lower productivity. It is important to note that all workers get along so their stress is not caused by their relationships with one another but rather the design of the workplace and their workload.

JACK:

In order to get quantitative data, the postures from the surveys were recreated in JACK. From that RULA scores and compression loads were determined.

The first posture that can be analyzed was standing in front of a 91.44 cm counter to manipulate pills which is a task done by worker 1 and worker 3. Respectively the RULA scores were 3 and 4. The scores were not as alarming as other postures however they were not perfect due to the strain in the neck from looking down and the arms from reaching forward. The compression scores were 561.4 N and 310 N. Overall, the workers are experiencing discomfort from standing for long hours repeatedly.

The next posture that was analyzed was when the workers were seated at the desk when using the computer or filling out some paperwork for the customers. Workers 1 and 2 sit at the desk for long periods of time causing them to experience intense discomfort over time. This can be seen through the RULA scores of both of the workers as they both received a score of 6 meaning that changes need to be made to the workstation. Taking a look at the compression loads the workers experience a load of 774.6N and 1030.1N for workers 1 and 2 respectively. refer to table 5)

The final task the workers complained about was reaching down to clean or get supplies from the lower shelf. From Jack it can be analyzed that in fact that posture is causing a lot of strain on the body more specifically the lower back from having it curved and the arms from reaching forwards. From Jack it shows that the RULA is 6 which indicates that it is alarming and must be changed immediately. As well, the compression force is 1293.1 N.

DESIGN RECOMMENDATIONS:

In order to improve the worker's postures and productivity there are changes that can be implemented to make the workplace more accommodating. Due to the workers continuously sitting, standing and reaching to complete their day to day activities a few changes had to be made to the workplace.

Standing:

The workers that were being analyzed complained about standing for long hours during the normal work day, they also complained about the desk height being too high when they are filling prescription bottles and it hurt their shoulders. The way this was improved was making the worker stand on an anti-fatigue mat which could not be quantified using numbers but will have to be qualitatively tested once implemented with the work environment based on a second

round of surveys. The next improvement was the lowering of the desk which currently put strain on the shoulders and spinal load. Employee 3 experienced a spinal compression of 310N and a shoulder moment of -0.9Nm this changed to 252N for the spine and 1.3Nm for the shoulder. The final solution was to add a sit-stand stool to allow the worker to reduce the force on their spine after standing for hours, this will help break up the amount of time the worker is standing. Overall the implementations will help benefit the worker and allow for a more productive workday and less likelihood of future injury involving the workers spine.

Sitting:

Initially, the workers were working on a counter as a desk (refer to Table 11) that counter did not have a hole which resulted in a bad posture since workers have to sit far away which makes them reach in order to work (refer to table 4 and 5). To improve the sitting posture adding a hole on the inner side of the desk will create more space for the workers to freely move around without bumping their legs into the desk. We simulated the redesign of the desk onto JACK and it can be noted that when implementing this change the RULA scores changed drastically which can be seen in table 1.

Table 1. Comparison between original and redesign

	RULA score		Compression force	
	Original design	Redesign	Original design	Redesign
Worker 1	6	4	774.6 N	367.9 N
Worker 2	6	3	1030.1 N	803.2 N

This leads us to conclude that when the new changes are implemented the workers are automatically feeling less strain on their body. The compression scores also decreased meaning that the spinal load they experience when filling out the paperwork and using the computer. It can be noted that more than 74% of workers continue to experience pain which leads to distraction and decreased productivity. By implementing an ergonomic chair it can conform to each worker's specific shape. It also helps support the spine and keep all joints and tissues in a neutral position. (*Concepts seating , Benefits of ergonomic seating*) Due to the new changes the workers will have more space for their legs to move around and can adjust their positions accordingly. This will lead to less stress on their body and overall result in better postures which will decrease the risk of injury and eliminate a lot of the discomfort they are currently experiencing. Overall, this will positively affect their productivity and their wellbeing.

Reaching:

One of the most prominent complaints made is lower back pain. Some participants in the study believe majority of it is due to constantly leaning over, and bending whether it be for grabbing paper, notes, mediation, packaging, or other tasks such as cleaning. As of right now, the current system has the employee bend low, or drop to their knees to grab the items. The use of

these tools will ideally remove that motion, and allow them to comfortably perform their tasks. The new solution has 477N as total spinal compression which is drastically lower than the original value of 1218N.

The next possible solution was to solve the over extending done at the pharmacy. This action is typically done to grab items off shelves or cabinets. The solution proposed here would be a standard step stool. The step stool has multiple levels, and would allow numerous people of various heights to be able to reach or grab medication, or products without arching their back, bending their necks or extending their arms. This tool based on WATBAK analysis has a l4-l5 compression value of 522N which is well below the limits of NIOSH. This task can also be performed by 99.4% of people so it's a very beneficial cheap solution as well.

Cost benefit:

Table 2. Low and High Cost changes

Low cost	High Cost
<ul style="list-style-type: none"> - Anti-fatigue mat - sit stand stool - Step stool - Ergonomics chairs - Picker grabber 	<ul style="list-style-type: none"> - Raisable desk - Shelf pull out steps - Adding hole for sitting

The first category of the cost benefit analysis will be the High cost options. These options will have the highest initial cost and time to implement but will however provide the most optimal work environment. There are three high cost option in which the pharmacy may choose from: a adjustable desk that can be set to the desired height of the worker who is working at the desk, a shelf pull out step which will be put on the shelves to allow for a shorter worker to reach the top shelve without strain, an the adding a hole in the desk to allow the legs of the worker to sit closer to the computer while working on the computer like shown in Table 4. All of these options will provide the worker with the most optimal work environment, and also provide the pharmacy the options to accommodate the widest range of employees who can potentially work there in the future. If the company chooses to not go with any of these high cost options, they will have the option to choose the low cost options which will still provide the workers with a better working environment in which they are currently in.

The low cost method is the most cost effective solution possible. Instead of massive changes like the high cost method, the low cost method looks to alleviate the stress by incorporating numerous smaller changes that can make an impact right away. Most of these changes, such as the anti fatigue mat, step stools, and grabbers are very inexpensive. The tools can be purchased from \$30 upward and as a result is very bottom line friendly. The slightly more pricey items of the low cost method are the ergonomic chair and sit stand stool. Certain complaints were in regards to the pain experience from standing/ sitting all day. These sit/stand stool, and chairs are

a luxury and would pose as a quality of life improvement. The sit/ stand stool for instance would keep the worker relaxed against the cushion, and still allow for ease of walking when needed. The ergonomic chair would also support the employee while working, and can be adjusted by the user to obtain the ideal fit ergonomically.

DISCUSSION:

After careful analysis of all the options presented, it is confirmed that almost every change did indeed have a beneficial impact on the workers in the system at hand. The biggest limiting factor when implementing the changes in the system is cost, and space. Obviously a smaller pharmacy does not typically have the budget to opt into purchasing a whole new ergonomic counter top, or state of the art pull out step stools. So it is vital that the pharmacy be open to the ideas of implementing numerous smaller changes. Items such as anti-fatigue mats, is a very viable option to be placed around where lots of standing is done. Similarly better ergonomic chairs with arm and head rests that are adjustable would greatly improve overall work posture whilst sitting. Some careful considerations to make next time would be to do a more thorough examination of the tasks. Possibly take recording for a full week to gather a full scope of the timelines, and boundaries. This includes watching the workers do tasks themselves, and talking to workers directly. The circumstances of this year specifically and Covid 19, made this process slightly more challenging.

CONCLUSION:

The primary focus of this project was to increase human well-being and system performance. In order to do so, the team first needed to create a list of surveys that would help underline the main issues the workers are experiencing at the pharmacy. In the case of this project at the pharmacy the main issues were not stress related, they were more related to the ergonomics of the desks and workstations, other things included lifting and reaching. A computer program such as WATBAK, JACK can then be used to recreate the work environment the employees are in, and after getting the qualitative answers a redesign of the workplace can begin. There are two approaches that were taken for the pharmacy, the first being a basic yet effective approach and also economical. The other approach that was taken was a more advanced redesign of the workstation that would cost the company more money but it would also provide the best possible outcome for the worker and tailor to the highest range of future employees. Overall having two options to choose from gives the company more selection on what they want for the company and does not force them into a decision that might not be as suitable for them.

REFERENCES:

Benefits of ergonomic seating. (n.d.). Retrieved April 10, 2021, from
<https://www.conceptseating.com/benefits-of-ergonomic-seating>

APPENDIX:

Table 3. Original Posture for worker 1 - Standing

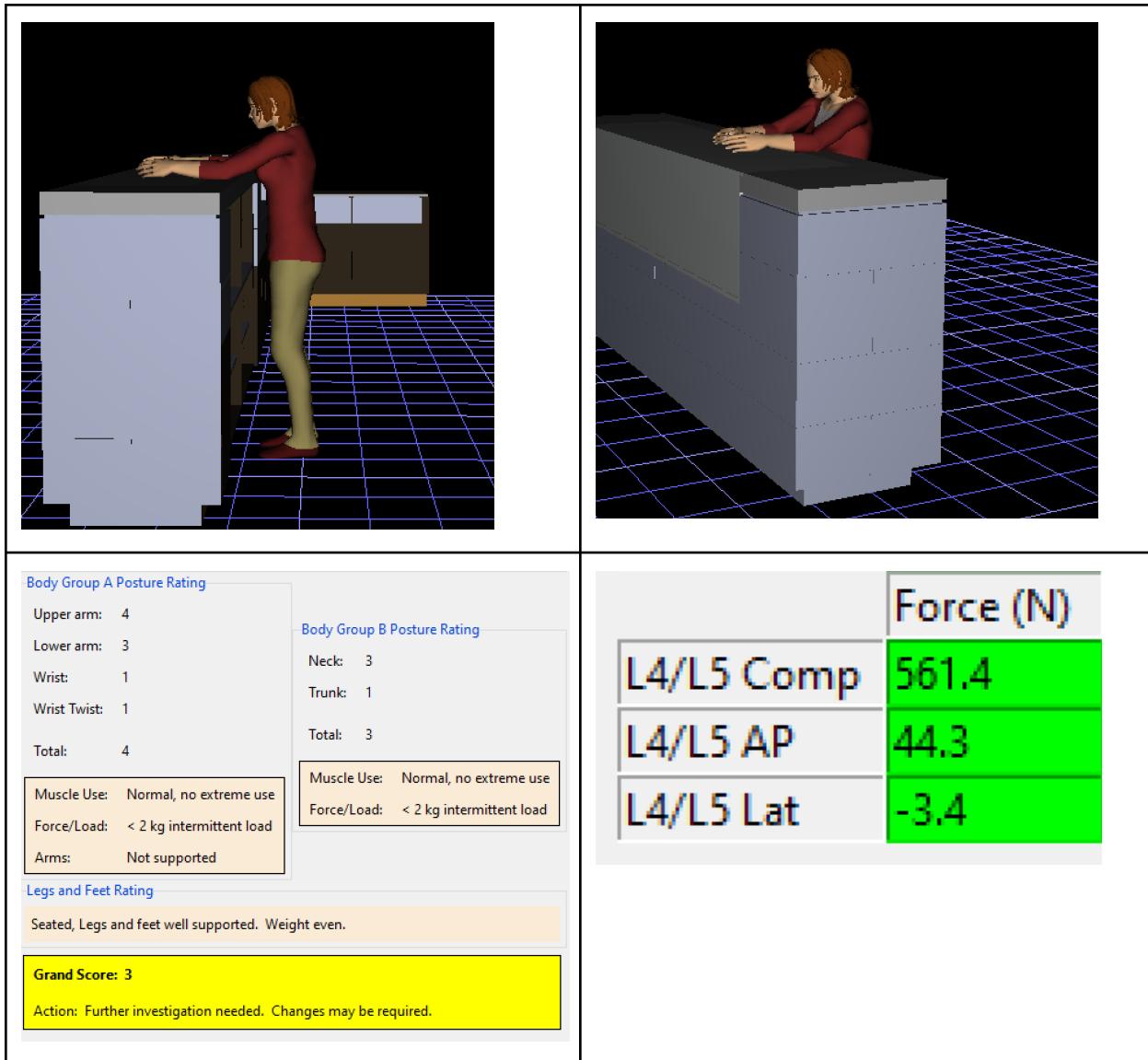


Table 4. Original Posture for worker 1 - Seated

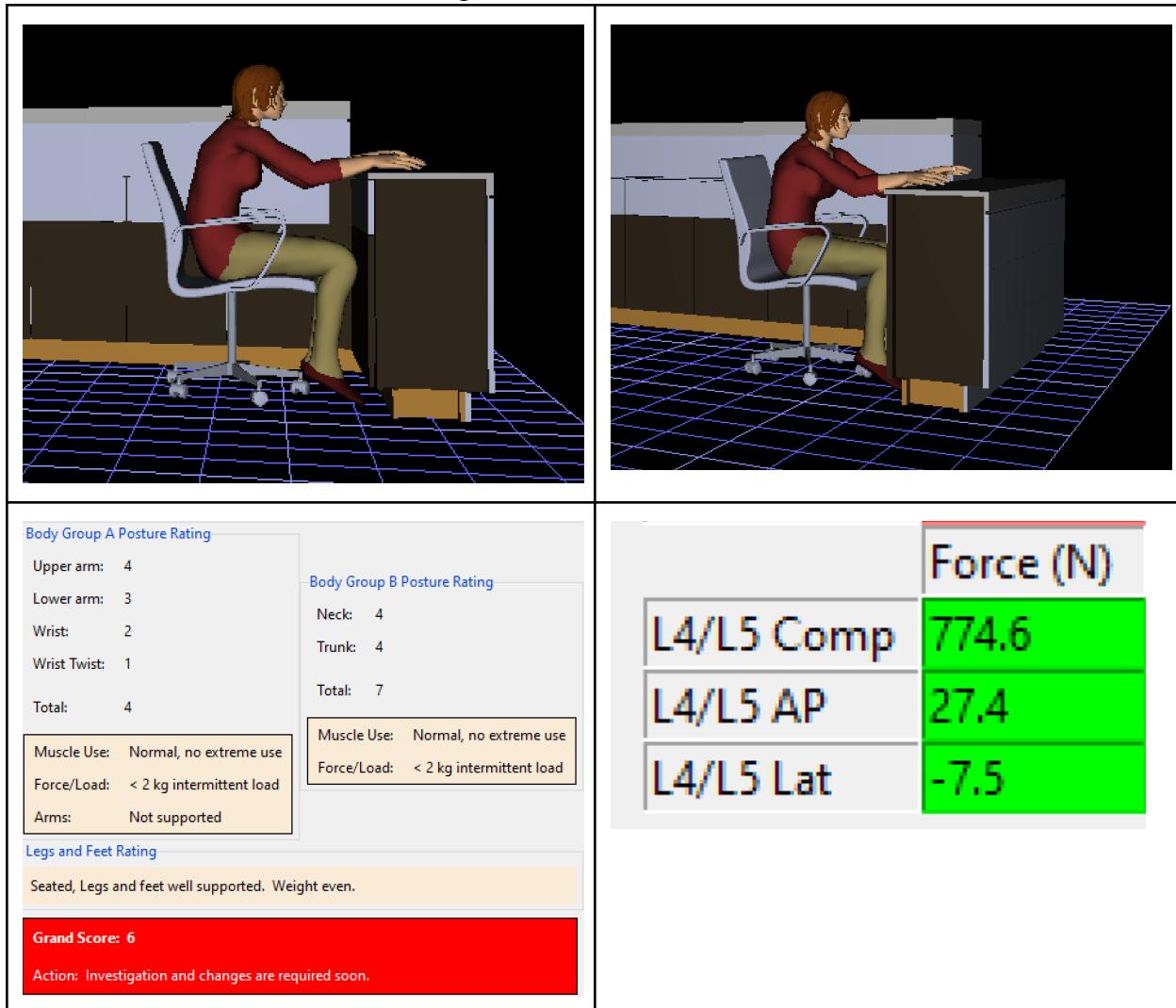


Table 5. Improved Posture for Worker 1- Seated

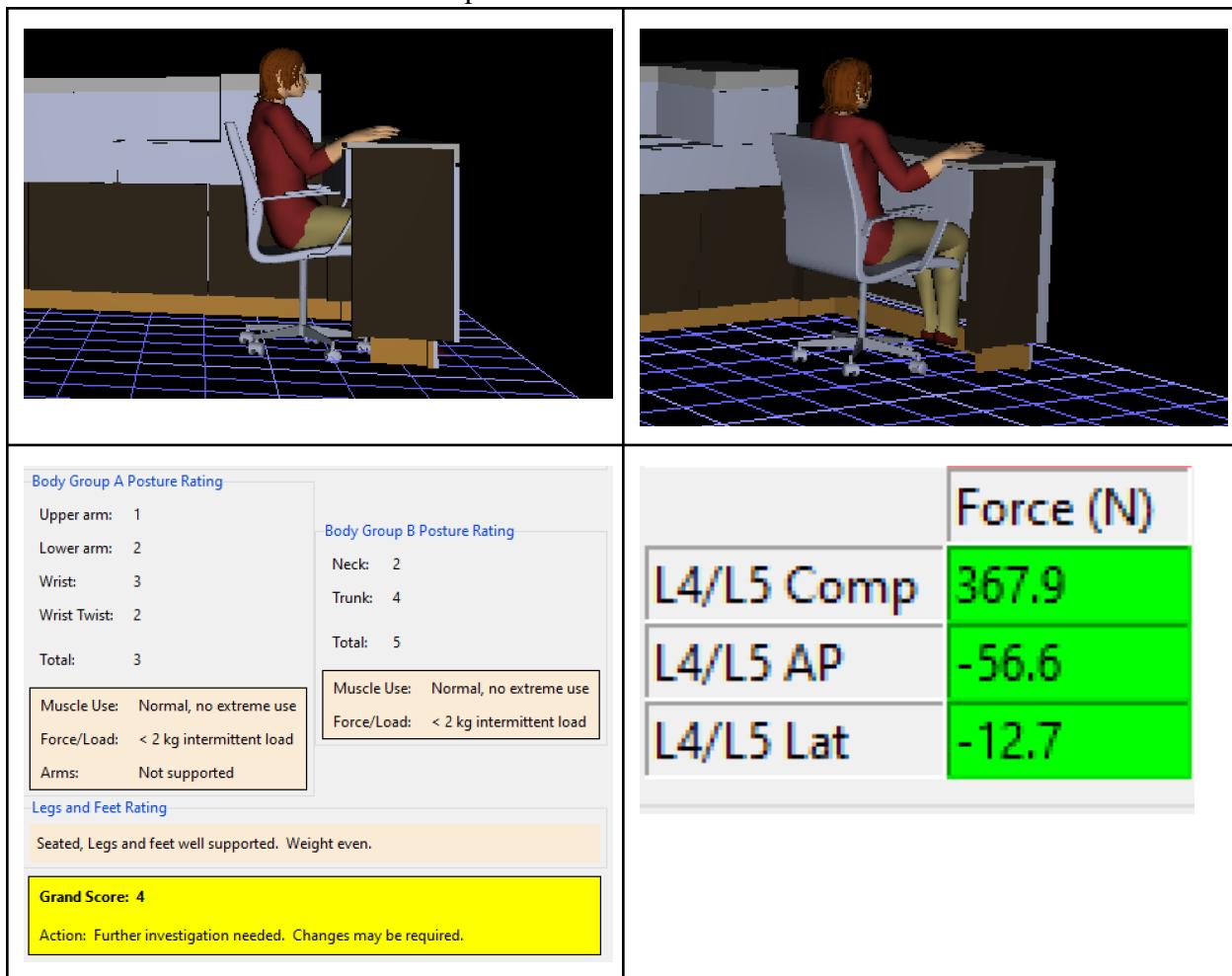


Table 6. Original Posture for worker 2 - Seated

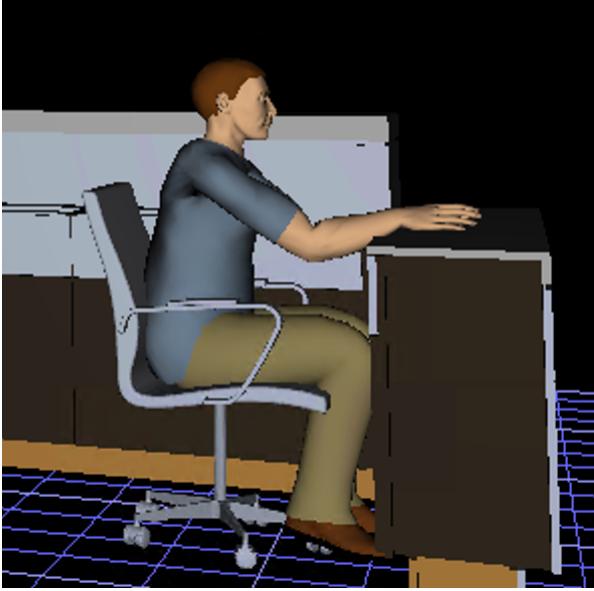
																									
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: left; padding: 5px;">Force (N)</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">L4/L5 Comp</td> <td style="padding: 5px; background-color: green;">1030.1</td> </tr> <tr> <td style="padding: 5px;">L4/L5 AP</td> <td style="padding: 5px; background-color: green;">142.0</td> </tr> <tr> <td style="padding: 5px;">L4/L5 Lat</td> <td style="padding: 5px; background-color: green;">-1.6</td> </tr> </tbody> </table>	Force (N)		L4/L5 Comp	1030.1	L4/L5 AP	142.0	L4/L5 Lat	-1.6	<p>Body Group A Posture Rating</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Upper arm:</td> <td style="width: 50%;">3</td> </tr> <tr> <td>Lower arm:</td> <td>2</td> </tr> <tr> <td>Wrist:</td> <td>2</td> </tr> <tr> <td>Wrist Twist:</td> <td>2</td> </tr> <tr> <td>Total:</td> <td>5</td> </tr> </table> <p>Body Group B Posture Rating</p> <table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Neck:</td> <td style="width: 50%;">4</td> </tr> <tr> <td>Trunk:</td> <td>1</td> </tr> <tr> <td>Total:</td> <td>5</td> </tr> </table> <p>Muscle Use: Mainly static, e.g. held for longer than 1 minute Force/Load: < 2 kg intermittent load Arms: Not supported</p> <p>Muscle Use: Normal, no extreme use Force/Load: < 2 kg intermittent load</p> <p>Legs and Feet Rating Seated, Legs and feet well supported. Weight even.</p> <p>Grand Score: 6</p> <p>Action: Investigation and changes are required soon.</p> <p style="text-align: right;">Update Analysis</p>	Upper arm:	3	Lower arm:	2	Wrist:	2	Wrist Twist:	2	Total:	5	Neck:	4	Trunk:	1	Total:	5
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Neck:	4																								
Trunk:	1																								
Total:	5																								

Table 7. Improved Posture for worker 2 - Seated

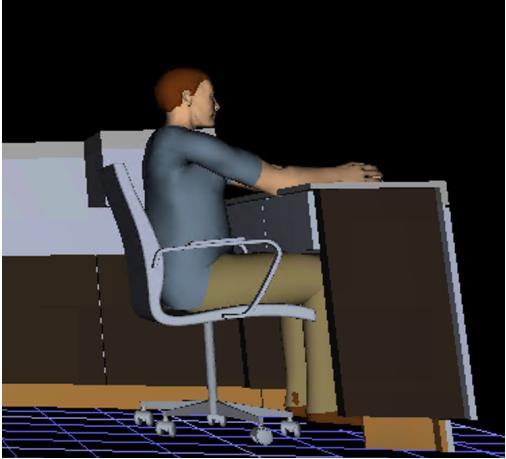
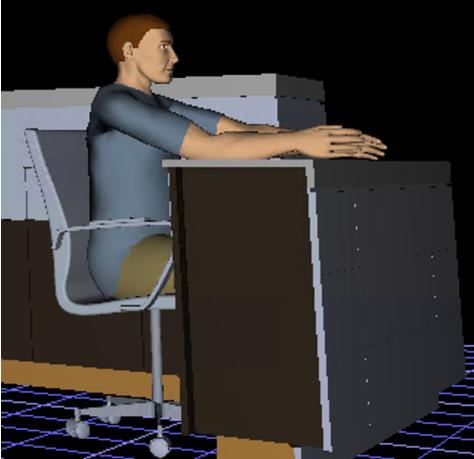
									
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Force (N)									
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L4/L5 AP	62.5								
L4/L5 Lat	-1.0								

Table 8. Original Posture for worker 4 - Reaching

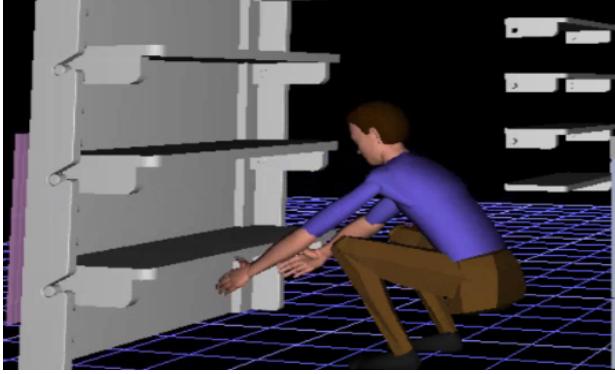
									
<table border="1"> <thead> <tr> <th></th> <th style="text-align: center;">Force (N)</th> </tr> </thead> <tbody> <tr> <td>L4/L5 Comp</td> <td style="background-color: green; color: white;">1293.1</td> </tr> <tr> <td>L4/L5 AP</td> <td style="background-color: green; color: white;">318.0</td> </tr> <tr> <td>L4/L5 Lat</td> <td style="background-color: green; color: white;">-2.7</td> </tr> </tbody> </table>		Force (N)	L4/L5 Comp	1293.1	L4/L5 AP	318.0	L4/L5 Lat	-2.7	<p>Body Group A Posture Rating</p> <p>Upper arm: 4 Lower arm: 3 Wrist: 2 Wrist Twist: 1 Total: 4</p> <p>Body Group B Posture Rating</p> <p>Neck: 4 Trunk: 3 Total: 6</p> <p>Muscle Use: Normal, no extreme use Force/Load: < 2 kg intermittent load Arms: Not supported</p> <p>Muscle Use: Normal, no extreme use Force/Load: < 2 kg intermittent load</p> <p>Legs and Feet Rating</p> <p>Seated, Legs and feet well supported. Weight even.</p> <p>Grand Score: 6</p> <p>Action: Investigation and changes are required soon.</p>
	Force (N)								
L4/L5 Comp	1293.1								
L4/L5 AP	318.0								
L4/L5 Lat	-2.7								

Table 9. Original Posture for worker 3 - Standing

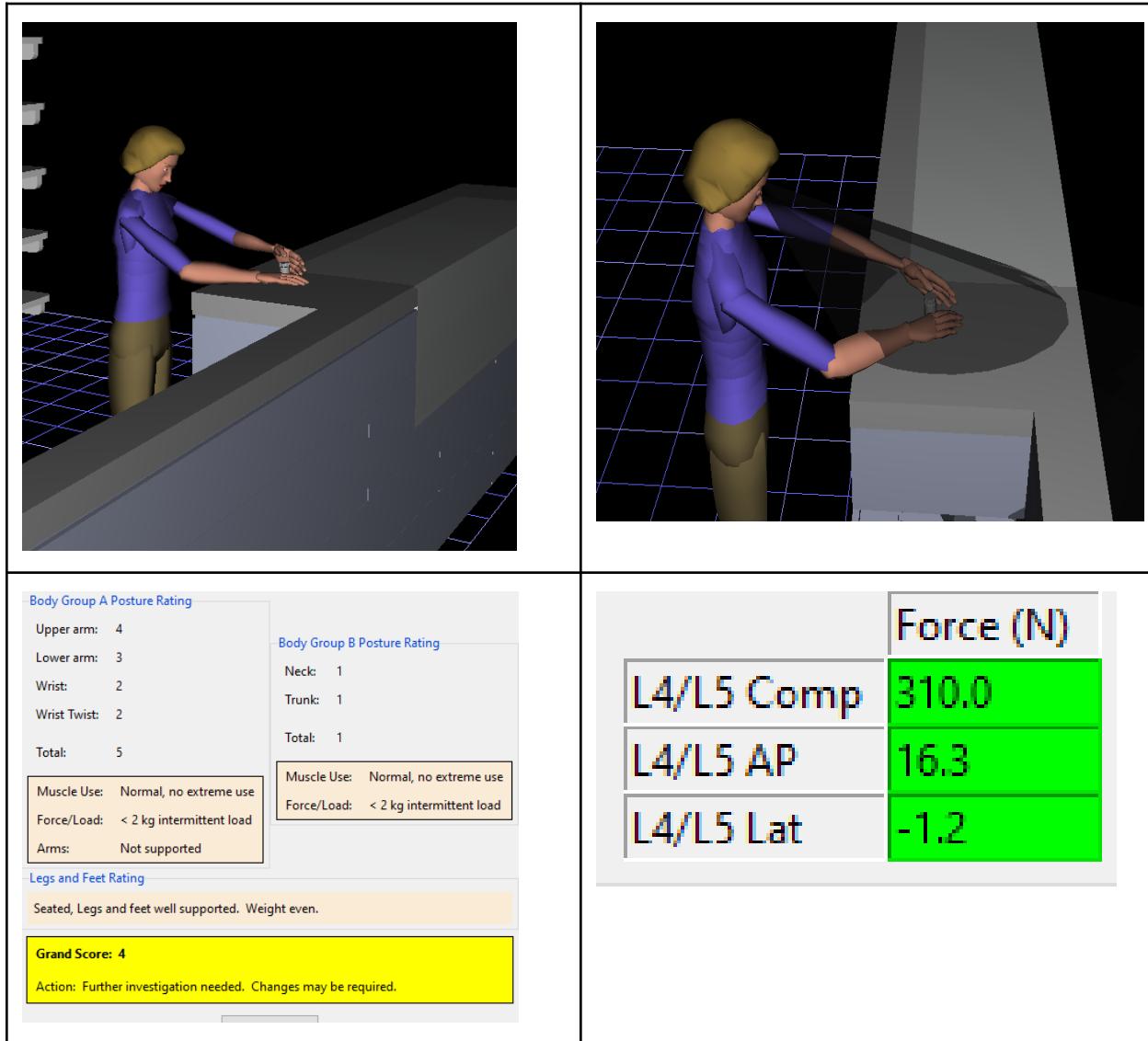


Table 10. WATBAK Analysis for worker 3 Redesign

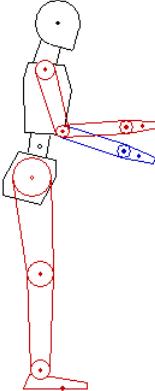
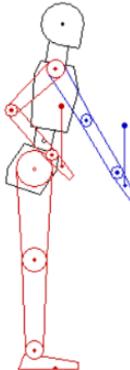
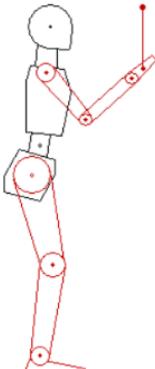
	Spine Compression Limits NIOSH MPL: 6376 N NIOSH AL: 3433 N Actual Value: 252 N	Spine Joint Shear Limit (none available) Actual Value: -18 N
	<u>L4-L5 Compression</u> Total: 477 N <u>Reaction Shear</u> Anterior: 41 N <u>Joint Shear</u> Anterior: 22 N	
	<u>L4-L5 Compression</u> Total: 522 N <u>Reaction Shear</u> Anterior: 23 N <u>Joint Shear</u> Posterior: -1 N	

Table 11. Westwood Pharmasave Pictures



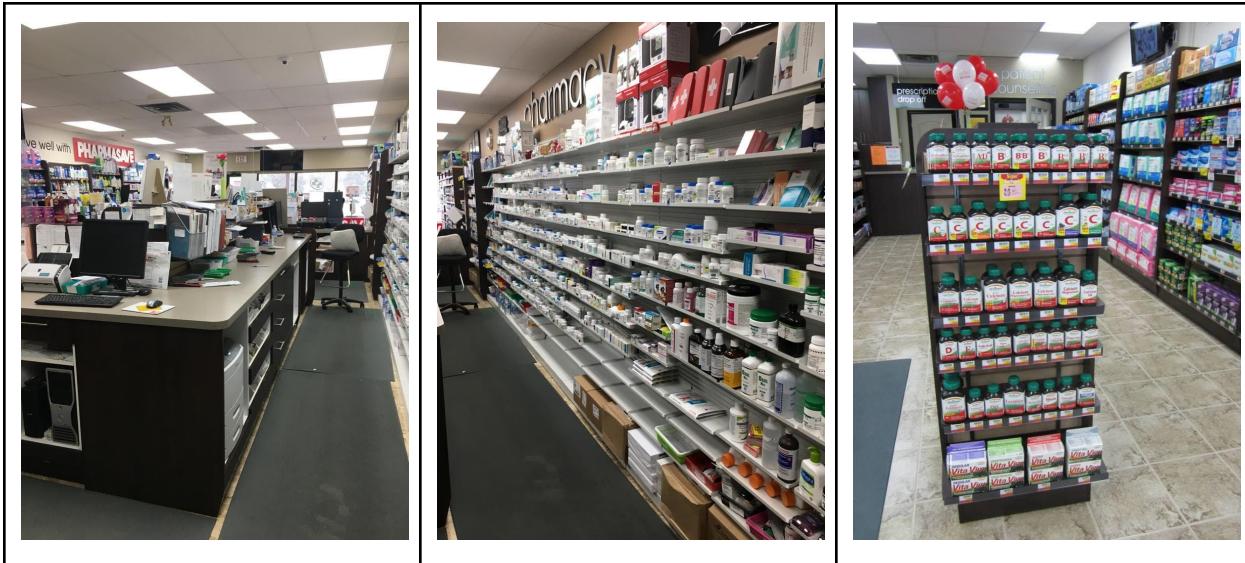


Table 12 :WATBAK for each worker

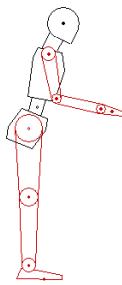


Figure 1. Worker 1: WATBAK Posture

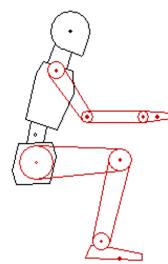


Figure 2. Worker 2: WATBAK Posture

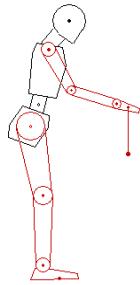


Figure 3. Worker 3: WATBAK Posture

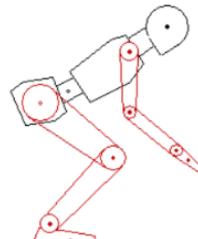


Figure 4. Worker 4: WATBAK Posture

The following images showcase the positions of the workers biggest complaint. A further WATBAK analysis will be conducted for the final report. Primary purpose will be to determine the overall affects these postures have on the spine and shoulder.

Figure 5: Spaghetti chart for pharmacy technician moving around a bird's eye view of the facility.

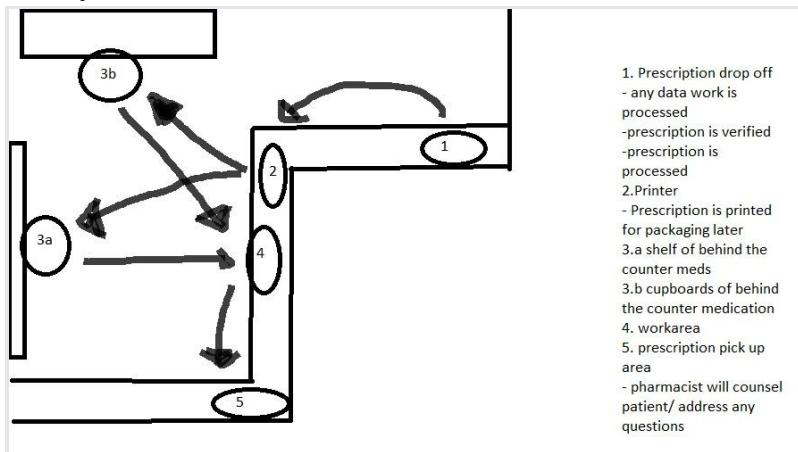


Table 13: Regions of pains for each worker from the survey

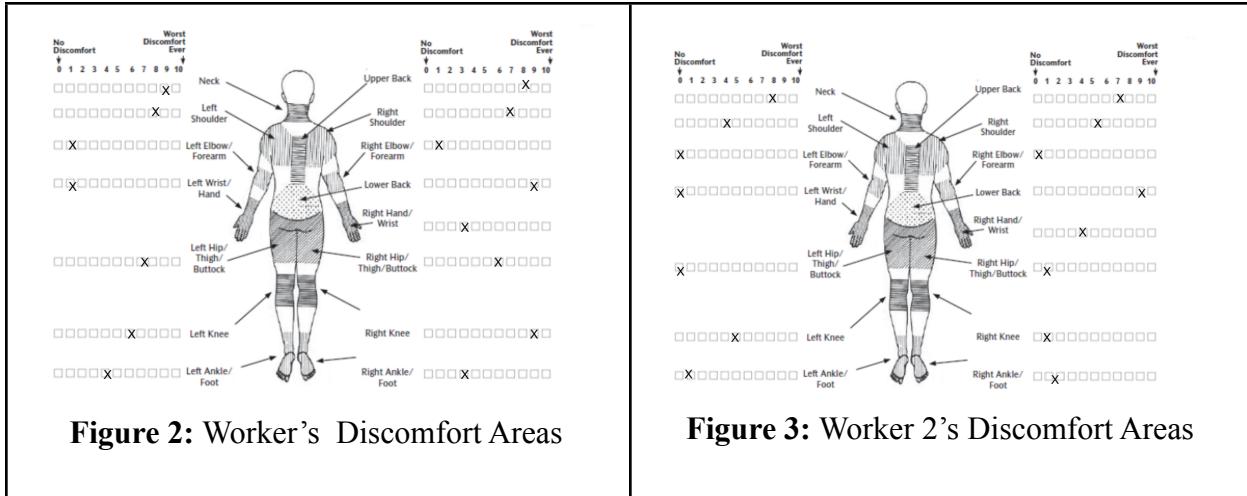


Figure 2: Worker's Discomfort Areas

Figure 3: Worker 2's Discomfort Areas

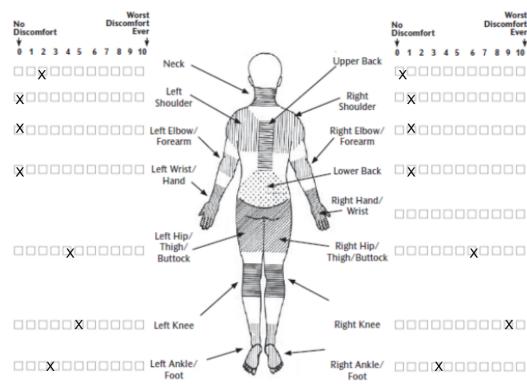


Figure 4: Worker 3's Discomfort Areas

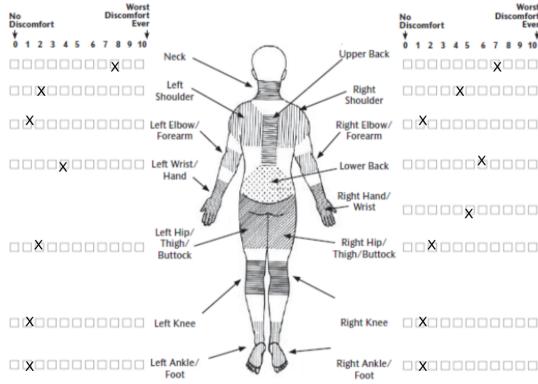


Figure 5: Worker 4's Discomfort Areas