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Occupational Health and Safety in Beekeeping: an Analysis of Bayburt and the Upper Çoruh Valley

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Abstract

Beekeeping is an agricultural activity closely intertwined with nature and involves various occupational risk factors. This study examines stationary and migratory beekeepers' occupational health and safety risks in the Bayburt and Upper Çoruh Valley regions. The research evaluates the chemical, physical, biological, and ergonomic risks beekeepers face and analyses their potential adverse effects on beekeepers' health and public health. It is noted that the use of antibiotics and pesticides poses a risk of residue in honey, potentially affecting the food chain and leading to occupational diseases. Using the Fine-Kinney risk analysis method, evaluations were conducted in 13 apiaries, identifying 17 risks: 5 ergonomic, 4 physical, 6 chemical, and 2 biological. Among these risks, heavy lifting and repetitive movements were prominent in terms of ergonomic risks, pesticide and antibiotic use in terms of chemical risks, apiary site safety and traffic accidents in terms of physical risks, and bee stings and wild animal attacks in terms of biological risks. The study emphasises the need to enhance occupational health and safety measures in the beekeeping sector and to adopt more modern production methods.

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1 INTRODUCTION

Beekeeping is an activity that involves the use of plant resources, bees, and labour together to produce honey, royal jelly, bee venom, pollen, and propolis, which humans have used for nutrition, health protection, and treatment purposes since ancient times. In addition, it includes queen bee, swarm, and package bee production processes, which provide significant income. The influential role of bees in pollination is of great importance to the agricultural sector. Beekeeping is the most nature-dependent form of livestock farming because the way honeybees live and the raw materials for their products come directly from nature [1].

Beekeeping's dependence on nature makes it highly sensitive to environmental changes such as climate change, habitat destruction, and pollution. These factors directly influence the health and productivity of bee colonies and, consequently, the quality and quantity of bee products. Moreover, the multifaceted nature of beekeeping as a craft that requires skill, knowledge of bee biology, and adaptability to changing conditions underscores its complexity and importance as a livelihood [2].

Beekeeping is a globally widespread agricultural activity, with approximately 92,996,837 hives and 2,168,295 tons of honey produced, according to the 2019 FAO (Food and Agriculture Organization) statistics. Reasons for choosing beekeeping include low capital requirements, high return rates, low costs, relatively low labour needs, the long shelf life of the products, and the desire for a hobby and additional income. Moreover, the fact that it can be done without the need for land makes it an attractive option for farmers without land [3].

Global interest in apiculture has also risen due to the increasing demand for natural and organic products. Bee products such as propolis and royal jelly are gaining popularity for their medicinal properties, further boosting their market value. This trend highlights the economic potential of beekeeping not just in rural areas but also as a small-scale urban enterprise, especially in developing countries [4].

Turkey has an advanced structure in terms of natural conditions for beekeeping. Ensuring the conscious use of these natural advantages will increase the production of other bee products, along with honey, which is a perfect food in every aspect [5]. Beekeeping is classified as a "hazardous" profession under code 01.49.01 in the Workplace Hazard Classes List published in the Official Gazette dated 27.2.2017 and numbered 29992. According to 2019 FAOSTAT data, India ranks first in the world with 12,247,332 hives, China second with 9,230,940 hives, and Turkey third with 8,128,360 hives [6]. This shows that beekeeping is widely practised in Turkey. However, although beekeepers and institutions that support this profession through training and projects are partially aware of the occupational health and safety risks in beekeeping, no scientific risk analysis has been conducted.

Despite its widespread adoption in Turkey, the beekeeping sector faces challenges such as inadequate infrastructure, limited access to modern equipment, and insufficient awareness about good practices. Addressing these issues through targeted training programs and supportive policies could significantly enhance both productivity and occupational safety in the sector [7].

This study is critical in identifying and addressing the occupational health and safety risks in the beekeeping profession, which is classified as hazardous. The widespread use of antibiotics and pesticides during beekeeping activities can cause occupational diseases and threaten the health of all consumers by leaving residues in honey and entering the food chain. Pesticides can cause poisoning in the short term, and prolonged exposure can lead to chronic nervous system diseases, hormonal disorders, and diabetes or exacerbate the onset of such diseases.

Furthermore, the integration of sustainable agricultural practices in beekeeping, such as the use of natural pest control methods, could minimize chemical exposure risks. Promoting eco-friendly approaches not only protects beekeepers' health but also enhances consumer trust in bee products, ensuring their safety and marketability [8].
Occupational health and safety, as defined by the WHO (World Health Organization) and the ILO (International Labour Organization), is aimed at raising the physical, mental, and social health and well-being of all workers to the highest level [9]. Maintaining this level requires eliminating the negative health impacts of workplace conditions, environments, and products, removing risk factors that could cause injuries and accidents, and placing workers in jobs suited to their physical and mental characteristics, thus creating a safe working environment that takes both physical and psychological needs into account [10].

Occupational health and safety studies have shown that accidents and occupational diseases can be significantly prevented if adequate and effective measures are taken. These measures include controlling hazards at the source, planning work systems to reduce risks to the lowest level, using less dangerous materials instead of hazardous ones, and using personal and protective equipment. Furthermore, occupational health and safety should be a

principle embraced by upper management, and all parties should adopt shared values and responsibilities to implement the necessary precautions [11].

In this context, using the Fine-Kinney risk analysis method, this study aims to identify the "occupational health and safety risk factors" in the beekeeping sector, particularly ergonomic, physical, biological, and chemical exposures, such as the use of agricultural chemicals and antibiotics for bee diseases, in 13 apiaries operated by stationary and migratory beekeepers in the Çoruh Valley and Bayburt. Recommendations were also made to mitigate these risks.

2 MATERIALS AND METHODS

2.1 Study region

This research is planned as a cross-sectional study aimed at identifying the occupational health and safety risks in the beekeeping profession and determining the impact of these risk factors on both beekeepers and public health. The study focuses on 13 apiaries operating in the Çoruh Valley and Bayburt regions, utilising the Fine-Kinney risk analysis method to identify occupational health and safety risks related to ergonomic, physical, biological, and chemical exposures stemming from agricultural pesticides and bee diseases. The study aims to identify the beekeeping sector's occupational health and safety risk factors and propose measures to prevent these risks. Approximately 550-600 beekeepers operate in the region. Information on the locations of the examined apiaries is provided in Figure 1 and Table 1.

Figure 1. Regional distribution of examined apiaries

Table 1. Location information of examined apiaries

APIARY	REGION OF THE	COORDINATES	DATE OF EXAMINATION
01	Mülk	40º 17’ 28º N - 40º 55’ 14º E	August - September 2020
02	Yıldıztepe	40º 39’ 20º N - 41º 03’ 46º E	August - September 2020
03	Değirmenli 1	40º 30’ 12º N - 41º 01’ 45º E	August - September 2020
04	Değirmenli 2	40º 30’ 18º N - 41º 05’ 01º E	August - September 2020
05	Moryayla	40º 36’ 36º N - 40º 54’ 49º E	August - September 2020
06	Aktaş	40º 26’ 17º N - 41º 03’ 56º E	August - September 2020
07	Numanpaşa	40º 32’ 56º N - 41º 07’ 05º E	August - September 2020
08	Karayaşmak	40º 09’ 41º N - 39º 54’ 47º E	August - September 2020
09	Kokmuşlar	40º 11’ 22º N - 39º 50’ 23º E	August - September 2020
10	Baraj	40º 07’ 53º N - 39º 53’ 23º E	August - September 2020
11	Boğaz	40º 13’ 42º N - 40º 04’ 31º E	August - September 2020
12	İspinlik	40º 11’ 19º N - 39º 54’ 44º E	August - September 2020
13	Hoga	40º 20’ 12º N - 40º 55’ 07º E	August - September 2020

The Çoruh Valley is known for its rich biodiversity due to its natural features. The valley is located in the Caucasus Ecological Region, one of the world's 200 most ecologically significant areas identified by the WWF (World Wildlife Fund), and it is one of nine essential plant areas on the Turkish side of this region. The basin, with an area of 19,748 km², lies between 39° 40' and 42° 35' longitude and 39° 52' and 41° 32' latitude, bordered by the Eastern Black Sea Mountains to the north, the Giresun Mountains to the west, Otlukbeli, Dumlu, Kargapazarı, Güllü, and Allahüekber Mountains to the south, and the Yanlızçam Mountains and Georgia to the east. As one moves inland from the Black Sea coast, the climate transitions from temperate to continental. The mountains surrounding the Çoruh River rise to 3,000 meters within 15 km, while the valley floor descends to 75 meters near the Georgian border [12, 13].

Bayburt, located within the study area, is situated in the Eastern Black Sea region of the Black Sea Region, between 40° 37' north latitude and 40° 45' east longitude, 39° 52' south latitude and 39° 37' west longitude. Bayburt, located along the Çoruh River at an elevation of 1,550 meters above sea level, covers an area of 3,739 km². Geographically, it consists of a basin extending between mountain ranges to the north and south, and its topography includes mountains, plains, and valleys [14]. Bayburt is a newly developing region in terms of beekeeping, with 72,266 hives recorded in 2018 and 408 tons of honey produced in the same year, according to Turkish Statistical Institute (TÜİK) data. Recently, migratory beekeeping activities have increased significantly in the region [15].

2.2 Risk assessment method

The Fine-Kinney method was used to conduct a risk assessment for production activities in the beekeeping enterprises examined in this study. The Fine-Kinney method is a mathematical risk assessment method in which risks are ranked according to priority. This helps determine the priority for resource allocation. The severity of potential damage to humans, businesses, or the environment is calculated, and based on the severity score, the priority of necessary preventive measures is determined. Risks are ranked in order of importance. Unlike other methods, the Fine-Kinney method includes a frequency scale in its calculations. The scales used in Fine-Kinney risk analysis are Probability (P), Frequency (F), and Severity (S). During the application of this method, potential event values are found in tables, which are mathematically multiplied to calculate the risk score. The formula used for an undesirable event is given below: [16, 17].

$$Risk\ Score(R) = Probability(P) \times Frequency(F) \times Severity(S) \quad (1)$$

In the Fine-Kinney assessment method, the probability is the likelihood of an undesirable event occurring over time, resulting in damage or injury. Probability values are rated between 0.1 and 10, and the probability value is determined by assessing whether the safety measures in the workplace are sufficient to prevent damage. The probability scale is shown in Table 2. Frequency is the frequency of exposure to the hazard over a specified period. Frequency values are rated between 0.5 and 10. When evaluating the frequency, it is not the frequency of the task itself but the frequency of exposure to the hazard during the task that is considered. The frequency scale is also shown in Table 2. Severity is the estimated damage a hazard may cause to humans and the environment. Severity values are rated between 1 and 100. In cases of doubt or uncertainty about the severity of an event, a higher value should be selected. The severity scale is also shown in Table 2 [16, 18].

After the hazards in the workplace are evaluated, the risk score is calculated by multiplying the probability, frequency, and severity values, and the risk level is determined based on the risk score range, as shown in Table 3. The priority of safety measures and the sequence of preventive actions are determined based on the risk scores [16].

3 RESULTS AND DISCUSSION

Using the Fine-Kinney method, this study systematically categorised occupational health and safety risks in the beekeeping sector. The risk analysis identified 5 ergonomic, 4 physical, 6 chemical, and 2 biological risk factors. In the ergonomic risk group, the probability of "Manual Handling of Heavy Loads," "Repetitive Movements," and "Incorrect Body Postures" was rated as "6- highly probable," their frequency as "6- frequently (once or more per day)," and their severity as "7- serious (significant harm, external treatment, loss of workdays)." The risk score for all three risks was calculated as "252- High Risk (200 <R <400)- To Be Addressed with a Short-Term Action Plan." Another ergonomic risk, "Contact with Hard Surfaces," was evaluated with a probability of "6- highly probable," a frequency of "6- frequently (once or more per day)," and severity as "3- important (low work loss, minor damage, first aid)." The risk score was calculated as "108- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan." Another ergonomic risk, "Prolonged Standing," was rated with a probability of "10- very high probability," a frequency of "6- frequently (once or more per day)," and

severity as "3- important (low work loss, minor damage, first aid)," yielding a risk score of "180- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan" [19].

Table 2. Probability, frequency, and severity scales

PROBABILITY		FREQUENCY			SEVERITY		
Value	**Description**	**Value**	**Description**	**Category**	**Value**	**Description**	**Category**
0.2	Almost Impossible	0.5	Very Infrequent	Once per year or less	1	Worth Considering	Minor - Harmless or Negligible Impact
0.5	Low Probability	1	Seldom	Once or a few times annually	3	Important	Minimal Work Loss, Minor Injury, First Aid Needed
1	Unlikely	2	Infrequent	Once or a few times monthly	7	Serious	Notable Damage, Medical Treatment, Lost Workdays
3	Possible, Though Uncommon	3	Occasionally	Once or a few times weekly	15	Very Serious	Disability, Loss of Limbs, Environmental Harm
6	Likely	6	Regularly	Once or more each day	40	Severe	Death, Total Disability, Major Environmental Damage
10	Very High Probability	10	Continuously	Constant or multiple times per hour	100	Catastrophic	Multiple Fatalities, Large-Scale Environmental Disaster

Table 3. Impact-damage outcome scale

RISK VALUE	DECISION	ACTION
R < 20	Acceptable Risk	Immediate action may not be necessary
20 < R < 70	Definite Risk	Should be incorporated into the action plan
70 < R < 200	Significant Risk	Needs careful monitoring and should be included in the annual action plan
200 < R < 400	High Risk	Should be tackled in a short-term action plan
R > 400	Very High Risk	Work should be halted, and immediate precautionary measures must be implemented

In the physical risk group, the probability of "Safety Risks" was rated as "3- rare but possible," its frequency as "1- very rare (once or a few times per year)," and its severity as "7- serious (significant harm, external treatment, loss of workdays)," with a calculated risk score of "21- Certain Risk (20 <R <70)- To Be Included in the Action Plan." Another physical risk, "Low Pressure," was evaluated with a probability of "1- very low probability," a frequency of "3- occasionally (once or a few times per week)," and severity as "3- important (low work loss, minor damage, first aid)," resulting in a risk score of "9- Acceptable Risk (R<20)- May Not Require Immediate Measures." The risk factor "Thermal Comfort" in the physical risk group was assessed with a probability of "6- highly probable," a frequency of "6- frequently (once or more per day)," and severity as "7- serious (significant harm, external treatment, loss of workdays)," yielding a risk score of "252- High Risk (200 <R <400)- To Be

Addressed with a Short-Term Action Plan." Lastly, "Traffic Accidents" was evaluated with a probability of "3- rare but possible," frequency as "1- very rare (once or a few times per year)," and severity as "40- very severe (death, permanent disability, severe environmental impact)," resulting in a risk score of "120- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan"[7, 19].

Table 4. The risk analysis

					RISK ASSESSMENT					
RISK NO	**RISK GROUP**	**RISK TYPE**	**HAZARD SOURCE**	**IDENTIFIED RISK**	**PROBABILITY**	**FREQUENCY**	**SEVERITY**	**RISK SCORE**	**RISK DEFINITION**	**CORRECTIVE PREVENTIVE ACTIONS (CPA)**
1	Ergonomic Risk	Manual Handling of Heavy Loads	1. Handling heavy materials such as beehives, honey extractors, etc., by a single person: loading, unloading, transporting, and placing in the apiary. 2. Harvest operations	1. Handling heavy materials such as beehives, honey extractors, etc., by a single person: loading, unloading, transporting, and placing in the apiary. 2. Harvest operations	**6**	**6**	**7**	**252**	**HIGH RISK**	1. Mechanical systems should be used to minimise the force applied by the beekeeper. 2. Adjustable handcarts should be provided for transporting loads. 3. If possible, the weight of beehives and other loads should be reduced. 4. The apiary should be organised to minimise bending, reaching, and overhead lifting. 5. a single person should not carry Beehives. 6. Beekeepers should be trained in manual handling tasks.
2	Ergonomic Risk	Repetitive Movements	1. Hive and frame inspections 2. Harvest operations	1. Hive and frame inspections 2. Harvest operations	**6**	**6**	**7**	**252**	**HIGH RISK**	1. The force required for repetitive movements should be reduced. 2. Work schedules should allow breaks and task rotation to engage different muscle groups. 3. Beekeepers should be allowed to set their own pace. 4. Avoid setting quotas or job limits that pressure workers. 5. Beekeepers should be given time for stretching and relaxing. 6. Training on how to rest muscles is necessary.
3	Ergonomic Risk	Contact with Hard Surfaces	1. Tasks during hive and frame inspections or maintenance of hives	1. Tasks during hive and frame inspections or maintenance of hives	**6**	**6**	**3**	**108**	**SIGNIFICANT RISK**	1. Kneepads should be provided for tasks requiring knee work. 2. Workers should be trained to avoid prolonged contact with hard or sharp surfaces.

4	Ergonomic Risk	Incorrect Body Posture	1. Tasks during hive and frame inspections or maintenance of hives	1. Injuries 2. Musculoskeletal disorders 3. Carpal tunnel syndrome	**6**	**6**	**7**	**252**	**HIGH RISK**	1. The apiary should be organised to reduce bending and stretching. 2. Elevating stands should be placed under beehives for more accessible work at waist height. 3. Other materials should be stored between knee and shoulder height. 4. Platforms should be used to avoid reaching overhead. 5. Beekeepers should be trained in proper posture.
5	Ergonomic Risk	Prolonged Standing	1. Tasks during hive and frame inspections or maintenance of hives	1. Musculoskeletal disorders 2. Circulatory system diseases	**10**	**6**	**3**	**180**	**SIGNIFICANT RISK**	1. Footwear should support natural foot posture and allow movement, with heels no higher than 5 cm. 2. A chair or stool should be provided for rest periods. 3. Avoid extending beyond the arm's reach, twisting, or bending inappropriately. 4. Hive height should be at elbow level; short beekeepers should use a platform. 5. Beekeepers should keep a 20-30 cm distance between themselves and the hive. 6. When standing, the beekeeper should face the hive and turn by moving their feet instead of twisting their body.
6	Physical Risk	Safety Risks	1. Selection of unsafe apiary location	1. Illnesses 2. Injuries 3. Death	**3**	**1**	**7**	**21**	**CERTAIN RISK**	1. The location should allow easy access to health, nutrition, and other social needs. 2. It should be away from areas where the government does not permit residence due to terrorism or similar risks. 3. The area should have easy access to communication and transport. 4. Avoid regions prone to theft. 5. Stay away from roads with heavy traffic. 6. Avoid areas where frequent agricultural spraying occurs. 7. Stay away from public parks and recreational areas. 8. Choose locations sheltered from wind and rain, with shade in the summer and facing south in the winter. 9. Ensure at least a 3 km distance between two apiaries.
7	Physical Risk	Low Pressure	1. Hive and frame inspections 2. Harvest operations	1. Respiratory issuesHeadaches 3. Nausea 4. Vomiting 5. Loss of appetite 6. Restlessness 7. Personality changes 8. Insomnia	**1**	**3**	**3**	**9**	**ACCEPTABLE RISK**	1. Avoid beekeeping in areas higher than 2000 meters above sea level. 2. Engage in non-strenuous exercises. 3. Drink plenty of water and maintain a healthy diet.

8	Physical Risk	Thermal Comfort Risks	1. Hive and frame inspections 2. Harvest operations	1. Heat rash 2. Heat exhaustion 3. Heat cramps 4. Heatstroke 5. Pharyngitis 6. Bronchitis	**6**	**6**	**7**	**252**	**HIGH RISK**	1. Work hours should be scheduled considering the hottest hours. 2. More workers should complete tasks posing thermal risks quickly. 3. Rest breaks should be provided at appropriate intervals and environments. 4. Rotation among workers should be implemented. 5. A first-aid unit should be established, and workers should be trained. 6. Personal protective equipment should provide protection and comfort; ventilated materials allowing breathing should be preferred.
9	Physical Risk	Traffic Accidents	1. Transporting beehives or the apiary	1. Injuries 2. Death	**3**	**1**	**40**	**120**	**SIGNIFICANT RISK**	1. Follow traffic rules and establish a culture of safety. Beekeepers should also ensure maximum weight and height limits are adhered to during loading, and they should avoid driving when tired or sleep-deprived.
10	Chemical Risk	Use of Organic Acids	1. Contact with formic acid or oxalic acid due to usage	1. Chemical burns 2. Chemical poisoning 3. Cancer 4. Skin diseases 5. Death	**3**	**3**	**15**	**135**	**SIGNIFICANT RISK**	1. The use of these chemicals should be limited, and they should be removed from the environment. 2. Workers should be trained on what to do in case of contact. 3. Material Safety Data Sheets (MSDS) for chemicals must be available, and safety precautions outlined in them should be followed.
11	Chemical Risk	Heavy Metal Residue in the Hone	1. Exposure to heavy metals (Fe, Cu, Zn, Pb) due to environment and contamination)	1. Poisoning of both beekeeper and bee products 2. Cancer 3. Death 4. Public health issues	**6**	**1**	**40**	**240**	**HIGH RISK**	1. Select apiaries at least 5 km from urban centres, highways, and industrial facilities. 2. Use registered, heavy-metal-free chemicals for disease and pest control. 3. Beekeepers should be educated on heavy metal contamination in bee products. 4. Collection, extraction, and storage equipment should be made from stainless steel, and hives should be kept away from waste disposal centres. When harvesting royal jelly, use wooden or glass spoons.

12	Chemical Risk	Use of PAHs	1. Naphthalene usage	1. Poisoning of both beekeeper and bee products 2. Cancer 3. Death 4. Public health issues	**6**	**1**	**15**	**90**	**SIGNIFICANT RISK**	1. Beekeepers should be trained and subject to strict inspections regarding the residue risks of naphthalene, especially in combs, and its health hazards. 2. Licensed alternatives should be used instead of naphthalene for disease and pest control. 3. No drugs should be applied during production, and no bee products should be harvested from diseased hives.
13	Chemical Risk	Pesticide Usage	1. Use of Caumophos and Amitraz	1. Poisoning of both beekeeper and bee products 2. Cancer 3. Death 4. Public health issues	**6**	**1**	**40**	**240**	**HIGH RISK**	1. Avoid using unlicensed and intensive drugs that can leave pesticide residues in honey. If necessary, use licensed drugs outside the honey production season. 2. In case of disease in bee colonies, seek expert support and use appropriate licensed drugs. If American or European foulbrood is detected, inform the relevant authorities to prevent potential spread. 3. Beekeepers should adhere to hygiene practices, especially regarding polluted water sources.
14	Chemical Risk	Antibiotic Usage	1. Use of Sulfa, Tetra, Strepto antibiotics	1. Poisoning of both beekeeper and bee products 2. Cancer 3. Death 4. Public health issues	**6**	**1**	**40**	**240**	**HIGH RISK**	1. Avoid using unlicensed and intensive antibiotics that can leave residues in honey. If necessary, use licensed drugs outside the honey production season. 2. When diseases are detected in bee colonies, seek support from experts and use appropriate licensed antibiotics. Diseases like American or European foulbrood should be reported to authorities to prevent their spread. 3. Beekeepers should adhere to hygiene practices, especially regarding polluted water sources.
15	Chemical Risk	Fire	1. Use of smoker 2. Use of gas or primitive methods for lighting and heating	1. Injuries 2. Death	**3**	**1**	**40**	**120**	**SIGNIFICANT RISK**	1. Always keep water or appropriately sized fire extinguishers nearby when using a smoker. 2. Only dry fuel like paper, pine needles, and bark should be used when lighting smokers, and flammable materials should not be used. 3. Smokers should be lit away from hives and only placed near other beekeeping equipment once wholly extinguished. 4. During colony transport, ensure smokers are fully extinguished before leaving the apiary.

16	Biological Risk	Wild Animal Attack	1. Apiary location selection 2. Storage operations	1. Injuries 2. Death	**3**	**1**	**40**	**120**	**SIGNIFICANT RISK**	1. Electric fencing or simple sensor-based early warning systems should be installed to prevent wild animal attacks
17	Biological Risk	Bee Stings	1. Hive and frame inspections 2. Harvest operations 3. Transportation operations	1 1. Injuries 2. Death	**10**	**6**	**3**	**180**	**SIGNIFICANT RISK**	1. Personal protective clothing and masks should be worn. 2. Beekeepers should keep ready-to-use adrenaline auto-injectors in their homes and apiaries. Those with allergies should carry their auto-injector and be trained in its use. Beekeepers should also receive training on the use of these injectors. If systemic reactions occur, venom immunotherapy should be administered to positive patients.

In the chemical risk group, the probability of "Use of Organic Acids" was rated as "3- rare but possible," its frequency as "3- occasionally (once or a few times per week)," and its severity as "15- very serious (disability, loss of limb, environmental impact)," resulting in a risk score of "135- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan." The risk of "Heavy Metal Residue in Honey" was evaluated with a probability of "6- highly probable," a frequency of "1- very rare (once or a few times per year)," and severity as "40- very severe (death, permanent disability, severe environmental impact)," yielding a risk score of "240- High Risk (200 <R <400)- To Be Addressed with a Short-Term Action Plan." Another chemical risk, "Residue from PAH Use," was rated with a probability of "6- highly probable," frequency as "1- very rare (once or a few times per year)," and severity as "15- very serious (disability, loss of limb, environmental impact)," with a calculated risk score of "90- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan." The risk of "Pesticide Residue in Honey" due to pesticide use was rated with a probability of "6- highly probable," frequency as "1- very rare (once or a few times per year)," and severity as "40- very severe (death, permanent disability, severe environmental impact)," resulting in a risk score of "240- High Risk (200 <R <400)- To Be Addressed with a Short-Term Action Plan." Similarly, the risk of "Antibiotic Residue in Honey" due to antibiotic use was rated with a probability of "6- highly probable," frequency as "1- very rare (once or a few times per year)," and severity as "40- very severe (death, permanent disability, severe environmental impact)," yielding a risk score of "240- High Risk (200 <R <400)- To Be Addressed with a Short-Term Action Plan." Lastly, the risk of "Fire" was evaluated with a probability of "3- rare but possible," frequency as "1- very rare (once or a few times per year)," and severity as "40- very severe (death, permanent disability, severe environmental impact)," with a risk score of "120- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan" [7, 8, 20-24].

In the biological risk group, the probability of "Bee Stings" was rated as "10- very high probability," frequency as "6- frequently (once or more per day)," and severity as "3- important (low work loss, minor damage, first aid)," resulting in a risk score of "180- Significant Risk (70<R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan." Another biological risk, "Wild Animal Attacks," was rated with a probability of "3- rare but possible," frequency as "1- very rare (once or a few times per year)," and severity as "40- very severe (death, permanent disability, severe environmental impact)," with a calculated risk score of "120- Significant Risk (70 <R <200)- To Be Monitored Carefully and Addressed with an Annual Action Plan" [25-28].

4 CONCLUSION

In this study, aimed at identifying occupational health and safety risk factors in the beekeeping sector, data was collected through face-to-face interviews and in-depth discussions with 23 workers from 13 apiaries operating in the Upper Coruh Valley and Bayburt Province, regions with significant beekeeping potential in Turkey. The Fine-Kinney risk analysis method identified occupational health and safety risks based on exposure to ergonomic, physical, biological, and chemical substances used in agricultural pesticides and treatments for bee diseases. As a result of the risk assessment, 5 ergonomic, 4 physical, 6 chemical, and 2 biological risk factors were identified.

These risks include manual handling of heavy loads, repetitive movements, incorrect body postures, contact with hard surfaces, prolonged standing, safety risks, low pressure, thermal comfort, traffic accidents, the use of chemicals or organic acids, the use of naphthalene, antibiotic usage, pesticide usage, fire, wild animal attacks, and bee stings.

Despite beekeeping being regarded as a secondary profession or a hobby in Turkey, it presents significant occupational health and safety risks, making it a "hazardous" occupation. Occupational hazards in beekeeping arise from exposure to ergonomic, physical, biological, and mainly chemical substances used to combat bee diseases and pests, which may also pose a public health threat due to potential honey contamination. It was observed that some beekeepers in the region. However, illegal or unregulated chemicals are not used extensively to combat bee diseases and pests, which can pose health risks to bees, beekeepers, and consumers. The issue of unlicensed antibiotic use, particularly in treating brood diseases, and using unlicensed drugs designed for other livestock species in beekeeping must be addressed through stricter control mechanisms. Efforts should be accelerated to harmonise Turkish regulations with European Union standards, and beekeepers should be trained in beekeeping practices, disease prevention and control, and producing high-quality bee products.

In this section, the importance and effects of the study should be clearly stated. In the conclusion part, the results should not be repeated.

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Author Contributions

Mustafa ÖZDEMİR: Investigation, analysis, writing–original draft, writing– review & editing
Osman YILDIZLAR: Research planning, writing–review & editing

All authors read and approved the final manuscript.

Conflict of interest

No conflict of interest was declared by the authors.

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