

Ergonomic Risk Assessment in a Greenhouse Nursery Operation

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Abstract

Florida has the second largest greenhouse and nursery industry of any state in the U.S. and it contributes more than \$20 billion to the state's economy. According to the workers' compensation data from 2010 to 2019, greenhouse, nursery and floriculture workers had the highest number of injuries; musculoskeletal disorders (MSDs) being the most common occupational injuries. The aim of this study was to investigate the risks for MSDs from repetitive tasks in a nursery operation.

Two highly repetitive and consistent nursery operation tasks in day-to-day operations were selected to make video-based ergonomic assessments. These tasks were moving pots and trays to and from a rolling table and multi-shelf cart. Videos of two people conducting the same tasks were uploaded to KineticaLabs, an ergonomic assessment tool used to generate work task data.

There is minimal difference in the sequential order of joints at most risk for the overall combined tasks for our subjects and relative difference in the order of joints at most risk for individual tasks, given the height disparity between subjects (6'2", 5'4"). Elbow joints were at a highly disproportionate level of risk for all tasks; thus, there needs to be further investigation into the MSD risk for elbow/wrist/hand joints in nursery operations. We compared combined tasks for specific joints and single-frames to draw conclusions as to which postures are more/less optimal when doing the specific action.

Introduction

Agricultural workers are at high risk of work-related musculoskeletal disorders (MSDs). Work-related MSDs occur when muscles, tendons, and ligaments are used repetitively and/or in awkward positions. (BLS, 2020).

This research study was designed to investigate the differences in work tasks and activities for two persons of different physical stature to assess MSD risks.

Our specific **research objectives** were to:

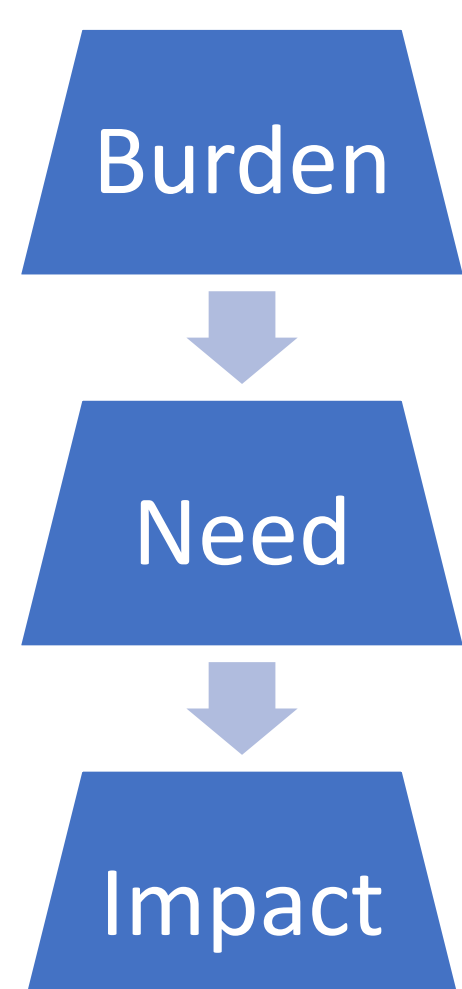
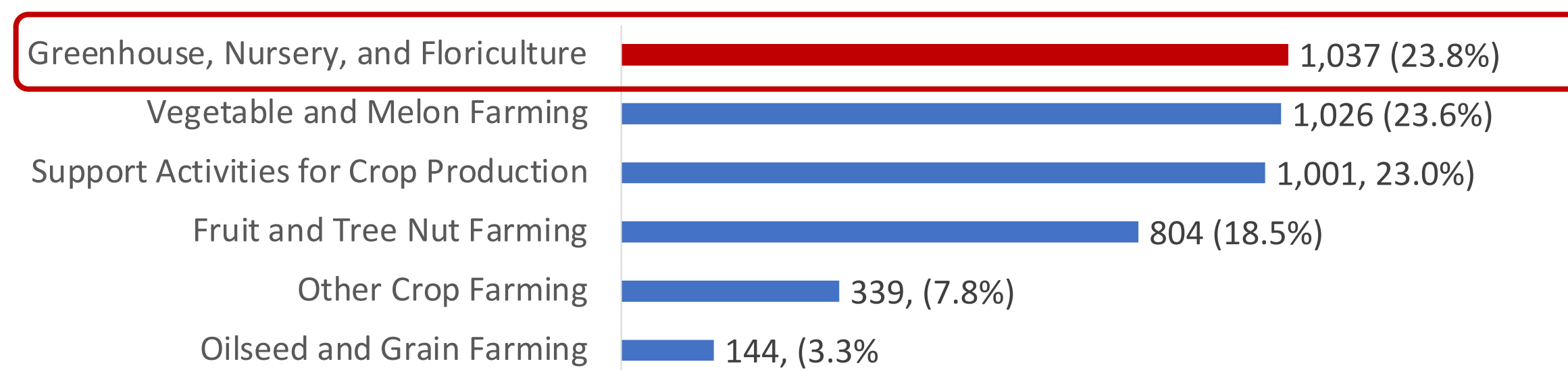
1. Quantify MSD risks associated with selected nursery operation tasks and
2. Provide recommendations for MSD prevention.

Methods

Part 1: Determination of Industry Group at Risk

Data source: the Florida Department of Financial Services, Division of Workers' Compensation, Workers' Compensation data, 2010-2019 for Agriculture Industry.

MSD related cases from the WC data were identified by the nature of injury cases including carpal tunnel syndrome, dislocation, hernia, inflammation, sprain or tear, strain or tear.



Greenhouse, nursery, and floriculture workers had the highest number of MSDs. The nursery and greenhouse industry in Florida provides 150,000 jobs and is continually expanding. It is the second-largest among all states. (UF/IFAS, 2022)

More emphasis has been placed on operation efficiency but lacking is the understanding of employee practices as it relates to task completion.

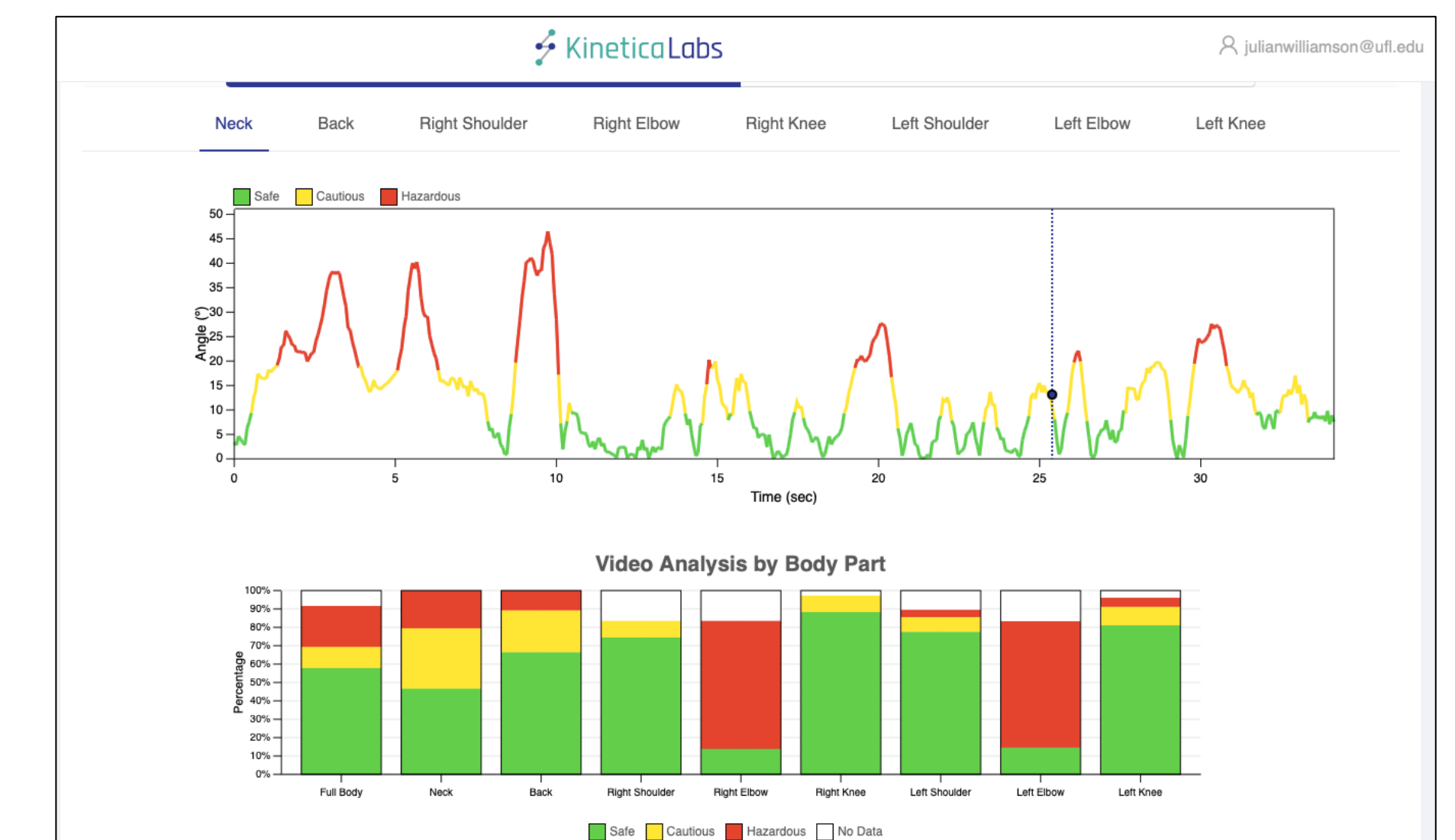
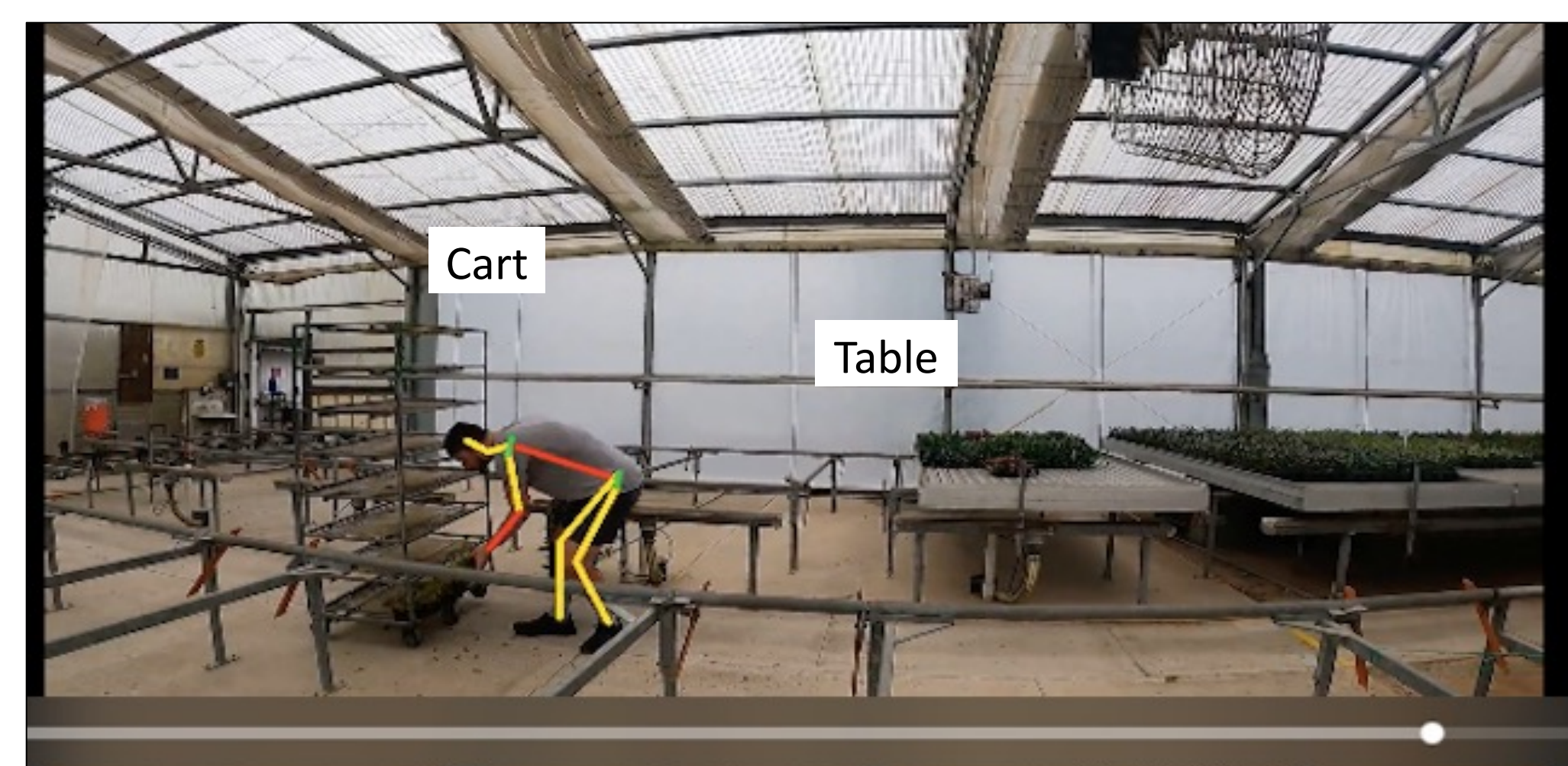
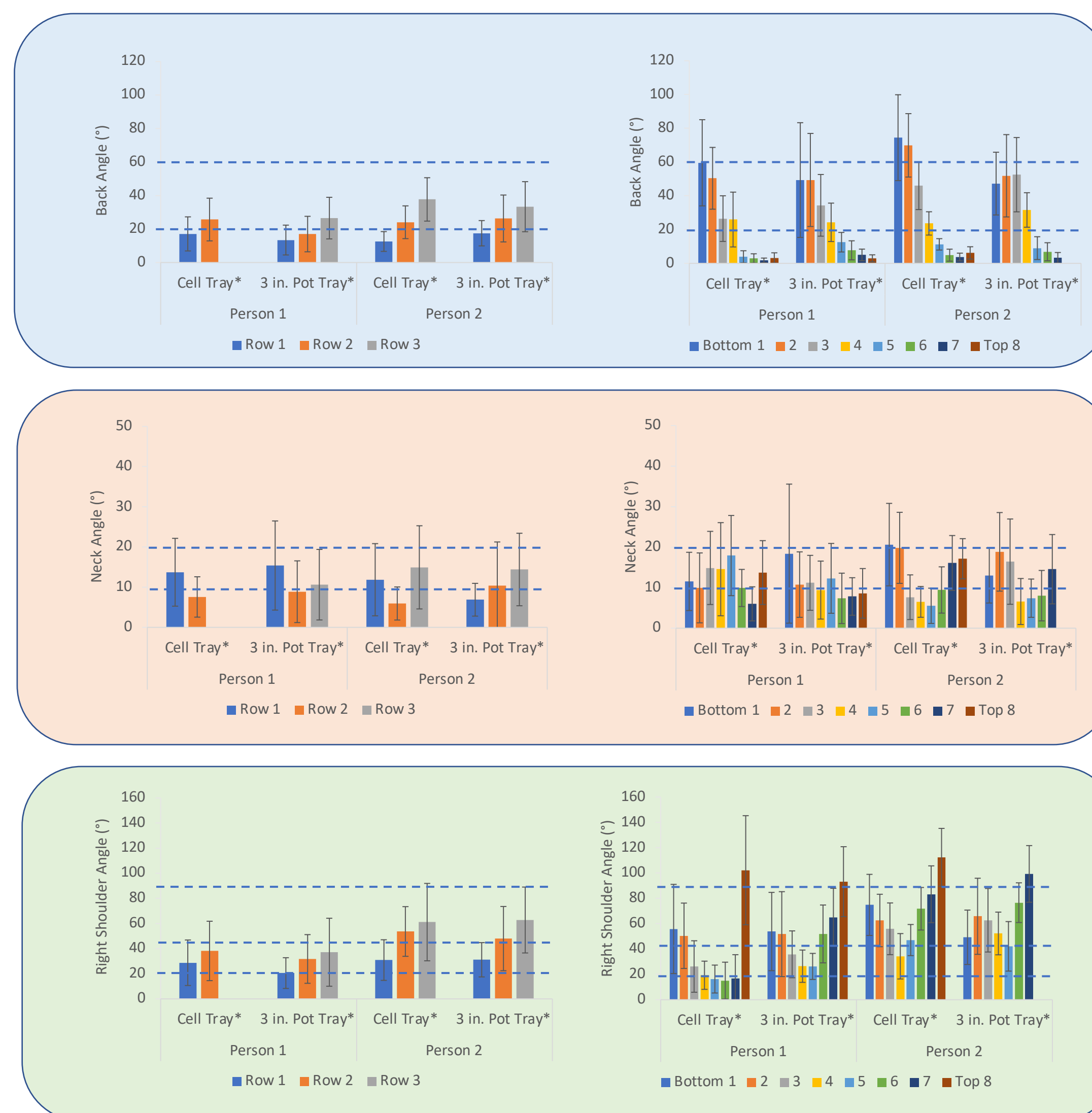
This project will generate information to lead us to follow-up with research for other physical labor-required crop production industry sectors. Additionally, it will contribute to recommendations for the workplace settings.

Part 2: Non-Invasive AI-Based Ergonomic Posture Analysis

- Two commonly performed tasks were selected.
- We recorded the tasks using non-invasive techniques.
- We repeated the tasks multiple times with two subjects – a 6'2" male and a 5'4" female.
- Dynamic lifting movements allow for differences in postural forms to be evaluated through the duration of the tasks.
- Selected videos were pre-processed and trimmed into 30-second segments and then uploaded to the Kinetica Labs (<https://www.ehs.com/kineticalabs/>) software. The sample rate of the tool is 15 frames/second; a maximum of 450 frames were analyzed for a 30-second video.
- Data was drawn from each frame and the joint angles of different body parts were used to develop RULA (Rapid Upper Limb Assessment) scores and postural angles for body parts under risk.
- **Independent Variables:** Person, Vertical Cart Shelf Levels, Horizontal Table Rows, Size of Pot

Person	Vertical Cart Shelf Levels (1-8)	Horizontal Table Rows (1-4)	Size of Pot
<ul style="list-style-type: none"> • Person 1 – 6'2" male • Person 2 – 5'4" female 	<ul style="list-style-type: none"> • Shelf 1: 4-13 in. (bottom) • Shelf 2: 13-22 in. • Shelf 3: 22-31 in. • Shelf 4: 31-40 in. • Shelf 5: 40-49 in. • Shelf 6: 49-58 in. • Shelf 7: 58-66 in. • Shelf 8: 66 in. (top) 	<ul style="list-style-type: none"> • Row 1: 0-16 in. • Row 2: 16-32 in. • Row 3: 32-48 in. • Row 4: 48-60 in. 	<ul style="list-style-type: none"> • Cell Tray: 72, 1 in. width liners • 3 in. Pot Tray: 12, 3 in. width pots

Results



Assessment

Back	Neck	Shoulder
<p>Table Rows:</p> <ul style="list-style-type: none"> • The task risk increases from row 1 to row 3. • Row 1 shows low risk, task 2 risk is varied, and task 3 has medium risk. • Row 1 is at low risk and row 2 and row 3 are at low to medium risk. • Both persons show similar risk for each task. <p>Cart Shelves:</p> <ul style="list-style-type: none"> • The task risk decreases from shelf 1 to shelf 8. • There is a significant reduction in risk between shelf 3 to shelf 5. • Both persons show similar risk for each task with the most variation occurring with shelf 3. 	<p>Table Rows:</p> <ul style="list-style-type: none"> • The task risk varies from low to medium without a clear trend between different rows and for both persons. <p>Cart Shelves:</p> <ul style="list-style-type: none"> • The task risk varies significantly from shelf 1 to shelf 8, with person 1 showing no trend and person 2 showing risk reduction from shelf 4 to shelf 6. • Both persons do not show similar risks. 	<p>Table Rows:</p> <ul style="list-style-type: none"> • The task risk shows an increased angle for upper arm positions from row 1 to row 3. Row 1 is at low risk and row 2 and row 3 are at low to medium risk. • Both persons show a similar trend of increasing risk, but Person 2 has a higher risk for row 2 and row 3. <p>Cart Shelves:</p> <ul style="list-style-type: none"> • The task risk varies between each shelf and for each person for the upper arm position. • Generally, shelves 1, 2, and 6 show low to medium risk while shelves 7 and 8 show medium to high risk. • A similar trend between both persons shows reduced risk in the middle shelves compared to the shelves near the top and bottom.

Recommendations

Engineering improvements: One-size does not fit all - making physical changes on tables and carts to accommodate workers in different sizes. Adjustable heights etc.

Administrative controls: Incorporate neck posture awareness into the employee training program; Encourage employees to do specific rehabilitation exercises and stretches for back and shoulders; Rotating workers through different tasks during a shift to prevent them from performing repetitive tasks for a long period.

Conclusions and Future Directions

- By using nonintrusive ergonomic assessment methods, we can assess ergonomic risks for the workers and make modifications to improve the work site conditions.
- Pot size options provided similar data and do not present any relationship to MSD risk.
- Back and shoulder risk follow a pattern with varying tasks while neck risk did not.
- Both persons had similar trends in risk with some variation for back and shoulders while neck risk did not.

The results of the study provide preliminary assessments of MSD risks for selected nursery tasks, which could serve as the foundation for future ergonomic hazard. Future studies might seek to incorporate self-reported data from workers. Deeper assessment into the ergonomic risk for joints from the elbow to finger should be conducted to understand how they are impacted during dynamic and static work tasks.

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