ABSTRACT

HERNANDEZ PERDOMO, LUZ ANYELA. Animal Welfare During Live Haul of Market-Ready Turkeys: Crew Member Perspectives and Training (Under the direction of Dr. Allison Pullin).

Live haul is a key stage in the management of market-ready turkeys, involving the handling, herding, and loading of birds for transport to the processing plant. During this process, turkeys may become physically injured with bruises, scratches, and/or broken/fractured/disjointed bones, which compromise animal welfare and carcass quality. Improving human-animal interactions is a strategy to mitigate injuries. We aimed to investigate live haul crew members' perspectives about animal handling, specifically to identify processes and challenges associated with proper handling. We also aimed to incorporate these perspectives into a virtual training program about proper animal handling during live haul.

For the first objective, six focus groups were conducted with a total of 38 English- and Spanish-speaking live haul crew members. Participants were recruited from four commercial turkey companies in North Carolina, Pennsylvania, and Virginia. Discussions explored how the live haul process is carried out on farms, current training methods, situations that make the job challenging, strategies used to manage those situations, and external factors that could improve the job. Thematic analysis revealed three main factors affecting the implementation of handling, herding, and loading techniques, with 54% of the comments referring to farm factors, 33% to human factors, and 13% to animal factors. The subfactors of sex, age, injury, disease status, and production type were identified within the animal factor. The subfactors of informal training, learning by experience, formal training, human safety concerns, physical endurance, and handling strategy were identified within the human factor. Finally, the subfactors of farm characteristics, environmental conditions, equipment, and scheduling logistics were identified

within the farm factor. All of the subfactors were interrelated. The data revealed that informal training is the primary method by which crew members learn their job (i.e., by shadowing other crew members), which can result in inconsistent handling practices. Establishing standardized, formal training can improve consistency in turkey handling. In addition, effective communication among veterinarians, farmers, nutritionists, and crew members can improve the efficiency of the live haul process and animal welfare outcomes. Specifically, coordinated decisions on lighting, temperature control, and litter management can support bird mobility and health during herding and loading. Future research is needed to address farm design, mechanical aids for moving lame birds, and protective equipment to improve crew endurance and safety.

These findings guided the second objective: to develop a bilingual virtual training program on proper animal handling during live haul with three self-paced modules. Module one addressed the basic aspects of animal behavior and health that affect bird movement. Module two focused on the techniques for handling and herding turkeys, while Module three presents the techniques for loading turkeys. The training tool was developed as a computer-based program that integrates real-world media from commercial farms with voice-over narration in English and Spanish, allowing participants to engage in an interactive and practical immersive learning experience. Knowledge checks were included throughout the modules to reinforce understanding and retention. The modules addressed the challenges identified during the focus groups to provide clear, practical guidance for implementing proper handling, herding, and loading techniques. Each module was developed for real-world use through a highly visual and interactive format that uses simplified language. This industry-informed resource can be used across the turkey industry for onboarding and annual training, to support compliance with company policies and animal welfare audits. The training tool is hosted on North Carolina State

University’s Reporter platform, providing free access for crew members, veterinarians, industry professionals, and educational programs, including poultry science and animal welfare.

Animal Welfare During Live Haul of Market-Ready Turkeys: Crew Member Perspectives and Training

by
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DEDICATION

To my family, those with me today, and those who live in my memory. May this achievement honor the love and strength you have given me.

BIOGRAPHY

Luz Anyela Hernandez Perdomo grew up in Bogotá, Colombia, where she developed an early interest in animal health. She earned her degree in Veterinary Medicine from the National University of Colombia and later completed a specialization in Marketing Management at EAN University in Colombia. As an undergraduate, she was a member of the students' poultry club, where she organized, along with other students and a professor, the university's first student poultry congress. Through this experience, she began developing her communication skills by securing appointments and speaking with company managers to obtain financial and speaker sponsorships for the congress. She also collaborated on poultry farm activities with her group and attended weekly meetings on various poultry topics. Additionally, her ongoing interest in helping animals led her to volunteer at a dog and cat shelter while she was a veterinary student.

Her professional experience in the poultry industry began in 2007 when she started working for Biovet, which later became Provimi Colombia. Since then, she has held various roles in the industry, including technical, commercial, and biotechnology positions. Her academic and professional journey has helped her develop the ability to interpret scientific data and translate experimental findings into practical solutions. This combination of scientific training and industry experience sparked her interest in how management practices directly impact animals, leading her to pursue a Master of Science in Poultry Science with a focus on Animal Welfare under the guidance of Dr. Allison Pullin.

For her graduation research, she investigated how practices during the live haul of market-ready turkeys impact animal welfare, based on the experiences of crew members, and developed a training program to support improved handling methods. After graduation, Anyela planned to continue working in the poultry industry.

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CHAPTER 1

Literature Review

The United States is the largest producer of turkeys in the world, raising 200 million birds to yield 6.57 billion pounds of meat in 2024 alone (USDA ERS, 2025b; USDA NASS, 2025). The handling, herding, and loading of market-ready turkeys, which are part of the live haul process before transportation to processing plants, present significant welfare challenges due to the potential for stress and injury (Erasmus 2018). Improper handling during live haul can result in death or injury to the bird, including but not limited to bruises, fractures, scratches, and skin abrasions (Prescott et al., 2000). These injuries not only impact the bird's affective state but can also result in significant economic losses due to carcass downgrades at processing (USDA AMS, 1998; Van Staaveren et al., 2020). In 2023, over 1,300 turkey carcasses were condemned in the U.S. due to bruising, according to publicly available data from USDA NASS (2024); however, there is no published detailed data on injury-related downgrades. In Canada, a study involving 1.4 million turkeys found that 10% had bruised legs and 11.7% of the hens required wing trimming due to carcass defects (McEwen and Barbut, 1992). Similarly, in France, assessments of 60 turkey flocks found that fresh bruising linked to live haul occurred in 7% of carcasses on the body or hip and 6.4% on the wings (Allain et al., 2013).

During live haul, birds are exposed to multiple potential stressors, including deprivation of food and water, changes in light conditions, unfamiliar noises, confinement, temperature changes, and, at times, improper handling. These conditions can compromise animal welfare and, in some cases, lead to mortality (Martrenchar et al., 1999; Vosmerova et al., 2010; Schwartzkopf-Genswein et al., 2012). Understanding turkey behavior and physical characteristics are essential for reducing welfare risks during live haul (Kapell et al., 2017;

Krautwald-Junghanns and Koscica, 2020). Turkeys are highly sensitive to environmental factors, sudden movements, and novel visual stimuli, which can provoke stress responses such as wing flapping, piling, and jumping (Weeks and Nicol, 2020; Jackson et al., 2025). Additionally, it is important to understand turkey diseases (Porter, 2018) and barn conditions that affect turkey movement during live haul (Leishman et al., 2021).

This literature review examines aspects that influence turkey welfare during live haul, based on research related to behavior, factors influencing turkeys' movement, stress responses, welfare indicators, and human-animal interactions. It also addresses the training of crew members and analyzes the proper techniques for handling, herding, and loading, including how third-party certification programs and welfare audits contribute to establishing standards for animal welfare.

Turkey Domestication and Production

Turkeys were first domesticated in Mexico approximately 2,000 years ago and were quickly introduced and distributed across Europe via Spanish exploration (Thornton et al., 2012). The domesticated turkey was brought to North America in the 18th century, where breeding efforts initially concentrated on improving plumage characteristics for ornamental purposes. However, in the 20th century, producers shifted their focus to selecting for meat traits (Speller et al., 2010; Lipe et al., 2016). Modern turkey production now focuses on raising turkeys for meat production with intensive, indoor systems comprising most of the United States' production to date. House inventories vary between 5,000-20,000 single-sexed birds, placed in the house at the same time and age to ensure consistent market weights and minimize health risks (Keeling, 2002). Latency to reach market weight varies due to multiple factors but typically ranges between 10-14 (hens) or 16-20 weeks (toms; Marchewka et al., 2019; National Turkey

Federation, 2023). Once market weights are achieved, turkeys are herded and loaded onto trucks to be transported to processing facilities in an event referred to as live haul (Barnes et al., 2013).

In contrast to the layer or broiler industry, turkeys are not picked up individually and placed into transport coops inside the house. Turkeys are instead herded through the house to conveyor belts at the house doors to be manually or automatically placed into the transport coops, thus requiring concerted time, effort, and human-bird interaction from the live haul crew members (Barnes et al., 2013). Individual bird and flock behavior can play a critical role in the success or failure of herding events, given that behavioral patterns closely relate to an animal's internal affective state and physiological response (Price, 1999). Despite domestication and purposeful selection pressure, behavioral patterns in turkeys remain remarkably stable, such that the natural behavior of individual birds and flocks are maintained (Krautwald-Junghanns and Koscica, 2020).

Individual Bird and Flock Behavior

Flight Zone and Point of Balance

Domesticated poultry are descendants of prey species who evaded predators primarily through flight (Beauchamp, 2022). As a result, turkeys are highly sensitive to potentially threatening stimuli, such as sudden movements or novel visual stimuli (Jackson et al., 2025). In barn settings, individual turkeys will maintain distance from unfamiliar people, known as their flight zone. The flight zone refers to the distance at which an approaching person causes the bird to move away (Karcher, 2018; Figure 1). When a person stands outside of the flight zone, turkeys will direct their body towards the person; however, upon entering the flight zone, the turkey will turn and move away (Blumstein, 2003). Birds in the same flock can exhibit different flight zone sizes due to inherited temperament traits, individual experiences, and factors such as the approaching person's speed, size, and direction. Rapid movements by the person cause the flight zone to be larger (Grandin and Deesing, 2022).

In addition to the flight zone, the point of balance (i.e., imaginary line located at the turkey's shoulder joint) also plays an important role in bird handling. A turkey will move forward if the handler stands behind this point, and will back up if the handler stands in front of it (Karcher, 2018; Figure 1). Both the flight zone and point of balance can be used to the advantage of the crew member by motivating the bird to move in the appropriate direction for loading (Karcher, 2018).

Flock Behavior

From a group perspective, the flight zone and point of balance can also be applied to a flock of turkeys. In commercial barns, turkeys tend to group and move together as a flock. This behavior has evolved to protect birds against predators and improve foraging efficiency (Estevez, 2018). Flock members benefit from collective sensory abilities, enabling them to better detect approaching predators and reduce the likelihood of being killed by a predator within a larger group (Estevez, 2018; Beauchamp, 2022). In commercial settings, flocking behavior is utilized to improve herding and loading efficiency.

Factors influencing turkey movement and handling

Multiple factors can influence the efficacy of humanely handling turkeys. The following section will describe key factors to consider when moving market-ready turkeys.

Locomotion (Mobility)

Locomotion or mobility refers to a bird's movement from one place to another (Dickinson et al., 2000; Jaihuni et al., 2023) and includes walking, running, and wing-assisted jumping (Stover et al., 2018). Locomotion is an important indicator of turkey health, welfare, and productivity and can be impaired by physical and environmental conditions (Da Costa et al., 2014; Yang et al., 2024). Current genetics used in commercial turkey production have selected for birds with body weights up to three times greater than their wild counterparts. However, with this selection, minimal skeletal changes have occurred, specifically in terms of bone strength and length (Stover et al., 2018). Given the combination of increased body weight on the same skeletal frame, leg health and mobility are often negatively impacted, increasing the prevalence of abnormal gait and reduced mobility (Da Costa et al., 2014; Kapell et al., 2017; Mulim et al., 2024).

Environmental conditions can also impact turkey mobility and increase the risk of lameness within a flock. Such factors include, but are not limited to, animal stocking density, flock health status, stress, and nutrition (Jaihuni et al., 2023). At 21 weeks of age, turkeys occupy 0.20 m^2 when standing (Ellerbrock and Knierim, 2002) with greater anticipated space needed for locomotion (Erasmus, 2017). Martrenchar et al. (1999) investigated the impact of barn density (0.4m^2, 0.3m^2, and 0.25m^2 per turkey) on gait scores in 16-week-old toms using a six-point gait score, with 0 representing a normal gait and 5 representing a bird unable to walk. The study found that higher densities were associated with poorer gait scores. At the highest density (0.25m^2), 42.3% of birds scored 1, nearly twice the percentage observed at 0.4m^2 and 0.3m^2. For gait score 2, the percentage at 0.25m^2 (7.7%) was similar to 0.3m^2 but approximately twice that of birds at 0.4m^2. These findings suggest that high density may contribute to reduced and impaired locomotion.

In addition to density, litter and house conditions also influence bird mobility. Footpad dermatitis, a condition characterized by inflammation of the footpads, can lead to abnormal gait or reduced mobility if the structural integrity of the foot is compromised due to ulceration, bacterial infection, and inflammation (Martland, 1985; Clark et al., 2002). Footpad dermatitis is a significant issue in turkey production, with estimates suggesting less than 5% of turkeys are free from clinical signs specific to this condition (Da Costa et al., 2014). Wet litter is the primary factor that increases the incidence and severity of the disease in a flock (Mayne, 2005). In a turkey house, poor litter quality worsens health risks, increasing the prevalence of footpad dermatitis (Da Costa et al., 2014; Leishman et al., 2021). Various factors can influence footpad dermatitis occurrence, but maintaining dry litter is a fundamental step in reducing the incidence of this condition in turkey flocks (Shepherd and Fairchild, 2010; De Jong et al., 2012; Leishman et al., 2021).

Lastly, reoviral arthritis, a current disease challenge in the U.S. turkey industry, has also significantly impacted bird mobility, with up to 40% of an infected flock exhibiting clinical signs of lameness (Porter, 2018). Lameness associated with this virus is progressive, presenting as early as 8 to 12 weeks of age and worsening over time (Sharafeldin et al., 2015; Porter, 2018). Affected turkeys show swollen hocks (tibiotarsal joint) in one or both legs with fluid accumulation, edema, fibrosis, tenosynovitis, and occasional tendon ruptures (Mor et al., 2013; Porter, 2018).

Sex-Specific Behavior

In commercial turkey production systems, toms and hens exhibit distinct behavioral differences (Marchewka et al., 2019). Toms are generally more confrontational and territorial than hens, likely due to increased testosterone as they approach sexual maturity at market weight (Kiezun et al., 2015). Head pecking is commonly used by toms to establish dominance and is observed less frequently among hens (Dalton et al., 2013; Ferrante et al., 2019). When toms perceive other birds, objects, or a handler as threats, they may respond with aggressive behaviors such as jumping, scratching, and raking (Hale and Schein, 1962; Karcher, 2018).

Differences in physical and behavioral outcomes between male and female turkeys have also been observed. As described in the previous section, toms are at a higher risk for lameness, immobility, and injuries (Oviedo-Rondón et al., 2018; Ferrante et al., 2019). The behavioral differences between male and female turkeys necessitate different herding and loading strategies (Huff et al., 2007; Marchewka et al., 2019). Due to their larger size, heavier body weight, and possible aggressive behavior, toms are often slower and more physically challenging to herd and load (Karcher, 2018). In contrast, lighter hens may be initially easier to herd through the barn as they are more active and mobile than toms, but greater activity can also create higher risks of wing flapping, piling, and jumping and subsequent bird injuries (Weeks and Nicol, 2020).

Light and Behavior Patterns

Turkeys are diurnal, meaning they are active during the day and inactive or sleeping at night. After detecting light from the environment, behaviors such as feeding, grooming, and sleeping follow daily patterns regulated by the light cycle (Keeling, 2002; Schwean-Lardner et al., 2014). A lighting program is a practice implemented in turkey production in which it is recommended that there be at least 8 hours of darkness after 5 days of age to promote good bone development and optimize growth performance (Aviagen, 2022). However, standard industry practice in the US turkey industry implements varying light: dark cycles that can influence herding and loading of market-ready turkeys. In a study on turkeys, Schwean-Lardner et al. (2016) evaluated gait scores to assess mobility in toms and hens exposed to four photoperiods (14L, 17L, 20L, 23L) at 11 and 17 weeks of age. At 11 weeks, males displayed more impaired mobility under longer day lengths, with an average gait score of 2.17 at 23L compared to 0.8 in females, likely due to males' heavier body weight and the shorter periods of darkness. When expressed as a percentage of the gait score observed at 23L, males averaged approximately 35%, 55%, and 75% under 14L, 17L, and 20L, respectively, while females averaged 33%, 48%, and 67% for the same photoperiods. By 17 weeks, both sexes showed similar responses, with average gait scores continuing to decline under longer photoperiods (1.87 at 23L). At this age, males and females reached approximately 50% of the 23L value under 14L, 65% under 17L, and 90% under 20L. The study also reported that from 12 to 18 weeks, increasing hours of light exposure were associated with a linear increase in eye-to-body weight ratio and signs of ocular pathology, potentially compromising vision.

Light intensity in turkey houses influences bird movement, with lower levels reducing activity. Mohammed et al., (2016) found that turkeys raised under 5 lux until 13 weeks of age walked about 8% less than those under 50 lux, while those under 25 lux walked about 3% less. Light intensity varies across poultry production systems. Aviagen (2022) recommends maintaining a light level of at least 80 lux, while American Humane (2020) suggests a minimum average of 10 lux after 14 days of age. For herding during live haul, light intensity is important to keep birds active to herd through the barn and ensure visibility for birds and for the crew members, but also not too bright that birds become overstimulated and risk piling, wing flapping, and jumping (US Poultry and Egg Association, 2016; European Commission, 2017). Unlike broiler chicken catching, it is not necessary to dim the light in the house to herd turkeys (Global Animal Partnership, 2022). Once turkeys are herded through the house and placed onto the conveyor belt to be loaded into transport coops, dimmer light is useful to minimize birds' activity during this stage of live haul. Loading at night when outdoor light intensity is lower can help the birds to be less active and more docile, making the loading process easier for crew members (Karcher, 2018).

Stress and welfare indicators

Stress is the bird's physiological and behavioral response to real or perceived threats, also known as stressors (Sapolsky, 2004; Vosmerova et al., 2010; Akinyemi and Adewole, 2021). Moving birds from the house to the processing plants involves numerous stages, including handling, herding, loading, and transportation (Martrenchar, 1999; Schwartzkopf-Genswein et al., 2012). During this process, birds are subjected to various stressors such as deprivation of feed and water, exposure to varying light intensities, unfamiliar noises, confinement, changing temperatures, and, in some cases, improper handling. These stressors can potentially lead to mortality (Martrenchar, 1999; Vosmerova et al., 2010; Schwartzkopf-Genswein et al., 2012).

Physiology of Stress Related to Handling and Transporting Market-Ready Turkeys

Physiological indicators of stress during live haul have been linked to herding and loading stressors in previous research. For example, Scanes et al. (2020a) evaluated changes in corticosterone (CORT) before and after herding in market-ready turkey toms 5m away, and reported that CORT levels increased by 53% after herding was performed by 4-5 people walking behind groups of birds compared to before herding. They attributed this response to stress toward the live haul crew members, the unfamiliarity of the herding experience, the disruption of the turkeys' social structure, and physical activity. Herding can also affect the turkeys' cardiovascular system. Boulianne et al. (1993) evaluated walking exercises in 14- to 18-week-old male and female turkeys across three stages: a 60m walk, an 80m walk, and 2 minutes of being hung by the legs to simulate processing. Electrocardiograms and blood pressure measurements afterward showed that heart rates increased by 22% and 30% during the walking exercises, while blood pressure declined. These results suggest that walking alters cardiovascular responses in turkeys. Additionally, 80% of the birds developed arrhythmias, reinforcing that cardiovascular function may represent a physiological limitation in turkeys during prolonged walking.

Another physiological indicator of stress is the change in heterophil-to-lymphocyte (H/L) ratios. In a study by Scanes et al. (2020b), toms weighing approximately 20 kg from commercial farms showed an increased H/L ratio from 1.1 before herding and loading to 1.3 just before transportation.

Temperature is an environmental stressor that affects turkeys (Davis et al., 2022; Poku et al., 2024), and turkeys can experience fluctuations in temperature during handling and transportation (Lesiów and Xiong, 2024). The thermoneutral zone of market-ready turkeys is 15.6 to 23.9°C, representing the ambient temperature condition at which turkeys can regulate their body temperature (Noll, 2022). Outside of this temperature range, birds modify their behavior to facilitate heat production or heat loss, attempting to regain the thermoneutral zone (Schwartzkopf-Genswein et al., 2012; Gonzalez-Rivas et al., 2020; Poku et al., 2024). Exposure to temperatures above the bird's thermal tolerance can result in hyperthermia due to insufficient heat loss. During heat stress, birds exhibit thermoregulatory behaviors, including wing droop, extended neck, and panting. Panting promotes evaporative cooling through rapid breathing (Comito et al., 2007; Vermette et al., 2017); although it helps dissipate heat, this response becomes less effective during conditions such as herding or high temperatures when birds are placed in coops, potentially leading to further physiological stress or distress (Boulianne et al., 1993; European Food Safety Authority, 2022). Twelve-week-old hens and 16-week-old toms were placed in coops for 8 hours and exposed to 20°C or 35°C at either 30% or 80% relative humidity. Core body temperature (CBT) was recorded every minute using miniature data loggers ingested into the crop or gizzard. The temperature began rising shortly after treatment started. Hens showed an average CBT increase of 0.09°C per minute under both humidity levels. In toms, the rate was 0.12°C at 35°C/30% and 0.18°C at 35°C/80%. Due to signs of distress, the 35°C/80% treatment for toms was stopped at hour 4 (Vermette et al., 2017).

In contrast to heat stress, exposure to low temperatures inside the house can lead turkeys to experience cold stress. Typical signs include huddling together, feather fluffing, and shivering, which reduce movement and help conserve energy (Poultry Service Association, 2017). Henrikson et al. (2018) further explored these behaviors by exposing 12-week-old hens and 16-week-old toms to 8 hours of cold conditions at -18°C. They found that hens huddle together 52% of the time and toms 30%, minimizing exposed body surface area to reduce heat loss. This thermoregulatory behavior becomes more critical under conditions that amplify cold stress, such as the windchill effect that birds can experience inside the house and on the trailer, where moving air increases heat loss from the body and makes the temperature feel colder than it is (Czarick and Lacy, 1996; Uemura et al., 2023). The severity of this effect increases as the ambient temperature drops, due to the greater temperature difference between the bird and the surrounding air (Czarick and Lacy, 1996).

Key Welfare Indicators for Handling, Herding, and Loading Turkeys

Animal welfare, as defined by the World Organization for Animal Health (2025), is the physical and mental state of an animal as determined by the conditions in which it lives and dies. Various assessment criteria have been developed to evaluate animal welfare (Manning et al., 2007; Kwon et al., 2024), such as the five domains model, which considers nutrition, environment, health, behavior, and mental state (Mellor et al., 2020). Within this framework, key welfare indicators (KWI) serve as measurable factors to evaluate welfare status, ranging from good to poor (Manning et al., 2007). During rearing, environmental factors influence behavioral development and ultimately affect behavior during the live haul (US Poultry and Egg Association, 2016; Hafez et al., 2021). The following section will review how key welfare indicators for handling and loading turkeys can help evaluate the animal's well-being.

Animal-based KWIs associated with live haul track the number and type of injuries to turkeys, offering insights into where and how injuries occur and enabling corrective and preventative actions (Manning et al., 2007; Buijs et al., 2017). While some injuries can be identified and addressed on the farm, others are detected at processing plants, revealing those missed earlier or sustained during transport and processing (International Poultry Welfare Alliance, 2024).

Herding and loading can result in injuries like skin damage, physical trauma, and bleeding (Prescott et al., 2000). It is estimated that 90 to 95% of bruises occur within the final 12 hours before processing (Northcutt, 2010). In France, an evaluation of 60 turkey flocks revealed an occurrence of fresh bruising, indicating that trauma occurred during the live haul stage. Recent bruises were recorded in 7% of birds on the body or hip, compared to 0.6% with older injuries, and 6.4% of birds had recent wing bruises versus 1.6% with older bruises (Allain et al., 2013). Similar concerns have been identified in Canada, where data from approximately 1.4 million turkeys showed that 10% of toms and hens had bruised legs, and 11.7% of hens required wing trimming due to carcass defects (McEwen and Barbut, 1992). Wing injuries can occur if birds' wings flap and hit their wings against loading equipment, or also if a turkey's wing protrudes out of the coops and becomes trapped between coops or door coops during loading (Glatz and Rodda, 2013).

Mortality during herding and loading can also serve as animal-based KWI, and birds that die during transport to the processing plant are classified as dead on arrival (DOA; Prescott et al., 2000; Nijdam et al., 2004; Ritz et al., 2005). The percentage of DOA in poultry is generally influenced by several factors, including health status, thermal stress, and physical injuries during the live haul (Manning et al., 2007; Cockram and JungDulal, 2018). Petracci et al. (2006) evaluated the incidence of DOA of 118 million turkeys from 2001 to 2005 in Italy and found that the average incidence of DOA was 0.38%, with a higher incidence during the summer (0.52%). Gickel et al. (2025) evaluated the DOA incidence among 11.9 million turkeys in Germany in 2022, finding an average rate of 0.14%. However, the higher rates of DOA reached were 1.23% in the spring season and 1.48% during the summer. Kittelsen et al. (2017) reported that impaired gait can be an indicator of infectious conditions and leg weakness and, consequently, has been associated with mortality on the farm and during transport in broiler chickens. Their study reported that osteomyelitis was linked to 10% of DOA in broilers.

Turkeys unfit for transport are those that manifest physical or health conditions that make them incapable of surviving the transportation to the processing plant. If these types of birds are transported, the likelihood of additional injuries and/or DOA is higher (International Poultry Welfare Alliance, 2024). During the herding and loading process, some industry standards recommend that turkeys meeting unfit for transport criteria are not loaded and euthanized by the flock owner or designated farm personnel. Euthanasia procedures are commonly performed according to guidelines set by the American Veterinary Medical Association (AVMA, 2020; US Poultry and Egg Association, 2016). According to the Poultry Service Association (2017), turkeys unfit for transport exhibit the following characteristics:

- Weak and unalert birds, with heads on the litter and fluffed feathers, that might not flee or move with the group, but should not be mistaken with fatigued birds.
- Birds with dark red or very pale skin on their head or neck, compared to others in the flock, may exhibit additional illness symptoms.
- Birds with swollen heads or necks with puffy faces and possibly swollen-shut eyes and head wounds.
- Turkeys with discharge from their eyes and/or nostrils.
- Emaciated birds.
- Birds with dislocated, broken, or exposed bones.

Human-animal interactions during live haul

In turkey production systems, human-animal interactions play a crucial role in influencing bird stress responses. Improving these interactions requires a better understanding of the factors that contribute to animals' stress and implementing techniques that promote calm and efficient bird management (Botheras et al., 2008).

Live Haul Process at the Farm

The live haul process is typically carried out by a team of six to eight crew members per barn (Global Animal Partnership, 2022). Handling involves direct physical contact with an individual bird, such as lifting and carrying it through the barn or loading it into a transport coop (National Turkey Federation, 2008). Herding refers to guiding groups of turkeys through the barn toward the loader conveyor belt (Global Animal Partnership, 2022). The loading begins once the birds arrive at the loader or conveyor belt (CMC Industries, 2022).

When crew members arrive at the house, they evaluate the environment to ensure that feeders, waterers, and other physical structures (e.g., enrichment) have been raised or removed, allowing birds to move freely without encountering physical barriers (Barnes et al., 2013). After confirming that the barn is free of obstacles, crew members set up a funnel-shaped structure inside the house, which is constructed with wooden or metal panels to gradually narrow the birds' path and direct them towards the loader (Barnes et al., 2013). Minimizing gaps between boards and sharp edges reduces the risk of injuries to birds and crew members (Poultry Service Association, 2017; European Food Safety Authority, 2022).

To prepare for herding birds, crew members divide part of the house with gates, netting, or flag lines to maintain a small group of turkeys near the funnel and prevent them from crowding to the far side of the house (Poultry Service Association, 2017). From this sectioned area, crew members herd a small group of turkeys toward the funnel entrance using tools such as plastic bags or flag sticks. Turkeys are social animals that tend to move together as a flock. By waving these tools in the appropriate area of the birds' flight zone and point of balance, crew members can effectively control the direction of movement (Poultry Service Association, 2017; Grandin and Deesing, 2022). As birds enter the funnel, additional crew members guide smaller groups through the narrowing pathway and onto the conveyor belt. When turkeys are moved in large groups and too quickly, there is a risk of wing flapping, scratching, and bruising. In some cases, individual birds may refuse to move during the herding process. It is acceptable to gently nudge them forward using a foot, knee, or hand, but kicking or hitting a turkey is never an acceptable handling practice (US Poultry and Egg Association, 2016). If a bird is reluctant to move due to weakness, injury, or immobility, it can become an obstacle for crew members during herding and a concern for animal welfare if birds are herded over the immobile bird (Poultry Service Association, 2017; European Food Safety Authority, 2022). When a bird needs to be moved to a designated hospital area or placed onto the conveyor belt, crew members must use two points of contact to handle the bird. Acceptable methods include holding both shoulders, one shoulder, and one or both legs, or both legs (Poultry Service Association, 2017; European Food Safety Authority, 2022).

The loading process involves moving turkeys onto the conveyor belt and then into transport coops on the truck. Maintaining proper density on the conveyor belt is essential to prevent turkeys from walking, sliding, or attempting to return toward the house. If a turkey becomes caught, the conveyor belt must be stopped immediately, and the bird must be carefully released following company policies (Poultry Service Association, 2017).

Depending on the conveyor belt system, birds may be placed into the coops manually or automatically (US Poultry and Egg Association, 2016; European Food Safety Authority, 2022). In manual loading, crew members transfer birds individually from the conveyor belt into the coops, using two points of contact: one at the base of the neck and the other under the tail or thigh. Improper handling, such as lifting birds by the wings or head, can lead to bruising and injuries (Poultry Service Association, 2017). Once inside the coops, birds must be placed upright, as those loaded on their backs may experience respiratory or cardiovascular distress and die before arriving at the processing plant (European Food Safety Authority, 2022). After placing the appropriate number of birds inside the coop, it is closed, and the conveyor belt is adjusted to align with the next coop (Barnes, 2013). The automatic loader is a system used to load turkeys into coops without direct handling by crew members. This method relies on a conveyor belt that extends into the coop, allowing birds to be transported directly inside. Some systems require two crew members: one operates the loader from a control panel, adjusting the belt’s speed, direction, and position, while the other opens and closes coops, counts the birds, and ensures they remain upright. In the other system, a single operator is responsible for all these tasks (CMC Industries, 2022).

Turkeys are highly sensitive to human presence and behavior (Botheras et al., 2008). Stressed birds are more prone to injuries as they attempt to flee from human contact during herding, displaying freezing or flight behaviors (Erasmus and Swanson, 2014; Marchewka et al., 2015). Correspondingly, market-ready turkeys loaded into boxes by herding, with minimal handling, exhibited lower heart rates (160 beats/min) compared to those placed into crates manually (180-270 beats/min; Prescott et al., 2000).

Attitudes and Skills of Farm Personnel

Human attitudes and skills determine how handlers interact with and handle animals (Hemsworth, 2003; Acharya et al., 2022). Attitude is the person's mental tendency to evaluate something as favorable or unfavorable to some extent (Albarracin and Shavitt, 2018). It consists of three components: the cognitive component, which refers to a person's beliefs about something; the affective component, which represents a person's feelings about something; and the behavioral component, which encompasses actions, intentions, and verbal expressions related to behavior (Breckler, 1984). Improving human-animal interactions in farm animal production requires focusing on key human attitudes (Destrez et al., 2013). While effective strategies involve staff selection and training, limited research has identified the optimal traits for individuals working with animals (Hemsworth and Barnett, 2000). However, some characteristics are recommended for animal handlers including a good general knowledge of the effect of the farm environment, an understanding of animal social interactions, practical experience in animal care, the ability to promptly identify signs of disease and seek appropriate intervention, and the capacity to work independently as well as part of a team (Coleman and Hemsworth, 2014; Acharya et al., 2022).

While various tests evaluate personality, motivation, and work preferences, no standardized selection process exists in agriculture (Hemsworth and Barnett, 2000). When considering factors that influence worker performance on the job, capacity, willingness, and opportunity play a central role (Blumberg and Pringle, 1982). Capacity refers to skills, health, ability, and knowledge; willingness includes motivation, job satisfaction, attitude toward animals, and general work attitudes; and opportunity involves working conditions, the behaviors of co-workers, and the organization's policies and procedures (Coleman and Hemsworth, 2014). Expanding on these concepts, research has examined how targeted interventions can impact human-animal interactions.

Wigham et al., (2019) conducted a one-year study starting in 2018 to evaluate the impact of welfare-focused training on broiler handling and product quality in two processing plants (Plant 1: Costa Rica; Plant 2: United Kingdom). All operatives received a 20-minute multimedia session covering handling, shackling, and neck cutting practices. Additionally, plant management staff participated in a two-day classroom-based program that addressed legislation, catching, transportation, lairaging, stunning, and the link between welfare and product quality. Assessments were conducted in three visits, pre-training (pre-T), immediately after training (post-T), and six months later (6mpost-T). In P1, the proportion of birds flapping vigorously at shackling declined at all of the six operators' positions, for instance, from 75% (pre-T) to 60% (Post-T) and 15% (6mpostT) at position 6. The proportion of birds with both carotids severed in plant P1 increased from 50% (pre-T) to 96% (post-T) and 92% (6mpostT). In P2, all assessed birds had both carotids severed at every visit. Regarding carcass quality, broken wings in P1 decreased from 6% (pre-T) to 3% (Post-T and 6mpostT), and in P2 from 8% (pre-T) to 4% (Post-T and 6mpostT). However, leg bruising increased in both plants, from 5.5% in P1 and 13% in P2 in pre-T to 17% by 6mpostT.

Training Types

Live haul crew members in the turkey industry can be trained through informal and formal training. While some industry manuals provide guidance, the training process for crew members is not well documented in the scientific literature. However, some authors have suggested that more structured training could help mitigate welfare concerns that arise during live haul (Schwartzkopf-Genswein et al., 2012; Jacobs et al., 2017).

Informal training involves learning by observing and collaborating with others on the job, often without structured guidance (Brown, 1989; Manuti et al., 2015). It is flexible, practical, and supports immediate learning through real-world tasks, promoting curiosity, self-motivation, and problem-solving (Beckett and Hager, 2005; Manuti et al., 2015). However, informal training is difficult to standardize (Marsick, 2009), and most of the learning is unplanned and occurs in response to specific situations (Manuti et al., 2015), and does not lead to official certification (Taylor and Evans, 2009). Without proper oversight, it may also lead to poor practices or habits (Dale and Bell, 1999), highlighting the need to complement informal learning with formal training (Eraut, 2004). On the other hand, formal training is organized around defined learning objectives, delivered over a structured timeframe, and includes dedicated support. It occurs outside the work setting and leads to certification (Rubenson, 2007). When applied to live haul crews, formal training can improve both handling skills and worker attitudes (European Food Safety Authority, 2022; Lutevele et al., 2025).

Although auditing programs require proper handling to promote turkey welfare (summarized in Table 1), the industry still faces ongoing issues with improper practices during live haul (Rubinkam, 2022). The injuries resulting from inadequate loading techniques are indicators of poor welfare and can lead to economic losses associated with downgraded carcasses at the processing plant (USDA AMS, 1998; Prescott et al., 2000; Van Staaveren et al., 2020). Public concern over animal welfare continues to rise (Bir et al., 2019), with buyers demanding third-party certified products to assure animal welfare (US Poultry and Egg Association, 2016). Training live haul crew members has significant advantages in poultry welfare. Effective programs can help them gain the knowledge and skills needed to perform their task properly preventing negative welfare outcomes (European Food Safety Authority, 2022).

The poultry industry's demand for manual labor suggests a need for more standardized training opportunities. According to a survey by the U.S. Poultry and Eggs Association in 2018, the average annual poultry employee turnover rate was 65% and for poultry processors, it was nearly 100% (Alonzo, 2018). One method of improving employee retention is through training (USDA RD, 2022; US Poultry and Egg Association, 2025). E-learning offers several advantages to address training needs by providing on-demand access and allowing learners to build knowledge in low-pressure settings at their own pace (Nycz and Cohen, 2007; Malmsköld et al., 2012; Huggett, 2018). E-learning allows participants to access a computer-based platform to complete training and assignments independently. The training is delivered through various multimedia methods, including videos, photos, animations, assessment activities, and sound recordings, which facilitate engagement (Nycz and Cohen, 2007). E-learning can also be designed to bridge geographical, cultural, and educational gaps by offering the program in multiple languages and utilizing different learning modalities (Malmsköld et al., 2012). It has been recognized that e-learning increases motivation, effort, and perseverance in other industries (Zavala-Cerna et al., 2025), and reduces the feeling of alienation due to a lack of knowledge (Klupiec et al., 2014), all of which are essential for performance improvement.

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Table 1.1 Comparison of audit programs for company and non-company crew members for handling, herding, and loading market-ready turkeys across certification systems.

Criteria	**Certification System**	
	American Humane[1]	Global Animal Partnership[2]
Animal welfare program	An animal welfare officer (AWO) must be present during the loading of each flock. A loading crew member preferably fills this position, but another person may fill it.	The live haul manager is responsible for the animal welfare program and compliance, and the live haul supervisor monitors the animal welfare practices and procedures.
Training	Crews must receive comprehensive annual training, including written instructions in their native language on handling and loading protocols and Standard operating procedures (SOP)	A written animal welfare training program must be available in all necessary languages and provided to crew members upon hire, before they handle any turkeys, and at least once every 12 months. Training records must be maintained.
Mechanical equipment	Crew members must be trained on properly managing equipment, such as conveyor belts. An SOP must be available for equipment inspections, routine maintenance, and cleaning.	Proper training on the use of equipment, such as conveyor belts, must be provided to the crew. Conveyor belts must be well-maintained, tested before use, and cleaned and sanitized after daily operations.
Herding and loading procedures	Enough crews must be present to ensure smooth herding. Birds must be calmly and gently guided to the funnel for easy loading.	The live haul manager must ensure shifts are staffed to prevent crew fatigue. Turkeys must be moved calmly, slowly, quietly, and in small groups. For each live haul event audited, the auditor must observe for at least 2 hours, excluding equipment setup time.
Transport coops	Coops must fit the turkey's size and weight; be free of sharp edges, and have a solid floor. A load supervisor or AWO must ensure that birds are upright and not caught by the coop doors, the density is adjusted for temperature, and birds can spread out. An auditor must evaluate at least 100 empty coops and 5 trailers after they have been loaded.	Crew supervisor must verify that all coops are clean, undamaged, and safe for turkeys, including checking for broken floors, protruding wires, and damaged doors. Coops must provide enough height for turkeys to sit upright without restricting head movement.
Lighting	Herding and loading must occur under low-light conditions to reduce the birds' stress responses.	The lights must be dimmed for turkeys individually carried to transport coops. Turkeys loaded using conveyor belts do not require the lights to be dimmed.
Weather conditions	An SOP must outline actions for herding and loading when extreme temperatures or humidity pose a risk to birds, including loading turkeys during the coolest part of the day, using fans, and protecting birds from wind, rain, hail, and snow.	Written policy on weather conditions that prohibit herd and loading during severe weather, which have the potential to pose a risk to human and animal health and safety.
Birds unfit for transport	Birds unfit or injured must be euthanized immediately using methods approved by the latest edition of the American Veterinary Medical Association.	Turkeys unfit for transport must not be loaded. A written policy, agreed upon with the farm manager before loading, must be in place to define who, among the farm staff, the farm manager, or a crew member, is responsible for euthanasia.
Emergencies	SOPs must include procedures to follow in the event of an emergency.	There must be a written protocol for emergencies.
Animal abuse reporting	The company must have a whistleblower policy that protects employees reporting animal welfare issues.	A written whistleblower policy must cover welfare violations, ensure reporting procedures, and protect against retaliation.
Audit failure	Certification will be denied in cases of willful acts of abuse or neglect, including kicking, throwing, yelling at, or purposely scaring the birds. Certification requires passing all mandatory items and scoring 85% or higher.	Certification will be denied for willful or egregious acts, such as kicking, hitting, dropping, throwing, beating, dragging, sitting on, running over, or any action that causes harm or injury. Nonconformances are minor, major, and critical. A critical issue denies certification. Two or more major ones reduce it to 6 months. Unresolved issues in 3 weeks may lead to a re-audit or shorter certification.

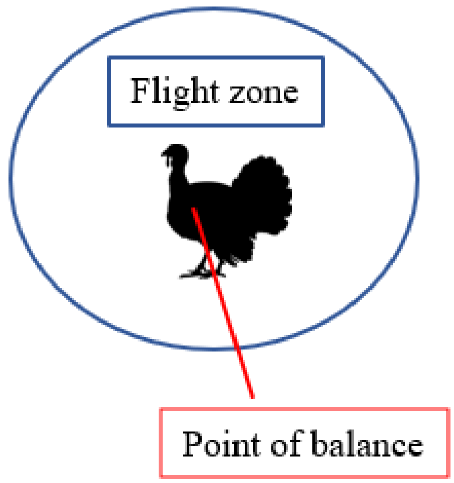
Table 1.1 (continued) Comparison of audit programs for company and non-company crew members for handling, herding, and loading market-ready turkeys across certification systems.

Criteria	Certification System		
	FACTA[3]	Certified Humane[4]	National Turkey Federation[5]
Animal welfare program	A designated person must be responsible for animal welfare in live haul operations.	A designated crew member must supervise, monitor, and uphold welfare standards during the live haul process.	A designated individual or management group must be responsible for the company's animal welfare practices.
Training	All new hires must receive turkey welfare training before handling the birds. Annual training must be documented and delivered in multiple languages as needed.	Managers must ensure all crew members are appropriately trained and competent.	Crews must receive training once per calendar year on the company's and farm's protocols for herding and loading, and new hires must be trained before handling birds.
Mechanical equipment	Equipment procedures must be in place to prevent bird deaths during extreme weather or ventilation failures. Loaders must be used in a manner that prevents injuries to the turkeys.	No specific information.	Loader equipment must be well-maintained and in proper working condition to prevent bird injuries.
Herding and loading procedures	Birds must be handled and loaded using proper techniques to prevent injuries.	Crews must prioritize bird welfare over speed, allowing enough time for careful handling.	Turkeys must be herded calmly and steadily using proper handling techniques from farm to processing.
Transport coops	Coops must be large enough for birds to lie down and move freely without being pressed by others. Coop doors must close fully to prevent birds from escaping during transport. At a minimum, the auditor must observe the loading of 10 transport coops.	Crew supervisor must ensure the coops provide proper ventilation and weather protection, are clean, have secure doors, and are free of sharp edges.	Coops must not have broken wires, damaged floors, or holes large enough for birds to escape. The cage density must allow turkeys to sit in a single layer without being caught by the doors.
Lighting	No specific information.	Herding should occur under low light to reduce the birds' fear responses.	No specific information
Weather conditions	Written policy to protect turkeys from extreme seasonal temperatures.	During loading, turkeys must be protected from the weather. In hot or humid conditions, load during cooler periods to reduce stress.	Written SOP outlining seasonal temperature adjustments to minimize the impact of hot/cold weather.
Birds unfit for transport	No specific information.	Turkeys unfit for transport must be identified before loading and promptly euthanized.	Unfit turkeys must not be loaded and euthanized on the farm.
Emergencies	A visible emergency plan must be in place for live haul.	No specific information.	No specific information.
Animal abuse reporting	No specific information.	No specific information.	No specific information.
Audit failure	Any willful act of abuse or neglect will result in immediate audit failure, and any score below 80% will also result in audit failure.	Producers must fully comply with all standards, as certification requires 100% compliance.	Willful acts of abuse result in automatic audit failure, including but not limited to kicking, hitting, or throwing birds.

Table 1.1 (continued) Comparison of audit programs for company and non-company crew members for handling, herding, and loading market-ready turkeys across certification systems.

[1] American Humane (2020)
[2] Global Animal Partnership (2022)
[3] FACTA (2022)
[4] Certified Humane (2018)
[5] National Turkey Federation (2025)

Figure 1.1 Flight zone and point of balance on a turkey.



CHAPTER 2

Handling and loading market-ready turkeys – Focus groups exploring the perspectives of live haul crew workers in the turkey industry

SUMMARY

Improper handling and loading of market-ready turkeys during live haul presents significant challenges in the U.S. turkey industry. Bird injuries, such as bruises, scratches, and/or fractured or broken bones compromise animal welfare and lead to economic losses. However, the factors contributing to these handling challenges remain understudied. We aimed to identify barriers to implementing proper handling and loading techniques for market-ready turkeys through focus groups with commercial live haul crews. Participants identified three key themes: animal, farm, and human factors. Animal factors, such as bird sex, age, weight, and mobility, required crew members to modify handling strategies and varied the efficiency of live haul. The farm factors centered on the importance of preparing the barn environment for live haul. Adjusting lighting, ensuring good litter quality, scheduling nighttime shifts, using loading equipment correctly, and maintaining stable temperatures improve bird movement. Human factors included employee training methods, where informal training was the primary way in which crew members learned how to perform their tasks; the physical demands of the job, especially in challenging situations; and specific handling strategies to efficiently move birds and minimize injuries to animals and crew members. Animal, farm, and human factors are often interconnected, which compounds the complexity of ensuring proper animal handling for live haul. Future research in formal training, the design of farms, loading equipment, and personal protective equipment may mitigate the

effects of these factors. Additionally, proactive teamwork and communication amongst veterinarians, producers, and live haul crews would better prepare farms for live haul.

DESCRIPTION OF PROBLEM

The United States is the world's leading producer of turkeys, with an industry valued at approximately $7.10 billion (Johnson, 2018). In 2022 alone, 210 million turkeys were raised, producing 6.66 billion pounds of turkey meat (USDA NASS, 2023). Turkeys are typically raised for 10 to 20 weeks, depending on bird sex, size, and product criteria for markets (Marchewka et al., 2019; National Turkey Federation, 2023). Once the market weight is achieved, turkeys are loaded and transported to slaughter plants for processing in an event commonly referred to in the industry as "load out" or "live haul" (henceforth referred to as live haul; Barnes et al., 2013).

Live haul is a critical production stage and requires extensive skill and training to be performed properly. Live haul crews typically consist of six to eight personnel who are responsible for herding and handling birds onto the truck for slaughter. Upon arrival, live haul crew members assess the facility to ensure feeders, waterers, and any other physical structures (e.g., environmental enrichments) have been raised or moved to remove any potential physical obstacles for bird movement. Following this, crew members build a funnel-shaped structure to create a confined, narrowing area to guide small groups of birds onto the truck. Crew members then herd small groups of turkeys (approximately 50 birds) towards the funnel using herding tools such as plastic bags or flag sticks (i.e., shredded plastic bags on the end of a stick) to the funnel entrance while additional crew members bring up even smaller bird groups (approximately 10 to 25 birds) through the funnel to the conveyor belt for loading. Turkeys are moved onto a slightly inclined conveyor belt that can be raised and lowered to reach truck transport coops (e.g., up to approximately 4 meters high; CMC Industries, 2022). The birds travel a short distance on the belt (e.g., approximately 8.5 to 10.5 meters in length) to be either manually placed or automatically loaded into the coops (US Poultry and Egg Association, 2016; CMC Industries, 2022; European Food Safety Authority, 2022; Bright Coop, 2024).

Although much effort has been made to safeguard turkey welfare by emphasizing appropriate handling in auditing programs (National Turkey Federation, 2024), improper handling of turkeys continues to remain a challenge for the industry (Rubinkam, 2022). Improper loading techniques can result in turkeys experiencing bruises, scratches, skin abrasions, and/or fractured or broken bones (Prescott et al., 2000). These physical injuries represent animal-based measures indicative of poor welfare and can result in substantial economic losses associated with downgraded carcasses at the processing plant (USDA AMS, 1998; van Staaveren et al., 2020). There is no publicly available data on the prevalence of injury-associated downgrades at federally inspected slaughter plants in the US; however, over 1,300 turkey carcasses were condemned in 2023 due to bruising (USDA NASS, 2024). Drawing on data from approximately 1.4 million turkeys, data from studies conducted in Canada reported that 10% of toms and hens had bruised legs and 11.7% of hens required wing trimming due to carcass defects (McEwen and Barbut, 1992). Similar issues were noted in turkey production in France in which 60 flocks of turkeys displayed high rates of fresh bruises indicative of trauma occurring during the live haul stage (cumulative recent bruises on the body or hip: 7% versus 0.6% old bruises; cumulative recent bruises on the wings: 6.4% versus 1.6% old bruises; Allain et al., 2013).

The underlying reasons for improper handling techniques during turkey live haul remain unclear. Understanding handlers' perspectives and challenges while herding and loading turkeys is crucial for improving turkey handling practices on commercial farms. Therefore, the objective of this study was to identify factors that hinder the effective implementation of proper handling and loading techniques for market-ready turkeys through the use of focus groups with commercial live haul crews.

MATERIALS AND METHODS

All research was reviewed and approved by the North Carolina State University IRB Committee for Human Subjects Research (protocol #26106).

Study Population and Participant Recruitment

Turkey producers located in the Eastern and Southeastern United States were recruited for the project using a combination of telephone calls, e-mails, and in-person recruiting at conference and extension events. Farms that expressed interest in participating worked directly with the authors to determine eligibility, and to plan and schedule visits. Thus, a convenience sampling methodology was implemented. To participate in the study, participants were required to have experience handling and loading market-ready turkeys and were offered a $50 gift card for completing the focus group.

Data Collection

Focus groups were conducted in person between December 2023 to October 2024. Four companies located in Pennsylvania, Virginia, and North Carolina participated in the study, and a total of six focus groups were completed. Focus groups were conducted in either Spanish (n = 2) or English (n = 4), depending on the participants' preference, and lasted between 40 and 60 minutes. The number of participants per focus group ranged from four to nine (38 participants in total). Prior to the initiation of the focus group, each participant received an individual consent form, a demographic survey, and a random number as their identification to anonymize individuals. All participants were made aware that the focus group would be audio-recorded to ensure accuracy in the data. Participants were reminded that participation was voluntary and that they could leave the focus group at any time, or decline to answer question(s).

One moderator and one assistant were present at each focus group to facilitate the discussions. Across the focus groups, the moderator and assistant varied and consisted of professors with expertise in animal welfare (ANP, MDPG); a professor with expertise in multilingualism and qualitative research methods (MC); a Master's degree student studying poultry science (LAH); and a Doctoral student studying multilingualism and educational equity (AA). Four of the five team members were bilingual and biliterate in Spanish. The discussion was prompted using seven questions (Table 1). The moderator posed follow-up questions as needed to stimulate further discussion.

Discussion Analysis

The focus groups were transcribed and coded using the qualitative data analysis software NVivo15 (NVivo version 15, Lumivero, Denver, CO) by two independent researchers employing the thematic analysis method outlined by Braun and Clarke (2006). Coder one was a Poultry Science Master's student (LAH). Coder two was a postdoctoral research scholar in animal welfare with a PhD and expertise in animal production and physiology (VRM). Both coders were bilingual and biliterate in Spanish.

Thematic analysis was used to summarize the data and discover patterns throughout the analytical process. The first focus group served as the exploratory group. After transcription and familiarization with the data, an initial codebook was developed with codes that emerged from the raw data (data-driven). Initial open coding fostered the creation of major themes, followed by axial coding that identified connections within themes to generate subthemes. This process was repeated by adding the other five focus groups, following the methodology outlined by DeCuir-Gunby et al. (2011). Themes and subthemes were also guided by existing literature. The two coders had excellent inter-rater reliability of 0.8 Cohen's kappa.

RESULTS AND DISCUSSION

A total of 25 English-speaking and 13 Spanish-speaking Latin-American turkey handlers participated in six focus groups (38 participants in total; 42 ± 13.7 min duration, mean ± SD). Four focus groups were conducted in English (n = 9, 4, 6, and 6 participants in each group), and two focus groups were conducted in Spanish (n = 5 and 8 participants in each group). Participants were predominantly male (92%) and ranged in age from 18 to 73 years old. Ninety-two percent of participants reported having loaded market-ready turkeys in the past six months, indicating recent handling and loading experience. From an education standpoint, 71% of participants stated that they had completed high school and 13% had some college education. Six individuals participating in the focus groups did not provide educational information (16%). Participants' experience working with turkeys varied widely, ranging from 1 day to 50 years. Twenty-six percent of participants had been working with turkeys for less than 1 year, 21% for 1 to 5 years, 8% for 6 to 9 years, 21% for 10 to 19 years, 21% for 20 to 35 years, and 3% for ≥ 36 years.

Themes and Subthemes

The data revealed three key themes (Table 2) and multiple interrelated subthemes (Figure 1) addressing challenges with implementing appropriate handling techniques of market-ready turkeys. The themes were animal, farm, and human factors. Table 3 includes representative quotes from each subtheme.

Theme 1: Animal Factors

The animal factors theme included topics related to physical bird characteristics that influenced the handling process (i.e., birds' sex, age, injuries, disease status, and production type). Several participants mentioned distinct challenges based on bird sex as toms and hens differ significantly in their behavioral responses and size (toms: 18 to 23 kg; hens: 4.5 to 9 kg). From a behavioral standpoint, toms were described as more curious, confrontational, and stronger than hens, which made herding and loading less efficient and more challenging. One participant described this experience as follows:

> *"if you got toms, they are nosy, they are going to come up, they want to know what you're doing up there…"*

Similarly, the size of the toms also influenced handling and loading, with live haul crew members recognizing that they needed to be more strategic with toms in order to maintain proper handling. One participant stated:

> *"…super toms might get 50 pounds, … when you say 40 pounds, you don't think of that as life-changing weight. So you pick up a 40-pound bag of dog food … No big deal, right? Well, what happens when that 40-pound bag of dog food starts fighting back with every ounce of strength in his body? Because that's basically what they do. When you go to grab him, you got about a split second where he doesn't know what's going on, and that's the transition where you grab him and put him in the cage."*

In addition to size, toms were also generally described as more aggressive and territorial than hens, likely due to increased testosterone as they approach sexual maturity at market weight (Kiezun et al., 2015). Toms commonly demonstrate higher prevalences of injuries associated with aggressive head pecking compared to hens (Dalton et al., 2013; Ferrante et al., 2019), and this behavior may often be redirected toward load crew members, making it additionally challenging to handle large and aggressive birds.

Hens can also present their own unique challenges during live haul. Hens were described as flightier and more reactive than toms with higher risks of wing flapping, piling, and jumping off of the loader (Weeks and Nicol, 2000). These behaviors can potentially lead to injuries, particularly broken and fractured wings, resulting in consequent carcass downgrades at the processing plant.

Age and mobility were identified as significant factors influencing herding and handling of market ready turkeys. As turkeys age, the angulation of the femorotibial articulation (i.e., the joint connecting the femur and tibia) changes to accommodate increasing weight, which reduces mobility of the birds (Oviedo-Rondón et al., 2018). This concern was noted by a participant that stated:

> *“...age, is definitely a big thing, depending on how old they are... more younger, they're more willing to do things. And as they get older, they're more likely [to] lay down and you've got to manually pick them up... because they won't move for you”.*

Bird age coupled with leg health have significant impacts on bird mobility and the efficacy of the handling process. Turkeys typically display higher levels of lameness and immobility as they age and increase in size, often due to increasing prevalences of footpad dermatitis from prolonged contact with high moisture litter (footpad dermatitis prevalence: 33.8% toms, 60% hens; Mitterer-Istyagin et al., 2011). In addition, turkey avian reovirus, or reoviral arthritis, is a current disease challenge in the U.S. turkey industry affecting mobility, with as much as 40% of the flock displaying clinical signs of lameness (Porter, 2018). Lameness associated with this virus is progressive, presenting as early as 8 to 12 weeks of age and worsening over time (Porter, 2018; Sharafeldin et al., 2015). Affected birds show swollen hocks (tibiotarsal joint) in one or both legs with fluid accumulation, edema, fibrosis, tenosynovitis, and occasional tendon ruptures (Mor et al., 2013; Porter, 2018). There is currently not an effective commercial vaccine for reoviral arthritis, so this remains a current and challenging health issue that impacts the live haul crews. In addition, non-infectious conditions such as toe deformities, leg fractures, and bone and cartilage abnormalities may also influence mobility (Dalton et al., 2016). Communication between veterinarians, farmers, and live haul crews is critical to ensure those handling the birds are aware of compromised flocks before arriving at the farm.

Taken together, sex, age, weight, and mobility were identified as specific factors impacting herding and handling of market-ready birds. Additional considerations including the use of specialized equipment to move less mobile or heavy birds and utilizing proper herding techniques (e.g., smaller groups, less use of herding tools) may improve these animal-based specific challenges during live haul.

Theme 2: Farm Factors

Participants highlighted how farm factors, such as farm characteristics, environmental conditions, scheduling logistics, and equipment, influenced the techniques and efficiency of handling and loading market-ready turkeys. Environmental conditions within and outside the barn stood out as a critical component impacting the success of handling and herding outcomes for live haul crews. Light intensity was identified as a key component during the loading process. One participant noted:

> *"If the light is too dim, they don't want to move. And you can't have them too bright because they don't want to move."*

Light intensity plays a critical role in regulating bird activity, where low light intensities or darkness increase melatonin production and subsequently decrease bird activity (Schwean-Lardner et al., 2016; Pal et al., 2019; Prusik and Lewczuk, 2019). Turkeys need to be active to herd towards the conveyor belt, so light is used in the barn to maintain flock activity. However, if the interior light is too bright, turkeys may become overly active and flighty and become more challenging for crew members to herd. Therefore, light intensity must be adequate to ensure overall flock activity but low enough to prevent excessive flightiness.

Most crews interviewed worked nighttime shifts, where turkey behavior is typically calmer. However, several participants noted brighter exterior light intensity creates challenges, such as when there is a full moon during a nighttime shift or loading during the daytime. As mentioned by one participant:

"In the summertime, we definitely do day loads. Definitely, hens are more jumpy. We get toms out there too during the day loads; they flap more during day loads than night loads…"

Similarly, another participant mentioned:

"It takes strength and willpower to do it to make it through a day load."

Outdoor illuminance has higher light intensity than in-barn recommendations (80 lux; Aviagen, 2022) and fluctuates widely based on geographic conditions, elevation, and weather (Lanca et al., 2019). The abrupt exposure to higher light intensities increases bird activity, complicating handling. Additional considerations specific to lighting should include loading turkeys during the night to maintain a dark environment between the loader and the transport trailer if scheduling permits (Barnes et al., 2013; Trampel et al., 2013)

The temperature inside the barn also influences bird behavior with respect to handling. Turkeys were reported to be less active if the house was too hot or too cold, and ventilation management was noted as a challenge. Crew members often do not have access to barn equipment controllers to regulate temperature, and producers with access may not be readily available during all live hauls. Even in properly managed houses, temperature within the flock can be influenced by outside temperature and changes to flock density, as described by this participant:

> *"...[after loading one side of the house] and they are gone, then that's just an empty space. And all the turkeys are on this [other] side, and it's just that you can start to see a change in the temperature [in the house]. And you can see your breath inside the house, and then you start...kind of worrying about what the turkeys are going to do."*

The thermoneutral zone in turkeys is 15.6 to 23.9°C, which represents the ambient temperature condition where turkeys can regulate their body temperature (Noll, 2022). Outside of this temperature range, birds modify their behavior to facilitate heat production or heat loss in an attempt to regain the thermoneutral zone (Schwartzkopf-Genswein et al., 2012). Henrikson et al. (2018) evaluated the impact of 8 hours of cold exposure (0°F or -18°C) on the behavior of 12 to 16-week-old turkeys, finding that 30 to 52% of the birds' time budget was spent huddling to reduce heat loss by minimizing the body surface area exposed to the cold. These findings support how turkeys decrease their activity during low temperatures and consequently become more difficult to herd towards the conveyor belt in cold conditions.

Participants also noted a significant impact of outdoor weather conditions (hot or cold) hindering bird movement. These factors required adjustments to loading schedules, like waiting for cooler times of the day to begin loading for both turkey and human welfare. For the latter, one participant mentioned:

"If it's cool and we got a lot of loads, I'll try to start them off a little early. If it's hot, and then of course we're going to try to start out when the sun goes down. So you know [the crew members are] not out there… about to pass out in the heat because it's a physical job."

With regard to the turkeys, another participant mentioned:

"You gotta watch the temperature and if [you] get [the turkeys] too cold, they won't walk. Get them too hot, they won't walk. You got to keep it right. Just right."

Birds exhibit behavioral changes in response to heat or cold stress caused by external environment conditions like hot or cold weather (Liu et al., 2022; Poku et al., 2024). These behaviors are consistent with those observed when temperature fluctuations occur inside a turkey barn. Sudden exposure to extreme temperatures can amplify stress and hinder mobility, making it challenging for crew members to move them effectively. Strong winds were also noted to disrupt birds' movement, highlighting the need for different loading techniques, such as using additional tarps around the barn doors to block drafts:

"If the air is coming through that door, and it's really heavy and strong. A lot of times turkeys, some of them don't want to go through it. That air hits them and ... they just stop. It's just like a complete difference to them that they're not used to all that air coming in on them at one time, especially in the winter time... that's when you need to put the tarp up and stuff like that because then it keeps that air from coming in on them. And then they just ...move a little bit better."

The participant's comment aligns with the concept of the windchill effect, where moving air dissipates heat from the turkey's body, causing it to feel colder than the actual air temperature. This effect intensifies as temperatures drop due to the greater temperature difference between the bird and the surrounding air (Czarick and Lacy, 1996). Using tarps to reduce air movement minimizes the windchill effect, prevents heat loss from turkeys, and ultimately encourages better mobility and comfort for the birds.

In addition to light and temperature, litter management was also one of the most highlighted farm factors influencing turkey handling. Litter quality varies widely from farm to farm, depending on how it has been maintained throughout the life of the flock. Crews experiencing less consistent litter conditions stated that they needed to adapt their handling strategies accordingly, particularly if litter conditions affect the proper placement of equipment. One participant elaborated on the implications of poor litter management affecting the birds and the crew members:

> *"The only thing that I've really noticed is like ... [litter] does make it hard on the turkeys driving them from one side of the house to the other because you have some holes in some houses, and it's that deep! And then you have turkeys that fall in the holes, and then you get turkeys tripping over those turkeys. And then ... that's how you start getting broken wings and stuff like that. And it's nothing you can do about it, because... you can't fill every single hole all the way back to the house... you would be there all day trying to fill in the house just to get it started. But that's like been a kind of a major issue, like we've been having with a lot of them... some of them are not as deep, but then you get some of them and it looks like trenches all the way through the house."*

Holes and uneven, compacted litter create hazards for injuries for the turkeys and crew members. The surface condition can also make it challenging for operating equipment, such as creating gaps between the loader belt and the ground that requires turkeys to step up onto the belt. Turkeys may trip or balk at the gap in the transition to stepping up onto the belt, which could result in piling or herding birds over fallen birds.

Litter condition was also linked back to animal factors. After a long production phase, litter moisture and caking increase and create higher risks for the incidence and severity of footpad dermatitis (Kuczynski and Ksenicz, 2002). One research group reported that only 4.7% of 16- to 20-week-old toms had normal footpads (Da Costa et al., 2014). Caking is multifactorial though as it is associated with bird weight, diet, type of bedding, and management, in addition to high stocking densities in barns that lead to a build-up of feathers, feed, and excreta on the floor (Leishman et al., 2021).

Characteristics of the farm design and equipment were identified as subthemes within farm factors, primarily resulting in poor handling outcomes for birds. This included logistical challenges such as truck delays and disruptions during the loading process. Some farms have live haul doors located in the middle and on either end of the house, which is more convenient for crews to herd turkeys a shorter distance to the loader (Barnes et al., 2013; Powell and Co Construction, 2024). However, some farms only have live haul doors on either end of the house, resulting in longer distances for herding. Longer distances will take more time and also may be more challenging if additional animal-related factors affecting the birds' mobility are present. Poor external conditions of the farm, such as road quality, were also mentioned as prolonging the loading process and not conducive for live haul. One participant specifically referred to these farm characteristics as "ugly", noting:

"There are also some ugly farms, and when the trucks turn around, the transporters have to struggle a lot. We have also had to struggle because the trucks are delayed, and the more experienced colleagues come out and help the transporters. This has been reported to the farmers, but they do nothing to fix the situation. So I feel that they should fix the road there because at any moment this could cause an accident."

Lastly, equipment and herding tools were commonly discussed as a factors impacting handling. Herding tools and loading equipment (e.g., manual versus automatic loaders) are selected typically by live haul crew preference and company availability of the equipment. Participants noted that red and orange colors for herding tools tended to be the most effective for bird movement, and plastic bags were the favored material for handling tools. Plastic bags are ideal for biosecurity as they are inexpensive, disposable, and can be left at a farm after live haul to minimize equipment moving between farms. Plastic bags are also lightweight and unlikely to injure animals and crew members. While all participants predominantly used manual loaders, those who had experience with automatic loaders noted how they significantly sped up the live haul process by reducing manual labor and truck maneuvering. This is similar to previous work conducted on automatic loading systems, showing that automated broiler loading can achieve loading times comparable to those of six crew members (Knierim and Gocke, 2003). However, automatic loaders were rarely used by individuals participating in the study, and future work should consider conducting focus groups with participants with more experience with automatic loaders.

Theme 3: Human Factors

The human factors theme included any discussion regarding formal and informal training, learning through experience, safety concerns for crew members, physical endurance, and handling strategies implemented by the handlers. Balancing human and animal welfare while ensuring efficient handling of market-ready turkeys was one of the participants' most highlighted concerns.

Focus group participants discussed how informal training was the primary method for training new employees, with many learning through observations of more experienced crew members rather than formal education. Further discussion also revealed the limited formal educational resources available for the humane handling of market-ready turkeys. Some participants noted that they began working without prior training or experience, and only a few mentioned having access to instructional videos. One of the handlers described the hiring process:

"He brought him in, signed the paper and sent him with the crew."

Another participant reaffirmed:

"[...] to a person who has just entered, I say, look, this is how the job is. To start, put on your boots, put on your overalls. Second, grab your flags, go, follow this person, and he will tell you how you are going to cut, catching a few turkeys or more at a time."

Formal training consists of having defined objectives and learning supports, an identifiable start and end, and is implemented with an educational method or by a training institution (Brown, 1989; Rubenson, 2007). While informal training occurs through everyday activities associated with work, it typically does not follow a structured framework as it excludes predefined learning objectives, designed learning periods, and organized learning support systems (Rubenson, 2007). Marsick (2009) discussed how informal learning can be challenging to standardize, while Dale and Bell (1999) mentioned that informal training can have other limitations like a narrow focus and the possibility of learning bad habits or incorrect lessons.

Informal training has its benefits, however, such as being flexible, adaptable, and troubleshooting problems through regular practice. The relationship between informal and formal training is dynamic, with each complementing the other. Each type of training inspires new ideas, leading to a rewarding and meaningful learning experience (Kazi, 2008; Marsick, 2009). Incorporating more formal training for live haul crews may also help to reduce employee turnover. For example, when asked the follow-up question of, "What did they expect new employees to know before going to the farm?", the participants answered that they wanted the new employees to be aware of the actual conditions and processes of loading turkeys. Some participants noted that without this background, some new hires only last one night after realizing the harsh conditions of the job.

Crew members also raised concerns about human safety. They described the physical risk of handling turkeys, mentioning injuries (e.g., broken fingers, broken noses, scratches) that occurred during the handling process, either from birds or equipment. One of the comments was:

"...One [turkey] jumped up and scratched me in the face. I was down for two sets…"

Participants also frequently mentioned physical endurance when handling and loading market-ready turkeys, emphasizing the need for stamina, strength, and resilience. These factors are particularly critical if other themes or subthemes are involved in prolonging the loading process. For example, one of them stated:

"At some point when you're loading turkeys, you're going to start getting fatigued, you run out of stamina. It starts getting harder."

Animal factors, in particular, were often related to physical endurance. Participants stated that the physical challenge was higher in farms where bird mobility was limited, requiring the crew members to manually pick up individual birds and carry them to the loader. One of the participants said:

> *"If it's a sickness to where the birds aren't going to walk, I might end up being there 12 or 13 hours, picking birds up, using a wagon or a wheelbarrow or a skid loader or something like that. And if you've done that before, where it's the middle of winter, and everybody is soaked from sweat because the birds are so sick, they won't get up".*

Environmental exposure and physical labor associated with daily tasks put crew members at risk for potential injury. In addition, repetitive movements, poor posture, and long working hours contribute to musculoskeletal disorders, while excessive workload and insufficient rest cycles lead to stress (OSHA, 2013; Magri et al., 2021). A study involving 80 poultry workers revealed that over half needed better knowledge of occupational health hazards, likely due to a lack of training and limited access to personal protective equipment (Mahmoud et al., 2023) Taken together, conditions that prolong live haul and/or make the process more physically challenging reduce stamina, strength, and resilience, and proper handling strategies may deteriorate as a result.

Participants mentioned the use of strategic handling techniques to alleviate some of the challenges during the interactions between handlers and birds. For example, participants highlighted how effective teamwork and crew coordination are critical for minimizing injuries and ensuring smooth loading of the birds. As indicated by one of them:

> *"So there should be two people on the loader and then six people in the barn, and they work together to herd the birds into the corral, and then herd the birds in the corral onto the loader. So there, there's always like two people on both sides of the corral, and there's a handful of guys in the back of the corral. Normally, what they do is like three or*

four guys walk back, and they'll cut a section of the herd, slowly move them in because you don't ... want to move 200 birds because if you got three or four guys, you can't control that many birds. They'll go to one side or the other and pile and kill each other. That, or they end up breaking each other's legs ... and then they're hurting each other."

Participants elaborated on the importance of herding smaller groups of birds to maintain control and reduce injury. The consensus across focus groups was to cut a small drive of approximately 50 birds from the flock to herd towards the loader. Once birds are inside the funnel, smaller drives of birds of approximately 10 to 25 turkeys are moved through the funnel to the conveyor belt to reduce the risk of piling. Another crew member complemented this strategy of herding the turkeys inside the barn:

"You want to take as small drives as you can. You don't want to over-pack them because then you can pack the belt too much. And you just want to ... let the turkey do the walk itself. ... You don't really want to shake the bag. You just want to kind of use it to kind of keep them going ahead of you. Too much shaking, then they're going to go crazy. You just want to kind of walk with them and let them do the walk up onto the belt."

According to Grandin (2021), effective handling relies on calm, stress-free methods that enhance productivity and ensure human safety. Proper training in fundamental animal behavior, such as flock behavior and handling techniques that utilize the flight zone and the point of balance, is essential for handlers to manage animals effectively. Turkeys are social animals and are motivated to move together as a flock (Beauchamp, 2022), as well as maintain distance from unfamiliar people, referred to as their flight zone. The point of balance is located at the animal's shoulder and is influenced by its wide-angle vision; animals will move forward when a handler positions themselves behind this point (Grandin, 2022). Applying these concepts when handling market-ready turkeys alongside calm shaking of bags or flag sticks, as crew members mentioned, helps to minimize stress during handling.

CONCLUSIONS AND APPLICATIONS

This study identified a variety of factors that affect the proper handling of market-ready turkeys that can influence both animal and human welfare. The data indicated that there are animal, farm, and human factors that affect handling and loading techniques. Live haul becomes even more challenging when these factors interact, and many factors are outside of the crew members' control. Some suggestions and recommendations follow:

1. Formal training is lacking for live haul crew members, which may lead to employee turnover and less consistency in proper animal handling. Formal training for new crew members and annual updates for existing crew members can be developed to standardize best handling practices across the industry, as well as communicate techniques for navigating challenging situations. Formal training tools would supplement existing informal training methods of having experienced crew members or other professionals model tasks in-person at the farms.
2. Communication and teamwork between veterinarians, farmers, nutritionists, and live haul crews could improve animal and farm conditions to make the live haul process more efficient. For example, controlling and optimizing interior and exterior light intensity and maintaining consistent barn temperatures can ensure appropriate levels of bird activity and movement. Consistent and daily management of litter across the life of the flock will mitigate the effects of litter condition on footpad health, bird movement, and equipment setup. Programs that monitor and incentivize farmers for good litter condition may

promote more consistent litter quality and subsequent bird mobility during live haul. If conditions are unable to be improved, advanced communication to live haul crews could better prepare them for a challenging flock (e.g., staffing a larger crew, bringing additional equipment and tools).

3. Further research is needed into farm design (including placement of doors for loading and road design and condition for trucks), loading equipment (including mechanical methods to humanely move lame birds inside a house), and personal protective equipment to mitigate the effects of challenging flocks on crew member stamina, endurance, and resilience.

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Table 2.1 Questions asked during focus groups with commercial live haul crews about handling and loading market-ready turkeys

Order	Question
1	What is your experience with handling turkeys?
2	Can you please describe the process for catching and loading market-ready turkeys?
3	Under what conditions would you not handle or load a bird?
4	How did you learn how to catch and load turkeys?
5	What situations have you experienced that made handling turkeys difficult?
6	What strategies or techniques have you used when faced with these difficult situations?
7	What external factors would help you handle turkeys better?

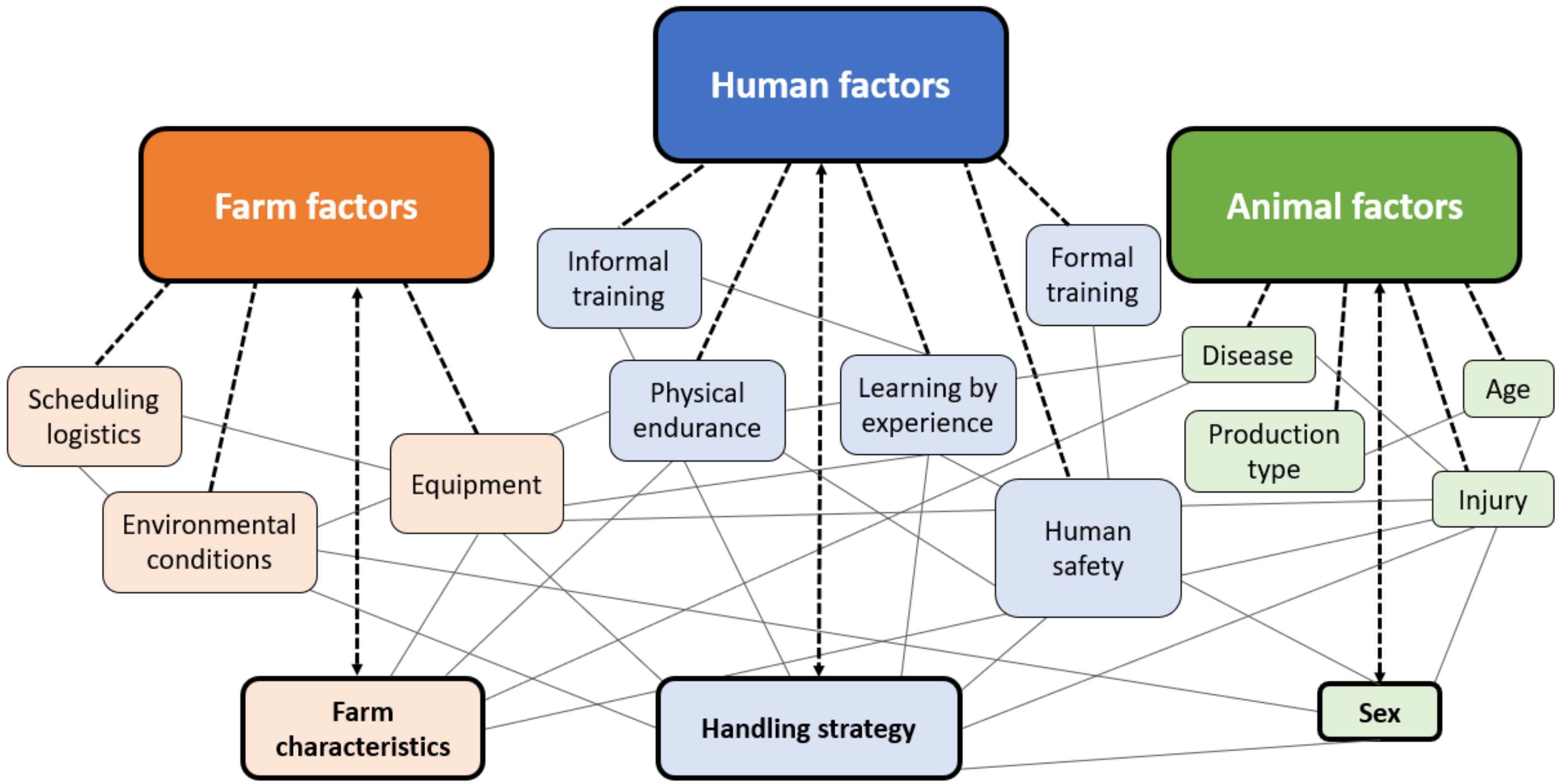
Table 2.2 Themes and subthemes identified with thematic analyses of focus groups about the challenges of implementing appropriate handling techniques for market-ready turkeys

Themes	Subthemes
Animal factors	Injury, Disease, Sex, Age, Production type
Farm factors	Farm characteristics, Environmental conditions, Scheduling logistics, and Equipment
Human factors	Informal training, Learning by experience, Formal training, Human safety concerns, Physical endurance, Handling strategy

Table 2.3 Principle themes and subthemes discussed by focus group participants, the proportion of comments, and a direct quote representing each theme. Focus group participants consisted of commercial turkey live haul crew members discussing factors that influenced the handling and loading of market-ready turkeys.

Themes	Subthemes	% of discussion	Direct quotes
Animal factors			
	Sex	5.8	"If you got toms, they are nosy, they are going to come up, they want to know what you're doing up there…"
	Age	0.4	"Age is definitely a big thing, depending on how old they are... more younger, they're more willing to do things. And as they get older, they're more likely [to] lay down and you've got to manually pick them up... because they won't move for you".
	Injury	3.2	"If you have 4/5 birds piling up, then you have to stop what you are doing and unpile them. Otherwise, you will have birds smattered on the bottom".
	Disease	2.8	"We had a flock that had real severe arthritis….there's one that's very memorable to all of us because we were still loading at noon the next day".
	Production Type	0.7	"They built too much weight for their muscle to handle…"
Farm factors			
	Environmental conditions	8.4	"If the light is too dim, they don't want to move. And you can't have them too bright because they don't want to move".
	Scheduling logistics	1.3	"A lot of that is out of my control because the plant dictates what they want that day".
	Farm characteristics	12.3	"There are also some ugly farms, and when the trucks turn around, the transporters have to struggle a lot. We have also had to struggle because the trucks are delayed, and the more experienced coworkers come out and help the transporters".
	Equipment	11.4	"If you have an automatic belt, in 22 minutes, you can have 800 birds on the truck".
Human factors			
	Informal training	5.6	"He brought him in, signed the paper and sent him with the crew".
	Formal training	2.8	"Training videos show you how to carry the birds, they show you how to move the birds".
	Learning by experience	4.9	"It takes time, long time...but from one year ahead, more or less, people defend themselves well".
	Human safety concern	9.2	"One [turkey] jumped up and scratched me in the face. I was down for two sets…"
	Physical endurance	6.1	"At some point when you're loading turkeys, you're going to start getting fatigued, you run out of stamina. It starts getting harder".
	Handling strategy	25.3	"You want to take as small drives as you can. You don't want to over-pack them because then you can pack the belt too much".

Figure 2.1 Thematic map showing the three main themes affecting proper handling and loading techniques of market-ready turkeys, as identified through focus groups with live haul crew members. Themes are color coded to correspond to their subthemes and connected by dashed lines. Subthemes with bold text were the most discussed subthemes during the focus group. The gray solid lines represent connections between the subthemes.



CHAPTER 3

Development of Interactive Training Modules on Handling, Herding, and Loading of Market-Ready Turkeys During Live Haul

ABSTRACT

Training for turkey live haul crew members is often limited to informal, on-the-job shadowing, which can result in inconsistent practices and variable welfare outcomes. To address these limitations, a virtual training program was developed to provide a structured, standardized information in English and Spanish. Content was based on the Poultry Handling and Transportation Manual for Turkeys, created by the US Poultry and Egg Association (2016), peer-reviewed literature, and factors identified during focus groups with live haul crew members that influence the handling and loading of market-ready turkeys. The training tool consists of three interactive modules: Module 1, Turkey Behavior and Health; Module 2, Techniques for Handling and Herding Turkeys; and Module 3, Techniques for Loading Turkeys. Each module integrated videos, photographs, interactive scenarios, and knowledge checks to reinforce learning and to connect welfare principles with handling practices. The program offers a consistent approach to training new workers, reinforcing correct practices among experienced crew members, and providing companies with a structured, readily available training framework that supports compliance with animal welfare standards.

INTRODUCTION

The live haul process is a critical stage in turkey production where animal welfare can be compromised (Jacobs et al., 2017). During handling, herding, and loading, turkeys may experience stress, bruises, scratches, broken bones, or even die before reaching the processing plant, all of which reflect compromised welfare (Prescott et al., 2000; Allain et al., 2013). In the United States, the public's concern regarding animal welfare in meat production has grown, with 67% of consumers seeking more information about a company's practices, including how animals are managed and handled (Annual Meat Conference, 2018). In addition, humane handling within the turkey industry continues to remain a challenge, with recent events in the media highlighting inappropriate and inhumane treatment of turkeys, specifically during handling and load-out (Rubinkam, 2022). However, despite these challenges, the industry continues to lack resources and readily available training tools to teach and prioritize on-farm humane turkey handling, herding, and loading.

Handling, herding, and loading market-ready turkeys is the primary job of live haul crew members. Live haul crew members often depend on informal, on-the-job training for humanely handling and herding turkeys, and require physical endurance and stamina to perform this demanding task (Hernandez et al, 2025). Currently, to the authors knowledge, there are no free and readily available formal educational tools or resources to train crew members on humane turkey handling. Coupled with high employee turnover in the poultry industry broadly (~65%; Alonzo, 2018), there is a significant need to develop proper training on turkey handling, herding, and transport to improve animal welfare and productivity (Coleman and Hemsworth, 2014).

Therefore, the objective of this study was to develop a virtual, on-demand, interactive training program for turkey live haul crew members who are responsible for the daily handling, herding, and loading of market-ready turkeys. This program was designed to strengthen workers' skills in human-animal interactions and provide guidance that aligns with acceptable animal welfare and industry practices.

MATERIALS AND METHODS

Training Tool Development

The multimedia training tool developed in this study consisted of educational modules designed following previous training frameworks utilized in swine and dairy training programs (National Milk Producers Federation, 2025; National Pork Board, 2025). A schematic overview of the training tool structure is presented in Figure 3.1, illustrating the pedagogical design and logistical flow of the interactive learning system.

Initial content development for the virtual training program began with reviewing and utilizing information outlined in the Poultry Handling and Transportation Manual for Turkeys (US Poultry and Egg Association, 2016). This manual provided the core principles for handling and transport of turkeys, and the training tool incorporated this information along with updated information from peer-reviewed journal articles and turkey welfare auditing tools (Chapter 1). Additionally, focus groups with live haul crew members were conducted to identify key factors that influence the handling and loading of market-ready turkeys, and information garnered from the focus group study was integrated into the training tool, shaping both the content and the practical approaches presented through learning activities (Hernandez et al., 2025).

Training Tool Multimedia

The training tool was developed over the course of seven months. Modules were developed by individuals with expertise in animal welfare (MPG, AP, VM) and poultry science (AP, LAH). Modules emphasized key aspects of the live haul process associated with animal welfare, including, but not limited to, turkey behavior and health, handling and herding techniques, and loading methods. Upon module development completion, experts in the U.S. turkey industry were recruited to review the modules to ensure their practicality and clarity. Recommendations from industry experts were then incorporated into the final modules.

Each module was constructed using photographs and video footage obtained from commercial turkey farms at the time of load out, with explicit permission from the live haul companies and farm owners to use anonymized images and videos for educational purposes. Media was collected on four commercial farms in the northeastern region of the U.S., each housing approximately 20,000 birds, with farms dedicated to either hens or toms. Trained personnel (AP, MPG, VM, LAH) collected video recordings and photographs using digital cameras (Sony ZV-1F and Sony Alpha 6600; Sony Corporation of America, New York, NY). Video recordings and photographs were used to enhance the learning experience by presenting realistic scenarios that facilitate knowledge transfer from the training program to real-world applications (Isbrandt et al., 2023). To protect confidentiality, crew members' faces, vehicle license plates, and company names were digitally blurred.

Upon completion of the modules, a third-party company was contracted to design the modules using the provided materials and detailed scripts. The interactive tool was designed to be accessible through the Reporter platform at North Carolina State University using a computer with internet access. Each module was independent of the other modules, but participants were required to complete the modules in the order in which they were presented.

RESULTS

Three multimedia training modules were developed with a targeted audience of live haul crew members. The estimated total time to complete all three modules was approximately 60 minutes. To strengthen learning and maintain engagement, the modules incorporated interactive knowledge check activities. These include video-based exercises, in which participants can select the correct handling practice, as well as sentence-based activities that require learners to identify whether a statement is correct or incorrect. An example of an interactive exercise is illustrated in Figure 3.2.

All modules were developed in both English and Spanish to ensure accessibility across a diverse workforce. Each module included a voice-over narration to reinforce comprehension, accompanied by a notes section providing the written version of the narration for participants who preferred or required text support. Below, each module is described in further detail.

Module One

Module one focused on turkey behavior and health, with an anticipated completion time of 20 minutes. The module covers how turkeys respond to their environment, including the presence of unfamiliar people, equipment, or changes in light temperature and air flow. Attention was also given to the differences in behavior between toms and hens, the importance of recognition of the flight zone and point of balance (Figure 3.3), and flocking behavior (Figure 3.4).

Module one also combined visual examples to connect health and behavior observations. Market-ready turkeys are at a higher risk of lameness. This condition manifests various leg health issues affecting the birds' mobility in varying degrees, ranging from walking more slowly to being unable to walk at all (Figure 3.5). Identifying these conditions is a crucial part of the live haul process, as they impact both the bird’s response to herding and the crew member’s ability to move turkeys safely and mitigate animal welfare concerns.

Module Two

Module two addressed the practical techniques for handling and herding turkeys inside the house and also had an anticipated completion time of 20 minutes. The training content discussed environmental conditions that influence turkey handling and herding, with a particular focus on utilizing funnels to herd turkeys. Module two also demonstrated how crew members should safely move birds in small groups using appropriate herding tools (Figure 3.6) and how to handle individual birds with two points of contact. Lastly, time was dedicated to the creation of a hospital area for sick birds that are unable to move (Figure 3.7), a process that facilitates the herding process by isolating compromised turkeys from the main flock.

As with module one, module two also included scenario-based examples to illustrate correct and incorrect herding techniques (Figure 3.8). Visuals demonstrated, for instance, how improper herding can cause wing flapping, jumping, or even bird death, while proper techniques improve flock movement. There is also a decision-making activity for what to do when there is a bird that is immobile in the funnel. By focusing on consistent herding, the module emphasized the link between crew members' actions, the environment, and the bird's response.

Module Three

The last module was developed to address techniques for loading turkeys, explaining how to move birds from the funnel onto the conveyor belt, and load them into the transport coops (20 minutes in length). This module went into detail on how the structure and shape of the funnel guide the birds toward the conveyor, emphasizing the importance of slowing movement and breaking the flock into smaller groups to manage bird density in the conveyor belt (Figure 3.9). This module also presents the process for loading turkeys into coops, with distinctions made between manual and automatic loading methods (Figure 3.10, 3.11). In addition, participants are instructed on evaluating the conditions of coops before use and on understanding how environmental factors, such as light or temperature, affect loading and bird density in transport coops. By focusing on crew coordination, equipment use, and proper techniques, the module connects all the concepts learned, completing the sequence of the modules.

DISCUSSION

Training for live haul crew members in turkey production can be conducted through informal and formal training methods. Informal training, which involves shadowing and working alongside experienced workers, is the most common approach in the turkey industry (Hernandez et al., 2025). While this method allows workers to learn directly on the job, it also increases the risk of transmitting poor practices or inconsistent information to individuals with little to no previous handling and herding experience (Dale and Bell, 1999; Manuti et al., 2015). In contrast, formal training is organized around specific learning objectives, delivered within a defined structure, and often results in certification (Rubenson, 2007). However, to date, there are limited formal training resources readily available for use by turkey live haul crew members (Hernandez et al., 2025). Therefore, the objective of this study was to develop a virtual, on-demand, interactive training program for turkey live haul crew members who are responsible for the daily handling, herding, and loading of market-ready turkeys.

E-learning, or online training, is a methodology that successfully meets training needs in multiple disciplines by offering on-demand access, allowing companies to utilize training when required, creating a safe environment for learners to practice, and overcoming geographical, cultural, and educational distances (Malmsköld et al., 2012). Our study developed an online training tool that is a no-cost program that is easily accessible to any individuals interested in learning more about turkey handling, herding, and load out. This tool is the first of its kind to provide science-based evidence on how to humanely handle turkeys and decrease the risk of poor welfare outcomes during live haul. Previous studies have shown that e-learning can strengthen the motivation, effort, and persistence of trainees (Zavala-Cerna et al., 2025), mitigate feelings of exclusion associated with knowledge gaps (Klupiec et al., 2014), and support long-term knowledge retention (Coleman et al., 2001). With this program, it is our intent to improve turkey welfare by properly training loading crew members on how to properly handle, herd, and load turkeys using e-learning.

Our training was developed using a variety of instructional media, including videos, images, animations, assessments, and audio recordings. This is important as media can be translated into different languages and visuals allow learners to capture concepts without having to rely heavily on text (Nycz and Cohen, 2007). The development of bilingual modules that combine videos, images, and interactive scenarios fulfills the training needs of live haul crew members by providing a resource in both English and Spanish. This feature is particularly important in the US poultry industry, given that 26.5% of workers are Spanish-speaking (Constance et al., 2023). This training tool can be used to establish a common foundation of knowledge across multilingual crews, thus providing companies with a practical way to standardize training, enhance communication within diverse teams, and demonstrate their commitment to animal welfare and workforce development.

The choice to use e-learning as our training tool is also important when considering the demographics, technological access, and work schedule demands of our live haul crew members. Based on focus groups with 38 turkey live haul crew members, 71% had completed high school, and 13% had some college education (Hernandez et al., 2025). It can be inferred that these workers possessed sufficient knowledge and skills to operate a computer and the internet for e-learning. Each crew begins their shift by gathering at the company office before departing together in a single vehicle to the turkey farm. Because farm locations vary daily, the company office serves as a consistent base where internet access and computers are available, making it the most practical site for completing an online training. Flexibility was also essential, as training needed to be available both during the day, when schedules occasionally required it, and more commonly in the evening since crew members typically work night shifts. To address this need, the training was designed to have a maximum total duration of 60 minutes. It was divided into segments that participants could pause and resume as needed, aligning with adult learning preferences for pacing and scheduled breaks if needed (Backes, 1997). Whenever technical language was required, the concepts were explained in clear and accessible terms to ensure understanding among participants who had not received formal training in handling, health, or welfare.

The decision to design the training as bilingual, interactive e-learning modules was directly shaped by the limitations of informal training and the practical considerations of formal training in the turkey industry. The three modules were built to resolve the gaps observed in proper training. Features like pausing and replaying content, short segment sessions, and clear bilingual explanations were selected to align with crew demographics, their work schedules, and company logistics. In this way, the general advantages of e-learning were applied to the specific context of the turkey live haul, producing a training tool that was both accessible to workers and functional for company adoption.

IMPLEMENTATION AND FUTURE APPLICATIONS

The training modules are designed for use across the turkey industry, supporting onboarding of new workers, annual training of crew members, and serving as a resource for veterinarians, industry professionals, and educational programs in poultry science and animal welfare. The modules are freely accessible through the North Carolina State University Reporter platform, allowing broad distribution and use. The English training program is titled, "A Guide to Handling Market-Ready Turkeys for Live Haul", and the Spanish training program is titled, "Guía de Manejo para el Transporte en Vivo de Pavos Listos para el Mercado".

Future work will involve assessing knowledge gain through the use of pre- and post-training surveys with live haul crew members. These surveys will measure how effectively the training modules convey principles of handling, herding, and loading. Additionally, evaluating crew members' perceptions of the quality and usability of the training tool will provide insight into its practical value.

CONCLUSIONS

The development of the training module program addresses the limitations of informal and inconsistent training practices in the turkey live haul industry by offering a structured, bilingual (English and Spanish), and interactive option for the turkey industry. The modules provide clear and practical guidance for proper handling, herding, and loading of market-ready turkeys, presenting information in a way that connects animal welfare principles with daily practices. By combining videos, photographs, interactive scenarios, and knowledge checks, the program reinforces recommended techniques and supports consistent application of handling, herding, and loading practices. The modules were designed for real-world use by combining highly visual content, simplified language, interactive activities, and an online format, making the training accessible to diverse audiences and suitable for integration into daily industry practices.

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Figure 3.1 Training tool structure. The schematic illustrates the logistical flow of the interactive training tool, from access to certification. Each module integrates videos, photographs, interactive scenarios, and knowledge checks to reinforce learning. Successful completion of all modules leads to certification

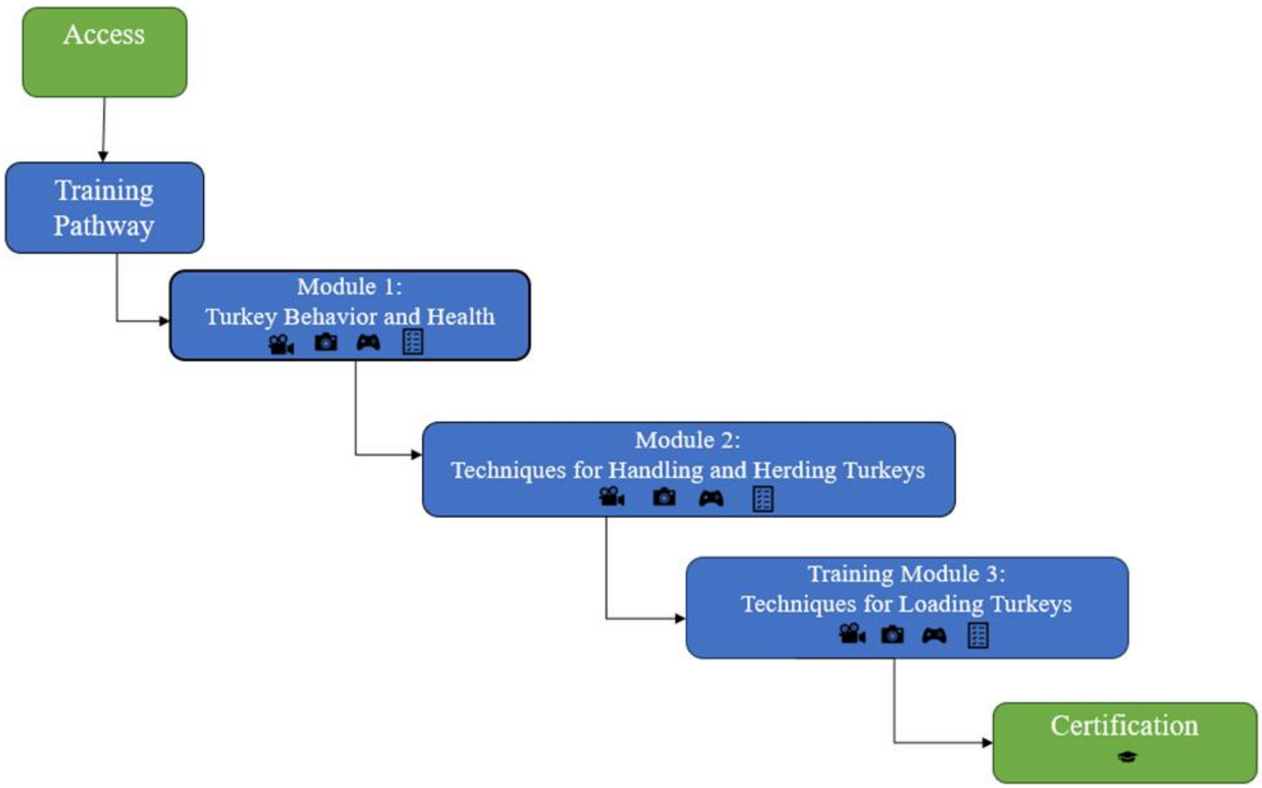

Figure 3.2 Example of interactive exercise (screenshot video). Modules use video-based exercises and sentence-based activities to support learning.

Figure 3.3 Recognition of the flight zone (a) and point of balance (b) (screenshot videos). The figure illustrates the two key concepts used to guide bird movement during handling.

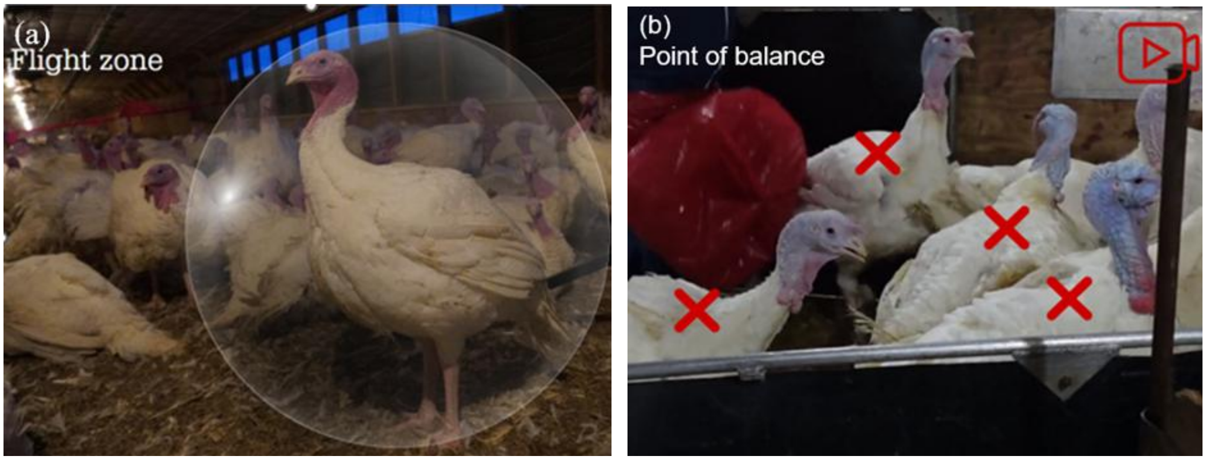

Figure 3.4 Turkey flock behavior (screenshot video). The figure illustrates how turkeys move as a flock during the live haul.

Figure 3.5 Leg health issues (screenshot video). Different causes of lameness, a common issue in market-ready turkeys, affect mobility during the live haul.

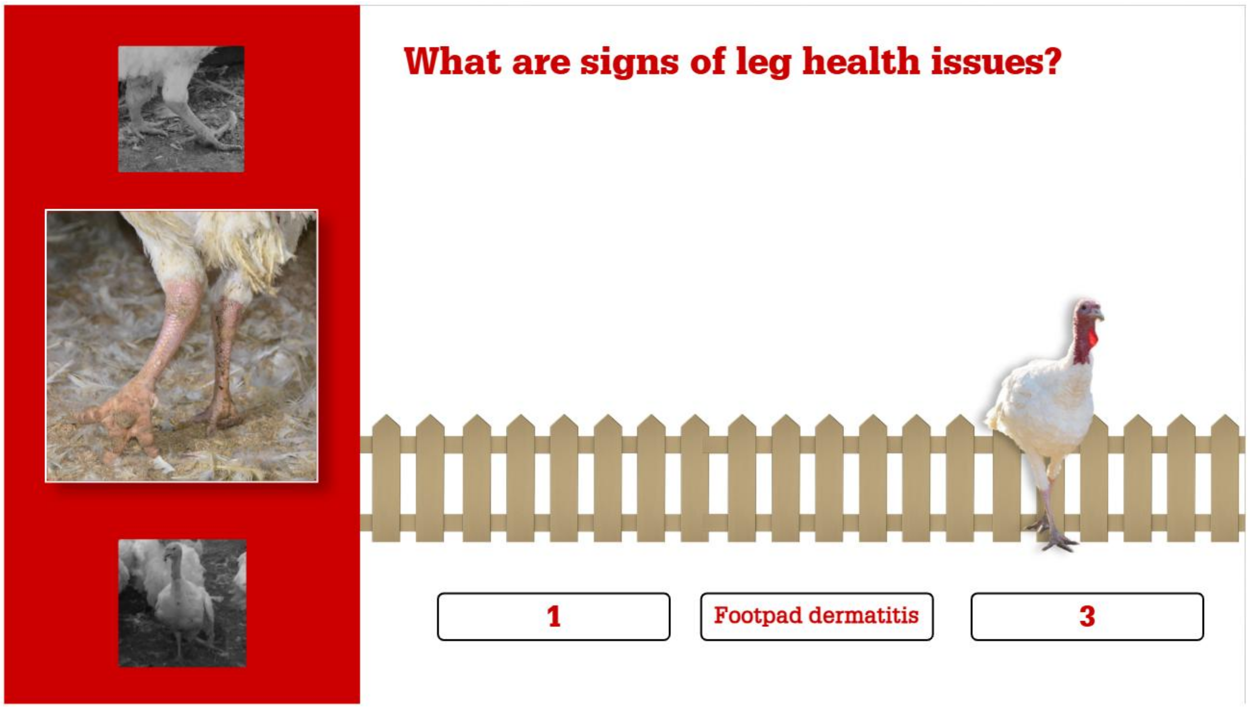

Figure 3.6 Herding a small group of birds using the herding tools properly (screenshot video). The figure shows the correct use of herding tools to guide turkeys in small groups while maintaining bird movement and control.

Figure 3.7 Hospital area for sick birds that are unable to move. The creation of the hospital area facilitates the herding of market-ready turkeys.

Figure 3.8 Scenario-based examples to illustrate correct and incorrect herding techniques (screenshot video). The figure illustrates that improper herding can lead to wing flapping and jumping of the turkeys.

Figure 3.9 Slowing movement and dividing flocks into smaller groups to manage bird density on the conveyor belt (screenshot video).

Figure 3.10 Differences between the manual and automatic loading methods (video screenshot). The figure illustrates contrasting approaches to loading procedures.

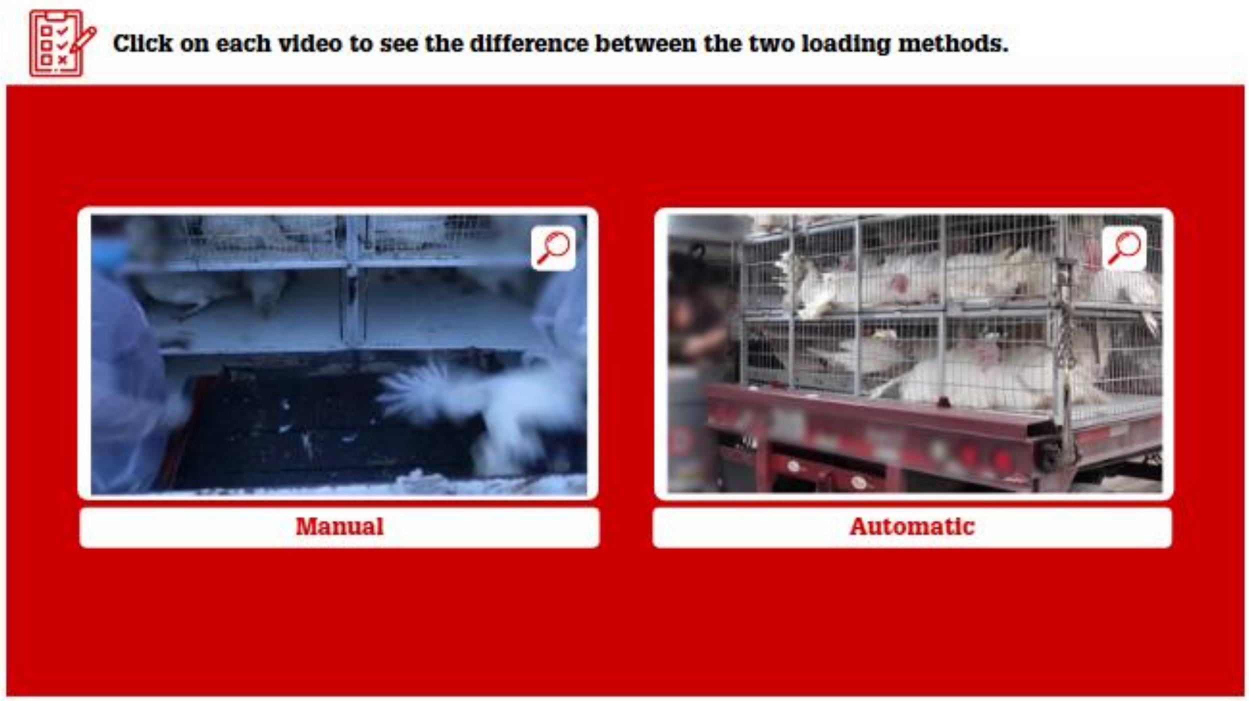

Figure 3.11 Using two points of contact on the bird to load turkeys inside the coop in the manual loading method (video screenshot).