Humeral kinematic variability during simulated farm task performance across laboratory and in-field agricultural settings

Denise Balogh[1], Loukas Sherlock[1], & Angelica E. Lang[1]
[1]Canadian Center for Rural and Agricultural Health, University of Saskatchewan, Saskatoon, Canada
Email: denise.balogh@usask.ca

Summary

Humeral kinematics were measured during simulated farm work tasks in three locations. Within and between participant variability, as well as differences across locations were determined. This study reflects the need for in-field research, as simulated occupational movements in-lab may not always reflect real world demands.

Introduction

Farmers are at high risk for the development of musculoskeletal disorders of the shoulder due to the performance of physically demanding work involving high force, high humeral elevation demands, repetitive movement, exposure to vibration, and extended periods spent in driving postures [1]. Certain humeral kinematics, such as high elevation and internal rotation, are considered to be risk factors for shoulder injury [2,3], but the humeral kinematic requirements for many farm work tasks need to be better defined. Measuring authentic farm work in many participants can be difficult, as farm work and farm tools are not standardized from farm to farm, and travel to farms can be difficult. There remains a need to determine whether simulating farm work in a lab setting will fully capture the movement demands of high-risk farm tasks. This study assessed kinematic variability during farm task performance across three locations. It was hypothesized that variability would be lowest in the lab and higher on natural farms, and that location would elicit differences in task performance.

Methods

Three IMUs (XSens, Awinda) placed on the sternum and bilateral humeri tracked upper limb kinematics during 4 simulated farming work tasks (overhead drill, shovel, climb ladder, seed bag lift), and in 3 different locations; 1) laboratory (10 participants, 6F/4M, average age = 33.2); 2) an agricultural tradeshow, 'Ag in Motion' (10 farmers, 6F/4M, average age = 34.9); 3) grain/cattle farms (10 farmers, 6F/4M, average age = 33.9). Three repetitions of each task were recorded. Mean and peak humeral elevation and axial rotation (mean, peak internal and external) angles were evaluated for the primary 'mover' arm during each of the tasks.

Coefficient of variation was calculated to assess the rep to rep (within) variability for each outcome and was compared between locations with 1-way ANOVAs ($p < .05$). Median absolute deviation (MdAD) was derived to assess between participant variability and descriptively compared between locations. Finally, 1-way ANOVAs ($p < .05$) tested the effect of location on mean and peak angles during task performance.

Results and Discussion

The results for the overhead drill and shovel tasks are reported in this abstract. Within participant variability for peak internal rotation during the shovel task was lower in the lab than at the individual farms or Ag in Motion ($F_{2,27}$=5.594, p=.009). Between participant variability for all outcomes ranged from 4.7-19.2 MdAD in the lab, 6-14.2 MdAD at Ag in Motion, and 3.8-25.8 MdAD on the individual farms. The MdAD was lowest across all outcomes in either the lab or Ag in Motion locations, except for the mean axial rotation during the overhead drilling, in which the MdAD was lowest on the individual farms. As hypothesized, variability was generally lower in the controlled settings (lab and Ag in Motion), however for many outcomes the within and between variability were comparable across all three locations.

When comparing task performance across locations, mean ($F_{2,27}$=17.1, p<.001) and peak ($F_{2,27}$=6.0, p=.007) humeral elevation were higher on the individual farms than in the lab or Ag in Motion during the overhead drill. Peak internal rotation ($F_{2,27}$=4.4, p=.023) was greater when drilling at Ag in Motion compared to when simulating this task in the lab (Fig 1A). For the shovel task, peak external rotation ($F_{2,27}$ = 5.6, p = .017) was greater on the individual farms and Ag in Motion than when simulating this task in the lab (Fig 1B).

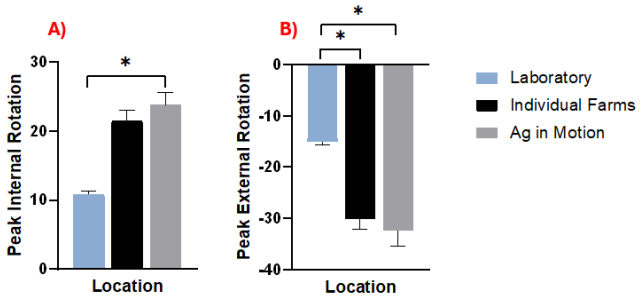

Figure 1: Mean (95% CI) A) peak humeral internal rotation during the overhead drill task and B) peak external rotation during the shovel task. * indicates significant differences between locations.

Conclusions

Simulating an occupational task in-lab may not fully reflect the demands of the task when performed in a real-world settings. Humeral axial rotation in particular may differ between in-lab and in-field performance work tasks.

Acknowledgments

Funded by WorkSafe BC (PROJ 358803).

References

[1] Fathallah F. (2010). *Appl Ergon*, **41**: 738-743.
[2] Seitz A et al (2011) *Clin Biomech*, **26**: 1-12.
[3] Van der Molen et al (2017) *OEM*, **74**:745-755