

Occupational Health and Safety Risks in the Village Milk Collection Center

Filiz ARICAK

TRAKYA UNIVERSITY

Abstract

Introduction: This study aimed to identify and appraise occupational health and safety (OSH) hazards at a village-level milk collection center and to prioritize controls using a 5×5 risk matrix.

Methods: We conducted non-participant, on-site observation over five consecutive days covering both morning and evening intake–cooling–dispatch workflows. Discrete hazards were listed in situ, described operationally, and scored as likelihood (1–5) × severity (1–5) to yield a 1–25 risk score. Scores were mapped to predefined classes (Unacceptable, Significant, Moderate, Acceptable, Negligible) to guide prioritization.

Results: Nineteen hazards were identified. Three were Significant (15.8%): electrical integrity deficiencies (exposed conductors at the exterior panel; compressor/cabling) and high musculoskeletal load from manual handling of heavy churns. Twelve were Moderate (63.2%), dominated by sanitation–workflow interfaces (chemical segregation and storage, adequacy of post-cleaning rinsing, food-contact compliance of hoses/receptacles) and personal hygiene during sampling. Four were Acceptable (21.1%) within existing controls. No hazard reached Unacceptable or Negligible. The pattern indicates a small set of high-leverage risks surrounded by a larger mid-tier cluster amenable to procedural standardization.

Conclusion: Immediate engineering/administrative controls for electrical and ergonomic risks, coupled with standardized hygiene and housekeeping routines (chemical management, verified rinsing, cable discipline, PPE and hand hygiene), offer a pragmatic path to risk reduction without disrupting operations. These actions are expected to improve worker safety and, by stabilizing sanitation-sensitive steps, support product quality in early-stage dairy supply chains.

Keywords: Dairy Products; Occupational Health; Risk Assessment; Rural Health; Safety Management.

Introduction

Milk is a staple food consumed across all age groups and forms the basis for a variety of products, including fermented dairy, butter, skim milk powder, and ice cream [1]. Beyond its nutritional value, milk collection and processing support rural livelihoods. Owing to its physicochemical properties, however, raw milk is highly perishable and prone to microbial contamination, which poses risks to public health as well as to workers involved throughout the supply chain [2].

In many regions, raw milk is collected from dispersed smallholder farms and aggregated at village-level collection centers, where initial checks are performed and milk is transferred to cooling tanks before periodic transport to processing plants [3]. Insufficient controls at any stage may compromise both product safety and occupational safety and health (OSH). Because milk deteriorates rapidly without adequate cooling, various technical and organizational interventions have been proposed and implemented over the years to improve quality and safety [4].

Existing studies describe recurrent hazards across milk collection and transport: biological contamination (e.g., *Staphylococcus aureus*, *Listeria* spp., and pathogenic *Escherichia coli*), chemical hazards (e.g., antibiotic residues and aflatoxins), temperature control failures, and logistical deficiencies in routing and timing [5; 6; 7; 8]. While these risks are well recognized in general dairy operations, there is limited, practice-oriented evidence from village-scale milk collection centers, where infrastructural constraints, hygiene practices, and manual handling can intensify OSH concerns alongside product safety issues.

This study aims to identify hazards and assess risks at a village-level milk collection center using a non-participant observational approach and a 5×5 risk matrix method. By mapping the distribution and severity of hazards, we seek to generate actionable OSH recommendations for low-resource collection settings.

Methods

This observational study was conducted at a village-level milk collection center in Tayakadın (Edirne, Türkiye). The center operates two intake sessions daily (morning and evening); only cow's milk is accepted. Collected milk is dispatched to the processing plant's tanker in the morning. The enclosed area is approximately 24 m² and contains a 1,500-L cooling tank, an electric water heater, a sink, and an electronic scale; cleaning chemicals and brushes used for tank and surface sanitation are stored on-site. A non-participant, on-site observation approach was adopted to capture occupational safety and health (OSH) hazards under natural working conditions without interfering with routine tasks [9; 10]. Prior to data collection, the milk collector was informed and permission to observe was obtained. Fieldwork took place on 1–5 June 2025 and covered both morning and evening operations. During observations, work tasks, equipment use, environmental conditions, and workflow-related hazard cues were documented in detail and photographed, avoiding any personally identifying images.

Hazards identified from field observation were appraised using a 5×5 risk-matrix method widely used in OSH practice as a decision-matrix technique [11; 12]. For each hazard, a risk score was calculated as the product of the likelihood of occurrence (1–5) and the severity of consequence (1–5), yielding a 1–25 scale. Operational definitions for likelihood and severity are provided below (Table 1).

Table 1. Likelihood and severity rating scales (5×5) [11]

Rating	Likelihood descriptor	Indicative frequency	Rating	Severity descriptor	Operational definition
1	Rare	~1/10,000; exceptional circumstances	1	Insignificant	No work-hour loss; first aid only; minor production loss
2	Unlikely	~1/5,000; may occur at times, unusual	2	Minor	No lost workday; outpatient/first-aid care; no lasting effect
3	Possible	~1/1,000; has occurred before, may recur	3	Moderate	Minor injury requiring inpatient care
4	Likely	~1/100; expected in many situations	4	Major	Serious injury needing long-term treatment/therapy; occupational disease
5	Almost certain	~1/10; expected to occur	5	Catastrophic	Death or permanent total disability

Based on established decision rules, [13] aggregated risk classes guided prioritization and control planning: the class definitions and corresponding control guidance are summarized below (Table 2).

Table 2. Risk classes (5×5) and control guidance [13]

Risk class	Typical scores	Control guidance
Unacceptable	25	Do not start work or immediately stop ongoing activities until risk is reduced; avoid task if not reducible.
Significant	15, 16, 20	Suspend work; implement urgent controls and, where relevant, emergency measures.
Moderate	8, 9, 10, 12	Plan and implement risk-reduction measures; tracking may take time.
Acceptable	2, 3, 4, 5, 6	No additional planning required; maintain and monitor existing controls.
Negligible	1	Record; routine monitoring only.

Resulting risk classes were used to rank hazards and to derive actionable improvement recommendations, with emphasis on high-risk groups. The study adhered to the principles of the 2013 revision of the Declaration of Helsinki; institutional ethical approval was obtained prior to data collection, and a copy of the approval letter will be submitted with the manuscript

(insert committee name and approval number/date here). No personal or sensitive data were collected; observations focused on tasks and workplace conditions.

Results

The routine workflow at the village-level milk collection center proceeds as follows. Smallholder producers deliver fresh cow's milk to the center in metal churns. Upon receipt, the collector performs an organoleptic screening (odor, visible spoilage), weighs the milk, conducts a brief physical appraisal, and transfers the acceptable milk to a 1,500-L cooling tank. Transaction details (producer identity and delivered volume) are recorded after transfer. When the processing plant's tanker arrives, the driver parks at a safe distance, draws a sample from the tank, performs an on-vehicle antibiotic test, and connects the transfer hose to the tank's valve. Milk is then moved to the tanker using a compressor. After dispatch, the collector cleans the tank with chemical detergents and rinses thoroughly with water; the interior floor is also washed to prevent odor build-up. All stages were observed in situ across both morning and evening sessions over five consecutive days using a non-participant approach. Observations focused on task sequence, equipment use, environmental conditions, and behaviors relevant to occupational safety and health (OSH), without intervening in routine operations.

Nineteen discrete hazards were identified and scored with a 5×5 decision-matrix method. For each hazard, the risk score was computed as likelihood (1–5) $\times$ severity (1–5), and then mapped onto predefined risk classes. The resulting hazard register, including prioritized control statements, is presented in Table 3. Three items reached the Significant class (score 15 or 16): (i) exposed conductors and structural cracks beneath the exterior electrical panel; (ii) manual handling of heavy churns leading to high ergonomic load; and (iii) compressor-related electrical/mechanical risk in the absence of cable management and moving-part guarding. Twelve items were classified as Moderate, most of which reflected hygiene-chemical interfaces (e.g., proximity of detergents to the cooling tank, insufficient rinsing after chemical cleaning,

open storage of chemicals) and hygiene-handling issues (e.g., non-sanitary receptacles and transfer hose cleanliness, personal hygiene during sampling). Four items were Acceptable within current controls: uneven ramp with low traffic, occasional instrument malfunction risk in the antibiotic tester, inadequate cleanliness of sample cups when promptly corrected, and suboptimal layout that nonetheless permitted basic cleaning access. No hazard reached the Unacceptable (score 25) or Negligible (score 1) classes.

Class frequencies were: Significant, $n = 3$ (15.8%); Moderate, $n = 12$ (63.2%); Acceptable, $n = 4$ (21.1%); total $n = 19$ (100%). These proportions are summarized in Table 4 and visualized in Figure 1. The dominance of Moderate hazards indicates a system in which routine OSH performance can be materially improved through standardizable housekeeping, hygiene, chemical management, and maintenance practices, while Significant items warrant immediate attention before work proceeds. In particular, electrical integrity (panel enclosure, locking, and insulating; cable routing and protection) and ergonomic load management (mechanical aids for lifting, safe-handling training) constitute first-line priorities. At the same time, temperature-reliant steps (cooling reliability under heat stress) and sanitation interfaces (post-chemical rinse adequacy, segregation and secured storage of chemicals, and food-contact status of hoses and containers) represent recurrent sources of Moderate risk where planned actions and monitoring can achieve stepwise reductions. Finally, general housekeeping (slip–trip–fall control via floor regularization and cable discipline) and personal hygiene compliance during sampling are cross-cutting contributors to risk that reinforce the need for training and supervision.

Taken together, these findings reflect a pattern typical of low-resource collection settings: a small number of high-leverage hazards that determine overall risk posture, surrounded by a larger set of mid-tier hazards responsive to procedural standardization. The register below is intended to be actionable, with each entry coupled to a concise control statement aligned with the risk class.

Table 3. Consolidated hazard register with likelihood (L), severity (S), risk score (L×S), class, and concise control statements (n = 19)

No.	Hazard (operational description)	Primary risk	L (1–5)	S (1–5)	Score	Class	Control (concise, class-aligned)
1	Structural cracks below exterior electrical panel; visible conductors	Electric shock	3	5	15	Significant	Enclose, lock, and insulate panel; protect exposed conductors against weather and contact.
2	Uneven, cracked ramp with irregular slope	Fall on same level	2	3	6	Acceptable	Resurface with even concrete; correct slope and edges.
3	Substandard cleanliness of interior surfaces	Biological contamination	2	4	8	Moderate	Implement cleaning SOP; integrate pest control and hygiene checks.
4	Irregular, worn floor	Slip, trip, and fall	4	3	12	Moderate	Install non-slip, cleanable flooring; schedule routine repair.
5	Detergents stored near cooling tank	Chemical contamination/exposure	3	3	9	Moderate	Segregate chemicals in closed, labeled cabinets away from food contact areas.
6	Non-sanitary churns/receptacles	Biological risk	3	3	9	Moderate	Clean and disinfect equipment regularly; document periodic checks.
7	Improper raw-milk handling	Biological risk	3	3	9	Moderate	Enforce glove use; ensure hand sanitizer availability at point of use.
8	Manual lifting/transport of heavy churns	Musculoskeletal load	4	4	16	Significant	Provide mechanical aids; deliver safe-handling training and supervision.
9	Cooling failure under heat stress	Quality loss/spoilage	3	4	12	Moderate	Maintain redundancy; perform preventive maintenance with heat-season checks.
10	Inadequate personal hygiene during sampling	Biological risk	3	3	9	Moderate	Provide hygiene training; require PPE (gloves, caps, gowns).
11	Antibiotic tester malfunction	False result	2	3	6	Acceptable	Schedule calibration/functional checks per manufacturer guidance.
12	Contaminated transfer hose	Biological risk	3	3	9	Moderate	Use food-contact-grade hose; replace at defined intervals.
13	Compressor and cables without safeguards	Electric/mechanical injury	3	5	15	Significant	Route cables via reels/ducts; guard moving parts; enforce periodic inspection.
14	Cable clutter along transfer path	Trip and fall	3	3	9	Moderate	Install warning/segregation; block pedestrian passage during transfer.
15	Chemical use during cleaning	Exposure	3	3	9	Moderate	Train on chemical hazards; require PPE (gloves, goggles, gowns, masks).

No.	Hazard (operational description)	Primary risk	L (1–5)	S (1–5)	Score	Class	Control (concise, class-aligned)
16	Chemicals left uncapped/exposed	Contamination/poisoning	3	4	12	Moderate	Store in capped, preferably lockable cabinets (metal/plastic).
17	Inadequate rinsing after chemical cleaning	Chemical carryover	3	4	12	Moderate	Rinse thoroughly; verify absence of residue before reuse.
18	Suboptimal cleanliness of sample cups	Cross-contamination	2	3	6	Acceptable	Wash with detergent, rinse with potable water, and dry between uses.
19	Cluttered layout impeding cleaning	Hygiene deficit/dust accumulation	3	2	6	Acceptable	Reorganize layout to enable thorough, routine cleaning.

As summarized in Table 3, electrical and ergonomic hazards produced the highest risk scores, followed by moderate-level hygiene and chemical handling risks. The quantitative distribution of classes derived from these data is presented in Table 4.

Table 4. Distribution of hazards by risk class (n, %)

Risk class	n	%
Significant	3	15.8
Moderate	12	63.2
Acceptable	4	21.1
Total	19	100.0

Taken together, the class distribution in Table 4 (visualized in Figure 1) indicates that the center's risk profile is dominated by hazards in the Moderate band, with a smaller subset of Significant items that concentrate around electrical integrity and manual handling. This pattern suggests two complementary priorities: (i) immediate engineering and administrative controls for the few high-leverage hazards that currently constrain safe operations, and (ii) standardized routines to drive incremental reductions across the broader group of hygiene- and housekeeping-related risks. Notably, several Moderate hazards arise at the interface of sanitation and workflow (chemical segregation and storage, post-cleaning rinsing verification, and food-contact compliance of hoses and receptacles), underscoring the importance of procedure design as much as equipment condition.

In practical terms, the hazard register provides an actionable queue: eliminating the Significant items is expected to yield disproportionate gains in overall risk posture, while protocolized checks (e.g., pre-shift inspections, documented cleaning and PPE compliance) can steadily compress the Moderate cluster. The following Discussion interprets these findings in the context of comparable low-resource dairy collection settings, highlights likely mechanisms behind the observed pattern, and outlines implications for implementation and monitoring.

Discussion

This field-based assessment identified nineteen discrete hazards across the intake–cooling–dispatch workflow of a village-level milk collection center and appraised their occupational risk using a 5×5 decision matrix. Three hazards reached the Significant class (scores 15–16) – electrical integrity deficiencies around the exterior panel and compressor, and high musculoskeletal load from manual handling of heavy churns – indicating conditions that warrant immediate control before routine operation resumes. Twelve hazards were Moderate, dominated by hygiene–chemical interfaces (segregation and storage of cleaning agents, adequacy of post-cleaning rinsing, food-contact status of hoses and receptacles) and by personal/operational hygiene during sampling. Four hazards were Acceptable within current controls; no item was Unacceptable (25) or Negligible (1).

When positioned against recent evidence, the ergonomic signal in our data aligns with reviews and field investigations showing that lifting, awkward postures, and repetitive manual tasks place dairy workers at elevated risk of musculoskeletal disorders; interventions consistently prioritize mechanical aids and workstation redesign as first-line controls [15;16]. Our observation of undercontrolled electrical integrity at farm-adjacent sites is also consistent with rapid reviews of agricultural workplaces, which emphasize enclosure, grounding or residual-current protection, and structured inspection regimes to mitigate shock and arc hazards [17].

The Moderate cluster we observed at sanitation–workflow interfaces mirrors value-chain studies reporting practice-linked contamination nodes during collection and transfer in small-scale dairy systems; these studies highlight good hygiene practices, cleaning verification, and standardized procedures as tractable levers for risk reduction in low-resource settings [18; 19]. Open chemical storage and potential carryover detected here are congruent with surveys showing variable adoption of documented hygiene programs and the need for clearer segregation and labeling of chemicals in small-scale plants [18]. In parallel, although we did

not assay aflatoxin M1 (AFM1), the chemical-risk signal we recorded is coherent with umbrella and regional reviews documenting persistent AFM1 occurrence in milk and dairy products and underscoring the importance of upstream feed controls and verification [20; 21].

Temperature-reliant steps in our workflow (cooling reliability under heat stress) echo engineering literature on cold-chain resilience, where phase change material-based thermal buffering and related low-cost solutions have been proposed for short-haul transport; such measures could be adapted to village-level collection centers to stabilize quality without grid dependence [22; 23]. More broadly, factory-level and plant-adjacent hazard surveys that include milk collection areas report mixed profiles similar to ours and advocate the same hierarchy of controls, suggesting transferability of our recommendations beyond a single site [24].

Methodologically, the 5×5 matrix balanced practicality and transparency for on-site decision-making; it enabled rapid prioritization and communication with stakeholders. At the same time, matrix-based scoring entails an element of subjectivity, especially when likelihood and severity must be inferred from short observation windows. We mitigated underestimation by applying the highest credible likelihood–severity combination for recurrent hazards, but future work could triangulate these appraisals with alternative frameworks (e.g., Fine–Kinney, bow-tie analysis, or HACCP-style verification) and with targeted safety training, including e-learning programs that have shown improvements in safety climate among dairy supervisors [24; 25]. Finally, our single-site design limits generalizability; nonetheless, it provides practice-oriented evidence from an under-represented village-scale setting that aligns with risk patterns documented in comparable low-resource dairy chains and agricultural workplaces.

Conclusions

This study demonstrates that routine milk collection and dispatch at a village-level center is characterized by a small number of high-leverage hazards – principally electrical integrity lapses around the exterior panel and compressor and substantial musculoskeletal load from manual handling – embedded within a broader set of moderate risks linked to hygiene practices, chemical management, housekeeping, and sampling discipline. Using a 5×5 decision matrix across five days of non-participant observation, nineteen discrete hazards were identified and ranked; three were classified as Significant and twelve as Moderate, indicating that the overall risk posture can be materially improved by eliminating a few critical hazards while standardizing day-to-day routines that drive the mid-tier cluster.

In practical terms, immediate controls should harden electrical safety by enclosing, locking, and insulating the panel, protecting exposed conductors, routing cables through reels or ducts, and implementing residual-current protection with a lock-out/tag-out procedure for maintenance. Compressor safety should be reinforced with guarding of moving parts, documented inspection, and verified earthing and cable integrity. Ergonomic load should be reduced by introducing mechanical aids for lifting and transport of churns, delivering competency-based safe-handling training, and optimizing transfer heights to minimize stooping and twisting. Over the subsequent months, routines should institutionalize segregated and locked chemical storage with safety data sheets, verified post-cleaning rinsing of the cooling tank, food-contact compliance and scheduled replacement for hoses and receptacles, and point-of-use hygiene with PPE and hand sanitizer. Housekeeping should regularize floor finishes and eliminate cable clutter along transfer paths while preventive maintenance enhances cooling reliability with heat-season checks and basic redundancy for equipment or power interruptions. From a sustainability perspective, periodic refresher training, pre-shift checklists, and a simple near-miss learning loop can maintain performance and guide incremental improvements.

Although based on a single site, these controls are transferable to comparable low-resource collection settings and are expected to reduce injury and contamination risks, support product quality, and lower spoilage-related losses without disrupting operations.

References

1. Maia L, Rodrigues L. Saúde e segurança no ambiente rural: uma análise das condições de trabalho em um setor de ordenha. *Ciencia Rural*. 2012;42:1134-1139. doi:10.1590/S0103-84782012000600030.
2. Wasmuth I, Warinner C, Stallforth P. Microbial dynamics and *Pseudomonas* natural product production in milk and dairy products. *Natural Product Reports*. 2025;42:842-855. doi:10.1039/d4np00074a.
3. Pattanaik RN. Hazards & safety measures in dairy industry – a review. *International Journal of Engineering Research & Technology (IJERT)*. 2019;8(1):22-26.
4. Dijkink B, Esveld E, Broeze J, Vollebregt M. Evaluation of scenarios for improving the collection system for a milk factory in Ethiopia. *Frontiers in Sustainable Food Systems*. 2021;5:645057.
5. Paredes-Belmar G, Montero E, Leonardini O. A milk transportation problem with milk collection centers and vehicle routing. *ISA Transactions*. 2022;122:294-311. doi:10.1016/j.isatra.2021.04.020.
6. Sayın C, Mencet MN, Taşcıoğlu Y. Süt toplama merkezlerinin, sokak sütçülüğünü önlemedeki rollerinin belirlenmesi: Antalya ili örneği. *Akdeniz University Journal of the Faculty of Agriculture*. 2010;23(2):117-125.
7. Fagundes H, Barchesi L, Filho AN, Ferreira LM, Oliveira CA. Occurrence of *Staphylococcus aureus* in raw milk produced in dairy farms in São Paulo state, Brazil. *Brazilian Journal of Microbiology*. 2010;41(2):376-380. doi:10.1590/S1517-838220100002000018.
8. Omar SS. Aflatoxin M1 levels in raw milk, pasteurised milk and infant formula. *Italian Journal of Food Safety*. 2016;5(3):5788. doi:10.4081/ijfs.2016.5788.
9. Oswald D, Sherratt F, Smith S. Problems with safety observation reporting: a construction industry case study. *Safety Science*. 2018;107:35-45.

10. Mazloumi A, Kouhnavard B. Investigation of observational techniques ergonomic risk assessment of work-related musculoskeletal disorders among farmers: a systematic review. *Journal of Agromedicine*. 2025;30:616-639. doi:10.1080/1059924X.2024.2436447.
11. Gul M, Ak MF. A comparative outline for quantifying risk ratings in occupational health and safety risk assessment. *Journal of Cleaner Production*. 2018;196:653-664.
12. Arıca F, Çağlar E. Bir fabrika mutfığı örneği: kapsamlı risk analizi ve iyileştirme önerileri. *Osmaniye Korkut Ata Üniversitesi Fen Bilimleri Enstitüsü Dergisi*. 2024;7(5):2244-2262. doi:10.47495/okufbed.1421383.
13. Gul M, Guneri AF. A fuzzy multi criteria risk assessment based on decision matrix technique: a case study for aluminum industry. *Journal of Loss Prevention in the Process Industries*. 2016;40:89-100.
14. Parlak T. Gıda ürünleri üretiminde hijyen kavramına farklı bir bakış. *OHS Academy*. 2020;3(2):73-101. doi:10.38213/ohsacademy.740.
15. Gregg C, Bisi G, Orlandi M, et al. Work-Related Musculoskeletal Disorders: A Systematic Review on Risk Factors in Agriculture and Dairy Farming. *J Clin Med*. 2024;13(13):3964.
16. Buisseret F, Ciuti G, Galli M, et al. Occupational risk factors for musculoskeletal disorders among workers in dairy diversification. *Int J Environ Res Public Health*. 2024;21(1):76.
17. SafeWork NSW. Electrical hazards on Australian farms: A rapid review of electrical perceptions in agriculture. Sydney: NSW Government; 2024.
18. Djekić I, Veličković M, Smigic N, et al. Level of adoption of hygiene practices in small-scale dairy plants: a Serbian case study. *Foods*. 2024;13(9):1448.
19. Desisa BA, Yilma MT, Andualem BT, et al. Exploring hygienic milk and meat handling practices and associated factors along the value chain in Ethiopia. *Int J Environ Res Public Health*. 2025;22(1):87.
20. Malissiova E, Katsioulis A, Pexara A, Govaris A. A 20-year data review on the occurrence of aflatoxin M1 in milk and dairy products in Mediterranean countries. *Dairy*. 2024;5(3):338–361.
21. Jahromi AS, Hemati F, Khezri AA, et al. Prevalence and concentration of aflatoxin M1 in milk and dairy products: an umbrella review of meta-analyses. *Foods*. 2025;14(4):854.

22. Calati M, Piselli G, Stellacci S, et al. Thermal storage based on phase change materials for refrigerated transport and cold distribution: a review. *Energy Storage Mater.* 2022;47:553–576.
23. Chaomuang N, Lertsuwan K, Sangsawang K, et al. A case study on raw milk preservation for local transport using water-based PCM gel packs and UV-reflective covers. *Case Stud Therm Eng.* 2025;53:103717.
24. Özbakır O. Hazard and risk assessment in a dairy products factory in Iğdır province using the Fine–Kinney risk method: recommendations for mitigation. *J Agric Environ For Sci.* 2023;7(3):563–572.
25. Douphrate DI, Khatri M, Sall AA, et al. Implementation and effectiveness evaluation in the dairy farm industry: safety leadership e-learning training. *Int J Environ Res Public Health.* 2025;22(5):456.