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EVALUATION OF EMPLOYEE POSITIONS BY DIFFERENT ERGONOMIC RISK ANALYSIS METHODS IN MANUAL HARVESTING OF HAZELNUTS

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ABSTRACT

In this study, working postures during the manual harvesting of hazelnuts were analyzed with four different ergonomic risk assessment methods, namely REBA, AWBA, OWAS, and RULA, and the differences between them were revealed. The most appropriate method for manual harvesting activities was determined. Hand harvesting of hazelnuts; It consists of three main workstations: shaking the branches by hand, collecting them manually from the branches, and containing them manually from the ground. There are three different ways of sitting in the hand-harvesting of hazelnuts: standing on knees, bending over, or cross-legged. During the manual harvest, the workers' movements at all workstations were observed and recorded with a camera. Images were analyzed using the ErgoFellow 2.0 program. As a result of the analysis, working postures that may cause musculoskeletal disorders (MSD) were determined. According to the analysis results, shaking the hazelnut by hand and harvesting from the branch by hand were risky compared to the other three analysis methods, except for the Ovako Working Posture Analyzing System (OWAS) method. In manual harvesting from the ground, high-risk scores were obtained in all working postures, Rapid Entire Body Assessment (REBA), Agricultural Whole-Body Assessment (AWBA), Rapid Upper Limb Assessment (RULA), and OWAS methods, and it was determined in the category of urgent action change. Among the ergonomic risk analysis methods, it can be said that AWBA is the analysis method that includes the closest positions of working postures in the manual harvest of hazelnuts.

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1. Introduction

Türkiye has 74.50% of the world's hazelnut planting areas, with approximately 700 thousand hectares. The production amount of in-shell hazelnut is about 665 thousand tons, and it meets 76% of the world hazelnut production. Hazelnut export is approximately 500 thousand tons, and it realizes 75% of the world's hazelnut export (TUIK, 2022). However, hazelnut is the sole source of income for approximately 500 thousand farmer families. Hazelnut can be grown economically up to 60 km inland from the coast and up to 750 m altitudes in the Black Sea Region. In hazelnut cultivation, the hearth planting method is generally applied. This method is the traditional planting method used in hazelnut production regions. Approximately 91% of the hazelnut production areas in Terme and Çarşamba counties of Samsun province have a dibbling planting system, and the remaining 9% have a row planting system (Beyhan and Sauk, 2018). The healthiest way to harvest hazelnuts is to shake the reached harvest maturity hazelnuts to the ground and collect the fallen hazelnuts. However, the harvesting method widely applied in the Black Sea Region is the manual harvesting of hazelnuts from the branch because the harvest is prolonged until the rainy periods and the drying problem. Hand harvesting of hazelnuts is one of the essential and labor-intensive work groups that need human labor in agricultural activities. Hand harvesting of hazelnuts in Turkish conditions requires 306 BIGh/ha. This figure constitutes 71% of the total working time for production and 55% of the production cost (İlkyaz, 1986). This situation significantly increases the hazelnut production cost and causes a labor-based labor requirement during harvest (Beyhan and Sauk, 2018). Despite significant technological developments, the agricultural sector is seen as one of the most challenging and dangerous sectors concerning occupational accidents and diseases. Musculoskeletal disorders (MSD) are frequently seen in employees due to the high number of human labor processes and the very different body postures of the employees. Accordingly, determining which body posture is riskier regarding employee health is an essential field of work in ergonomics. Work-related factors related to occupational musculoskeletal disorders and accelerating the discomfort process are considered ergonomic risk factors (Kır, 2015). Repetitive body movements (such as bending, twisting, squatting, reaching, and holding) during the hand-harvesting of hazelnuts cause MSD in the body's tendon, muscle, nerve, and soft tissue systems (Baş et al., 2018). Agricultural activities have a dynamic structure. For this reason, it is more difficult to systematically analyze the physical factors that workers working in the agricultural sector are exposed to compared to other sectors. When the studies in the literature are examined, it is seen that many studies are using ergonomic risk assessment methods in different agricultural activities and sectors. Das and Gangopadhyay (2015), in their study using the REBA and OWAS method, determined that the waist region was the most affected body area in potato growers. Aygün et al. (2018), in their study using REBA and RULA methods on the bodily load scores of workers in citrus orchards, determined that the most challenging jobs for the worker were cutting and harvesting sap on tree branches and carrying baskets full of citrus fruits on the back. Akalp et al. (2021), in their study where they analyzed the working postures of the workers working in the olive grove with the REBA method, found that the ergonomic risk analysis scores varied according to the workstation and the risk levels of the working postures were high and very high. Riemer and Bechar (2016), in their study using REBA and OWAS methods on the strains of agricultural workers working in the pepper and tomato harvest, determined that collecting by bending to the ground included high ergonomic risk while collecting by kneeling included moderate ergonomic risk. Zhang et al. (2019), in their study where they evaluated employee postures during apple picking using the RULA method, found that employees exhibited body postures that could cause MSD in 64% of the harvest time. Schuman (2002) found that the risk of back injury is caused by repetitive loads applied to the upper extremities and trunk, bending, twisting movements, and carrying repetitive overloads. Again, Kamble et al. (2022) found that in cotton picking by hand, the body postures of the workers, legs, shoulders, and lower back revealed MSD.

There is a need to analyze the employee postures during the manual harvest of hazelnuts with different methods and compare the results. Since the results of different risk assessment methods are not compared too much, different risk assessment methods were used in our study. Working in this direction; this study aimed to analyze the postures of employees in the manual harvest of hazelnuts with four different ergonomic risk assessment methods to determine the differences between them and to decide on the most appropriate method for evaluating the manual harvesting activities of hazelnuts, to determine the ergonomic

risk scores that occur depending on the determination of the strains and loads that the workers are exposed to.

2. Materials and methods

2.1. Plant materials

This study was carried out in a farmer's orchard in Samsun province, Terme district (Figure 1). The characteristics of the hazelnut orchard where the collection trials were carried out are given in Table 1. The hazelnut orchard where the experiments were carried out has the Çakıldak hazelnut variety, which is widely grown in the region.


Figure 1. General view of the hazelnut orchard

Table 1. Characteristics of the hazelnut orchard where collection trials were carried out

Properties	Measurement Unit	Average Value
Harvest time		September 2022
Hazelnut planting		Hearth-like
Hearth planting dimensions		
Inter row	(m)	4.50
In row	(m)	4.50
Branch angle	(°)	57
Number of main branches in the hearth	(number)	19
Floor slope	(%)	1.15

2.2. Methods

The hazelnuts, which have reached harvest maturity, are either collected from the branch by hand or the branches are manually shaken and dropped to the ground by hand. Then, the collected hazelnuts are filled into baskets, and the hazelnuts in these baskets are transferred to sacks and taken to the threshing process. At these stages, employees have working postures that can cause MSD. Collecting operations carried out at ground level or above the shoulders outside the standard working areas are postures that may cause more MSD in employees. Within the scope of the study, three different workstations were observed; shaking the branches and harvesting by hand from the branch and the ground (Figure 2). Each workstation was observed separately in the hazelnut orchard, and video recordings and photographs were taken. Different working postures for each recorded workstation were analyzed using the ErgoFellow 2.0 program.

3. Results

3.1. Ergonomic risk analysis of body postures in shaking hazelnut branches

While shaking the hazelnut branches by hand, the body postures of the employees were examined, and their

physical risk scores were determined. According to this; for REBA; the action level was determined as "3", the risk score was "8-10", the risk level was "high," and action status was determined in the category of "change needed soon." for AWBA; the risk score was determined as " 3" and the risk level was determined in the "high" category. For OWAS, " 2-Working postures have harmful effects on the musculoskeletal system. Ergonomic regulation will be needed for these postures soon". For RULA, While the risk score was found to be risky with "7", the action status was determined as "4" in the category of urgent action required.

Figure 2. Working postures in the manual harvest of hazelnuts

3.2. Ergonomic risk analysis of manual harvesting of hazelnut from branch

During the manual harvest of hazelnuts, the body postures of the employees were examined, and their physical risk scores were determined. According to this; for REBA; the action level was determined as "3", the risk score was "8-10", the risk level was "high," and action status was determined in the category of "change needed soon." for AWBA; the risk score was determined as "4" and the risk level was determined in the "very high" category. For OWAS, "1-Working postures have no harmful effects on the musculoskeletal system. There is no need for ergonomic regulation for these postures". For RULA, While the risk score was found to be risky with "7", the action status was determined as "4" in the category of urgent action required.

3.3. Ergonomic risk analysis of manual harvesting of hazelnut from the ground

The hazelnut harvesters' body postures (cross-legged, bending over, and kneeling) were examined, and their physical risk scores were determined. In the cross-legged collection process, none of the existing analysis methods fully covers the working postures of the employees. In the bodily risk analysis of employee postures, identical scores were obtained in all ways, such as cross-legged, bent over, and the collection of hazelnuts by standing on one's knees. According to this; for REBA; the action level was determined as "3", the risk score was "8-10", the risk level was "high," and action status was selected in the category of "change needed soon." For AWBA, the risk score was determined as "3," and the risk level was determined in the "high" category. For OWAS, "4-Working postures have significant detrimental effects on the musculoskeletal system. The necessary ergonomic arrangements for these postures should be made immediately". For RULA, While the risk score was found to be risky with "7", the action status was determined as "4" in the category of urgent action required.

4. Results and discussion

Ergonomics interests medicine, engineering, business scientists, and all branches of science. For this reason, many studies have been carried out on the subject, and analysis methods have been developed. It has been determined that working postures evaluated within the scope of our study may cause MSD in hazelnut farming workers.

According to the results, different risk assessment methods applied to the same workstations can give different results. Commonly used OWAS, REBA, and RULA methods do not cover all body postures

developed in agricultural work. At the same time, it was determined that the analysis results obtained from the methods in some employee postures contradicted each other. The OWAS approach is inconsistent as it gives different results from the other techniques used in the study to analyze upper body extremities. Although the AWBA method, developed to fill this gap, includes 50 different body postures, it does not have some poses in hand-hazelnut harvesting. However, the analysis method that consists of the positions closest to the parts of the employees in the manual harvest of hazelnuts has been AWBA.

The use of technological developments in hazelnut mechanization will help reduce the discomforts related to the musculoskeletal system. The data obtained from this study can form the basis for future studies. Working body risk maps can be updated by analyzing different body postures in hand-harvesting hazelnuts with similar methods. Accordingly, the same body postures can be evaluated with more risk analysis methods, and hand-harvesting hazelnuts can determine the most appropriate risk assessment method.

Compliance with Ethical Standards

Conflict of Interest

As the author of article declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

Authors' Contributions

Hüseyin SAUK: Investigation, Conceptualization, Writing - original draft. **Kübra Meriç KALIN UĞURLUTEPE:** Formal analysis, Data curation.

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Consent for publication

We humbly give consent for this article to be published.

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