Original Article

Pattern of Trauma Related to Falling from Walnut Tree as an Occupational Injury: A Cross-Sectional Study in the West of Iran

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Abstract

Background: Evidence regarding the epidemiological characteristics and the mechanisms of trauma related to falling from walnut tree are limited in Iran. Therefore, this study was conducted to investigate the pattern of trauma related to falling from walnut tree as an occupational injury in Tuyserkan in the west of Iran in 2017. **Materials and Methods:** In this cross-sectional study, all the patients admitted in Vali-Asr Hospital for injuries caused by falling from walnut trees during the harvest for walnuts (from September to October 2017) were reviewed. The data were collected by a checklist including the demographic and clinical characteristics of the patients obtained from the hospital records. Data were analyzed using descriptive and analytical statistics by the STATA software version 12. **Results:** During the study, a total of 52 injured cases were registered in Vali-Asr Hospital. All patients were male, and 71.2% of them were rural dwellers. Falls were more concentrated in Friday (27%) and peaked in mid-days (19.2% of cases). Branch breaking was the common cause of falling in 30 (57.7%) injured cases. Nearly 70% ($n = 36$) of the cases were transferred to the trauma center by the emergency services. Among injured patients, 4 patients (7.7%) died. Overweight patients had a 7.75-fold higher chance of death or handicap compared to underweight patients ($P = 0.09$). **Conclusion:** Most of the cases were young men from rural areas who were economically important groups. High air temperature in mid-day time is in related to increase in the probability of falling; thus, it should be advised not to work at this time. A considerable proportion of injured patients were carried by family members to the hospital. Therefore, the general awareness that an injured person must be transferred to the hospital by the emergency medical services for the reduction of the severity of trauma is necessary.

Keywords: Falling, injuries, occupational injury, walnut tree

INTRODUCTION

According to the global projections, despite the fact that accidents and injuries ranked the tenth among all the causes of death in 2002, they will rise to the sixth in 2030.[1] Falling from height is one of the main causes of fatal and nonfatal injuries.[2] Falling can occur at any time and place, but it mainly occurs in occupational situations in adults.[3] Falling

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from tree in the agricultural societies in order to climb the tree to harvest products is another form of falling from the heights. Meanwhile, climbing walnut trees due to unique biological features such as having very crisp branches, walnut aggregate at the end of its long branches, slipping the surface as well as its considerable height is associated with a higher probability of falling.[4-6]

Evidence indicates that musculoskeletal injuries are the most common consequences of falling, although head and spinal cord injuries are common in these individuals.[7,8] The severity of injuries related to falling depends on the height, direction of falling, landing surface, and patients' age.[9] Unfortunately, most of the injuries related to falling from walnut trees take place in robust young people who are economically important groups.[4] However, the results of a study showed that children also had a high proportion of falling from trees, and the main reason for their falling was due to an attempt to harvest the remaining walnuts in the lateral parts of branches at the postharvest stage.[6]

According to the report by the Food and Agriculture Organization in 2011, Iran ranks second in global walnut production after China with a production of 485,000 tons/year.[10] It should be noted that Tuyserkan is one of the natural sites of walnut trees in Iran. Walnut production plays the most important role in the agricultural economy of this city with total area of about 5100 which even lies in the first place in Iran.[11] However, the methods of harvesting walnuts in the city are still traditional. Furthermore, the gardeners climb the trees and dislodge the fruits on these branch ends by extending the arm and body. As a result, this action imposed them at risk of falling from trees.

After comprehensive searching, only two studies conducted on traumas associated with falling from walnut tree were found in Iran.[12,13] Therefore, information about time distribution of falling from trees, the epidemiological characteristics of the injured patients, as well as the mechanisms of trauma from walnut tree fall in the country are limited. This study aimed to evaluate the pattern of trauma related to falling from walnut tree as an occupational injury in the city of Tuyserkan in the west of Iran in 2017.

MATERIALS AND METHODS

Study design
This retrospective cross-sectional study was carried out on registry information about falling from walnut trees in the Vali-Asr Hospital of the city of Tuyserkan (Hamadan Province) in the west of Iran in 2017.

Setting
Tuyserkan is located about 100 km south of Hamadan, in the west of Iran. According to the National Population and Housing Census 2016, it has a population of 101,666 in 33,537 households. This city is well known for the quality of its walnut trees within Iran and the world. Its weather is mild and nice in the summer and cold in the winter. Vali-Asr Hospital is the only center in Tuyserkan district where all injured patients are referred to.

Inclusion and exclusion criteria
In this study, all the patients admitted for injuries due to falling from walnut trees during the harvest for walnuts were reviewed. Patients with minor injuries who did not require hospital care or fell from a tree other than walnut tree were not considered.

Data collection tool
In this study, a census method was used to select the patients, and all the 52 admitted patients in the hospital due to falling from walnut trees from September to October 2017 (harvest period) were assessed. The data collection tool was a checklist including the demographic (gender, marital status, location, age, education, body mass index [BMI], and occupation) and clinical characteristics (falling cause, affected organ, injured transfer type, and injury outcome) of the patients registered in the hospital admission and discharge records. In this study, BMI ranges were underweight: under 18.5 kg/m^2, normal weight: 18.5–25 kg/m^2, overweight: 25–30 kg/m^2, and obese: over 30 kg/m^2; furthermore, the outcomes were divided into remission, handicap, or death. Triage nurses filled the form and the information about the injury during the patient admission. Moreover, this study recorded some extra demographic information, falling conditions as well as patients' outcome through interview with patients through telephone contact with a patient or his family.

Statistical analysis
For data analysis, descriptive statistics including frequency tables, range, mean, percentage as well as bar and radar chart were used to describe the study variables. Logistic regression was used to estimate the probability of injury outcome (remission/death or handicap) based on predictor variables. The data were encoded and analyzed using STATA 12 (StataCorp, College Station, TX, USA). $P < 0.05$ was considered to be statistically significant.

Ethics
In this study, the confidentiality and anonymity of the patients were protected. Ethics approval to conduct the research study was obtained by the Research Ethics Committee, Hamadan University of Medical Sciences (Ethical code: IR.UMSHA. REC.1397.266).

RESULTS

Baseline characteristics
During the study (September 2017 to October 2017), a total of 52 injured cases due to falling from walnut trees were registered in Vali-Asr Hospital. Table 1 shows the demographic characteristics of the cases. Among all the cases, the vast majority were married (78.9%). All of them were male, and 71.2% were rural dwellers. Moreover, 42.31% of the patients had high school education and 5.8% of them were illiterate.

Table 1: Demographical characteristics of the injured patients

Variable	Frequency (%)
Marital status	
Married	41 (78.9)
Single	11 (21.2)
Education	
Illiterate	3 (5.8)
Primary school	13 (25.00)
Guidance school	11 (21.2)
College or higher	22 (42.3)
Academic	3 (5.8)
Location	
Urban	15 (28.9)
Rural	37 (71.2)
BMI status	
Underweight	5 (9.6)
Normal	32 (61.5)
Obese	15 (28.9)
Age group (years)	
<30	10 (19.2)
30-49	21 (40.4)
50-69	18 (34.6)
≥70	3 (5.8)
Occupation	
Self-employed	18 (34.6)
Worker	13 (25.0)
Farmer	12 (23.1)
Retired	5 (9.6)
Work less	2 (3.9)
Employee	1 (1.9)
Student	1 (1.9)

BMI: Body mass index

The BMI status of 32 (61.5%) cases was normal. The mean age of them was 43 ± 12.3 years, and nearly 75% of them were categorized in 30–70 years. Being self-employed and worker with 34.6% and 25% of cases were the dominant occupations among them.

Time features of falling injury

Regarding the time distribution of injuries due to falling from walnut trees, most of the falls leading to injuries were related to September 14–October 14. Falling from walnut trees results in injury was more concentrated on Friday and Wednesday with nearly 27 and 20% of cases [Figure 1]. Moreover, 10 (19.2%) falls occurred in mid-day (12 pm) [Figure 2].

Mechanisms and characteristics of injury

Branch breaking was the common falling cause in 30 (57.7%) injured cases. The spinal cord and arm were the most common organs of injury with 23.1% of injuries for each. The mean delay in arriving at the hospital for medical care since time of injury was 32.7 min (range: 13–135). Furthermore, 69.2% (*n* = 36) of the cases were transferred to the trauma center by the emergency services while the rest were transported to the hospital by family members and one patient referred himself.
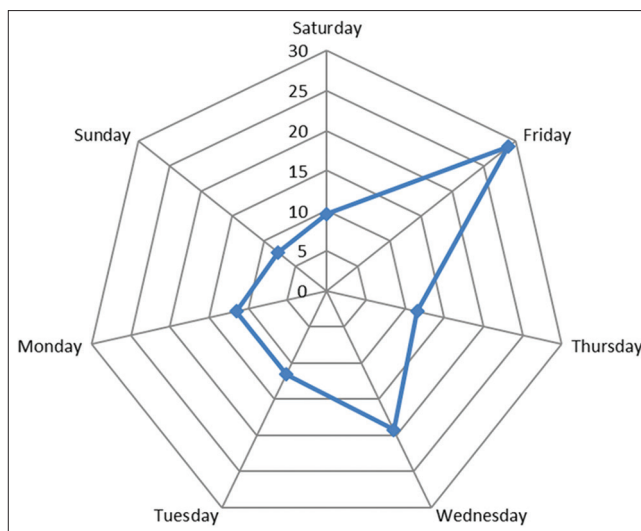

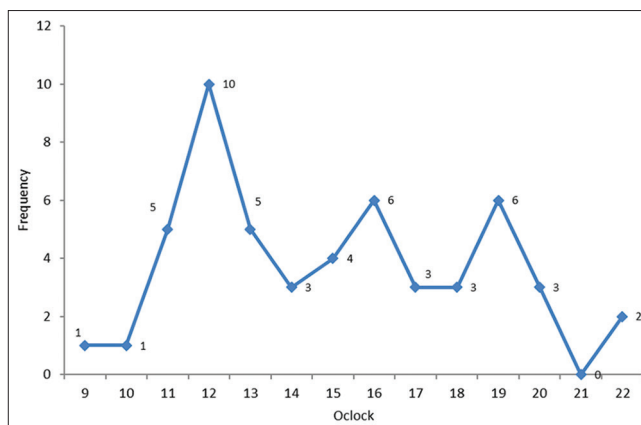**Figure 1:** Week day of falling from walnut trees leading to injury

Figure 2: Time of falling (O'clock) from walnut trees leading to injury

Among injured patients, 4 (7.7%) patients died, one of them encountered defect, and the others were discharged with good health condition [Table 2].

Determinants of falling outcome

Determinants of death or handicap among injured patients are presented in Table 3. Accordingly, patients with under- or overweight BMI status had a 7.75-fold higher chance of death or handicap compared to normal BMI patients ($P > 0.05$). There was a 3.25-fold higher chance of death or handicap in fall height ≤5 m compared to fall height >5 m ($P = 0.24$). Patients with age of 50 years and higher had a 2.42-fold higher chance of death or handicap ($P = 0.36$). Furthermore, transfer time to hospital does not have a significant effect on injury outcome (odds ratio = 1.94, 95% confidence interval: 0.29–13.1) ($P = 0.49$).

DISCUSSION

The results of the present study showed that the majority of the injured patients were young married men from rural areas with the self-employed or worker occupation who fell down

following the fracture of a walnut tree branch. The peak of the falling leading to injuries was related to September 14–October 14. Friday was the most common day of the fall, and at 12 O'clock, the fall occurred more than the rest of the hours. Fell down following the fracture of a walnut tree branch was the main cause of falling, and the spinal cord and arm were the most commonly affected organs.

Walnut is one of the important sources of income in Tuyserkan. In this city, falling from walnut trees is common, particularly

Table 2: Mechanisms, characteristics, and outcome of falling injury

Variable	Frequency (%)
Falling cause	
Branch breaking	30 (57.7)
Gliding	12 (23.1)
Faint	10 (19.2)
Affected organ (*n*=57)*	
Head	7 (13.5)
Neck	3 (5.8)
Face	4 (7.7)
Chest	10 (19.2)
Cord injuries	12 (23.1)
Hand	12 (23.1)
Abdomen	3 (5.8)
Foot	6 (11.5)
Injured transfer type	
Emergency medical system	36 (69.2)
Family members	15 (28.9)
Himself	1 (1.9)
Outcome**	
Remission	47 (90.4)
Handicap	1 (1.9)
Death	4 (7.7)

*Some of them had multiple trauma, **Cause of death for 3 patients was head trauma and one due to embolism resulting from the fracture and one patient had handicap due to spinal cord injury

during walnut harvest which is done in a traditional and nontechnical manner, and in every year, some people picking up walnuts fall from large trees and injure.

In the present study, all of the people falling from trees were male. Men are usually responsible for climbing the trees due to their physical agility. This finding is consistent with the results of other studies.[5,13,14] Furthermore, similar to another study,[4] the results demonstrated that falling from walnut trees affects young people who climb the trees to harvest. Probably, young males have not enough experience for climbing the trees to harvest and are less cautious.

Along with another study in Iran,[12] in the present study, breaking branches was the main reason for falling in nearly 60% of the patients. While slipping was the main cause of falling from other fruit trees.[15] Pests of walnut trees cause a cavity in the branches of the trees and their fragility as a result of the heavyweight of the human body.[16] In order to prevent gliding as one of the reasons for falling, it is recommended to wear good shoes and avoid climbing the tree during rainfall.

It was found that falls peaked in mid-day (12 pm). High air temperature in this time can be attributed to increased probability of falling. Relationship between high air temperatures and occupational injuries is previously approved.[17] Furthermore, work-related tiredness and hypotension may also be affected. In addition, a study reported that in the months of September and October which is the harvesting season, the rate of falling from tree is increasing.[4] The results of the present study are consistent with another study that reported month injuries for farmers and farmworkers.[18]

Our study indicated that the most common injuries were cord and arm, similar to some other studies.[5] However, the methods of harvesting walnuts are still traditional, and gardeners climb the trees and dislodge the fruits on these branch ends by extending the arm and body. This action imposed individuals at risk of injuries and death.[4]

Table 3: Effect of various predictors on falling outcome

Variable	*n* (%)	Remission, *n* (%)	Worse outcome		OR*	95% CI	*P*
			Handicap, *n* (%)	Death, *n* (%)			
BMI status							
Normal	32 (61.5)	31 (96.88)	1 (3.13)	0	1	-	-
Underweight	5 (9.6)	4 (80.0)	0	1 (20.0)	7.79	0.4-149.7	0.175
Overweight	15 (28.9)	12 (80.0)	0	3 (20.0)	7.79	0.73-82.0	0.089
Fall height (m)							
≤5	33 (63.5)	39 (92.86)	1 (2.38)	2 (4.76)	1	-	-
>5	19 (36.5)	8 (80.0)	0	2 (20.0)	3.25	0.47-22.7	0.24
Age group (years)							
<50	31 (59.6)	29 (93.55)	0	2 (6.45)	1	-	-
≥50	21 (40.4)	18 (85.71)	1 (4.76)	2 (9.52)	2.42	0.37-15.9	0.36
Transfer time (min)							
≤30	24 (46.2)	35 (92.11)	1 (2.63)	2 (5.26)	1	-	-
>30	28 (53.9)	12 (85.71)	0	2 (14.29)	1.94	0.29-13.1	0.49

*OR for occurring worse outcome (including death and handicap). OR: Odd ratio, CI: Confidence interval

In the present study, the mortality rate due to falling was 7.7%, which was lower than other studies.[4,12] This better outcome can be due to the concentration of Tuyserkan city and also the major gardens are around the city, and therefore, injured patients are immediately transferred to the hospital.

In the present study, the majority (69.2%) of the cases were transferred to the hospital by emergency medical services (EMS). Failure to transfer patients with safe methods, especially those with spinal cord injuries, worsened the complications caused by the fall. Unlike our study, in the conducted study in Bojnurd,[12] only 27.6% of the cases were transferred to the hospital through EMS. This difference in transferring type can partially justify the higher rate of disability in this study compared to our study with the one case of handicap.

This study had some limitations which have to be pointed out. First, patients with superficial injuries which were treated at home or in rural and urban health centers were not entered to the study; therefore, our report is prone to underestimation. Second, in cases of falling in the villages of the city's margin, they usually go to nearby neighborhood hospitals; therefore, our results are faced with underreporting. Third, because of small sample size and sparse data regarding death and handicap and unstability of findings, we could not have any discuss on outcome predictors. Regarding the retrospective nature of the study, the recall bias of patients for detailed description of the accident is a third limitation of the study.

CONCLUSION

Most of the cases are young married men from rural areas who are economically important groups. High air temperature in mid-day time is in related to increased probability of falling. Therefore, it should be advised not to work at this time. In order to prevent gliding as one of the reasons for falling, it is recommended to wear good shoes and avoid climbing the tree during rainfall. The results of the study also showed that a considerable proportion of injuries were carried by family members to the hospital. The general awareness that an injured person must be transferred to the hospital by the EMS for the reduction of the severity of trauma is necessary.

Conflicts of interest

There are no conflicts of interest.

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