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Ergonomic interventions for the reduction of back and shoulder biomechanical loading when weighing calves

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Abstract

Workers in the agriculture industry have exposure to many of the recognized risk factors for work-related musculoskeletal disorders. The focus of the current project was to develop and evaluate devices designed to reduce exposure to risk factors during the process of weighing beef calves. Ergonomic task analysis of current techniques used to weigh these calves indicated significant stress in the cervicobrachial and lumbar regions. Two ergonomic interventions—the "Handle Attachment" and the "Lever Arm"—were developed to improve the body posture of the lifter and reduce joint loading. A laboratory study and field evaluations were conducted for each of these designs. In the laboratory, muscle activities were quantified for the major muscles of cervicobrachial region, the lumbar region and knee extensor muscle group during the performance of the lifting task while using the two new interventions and the standard method. In the field evaluations, farmworkers used these devices and biomechanical models of the whole body postures were developed to quantify changes in the joint loading when using the interventions. The results show that both intervention techniques reduce the required muscle activity (8–71.6% reduction for the muscles of the cervicobrachial region, 2–43% reduction for the muscles of the lumbar region) and the joint loading (33–100% reduction in shoulder abduction moment and 42–57% reduction in spine compression) as compared to the standard method. Overall, the farmworkers noted that the "Handle Attachment" design is less cumbersome to move and use than the "Lever Arm" design, but laboratory study and field study revealed that the "Lever Arm" design provides the highest reduction in muscle activity and joint loading. Using either intervention while performing this task should decrease the risk to the low back and shoulders.

Relevance to industry

The ergonomic intervention research described in this report documents a reduction in exposure to risk factors for shoulder and low back injury in an at-risk population in the agriculture industry.

Keywords: Livestock handling; Lumbar injury; Shoulder injury; Biomechanical modeling; EMG

1. Introduction

While there were a number of studies that have considered the ergonomics of plant/crop agriculture (e.g. Earle-Richardson et al., 2004; Mirka et al., 2003; Fairfield Estill and Tanaka, 1998) an area that has received little attention in this industry is the ergonomics of livestock handling. Low back and shoulder problems represent two of the most common work-related injuries/illnesses for farmers/farmworkers. In a study of 516 injury/illness cases conducted by the New York Center for Agricultural Medicine and Health, it was reported that the most common occupational injury for farmers was strain in the back and shoulders (31%) due to overwork/overuse (55%) and assuming an awkward position (29%) (Earle-Richardson et al., 2003). The costs associated with these musculoskeletal disorders are considerable both in terms of disability and workers compensation costs. These statistics point to an occupation that is in need of ergonomic intervention efforts.

Farmers/farmworkers are exposed to many of the recognized risk factors for musculoskeletal disorders of the back and shoulder including heavy and repetitive lifting, forceful exertions of the upper body (pushing/pulling), long duration stooped postures, and awkward

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shoulder postures/motions (Bernard, 1997). Farmers are often lifting and/or carrying livestock out in the field on uneven ground, a situation which can create high joint loads, extremely awkward postures, and unexpected loading due to the often slippery conditions. In certain sectors of the beef cattle industry, for example, farmers are required to obtain the birth weight of a newborn calf because it is an important factor in determining future calf size and health. Calf weight has also been related to percentage of births with dystocia (slow or difficult labor) (e.g. Johanson and Berger, 2003; Phocas and Laloe, 2004) and since a calf's birth weight has some genetic component, obtaining this weight is an important selection criterion for reproducing heifers. This is usually done within 24 h of birth.

Our observation of the process of obtaining the birth weight indicates that the work can induce high stresses on the joints of the farmer's body, particularly the low back and the shoulder joints. One of the most popular ways to obtain the birth weight of the calf is to manually weigh it in the field. This process involves the farmer putting a harness around the torso of the calf and hooking a mechanical scale to the harness. A metal bar is connected through a hook to the top of the scale and is the leverage point used to lift the calf off the ground. The farmer has to lift the calf completely off the ground by either doing a front row lift or a shoulder press (Figs. 1a and 2a, respectively). Due to the height of the calf and length of the scale, the farmer's hand position is often at eye height or higher when the calf is completely off the ground. This position is extremely awkward and requires near maximum shoulder muscle force to maintain. Compounding the awkward posture is the need for the calf to be held off the ground while a reading is obtained from the scale, usually a 3–4 s duration. For many, this process also requires a hyperextension of the lumbar region. Every time a calf is born, this method is implemented. Therefore, the number of calves that are born per farm and the number of farmers that are readily available to weigh the calves dictates the number of times this method is used per person. The objective of this research was to develop and evaluate ergonomic interventions for weighing beef calves with the ultimate goal being an intervention that reduces the biomechanical stresses placed on a farmer when weighing a calf.

2. Methods

This project involved three separate phases of data collection: Analysis of existing methods, laboratory analysis of prototypes, and field analysis of prototypes. To assess current practices in beef calf weighing, field observations were conducted to analyze the process of obtaining the birth weight of a calf. Both the methods and the results of the analysis of the current practices are presented here as they provide the motivation for, and direction of, the intervention development efforts.

2.1. Baseline data

Digital pictures were taken of three farmers as they were lifting and weighing the calves to document the body

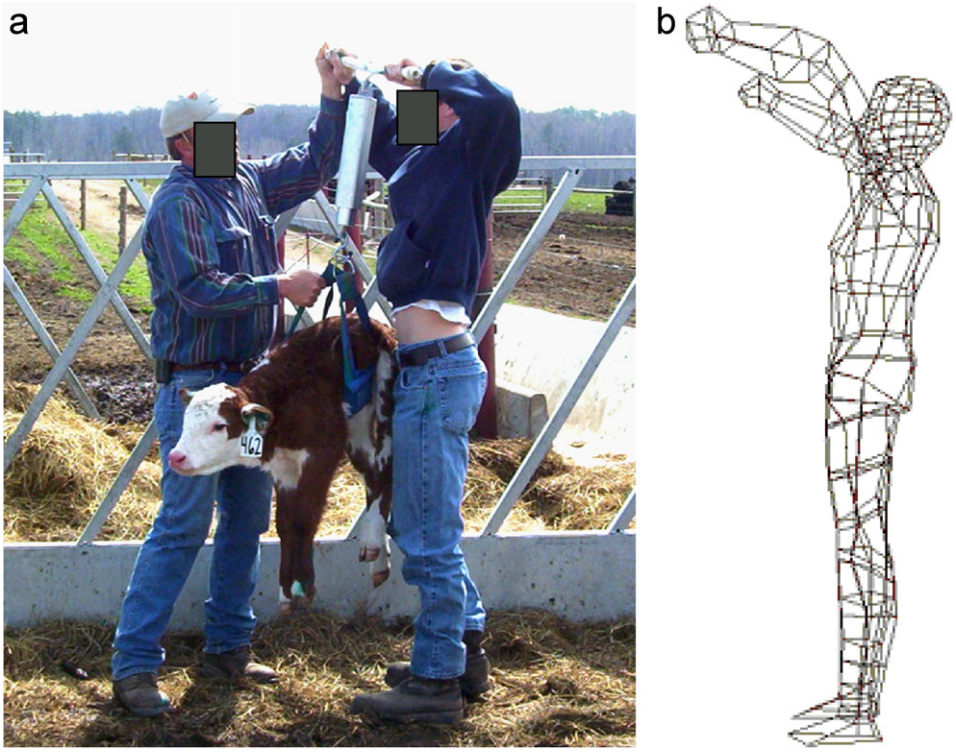

Fig. 1. (a) Front row lift technique for lifting calf, (b) biomechanical model of this task.