The Effect of Stress, Attitudes, and Behavior on Safety during Animal Handling in Swedish Dairy Farming

C. Lindahl, S. Pinzke, L. J. Keeling, P. Lundqvist

ABSTRACT. *Working with livestock is a hazardous activity, and animals have been found to be the most frequent injury source on dairy farms. Understanding the risk factors for injury and the causal relationships related to injuries and animal handling is important for developing prevention strategies and effective safety interventions. This study examined stress and handler attitude as possible risk factors for animal handling injuries in dairy farming, in particular when moving cows. Twelve dairy farms were visited on two occasions representing different stress levels: when cows were being moved to milking (low stress) and to hoof trimming (high stress). Behavioral observations of handlers and cows were performed, and questionnaires were completed on attitudes (risk acceptance, safety locus of control, and attitudes toward cows) and stress (perceived stress/energy level and job strain). The injury risks were found to be higher when moving cows to hoof trimming compared with moving cows to milking and gentle, moderately forceful, and forceful interactions were more frequently used. When moving cows to milking, observed risk situations were related only to the perceived energy level of the handler. When moving cows to hoof trimming, injury risks were correlated to job strain and time spent in the risk zone (defined as the area where the handler could be hit by the cow's head or hind legs). The time spent in the risk zone was positively correlated with job strain, age, and experience. Attitudes were not found to have significant impact on safety but were to some extent indirectly involved. These results suggest that the main focus in injury reduction work should be on reducing the time the handler spends in close proximity to animals during aversive procedures and on minimizing cow fear and stress by proper handling techniques and appropriate design of handling facilities.*

Keywords. *Agriculture, Behavior, Dairy cows, Human-animal interaction, Job strain, Occupational injury.*

Among farmers, working with livestock is considered to be the most hazardous activity performed on the farm (Allen et al., 1995; Kallioniemi et al., 2011). Livestock are consistently mentioned as one of the main contributors to agricul-

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tural injury (Brison and Pickett, 1992; Carstensen et al., 1995; Doyle and Conroy, 1988; Erkal et al., 2008; McCurdy and Carroll, 2000; Pinzke and Lundqvist, 2007; Pratt et al., 1992). Douphrate et al. (2009) analyzed livestock-handling compensation claims and found that injuries caused by livestock were more costly and resulted in more time off work than other agricultural injuries. Cattle-related injuries are generally more serious than other farm-related injuries (Carstensen et al., 1995).

Work activities that increase exposure and proximity to animals are positively associated with animal-related injuries (Douphrate et al., 2006). Milking in particular is mentioned in several studies as one of the major tasks related to injuries (Boyle et al., 1997; Douphrate et al., 2009; Erkal et al., 2008). Other animal-related activities found to be associated with a high injury risk in dairy farming include herding/moving and feeding (Erkal et al., 2008), and trimming and treating hooves (Boyle et al., 1997). In a study of workers' compensation claims by Douphrate (2009), being kicked, stepped on, or pushed by the cow were the three most frequent animal-related worker injuries.

Stress is reported to be a contributing factor to injury risk (Elkind and Cody-Salter, 1994; Rautiainen et al., 2004). Stress is related to behavioral changes, and there is most likely a correlation between physical or psychosocial levels of stress and behaviors that lead to agricultural injuries (Burns and Sullivan, 2000). Glasscock et al. (2006) concluded that there is a correlation between measurements of both stressors and stress symptoms and occupational injuries in agriculture in general. However, studies of the relationship between stress and occupational injury in an agricultural context are limited. Stress may be especially interesting in relation to animal handling because it can have an important effect on the behavior and reaction of the animals. For example, an increased heart rate in a person riding a horse, when that person was informed that the horse was going to be frightened by a novel object, resulted in an increase in the heart rate of the horse, even though nothing changed compared to the control situation (Keeling et al., 2009).

One way of measuring the psychosocial levels of stress at work is through the job strain model (Karasek, 1979), according to which a high stress load occurs when workers are facing high psychological workload demands or pressures, combined with low control or decision latitude in meeting those demands. Karasek (1979) developed a questionnaire to measure job demands and job decision latitude. Previous studies have shown that high job demands increase the frequency of unsafe behaviors (Hofmann and Stetzer, 1996) and near-misses (Goldenhar et al., 2003), as well as the likelihood of occupational injury (Swaen et al., 2004). Similarly, workers under high job strain have been shown to have a higher risk of occupational injury (Kim et al., 2009). The job strain model also states that a combination of high psychological job demands and low job decision latitude will lead to negative physical health outcomes, such as hypertension and cardiovascular disease (Schnall et al., 1994). Another instrument developed to measure emotional stress in the work life setting is the Stress-Energy questionnaire (Kjellberg and Iwanowski, 1989; Kjellberg and Wadman, 2002). The questionnaire consists of two scales measuring six different moods of stress (from feeling pressured to calm) and six moods of energy (from feeling active to passive). This questionnaire is a valid tool for measuring stress at work (Kjellberg and Wadman, 2002) and has been used in several studies on occupational stress (Eklöf et al., 2004; Kjellberg and Wadman, 2007). However, to our knowledge, there has been no previous study of the relationship between job strain or perceived stress/energy and risk of injury in relation to animal handling in agriculture.

Attitudes have repeatedly been suggested and discussed as a possible risk factor for in-

juries. Three aspects of attitudes can be identified as relevant to injury risks in animal handling: (1) the perception of whether one is in control of one's own safety (safety locus of control), (2) the attitude toward risk, and (3) the attitude toward cows and working with cows. The safety locus of control scale was developed by Jones and Wuebker (1985) to predict employees' disposition to injury and unsafe behaviors. The scale reflects the individual's belief or perception of who controls behavior and events, and ranges from internal to external locus of control. People with an external safety locus believe that injuries are due to chance events, bad luck, or fate, and they see no relationship between their own actions and safety. Those with an internal safety locus believe that they are responsible for their safety and that they can avoid injuries. Employees with a more external safety locus have been found to report comparatively more occupational injuries than those with a more internal safety locus (Jones and Wuebker, 1993).

The variables of attitude and perception of risk reflect the judgments that people make when they are asked to characterize and evaluate hazardous activities (Burns and Sullivan, 2000). An individual's attitudes toward risk are linked to beliefs about locus of control and are suggested to be associated through behavioral intentions to injury outcomes (Elkind, 2007). In relation to safety during the handling of dairy cows specifically, attitudes toward cows and working with cows may influence the handlers' behavior and their risk of injury. Hemsworth et al. (2000) presented some important relationships between the attitudes and behaviors of persons handling cows and the cows' fear of humans. A positive attitude toward the behavior of dairy cows was found to be correlated to a lower use of forceful negative tactile interactions (slaps, pushes, and blows), which consequently lowered the cows' fear responses to humans. Because fearful animals are hazardous to handle, positive attitudes toward cows and working with cows may have a positive impact on handler safety.

This study was conceived as a continuation of an earlier study by Lindahl et al. (2012), which adopted a qualitative approach whereby Swedish farmers were interviewed to obtain knowledge about their perspectives and views on risks and safety during livestock handling. The results from those interviews were used as background for the selection of variables included in the present study. The farmers considered moving animals to be a task associated with increased risks of injury (Lindahl et al., 2012). Situations that disrupted the routines, such as hoof trimming, were considered to be particularly hazardous because cows often become excited, nervous, and stressed in such situations.

In the present study, we opted to observe two activities involving moving animals: milking and hoof trimming. Milking is done two or three times daily, and the cows are moved as a herd (or in larger groups if kept in different pens) and are accustomed to the procedure and environment. Moving cows to milking was therefore chosen to represent a situation with low stress and fear levels, and a relatively low risk of injury. Hoof trimming is done less frequently, normally two or three times a year. The procedure includes unfamiliar environments for the cows, separation from the herd, restraint, and possibly painful treatment of claw lesions, and can consequently be perceived as stressful and frightening for the cows. Moving cows to hoof trimming was thus chosen to represent a situation of high stress and a high risk of injury.

The overall purpose of this study was to gain an understanding of how stress, handler attitudes, and behavior affect risk and safety during handling of dairy cows. The specific aim was to compare handler-cow interactions, risk situations and incidents, and the perceived stress level of the handler when moving cows to milking and to hoof trimming.

Furthermore, the aim was to study how job strain and attitudes toward risks, cows, and working with cows correlate to risk situations and incidents. Our hypotheses are specified in the Materials and Methods section.

Materials and Methods

Farms

Agricultural advisors and hoof trimmers in central and southern Sweden were contacted and asked to suggest suitable dairy farms for the study. The selection criteria were that the dairy farm had loose housing with cubicles and parlor milking, and that it was possible to study the same person handling the cows at hoof trimming and milking. Farmers were contacted by phone, informed about the study, and asked if they were willing to participate.

Twelve family-owned commercial dairy farms participated in the study. The herd size ranged from 45 to 430 dairy cows (mean = 157.5, SD = 123.5). The participating handlers ranged in age from 23 to 64 years (mean = 36.8, SD = 12.6). Eight of the handlers were employees, and four were farm owners (self-employed). Three of the handlers were female, and the rest were male. The experience of working with dairy cattle ranged from 3 to 40 years (mean = 15.6 years, SD = 10.9).

The handler was the same person moving the cows to milking and to hoof trimming within the farm. Sometimes this person also performed the milking, but never the hoof trimming. All farms hired a professional hoof trimmer who brought his/her own trimming chute (fig. 1) and sometimes also a gate system (fig. 2) to create a single-file alley to the chute. The trimming chute was placed in one of four locations: in a scrape/slatted floor alley in the cubicle area, in the barn just outside the cubicle area, connected to the return alley from the milking parlor (using the milking parlor as transfer alley), or outdoors.

Figure 1. Typical non-tilting hydraulic elevator trimming chute in use (photo: Sofia Åström).

Figure 2. Mobile single-file alley and trimming chute placed in a scrape alley (photo: Cecilia Lindahl).

Measurements

Data were collected during 2012 and early 2013. The farms were visited twice, once to observe the cows being moved to hoof trimming and once to observe them being moved to milking. On half the farms, the first visit coincided with hoof trimming; for the other half, it coincided with milking. We wanted to study the activities without affecting the farms' normal routines, so the time of observation was adjusted to the farms. The studies of moving to milking were carried out during afternoon milking, normally around 4:00 p.m., while hoof trimming usually started in the morning after milking was finished. The time between observation days varied between 5 and 61 days (mean = 26 days).

The data collected during each visit consisted of behavioral observations of the handler and the cows as well as details on the characteristics of the facilities. When the behavioral observations were finished for the day, the handler was asked to complete a questionnaire and to answer some short interview questions.

Behavioral Observations of Handler and Cows

The behavioral observations were conducted by the same two people on each farm, one always observing the handler and one always observing the cows. The observations started when the handler began to move the cows to milking or hoof trimming and ended when the cows were in the crowd pen before being milked or in the trimming chute before being trimmed. For each minute during the observations, the behaviors of the handler and of the cows within a 2 m radius of the handler were recorded continuously. The handler behaviors observed and the handler-cow interactions are listed in table 1. The categories were calculated as proportions of the total number of observations.

Table 1. Behaviors observed in handlers and definitions.

Interaction	Handler Behavior	Definition
Gentle	Calm talk	Talking to cows with a calm, soft voice, not with the intention to move cows but to calm them down.
	Petting	Stroking cows calmly, not with the intention to move cows.
Moderately forceful	Loud talk	Talking to cows with loud impatient voice, including shrill whistling.
	Moderately forceful tactile	Hitting, slapping, pushing, or kicking cows with moderate force.
	Object moderately forceful tactile	Hitting cows with an object (e.g., manure scraper, gate, or plastic pipe) with moderate use of force.
Forceful	Shouting	Very loud, harsh vocalizations.
	Forceful tactile	Hitting or kicking cows with high use of force.
	Object forceful tactile	Hitting cows with an object (e.g., manure scraper, gate, or plastic pipe) with high use of force.
	Tail twisting	Bending the tail with the intention to move cows.
Uncategorized	Talking	Talking to cows quietly or in conversational tone, including quiet whistling.
	Noise	Clapping hands or knocking/banging the interior, e.g., with a stick.
	Tactile	Contact with hand or body with no or low use of force.
	Object tactile	Contact with an object (e.g., manure scraper, gate, or plastic pipe) with low use of force.
	Waving	Waving arms or object.
	Running	Running.
	Pulling neck strap	Grabbing and pulling the neck strap.
	Pulling head collar	Pulling the head collar or lead rope.

The cow behaviors recorded were those indicating fear or stress and that could possibly pose a risk to the handler, e.g., flight, resistance, balking, freezing, kicking, head butting, and force on interior fittings. These behaviors were divided into different levels depending on their intensity or severity. Kicking and head butting were recorded as with/without making contact with the handler. Resistance was recorded when a cow did not want to move in the direction the handler wished and tried to turn back past the handler. This behavior was categorized into three levels: trying to turn without following through, turning back and passing the handler without contact, and turning back and running over the handler or pushing the handler into a wall or interior fitting. Freezing was recorded when the cow stopped, appeared tense or fearful with ears forward, and gave full attention to the item in question. Freezing was categorized into three levels depending on whether the cow started to walk again without contact by the handler, directly after contact by the handler, or only after repeated contact by the handler. Balking was recorded when the cow backed up and was categorized into two levels depending on whether the cow ceased balking voluntarily or the behavior was interrupted by the handler.

Risk Zone

The risk zone was defined as the area around the cow where the handler could be hit by the cow's head or hind legs in the case of head butting or kicking. At the end of each observed minute (t), the time spent by the handler in the risk zone was recorded as: $t = 0$, $0 < t < 1/3$, $1/3 \leq t \leq 2/3$, $2/3 < t < 1$, and $t = 1$. When calculating the mean percentage time spent in the risk zone, the midpoint of each category was used as an approximation of the observed time.

Risk Situations and Incidents

The frequency of situations and incidents that were possibly related to an increased in-

jury risk were recorded during the observations. "Risk situations" were defined as slips, trips, falls, other risk situations or incidents, and cow behaviors indicating fear or stress. "Incidents" were defined as events in which there was physical contact between the handler and a cow that could have resulted in injury, e.g., when the handler was kicked, head butted, run over, or crushed.

Our first hypothesis was that handlers would use more moderately forceful and forceful interactions, spend more time in the risk zone, and have more risk situations and incidents when moving cows to hoof trimming compared with milking.

Questionnaire

At the end of each observation day, the handler was asked to complete a questionnaire, which addressed different issues on the two visits. The first visit addressed background information, perceived stress and energy levels, the safety locus of control scale, and attitudes toward risk. The second visit addressed animal-related injuries since the previous visit, perceived stress and energy levels, and attitudes toward cows and working with cows. These terms are defined in the following paragraphs.

Background Information: Background questions concerned sex, date of birth, education, experience of working on a dairy farm, main responsibilities, status as employee or farm owner, and experience of animal-related injuries.

Perceived Stress and Energy Levels: To measure the handlers' perceived stress level during the observed animal handling, the Stress-Energy questionnaire was used (Kjellberg and Iwanowski, 1989; Kjellberg and Wadman, 2002). This questionnaire consists of a mood adjective checklist with six words describing each of the two dimensions (stress and energy). Three words represent the negative side of each dimension, and three words represent the positive side. The handler was asked to estimate to what extent each adjective described his/her feeling during the observed handling period using a six-point scale ranging from 0 = not at all to 5 = very much. The adjectives are shown in table 2.

The scales of the six negative words were inverted before a mean score for stress and energy was calculated, so that the high mean scores indicated high levels of stress and energy. The perceived neutral in the stress scale (neither stressed nor calm) is at a mean score of 2.4, and the corresponding neutral in the energy scale (neither active nor passive) is at 2.7 (Kjellberg and Iwanowski, 1989). Based on their stress and energy scores, individuals can be sorted into four categories: Exhausted (high stress, low energy), dedicated under pressure (high stress, high energy), bored (low stress, low energy), and dedicated without pressure (low stress, high energy).

Our second hypothesis was that the perceived stress levels of the handlers would be higher when moving cows to hoof trimming than to milking. Furthermore, a high stress level and low energy level was expected to be related to a high number of risk situations and incidents.

Safety Locus of Control Scale: The safety locus of control scale (Jones and Wuebker, 1985) used in this study was a modified version presented by Glasscock et al. (2006), altered to be more suitable for farmers. The scale consisted of 17 items concerning the respondent's beliefs about accident causation. A six-point scale ranging from "agree very

Table 2. Perceived stress and energy levels.

	Positive	Negative
Stress	Tense, stressed, pressured	Rested, relaxed, calm
Energy	Active, energetic, focused	Dull, inefficient, passive

much" to "disagree very much" was used for each item. The safety scale raw scores were calculated according to Jones and Wuebker (1985) and ranged from -17 (externals) to +17 (internals).

Our third hypothesis was that handlers with a lower safety locus of control score (i.e., externals) would spend more time in the risk zone and have more observed risk situations and incidents.

Job Strain: Job strain was measured using a questionnaire introduced by Karasek (1979) and modified by Theorell et al. (1988). The questionnaire had two dimensions: job demand and decision latitude. The questions had response alternatives from 1 to 4, where 1 = almost never and 4 = often. High scores indicated greater control and higher demands. By dividing the demand score by the decision latitude, a job strain score was computed (Theorell et al., 1988). Job situations described as psychologically demanding and at the same time with few possibilities for the workers to influence decisions are described as "strained" (Theorell et al., 1988). The job demands dimension included five questions:

- Does your work require you to work very fast?
- Does your work require you to work very hard?
- Does your work require too high a work effort?
- Do you have enough time to finish your work tasks?
- Does your work often involve conflicting demands?

The decision latitude dimension included six questions (three on skill discretion and three on authority over decisions):

- Do you learn new things in your work?
- Does your work require skill?
- Does your work require ingenuity?
- Does your work comprise repeating the same tasks over and over again?
- Are you free to decide how your work should be performed?
- Are you free to decide what your work should include?

Our fourth hypothesis was that handlers with a higher job strain score would have a higher perceived stress level and a lower energy level, which would be related to a higher number of risk situations and incidents.

Attitudes toward Risk: Attitudes toward risk were measured using a five-item questionnaire, previously used by Sprince et al. (2003), with the following statements (derived from Harrell, 1995):

- Farming is more dangerous than jobs in industry or manufacturing.
- Accidents are just one of the occupational hazards of farming that must be accepted if you are going to be in the business.
- Compared with other farmers, I am very conscientious about avoiding accidents.
- During a normal working week, it is common for me, while doing farm work, to experience a number of "close calls" that under different circumstances might have resulted in personal injury or property loss.
- To make a profit, most farmers take risks that might endanger their health.

The respondents were asked to say whether they agreed or disagreed with each statement. For statements 1, 2, 4, and 5, a score of 0 was awarded for disagreement and 1 for agreement. For statement 3, agreement was counted as 0 and disagreement as 1. If the total score was 0-2, the respondent was considered "risk averse"; if it was 3-5, the respondent was considered "risk accepting" (Alavanja et al., 2001; Sprince et al., 2003).

Our fifth hypothesis was that handlers categorized as risk accepting would spend more time in the risk zone and have a higher number of risk situations and incidents compared with those categorized as risk averse.

Attitudes toward Cows and Working with Cows: A questionnaire developed by Hemsworth et al. (2000) was used to measure the handler's beliefs about the characteristics of cows and working with cows. The questions were modified from the original version to better fit the aim of this study. The first section included 25 statements about the characteristics of cows. Each statement had five response alternatives: disagree strongly, disagree, neither agree nor disagree, agree, and agree strongly. The response alternatives were given a grade of 1 (disagree strongly) to 5 (agree strongly). The second section included ten questions about the handling of cows at different ages (primiparous cows and older cows). The response alternatives for each question were graded from 1 to 7.

Because of the limited amount of data, principal component analysis was not considered appropriate to reduce the number of variables. Instead, the 25 statements about cows were reduced to four factors depending on the essence of the statement: PosAtt, NegAtt, PosWork, and EasyMan (table 3). The ten questions about handling cows of different ages were reduced to three factors: HandlMilk, HandlHoof, and LowFear (table 3).

Our sixth hypothesis was that handlers with a more negative attitude would use more moderately forceful and forceful interactions and would have more observed risk situations and incidents.

Interview

A short interview with the handler was conducted after each behavioral study. The questions were:

Table 3. Reduction of statements and questions into seven factors.

Factor	Definition	No. of Items	Examples of Items	Higher Score
PosAtt	Positive attitude toward cow characteristics	7	Dairy cows are stimulating animals. Dairy cows are intelligent animals. Dairy cows require respect.	More positive
NegAtt	Negative attitude toward cow characteristics	10	Dairy cows are noisy animals. Dairy cows are smelly animals. Dairy cows are dirty animals.	More negative
PosWork	Cows are easy to work with	4	Dairy cows are easy animals to work with. Dairy cows are a pleasure to work with. Dairy cows are frustrating to work with.	Easier
EasyMan	Cows are easy to manage	3	Little experience is required to work with dairy cows. Little training is required to work with dairy cows. Little time is required to manage dairy cows.	Easier
HandlMilk	Little effort when cows are moved to milking	3	How easy are your dairy cows to move into the waiting pen for milking? How much physical effort (e.g., pushing and slapping) is required to move cows into the waiting pen?	Less effort
HandlHoof	Little effort when cows are moved to hoof trimming	3	How easy are your dairy cows to move into the chute for hoof trimming? How much physical effort (e.g., pushing and slapping) is required to move cows into the trimming chute?	Less effort
LowFear	Fear of humans	4	How do your dairy cows react to your presence in the barn when you are active? How do your dairy cows react to your presence in the barn when you are stationary?	Less fearful

- Was the observed handling representative of an average milking or hoof trimming?
- Did you ever feel stressed during the observed handling of the cows?
- Did you find that you were exposed to a risk of injury at any time during the observed handling?

Statistics

The statistical analyses were conducted in SPSS for Windows (version 20.0, IBM Corp., Armonk, N.Y.). Measurements from the behavioral observations of handlers and cows were not normally distributed. Interactions and risk situations/incidents when moving to milking and to hoof trimming were therefore analyzed using the related-samples Wilcoxon signed rank test. Time spent in the risk zone was considered to be normally distributed because it was calculated as a mean, and it was therefore analyzed using a paired t-test (two-tailed). Paired t-tests were also used for analysis of handlers' perceived stress and energy levels when moving cows to milking and to hoof trimming (one farm was excluded from this analysis due to missing data for milking). For consistency, all correlations were calculated using Spearman's correlation coefficient.

Comparisons were carried out on variables between males and females, employees and farm owners, risk averse and risk accepting, and external and internal safety locus of control. For the variables gentle, moderately forceful, and forceful interactions, risk situations, and incidents, the Mann-Whitney U test was used. Independent samples t-tests were used for the variables time spent in the risk zone, job strain, and attitudes toward cows and working with cows.

The significance threshold used was $p \leq 0.05$, and asterisks (*, **, and ***) were used to indicate significance ($p \leq 0.05$, 0.01, and 0.001, respectively).

Ethical Considerations

This study was approved by the Swedish Ethics Committee on Animal Experiments. The research procedures followed the Swedish rules and regulations on the use of human subjects in research. Informed consent was obtained from all participants.

Results

Handler-Cow Interactions

The proportions of gentle, moderately forceful, and forceful interactions were all significantly larger during moving to hoof trimming compared with moving to milking (table 4). When moving cows to milking, forceful interactions were only observed on three farms and with a very low frequency, and gentle interactions were observed on only two farms. Forceful interactions and gentle interactions were observed at all farms during moving cows to hoof trimming. No significant difference was found in the proportion of any of the interactions in table 4 between the sexes, employee/farm owner, internal/external safety locus of control, or risk averse/accepting.

The proportion of uncategorized interactions was significantly lower when moving cows to hoof trimming than to milking. Uncategorized interactions were not analyzed further (correlations) because they were not considered relevant to the hypotheses.

Time Spent in the Risk Zone

Time spent in the risk zone during handling of the cows was significantly higher ($p = 0.035$) when moving cows to hoof trimming (mean = 39.7%, SD = 18.3, $n = 12$) than

Table 4. Interactions when moving cows to milking compared with moving cows to hoof trimming (as a proportion of the total number of observations; *n* = 12).

	Milking		Hoof Trimming		
Interaction	Median	Range	Median	Range	p-Value[a]
Gentle	0.00	0.00 to 0.02	0.01	0.00 to 0.04	0.005**
Moderately forceful	0.08	0.00 to 0.25	0.18	0.08 to 0.34	0.012*
Forceful	0.00	0.00 to 0.03	0.07	0.03 to 0.18	0.002**
Uncategorized	0.92	0.71 to 1.00	0.71	0.56 to 0.84	0.002**

[a] * = $p < 0.05$ and ** = $p < 0.01$.

when moving cows to milking (mean = 21.2%, SD = 10.9, *n* = 12). No significant difference was found in time spent in the risk zone when moving cows to milking or to hoof trimming between the sexes, employee/farm owner, internal/external safety locus of control, or risk averse/accepting.

Risk Situations and Incidents

Risk situations when moving cows to milking were only observed on two farms, while all farms had risk situations when moving cows to hoof trimming. The risk situations were mainly related to the cow behaviors freezing, balking, and resistance. When moving cows to milking, there were no farms with incidents, while at hoof trimming all farms except two had incidents. Observed incidents were the handler being kicked, head butted, run over, backed into, and crushed between a cow and a wall or interior fixture. One person was also dragged when a cow he was trying to lead ran off.

The number of risk situations and incidents per minute was significantly higher when moving cows to hoof trimming compared with milking (table 5). There were no significant differences in the number of risk situations and incidents per minute between the sexes, employee/farm owner, and internal/external safety locus of control. When moving cows to hoof trimming, risk situations per minute were significantly more frequent ($p = 0.003$) for those handlers categorized as risk averse (median = 1.05, *n* = 5) than for those categorized as risk accepting (median = 0.64, *n* = 7).

Stress and Energy Levels of the Handler

The mean perceived stress levels when moving cows to milking and to hoof trimming were 1.26 (SD = 0.73, *n* = 11) and 1.26 (SD = 0.53, *n* = 12), respectively, which are below the neutral value of 2.4. The mean energy levels when moving cows to milking and to hoof trimming were 3.65 (SD = 0.74, *n* = 11) and 3.51 (SD = 0.29, *n* = 12), respectively, i.e., above the neutral value of 2.7. Thus, the handlers generally had a high energy level and a low stress level. There were no significant differences in perceived stress and energy levels when moving cows to milking compared with hoof trimming.

Figure 3 shows how the perceived stress and energy levels on each farm deviated from the neutral values. The energy levels were high except for two of the handlers. For milking, these two handlers are in the lower left quarter of the diagram, defined as “bored”

Table 5. Observed risk situations and incidents per minute when moving cows to milking and hoof trimming.

	Milking		Hoof Trimming		
	Median	Range	Median	Range	p-Value[a]
Risk situations per minute	0.00	0.00 to 0.05	0.95	0.58 to 1.65	0.002**
Incidents per minute	0.00	0.00 to 0.00	0.03	0.00 to 0.11	0.005**

[a] ** = $p < 0.01$.

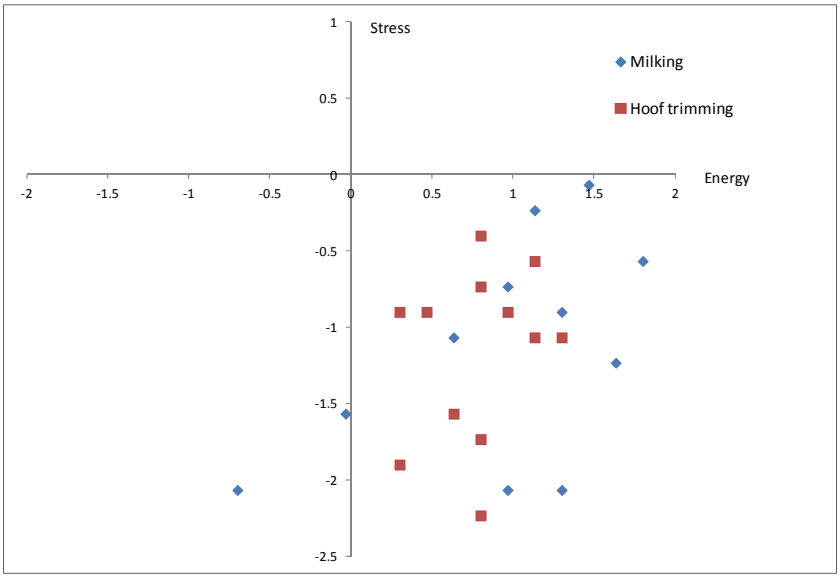

Figure 3. Perceived stress and energy levels (deviation from neutral) of the handlers during moving cows to milking and to hoof trimming.

(although one of the points is close to the neutral value, making it uncertain to which quarter it belongs), while the rest are in the "dedicated without pressure" quarter (lower right). When moving cows to hoof trimming, all handlers are in the "dedicated without pressure" quarter. Because of the generally low stress levels, no handlers are in the "dedicated with pressure" (upper right) or "exhausted" (upper left) groups.

Job Strain

The mean score for job demand was 2.45 (SD = 0.51), and the mean score for job decision latitude was 2.90 (SD = 0.43). Figure 4 shows the deviations of job demand and job latitude scores from the median for the 12 handlers. One handler is in the lower right quarter, indicating high strain. The mean job strain was 0.85 (SD = 0.20), and the job strain scores ranged from 0.56 to 1.37. Job strain was positively correlated to age ($r = 0.73$, $p = 0.007$), and the handler with high job strain was the oldest of the participants (64 years). This was the same handler classified as "bored" in the stress-energy model (fig. 3).

Safety Locus of Control and Attitude toward Risks

Safety locus of control scores ranged from -7 to 3 (median = 0). The handlers were split into two groups depending on their score: one group of negative scores (external locus of control) and one group of positive scores (internal locus of control). The two groups were then compared for differences in attitudes, incidents, handler-cow interactions, time spent in the risk zone, and job strain. No significant differences were found.

Risk attitude scores ranged from 1 to 5 (median = 2). Five handlers were found to be risk accepting, and seven were found to be risk averse. No significant differences were found between the two groups regarding attitudes, incidents, handler-cow interactions, time spent in the risk zone, and job strain.

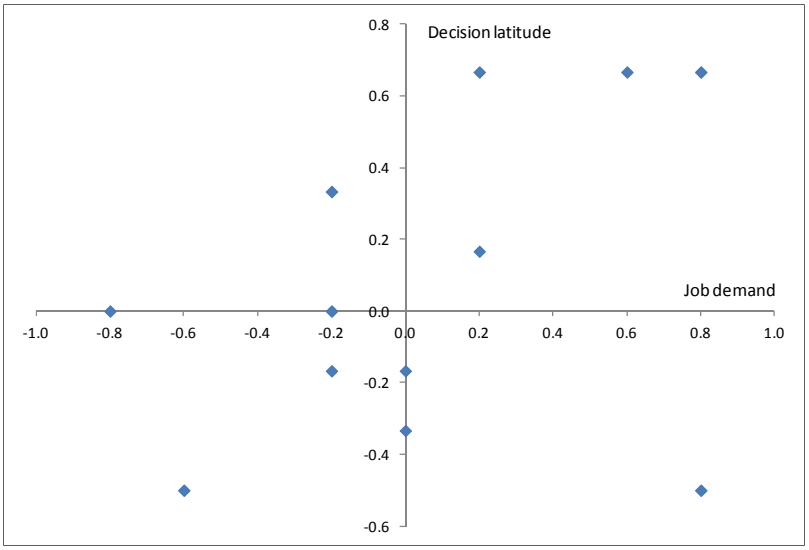

Figure 4. Job decision latitude and job demand of the 12 handlers shown as deviations from the median.

There was no significant correlation between safety locus of control score and risk attitude score. Risk attitude score and safety locus of control score showed no significant correlations with age, experience, herd size, handler-cow interactions, job strain, time spent in the risk zone, and incidents. Safety locus of control score was positively correlated to PosAtt ($r = 0.79$, $p = 0.002$), and risk attitude score was negatively correlated to PosWork ($r = -0.63$, $p = 0.028$).

Attitudes toward Cows and Working with Cows

The mean and range of scores in attitudes toward cows and working with cows are shown in table 6. There was a significant difference in PosAtt ($p < 0.01$) between handlers with internal and external safety locus of control, where internals had a higher score (mean = 4.60 and 4.05 for internals and externals, respectively). Internals also had a significantly higher LowFear score ($p < 0.05$) compared with externals (mean = 5.98 and 5.40, respectively). There was a significant difference in NegAtt ($p < 0.05$) between employees and farm owners, where employees had a higher score (mean = 2.71 and 2.05 for employees and farm owners, respectively).

No correlations were found between attitudes and risk situations or incidents when moving cows to milking or hoof trimming. Furthermore, no correlations were found between gentle or moderately forceful interactions and attitudes. The only correlation found

Table 6. Mean, standard deviation, and range for attitudes toward cows and working with cows (*n* = 12).

	Factor	Mean	SD	Range
Possible maximum score = 5	PosAtt	4.32	0.39	3.86 to 5.00
	NegAtt	2.49	0.52	1.50 to 3.40
	PosWork	4.13	0.64	2.75 to 5.00
	EasyMan	1.67	0.40	1.00 to 2.33
Possible maximum score = 7	HandlMilk	5.33	0.64	4.00 to 6.33
	HandlHoof	4.44	0.84	3.00 to 5.67
	LowFear	5.69	0.51	5.00 to 6.50

was a negative correlation between forceful interactions and PosAtt ($r = -0.71$, $p = 0.011$) when moving to milking. Correlations between attitudes and the variables age, experience, herd size, job strain, stress level, and energy level when moving cows to milking and hoof trimming are shown in table 7.

Interview

Milking

All handlers except one said that the observed handling was representative of an average milking. One handler said that he was more stressed than usual. This handler had one of the highest stress level scores at milking of all handlers, but it was still below the neutral value. Another handler said that he always felt stressed when moving cows to milking because of the tight time limits when moving cows around and serving the milking staff. He also had one of the higher stress level scores. Eight of the handlers said that they did not feel that they were exposed to any risk of injury during the handling. Four said that they felt exposed to a risk of injury, and two of these stated that there is always a risk in handling animals because of their size.

Hoof Trimming

All handlers said that the observed handling was representative of an average hoof trimming. Seven handlers said that they did not feel stressed, while five said that they did. Some of the stressful situations mentioned were when things do not go according to plan, when the hoof trimmer is waiting, and when the cow does not want to move. There were no significant differences in perceived stress levels, as determined from the Stress-Energy questionnaire, between those who said they felt stressed and those who did not in the interviews. Five handlers said that they felt exposed to a risk of injury during the observed handling, and the situations mentioned were the risk of being crushed or run over because of handling cows in tight spaces. Four of those handlers ranked high in time spent in the risk zone, risk situations, and/or incidents.

Summary of Correlations

A summary of the correlations found between different variables in relation to risk situations when moving cows to milking and to incidents when moving cows to hoof trimming is presented below.

Milking

When moving cows to milking, no incidents were observed, and risk situations were observed only on two farms. The only variable that was correlated directly to risk situa-

Table 7. Correlations between attitudes and the variables age, experience, herd size, job strain, stress, and energy when moving cows to milking and to hoof trimming.[a]

					Stress Level		Energy Level	
Factor	Age	Experience	Herd Size	Job Strain	Milking	Hoof Trimming	Milking	Hoof Trimming
PosAtt	-0.01	-0.03	-0.50	-0.13	-0.71*	-0.75**	-0.33	-0.25
NegAtt	-0.63*	-0.39	0.60*	-0.65*	0.38	0.04	0.49	0.34
PosWork	0.38	0.15	-0.71**	0.47	-0.82**	-0.54	-0.53	-0.48
EasyMan	0.06	0.02	0.67*	-0.06	0.39	0.58*	0.12	0.38
HandlMilk	0.02	-0.10	0.33	-0.10	0.43	-	0.41	-
HandlHoof	-0.40	-0.73**	0.32	-0.17	-	-0.05	-	0.17
LowFear	0.08	-0.16	-0.39	-0.01	-0.73*	-0.65*	-0.05	-0.12

[a] * = $p < 0.05$ and ** = $p < 0.01$.

tions per minute when moving cows to milking was perceived energy level ($r = 0.68$, $p = 0.022$). Herd size was positively correlated to perceived energy ($r = 0.76$, $p = 0.007$) and stress ($r = 0.74$, $p = 0.011$). Job strain was negatively correlated to time spent in the risk zone when moving cows to milking ($r = -0.73$, $p = 0.008$).

Hoof Trimming

When moving cows to hoof trimming, all farms except two had incidents, and all had risk situations. Risk situations per minute was only correlated to proportion of gentle interactions ($r = -0.63$, $p = 0.028$). Two variables were directly correlated to incidents per minute when moving cows to hoof trimming: time spent in the risk zone ($r = 0.67$, $p = 0.017$) and job strain ($r = 0.60$, $p = 0.037$). Time spent in the risk zone was positively correlated to experience ($r = 0.62$, $p = 0.030$), age ($r = 0.70$, $p = 0.012$), and job strain ($r = 0.62$, $p = 0.031$). Age was positively correlated to experience ($r = 0.67$, $p = 0.017$) and job strain ($r = 0.73$, $p = 0.007$). As for milking, herd size was positively correlated to perceived stress ($r = 0.67$, $p = 0.018$) and energy ($r = 0.61$, $p = 0.034$). Perceived energy level was negatively correlated to time spent in the risk zone ($r = -0.59$, $p = 0.045$) and job strain ($r = -0.65$, $p = 0.022$).

Discussion

Behavior of Handlers

The proportion of moderately forceful and forceful interactions was larger when moving cows to hoof trimming than to milking. This result was expected, since hoof trimming is outside the normal routine and a procedure to which cows are often averse, which makes handling the cows more challenging. The amount of force that some of the handlers used in their interactions with the cows was unexpected. A desire to be time-efficient and to get as many cows through the trimming chute as possible per day may cause handlers to use force when cows move too slowly or resist moving forward. Lack of knowledge and skill in animal handling is another probable reason. Previous studies have shown that rough and aversive handling of dairy cows can reduce milk yield (Breuer et al., 2000; Hemsworth et al., 2002) and make cows more fearful and difficult to handle (Boivin et al., 2003; Breuer et al., 2000, 2003; Hemsworth et al., 2000).

The proportion of gentle interactions was also larger when moving cows to hoof trimming, probably with the aim of calming nervous cows. From previous studies, it is known that gentle handling causes dairy cows to be less fearful and easier to manage (Boissy and Bouissou, 1988; Hemsworth et al., 1996). Waiblinger et al. (2004) concluded that stress reactions in cows can be reduced by previous positive handling, as well as by providing positive, gentle interactions during an adverse situation, thereby reducing the risk of injury during such procedures. This finding was also supported by Schmied et al. (2010), who found a stress-reducing effect of stroking (lower heart rate and less restless behavior) during an adverse procedure (rectal palpation). However, it has also been shown that people differ in their ability to calm cows (Waiblinger et al., 2004). Repeated stroking of dairy cows, particularly on the neck, leads to reduced avoidance and increased approach reactions to humans and can thus be a way to improve human-animal relationships and routine handling of dairy cattle (Schmied et al., 2008).

Many published studies on human-cow interactions refer to extensively kept dairy cows in large herds (Breuer et al., 2000; Hemsworth et al., 2000, 2002). In Sweden, dairy

herds are relatively small, with a mean size of 70 cows (Statistics Sweden, 2013), and cows are kept indoors eight to ten months a year during the winter season. These conditions make the cows very accustomed to being close to humans and being handled, which probably affects the way they react to handling and to different handling situations. Studies and dissemination of knowledge on best practices for animal handling on dairy farms under such conditions, focusing on improving safety, effectiveness, and animal welfare, would be very helpful to the farmers and their employees.

Time Spent in the Risk Zone, Risk Situations, and Incidents

Observed risk situations and incidents were higher when moving cows to hoof trimming than to milking. During milking, no incidents and very few risk situations were observed. Risk situations when moving cows to milking were only correlated to the perceived energy level of the handler. A possible explanation for this correlation is that a high energy level (feeling active, effective, and focused) might be interrelated with haste (i.e., a desire to act or move rapidly without necessarily being stressed), and haste is believed to generate a risk of injury (Kallioniemi et al., 2011; Rautiainen et al., 2004). Risk situations when moving cows to hoof trimming did not show the same correlation to energy level as when moving cows to milking. The different results for milking and hoof trimming may indicate that the risks of injury and the underlying causes are dependent on the situation, as was hypothesized. Despite the fact that that the frequencies of risk situations and incidents in this study were high considering the number of hours per day that the handlers were exposed to them, they are based on only two days of observations. Therefore, the results of the correlation analyses should be interpreted with some caution and should be seen as suggestions of possible relationships rather than final proof.

Incidents when moving cows to hoof trimming were directly correlated to time spent in the risk zone and job strain. The handler has to be within reaching distance (risk zone) of a cow to be affected by its actions. Therefore, the closer the handler is to the cow, the greater the risk of being injured in the event of an unexpected response or reaction by the cow (Lindahl et al., 2013; McCurdy and Carroll, 2000). The time spent in the risk zone most likely depends on the design of the handling facilities, handling technique, handler behavior, whether individual cows or a group are being moved, and the flight zone of the cows. With dairy cows, the flight zone is small, so presumably the handler has to be close to get them to move. Because risk zone was so clearly related to incidents, an effective way to reduce incidents would be to make sure the handler does not have to be in close proximity to cows in situations where the cows may be fearful or unwilling. The results also showed that time spent in the risk zone was positively correlated with job strain, age, and experience. Older and more experienced handlers have possibly become accustomed to the hazards related to their work.

Stress, Energy, and Job Strain

In the present study, we measured stress in two ways: with the Karasek (1979) job strain model, and with the Stress-Energy model. Kjellberg and Wadman (2002) showed an association between the two models in which perceived stress was positively correlated to job demands and perceived energy was positively correlated to job decision latitude. We did not find similar correlations in the present study. One probable explanation is that we used the Stress-Energy model to measure the handlers' subjective stress level during the specific tasks of moving cows to milking and to hoof trimming, while we used the job strain model to relate to the psychosocial work situation more generally.

In general, stress was low and energy was high, indicating that the handlers felt dedicated without pressure. The results showed no difference in perceived stress and energy levels when moving cows to milking and to hoof trimming. Instead, the decisive factor for subjective stress and energy levels, independent of work task, seemed to be herd size. Handlers working with larger herds had higher levels of both stress and energy. A low energy level was related to increased time spent in the risk zone, increasing the risk of injury. It is interesting to note that some handlers stated that they felt stressed during the observed handling, but the stress level according to the Stress-Energy model was below neutral (but above the mean). The model is possibly too crude to specify an exact neutral value, since the true neutral may vary between individuals.

Job strain was positively correlated to observed incidents when moving cows to hoof trimming and thus seemed to be more directly linked to safety. Job strain in relation to occupational injury in agriculture is an interesting issue for future research.

Risk Attitudes and Safety Locus of Control

It has been suggested that safety attitudes are related to risk behavior and injury-proneness. In the present study, we measured safety attitudes with two different questionnaires. The safety locus of control scale was designed to identify employees more prone to occupational injury. Earlier studies have shown that the safety scale measures safety consciousness and can differentiate between groups with varying injury histories (Jones and Wuebker, 1985, 1993). Our hypothesis was that a higher safety locus of control score would be related to a lower level of risk taking, e.g., less time spent in the risk zone and fewer risk situations and incidents. However, the results did not support this hypothesis. Safety locus of control was negatively correlated to perceived stress level for both milking and hoof trimming. This is in agreement with Elkind (2007), who stated that individuals with an external locus of control often feel out of control, which is a condition often related to stress. In addition, the handlers categorized as internals were found to have more positive attitudes toward cows and a belief that cows are less fearful compared with those categorized as externals, which can also contribute to a lower stress level.

The risk attitude questionnaire was used to differentiate between handlers who were risk accepting and those who were risk averse (Sprince et al., 2003). The expected outcome was that those who had a high score (risk accepting) would have a higher level of risk taking when handling cows. However, the results from this study suggest that the handlers categorized as risk averse had more risk situations during hoof trimming than those categorized as risk accepting. This finding was unexpected, although in keeping with Sprince et al. (2003), who did not find support for the hypothesis that attitude toward risk is associated with animal-related injuries. Additionally, Glasscock et al. (2006) found no relationship between safety locus of control or safety attitudes and injury. It could be incorrect to use the term “risk accepting” for the high scorers. Rather, a high score might indicate greater awareness of the risks associated with animal handling, and therefore “risk aware” would be a better term. For example, a positive answer to the first statement (“Farming is more dangerous than jobs in industry or manufacturing”) may show insight and knowledge, while a negative answer could be a sign of denial and lack of awareness. Furthermore, we do not know whether the handlers who disagreed with the statement that they encounter a number of close calls during farm work actually encounter fewer close calls than those who agreed with the statement.

Elkind (1993) found that many farmers perceive farming as dangerous, but that atti-

tudes about the importance of those hazards with respect to one's own life differ from knowledge of the hazards. Elkind (1993) also found that farmers who regularly take many safety precautions do not say that farming is any more or less dangerous than those who do nothing to protect their families and workers. Elkind (2007) argued that risk perception, locus of control, and chronic stress intervene between a person's attitude toward a specific hazard and his/her intentions to behave in a particular manner in order to minimize the risk of injury. Murphy (1981) found no correlation between safety attitudes and injuries and suggested that factors other than safety attitudes are likely to be more related to farm injuries.

In conclusion, the safety locus of control score and risk attitudes did not serve as good indicators of injury risks during the handling of cows. Other factors had more impact on the relevant variables related to risk-taking behavior, which supports the views of Elkind (1993) and Murphy (1981), who questioned the impact of safety attitudes on behavior. Nevertheless, it should be borne in mind that the present study only comprised a momentary measure of the risks taken by individuals and may not be representative of those individuals' risk behavior over a longer period or in other handling situations.

Attitudes toward Cows and Working with Cows

The results did not show any direct correlation between attitudes toward cows and working with cows and risk situations and incidents. Additionally, there was no clear overall association between interactions and attitudes, although we found a negative correlation between positive attitudes and the use of forceful interactions when moving cows to milking. Breuer et al. (2000) showed that a composite attitude score (high score representing positive attitudes), based on questions about patting and talking to cows and ease of movement of cows, was negatively correlated with the use of negative tactile interactions such as slaps, pushes, and blows in connection with milking. Hemsworth et al. (2000) found that positive beliefs about the general characteristics of cows were associated with the use of more positive interactions and less negative interactions by the handler when moving cows to milking. Both of these studies were conducted on commercial dairy farms in Australia. Thus, in this study, similar results as in previous studies were found when associated with a similar situation (milking), but not for hoof trimming. This observation may imply that additional research is needed on handling large animals in settings unfamiliar to the animal.

Worth noting is that a higher perceived stress level was related to a belief that cows are fearful of humans and that positive attitudes toward cows were related to a lower perceived stress level (consistent at both milking and hoof trimming). It is possible that a positive attitude toward cows is associated with higher job satisfaction and thereby also to a lower perceived stress level. A positive relationship between job satisfaction and positive attitudes toward pigs among handlers in large commercial piggeries was shown by Coleman et al. (1998). In addition, we found that employees had more negative attitudes toward cows than farm owners did, which may be linked to job satisfaction as well.

Limitations

The study was conducted on a relatively small number of farms, which limited the external validity, even if each farm was observed in both situations and so acted as its own control in the analysis. A small sample size indicates a low accuracy of estimates of correlation coefficients because the magnitude of a correlation is rather unstable in small samples. There was a possible selection bias due to the sampling method (non-

randomized) and the fact that the farmers who agreed to participate might have been more concerned about safety. As the data collection was conducted on commercial farms, it was possible to make observations in a natural setting with minimum interference and no manipulation. However, such field studies provide very low control over variables, so confounding bias is a risk. This applies to variables not controlled for in the study, such as the time of day for the measurements, weather conditions, the design of the handling facilities, and the number and age of the cows being moved to hoof trimming and milking. Thus, the results should be interpreted with some caution, even though several of the results found are supported by findings in the literature. Handling facility design and its effects on handler safety is presented in a separate article.

We only observed one milking and one hoof trimming per farm, so we do not know how the data vary within farms. Waiblinger et al. (2002) concluded that observation of one milking per farm (including collection of cows to milking and the actual milking) was sufficient due to a previously found high correlation in handler behavior between milkings. However, the variability in behavior may be higher during hoof trimming. To identify any abnormalities experienced by the handlers during the observations, the handlers were asked if the handling was representative of an average milking or hoof trimming after each observation session. Furthermore, there is a possibility that we did not see the handlers' worst behaviors during the observations because they were aware that we were observing the animal handling. To avoid any systematic effects related to the order of visits, half of the farms were first observed when moving cows to milking, and the other half were first observed when moving cows to hoof trimming.

Although the study was correlational, i.e., we were not able to show causality, and despite a number of limitations leading to a lack of generalizability of the findings, the results still point to some very interesting aspects of safe animal handling and should serve as an inspiration and springboard for future research.

Conclusions

Risk situations and incidents were more frequent when moving cows to hoof trimming compared with milking, implying that the risk of injury is dependent on the context of the animal handling. When moving cows to milking, observed risk situations were found to be related only to the perceived energy level of the handler. When moving cows to hoof trimming, injury risks were directly related to job strain and time spent in the risk zone. Attitudes were not found to have a significant impact on safety but were at least to some extent indirectly involved. Thus, the results suggest that the main focus of injury reduction efforts should be to reduce the time the handler has to spend in close proximity to animals during adverse procedures and to minimize animal fear and stress by proper handling techniques and appropriate design of handling facilities. There are already several examples of best practices for animal handling facilities that are well adapted to this purpose. Intervention studies are needed to quantify the consequences of systematically implementing these best practices under practical on-farm conditions in terms of safety, efficiency, and animal welfare.

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