5413 - A method for characterizing repetitive upper arm motions in apple harvesting and a comparison between working with ladders and mobile platforms

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The US tree fruit industry is facing market pressure due to labor shortages and price competition from foreign producers. In response to these market pressures, harvest-assisting mobile platforms were introduced in some apple orchards to replace conventional ladders. The platform is semi-autonomous and can carry 2-6 workers. Relative to traditional harvesting with ladders, the goal of this study was to determine whether the platform could lead to increased repetition and/or non-neutral upper-arm postures. Methods characterizing upper-arm postures are quite robust; however, methods for characterizing repetitive movements are less developed. This study aims to develop systematic methods for characterizing upper-arm repetition and apply these methods to evaluate the effect that mobile platform use has on upper extremity posture and repetition. Tri-axial inclinometers were used to continuously monitor upper-arm inclinations among 12 platform and 8 ladder workers over a full day of harvesting. Repetitions were counted based on different thresholds for changes in upper-arm inclination (5, 10, 15, 20, 25 and 30 degrees) (computational method) and were also calculated from a subset of workers that were video-taped (observational method). Differences in upper-arm repetition between computational and observational repetiton methods were compared and differences in repetition and posture between platforms and ladders were assessed using RANOVA. There were differences in upper-arm posture, in terms of the percentage of time in overhead posture, between the platform and ladder harvesting methods. With respect to the repetition rates counted from the videos, rates using the computational method were best approximated using 10-degree changes in upper-arm inclination. Using 10-degree changes in upper-arm inclination, repetitions were high (>15 repetitions/minute) for both platform and ladder use. Working on the platform exposed workers to less repetition than using ladders (18±0.49 VS 29±0.43 rep/min; p<0.0001). The method in this study differs from other lab-based studies which define repetitions based on movements passing through an anatomical or postural cut-point (e.g. Spielholz et al., 2001). Rather than relying on these cut points, which typically don't occur in field settings, this method may facilitate determining repetition rates in other types of occupational settings.

5499 - Ergonomic Comparison of Apple Picking from Ladders, Harvest-Assist Mobile Platforms, and the Ground

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US tree fruit production is changing due to increasing global competition, labor shortages, and consumer demand. To address these market demands, trees are now being planted to accommodate semi-autonomous harvest-assist mobile platforms, replacing harvesting with ladders. These mobile platforms may reduce ladder falls, but it is important to anticipate and mitigate other potential WMSD hazards, such as overhead work and decreased task variety. This study compared back and arm inclination between apple pickers using ladders and those working with the mobile platforms. The twenty pickers participated and were in three equipment groups: eight used ladders, six stood on the mobile platform, and six walked near to the mobile platform. When compared to the platform and ground pickers, the ladder pickers had to walk greater distances to unload the apples they harvested. Objective (inclination with tri-axial accelerometers) and subjective (Borg CR10) measures were used to assess back and arm inclination and perceived fatigue, respectively. Back flexion was summarized as percent time in four ranges: 0o-15o, 15o-30o, 30o-45o, and >45o. Left and right arm inclinations were summarized as percent time in four ranges: 0o-30o, 30o-60o, 60o-90o, and <90o. Objective (heart rate) and subjective (Borg RPE scale) measures for whole body exertion were also collected. Objective measures were monitored continuously the whole workday, whereas subjective measures wore collected before work, before lunch, end of lunch, and end of workday. The effects of equipment on the various dependent variables were analyzed using repeated measures ANOVA. No significant differences in back flexion or back Borg CR10 ratings were found across the three equipment groups. There was a significant difference across the groups for right (p=0.011) and left (p=0.021) arms with the percentage time >90o. Across groups, ladders pickers spent significantly more time working with their arms above 60 o. There was also significantly higher self-reported fatigue in the left shoulder for the ladder workers (p=0.008), but not for the right. Finally, ladder workers had higher heart rate and Borg RPE scores. Mobile platforms helped reduce the physical loads on the body and may increase workability allowing smaller statured and older workers to perform harvest work.

5583 - Prevalence of work-related musculoskeletal symptoms among US large-herd dairy parlor workers

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Introduction: Dairy production in the US is moving towards large-herd milking operations resulting in an increase in task specialization, work demands and musculoskeletal symptoms (MSS) among workers. The objective of this study was to estimate prevalence of work-related MSS among milking parlor workers at large-herd (>500 head) US dairies. Differences in work-related MSS by parlor configuration were also assessed. **Methods:** A modified version of the Standardized Nordic Questionnaire was administered to assess MSS prevalence among US large-herd parlor workers. Worker demographics and MSS prevalences were generated, and differences based on parlor configuration were computed via clustered logistic regression. **Results:** The study sample included 452 parlor workers among 32 large-herd

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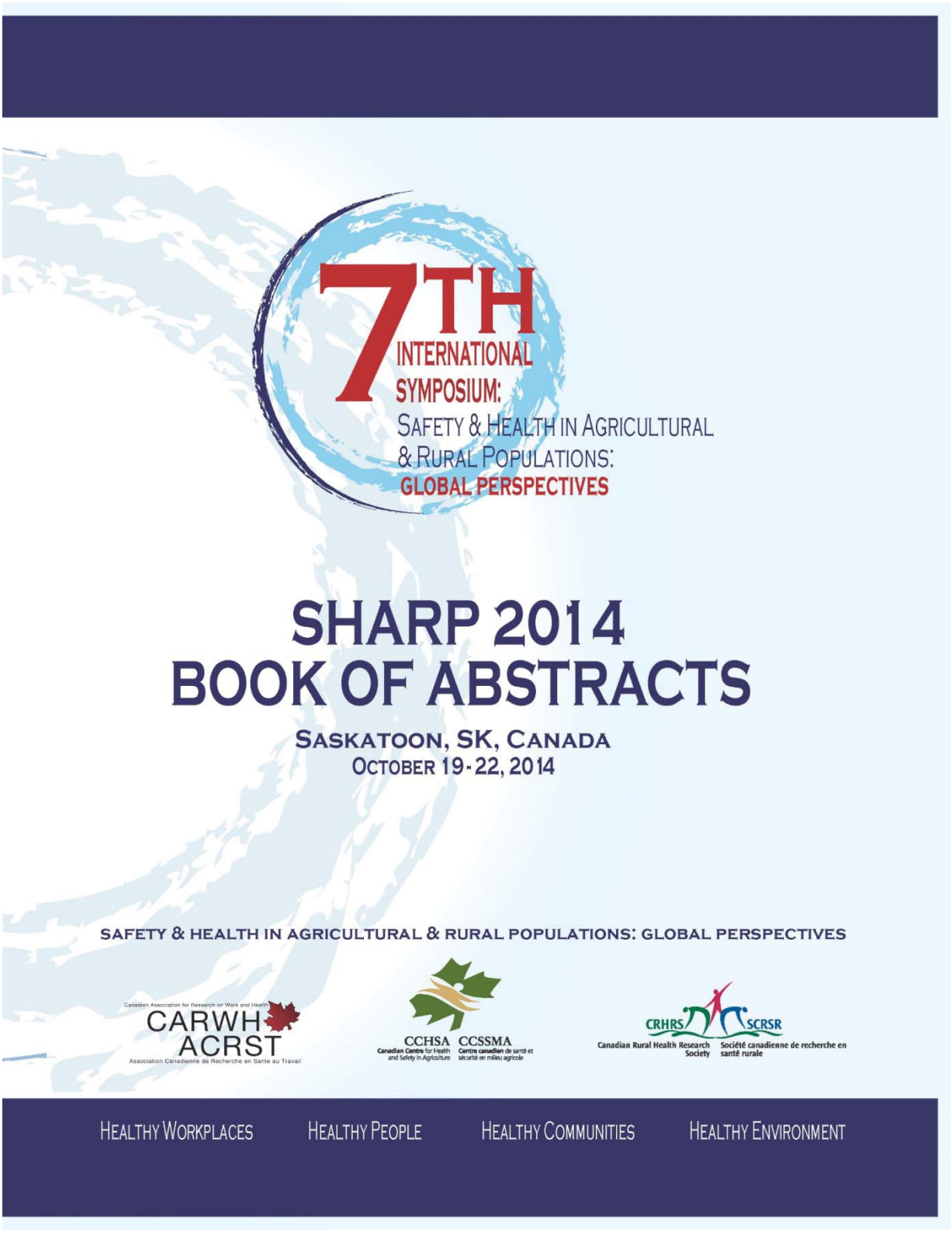

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