Open Access Library Journal
2025, Volume 12, e13080
ISSN Online: 2333-9721
ISSN Print: 2333-9705

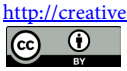
Epidemiological Investigation of Occupational Accidents of Insured Salaried Employees in Region of Thrace, Greece

Evdoxia Papazoglou, Evaggelia Nena, Christos Kontogiorgis, Eirini Deligiannidou, Grigorios Tripsianis, Theodoros Konstantinidis

Department of Medicine Democritus, University of Thrace, Alexandroupoli, Greece
Email: evpapazo@med.duth.gr

How to cite this paper: Papazoglou, E., Nena, E., Kontogiorgis, C., Deligiannidou, E., Tripsianis, G., and Konstantinidis, T. (2025) Epidemiological Investigation of Occupational Accidents of Insured Salaried Employees in Region of Thrace, Greece. *Open Access Library Journal*, **12**: e13080.
https://doi.org/10.4236/oalib.1113080

Received: February 13, 2025
Accepted: March 28, 2025
Published: March 31, 2025



Abstract

Background: Occupational accidents (OAs) are a subject of major interest due to their impact on workers' health, economic productivity, and the associated social and economic costs. Despite their importance, under-reporting of OAs remains a widespread issue. **Aim:** This research aimed to evaluate the prevalence of occupational accidents among workers aged 18 - 64 insured by the Unified Social Security Fund (USSF), assess the provision of safety measures and education in Occupational Health and Safety (OHS), and examine the association of accident-related factors with demographic and occupational characteristics in the region of Thrace, Greece, during the years 2017-2023. **Material & Methods:** A retrospective observational study was conducted using records from the Emergency Department (ED) of the University General Hospital of Alexandroupolis and personal phone interviews. Descriptive statistics and statistical analyses were performed using SPSS (v.29) with non-parametric methods. **Results:** During the reference period, 489 accidents were recorded in the study population, of which 385 (78.73%) occurred either at work or while commuting to/from work. Eight of these commuting accidents were fatal. The main demographic characteristics of the affected workers were early- and late-middle-aged men, with primary education level and Greek nationality. The predominant economic sectors were "Manufacturing" and "Other activities", typically involving small and medium-sized enterprises. Over 70% of employers did not provide adequate safety measures and OHS education, while in an additional 15%, these measures were minimal and/or inadequate. "Falls of the same level" accounted for nearly half of all accidents, and bone fractures, primarily affecting the lower and upper extremities, were the most common injury type. Over 20% of non-fatal accidents (23% of all OAs) resulted in disability or incapacity, causing a total of 22,937 lost workdays. Gender and age were

significant demographic variables differentiating the two sub-samples. Differences were also observed between occupational and accident-related variables, with several noteworthy correlations between these factors. **Conclusions:** Occupational accidents remain a critical public health and economic issue, with prevention efforts proving inadequate, particularly among small and medium-sized enterprises. These findings underscore significant concerns regarding future trends in occupational safety.

Subject Areas

Occupational Health

Keywords

Occupational Injuries, Safety Measures, Training of Workers

1. Introduction and Literature Review

According to the International Labour Office (ILO), an occupational accident is *"an unexpected and unplanned occurrence, including acts of violence, arising out of or in connection with work, which results in one or more workers incurring a personal injury, disease, or death. A case of occupational injury is the case of one worker incurring an occupational injury as a result of one occupational accident"* [1]. This may result in temporary or permanent incapacity for work—defined as the worker's "*inability to perform the normal duties of work in the job or post occupied at the time of the OA or can be fatal* (*as a result of occupational accidents and where death occurred within one year of the day of the accident*)" [1].

Occupational accidents represent a significant public health concern, with global estimates indicating 313 million non-fatal injuries and over 350,000 deaths annually. The associated economic losses are estimated at approximately 4% of global GDP, primarily due to absenteeism, temporary or permanent disability, increased insurance premiums, and reduced productivity [2].

Heinrich's accident triangle [3], introduced in 1931, established the "1:29:300" ratio, suggesting that for every serious injury, there are 29 minor injuries and 300 incidents with no visible damage. Bird [4] [5], extended this in 1969 with the "1:10:30:600" ratio, adding a property damage category. These models laid the foundation for industrial accident prevention and modern occupational health and safety (OHS) strategies. Although more recently criticized for limited applicability to highly specialized modern industries, the models emphasize that minor incidents indicate systemic hazards and their prevention can reduce severe accidents.

Hill and Trist (1953) studied the accident and absenteeism patterns of a stable organization over a four-year period in order to delineate the role of personal relationships in job effectiveness and satisfaction. They proposed that OAs causal factors are not only the physical risks and hazards of the workplace and the personal behavioral characteristics of the workers, but also the result of maladjustment of the

workers to work social context [6].

More recent studies focus on predictive models for occupational accidents and the complex interplay of etiological factors.

For example, Gordon *et al.* (2005), highlighted the importance of robust data collection systems capable of analyzing factors such as human errors, psychosocial influences, and workplace conditions. According to their developed instrument, the action error which cause the accident, is a result of a "situation awareness reduction" by several human/psychosocial factors, which in turn are related to work environmental factors, procedures and conditions [7].

According to Lundberg *et al.* (2009), the use of epidemiological models helps to evaluate the factors causing OAs. In most of them, four factors' domains are under consideration, namely, human, technology, organization, and information [8].

In the subway construction industry, Zhou *et al.* (2014) revealed 15 accident chains using network theory, identifying soil collapse, struck-by injuries, explosions, and machine collapse as key risks in 60% of cases. These findings suggest topological parameter analysis as valuable preventive tool [9].

In construction, inadequate risk management contributed to 84% of cases in one study of 100 incidents, which also identified problems related to worker/work-team behavior (70%), shortcomings of equipment or personal protective measures (56%), workplace conditions (49%) and suitability and condition of materials (27%). Skilled workers were involved in 60 cases, and unskilled in 27 [10].

This is related to the same sector report conducted by Hale *et al.* (2012) [11], with the aim of understanding the underlying factors of fatal accidents. Using the Human Factors Analysis and Classification System (HFACS) to classify the accident-related factors in a sample of 26 cases which involving 28 deaths, and a sample of 50 non-fatal cases as a control group, they found four main underlying factors on workplace level, namely (in descending order) "Risk planning, assessment and control", "Hardware & workplace ergonomics/usability/hazards", "Participation, motivation & conflict resolution", and "Competence, suitability", while in delivery system level "Hardware design, purchase & installation" factor predominates, followed by the "Planning & risk assessment" factor. Finally, at the corporate level, "leadership/top-management" and "contracting strategy" appeared as the main factors.

Epidemiological studies have highlighted regional patterns, such as Brunei Darussalam's rising occupational accident trend between 2014 and 2018. Males (98%), migrant (86%), and 30 - 39 years old (42.5%) workers, in the construction industry (56.4%) were most affected. "Struck by object" (37.7%) was the commonest cause and "upper limb" (43.9%) was the commonest body part involved [12].

A review [13] of Malaysian epidemiological studies on Oas (2000-2013) noted a higher incidence of fatal accidents among older (+60 years) men, Indian nationality, in transportation and agriculture sectors. "Transport and lifting equipment" (53%) and working environment (22%) were the main material agents, with (53%) and working environment in 22%, with "falling from height (28%)" and "being

struck by moving objects (17%)" as primary causes, resulted to fractures and unspecified wounds. In non-fatal OAs, men, aged 40 - 49 years, Indian nationality, agriculture and wood-product manufacturing sectors were more in-risk. The commonest injuries were the unspecified wounds (55%), and superficial injuries (10%), caused by "struck by moving objects (33%)", "falling from height (19%)", and "trapped between objects (17%)", and the material agents most involved were "working environment (41%)", and "handling of machines (20%)".

Epidemiology of Occupational Accidents and Reporting Procedures in Greece

In Greece, fatal accidents in the construction sector accounted for 40.7%of the 189 incidents reported between 2010 and 2013 [14]. According to e-Unified Social Security Fund (e-USSF) statistics using NACE Rev. 2 and ISCO 2008 classifications, occupational accidents from 2017 to 2020 were recorded as follows (See Appendix):

2017 [15]: 5.143 work-related accidents took place. Of the 4.749 OAs for which data was collected, 50 were fatal (1.1%). 43.3% had occurred in the 30 - 44 age group, and men (71.3%) and Greek nationality (89.1%) predominated. Most accidents occurred in companies employing up to 49 workers (53.8%), in "Wholesale and Retail Trade" (25.0%) and "Manufacturing" industries (19.8%), and the occupational categories "Plant & Machine Operators" (20.9%) and "Service—sales workers" (20.4%).

2018 [16]: 5.493 work-related accidents took place, increased by 6.8% compared to 2017. Of the 5.058 with recorded data,50 were fatal (0.99%). Demographics with the highest prevalence were Greek nationality (89.2%), men (69.8%) and 30 - 44 age group (42.7%) Companies employing up to 49workers (54%), "Wholesale and Retail Trade" (25.7%) and "Manufacturing" Industries (19.2%), "Plant & Machine Operators" (20.9%) and "Service—sales workers" (20.5%) were the most affected.

2019 [17]: 5.712 work-related accidents took place, increased by 4% compared to 2018. Of the 4.895 with recorded data, 53 were fatal (1%). Demographics with the highest prevalence were Greek nationality (89.8%), men (69.8%) and 35 - 49 age group (43.2%). Companies employing up to 49 workers (55.3%), "Wholesale and Retail Trade" (26.8%) and "Manufacturing" Industries (18%), "Plant & Machine Operators" (22%) and "Service—sales workers" (19.2%) were the most affected.

2020 [18]: 4378 work-related accidents took place. Of the 3657 with recorded data, 44 were fatal (1%). Total accidents decreased by 23.4% compared to 2019, due to restricted economic activity because of Covid-19 pandemic. Demographics with the highest prevalence were Greek nationality (91.2%), men (70.7%) and 35-49 age group (43.7%). Companies employing up to 49 workers (56%), "Wholesale and Retail Trade" (29.7%) and "Manufacturing" Industries (20.3%), "Plant & Machine Operators" and "Service—sales workers" (both with 20.5%) were the most affected.

According to Greek Legislation (Presidential Decree [PD] 17/96[1], as codified by Law No. 3850/2010[2], Articles 8 (par. 2) and 43 (par. 2) respectively), OAs must be reported by the employer to the competent authorities (local department of the Labour Inspectorate, local Police authorities, and the victim's Social Security Organization's services) within 24 hours. Cases of late reporting and/or deliberate concealment are investigated by the competent department of the Labour Inspectorate. The employer is subject to sanctions provided by Article 16 of PD 17/96 and Articles 71 & 72 of L. 3850/2010 when fails to report the work accident to the competent department of the Labor Inspectorate.

Since the establishment of the Labor Inspectorate's integrated information system (IIS) (ministerial decision 34331/Δ9.8920/2016[3], the employer can report OAs electronically (Article 2A(f)). Additionally, following the social security reform and digital transformation under Law 4670/2020[4] and Articles 14 and 15 (§ 2), the Joint Ministerial Decision No. 49876/14967 (14-12-2020)[5] and the General Document 549811/22-11-2022 of the e-USSF[6], employees can report OAs electronically to the e-USSF digital platform, provided that an electronic opinion of incapacity for work due to the accident has been issued by the competent health authorities.

In Greece, Oas are recorded by:

- The department of the Labour Inspectorate records notifications of OAs collected from its central and regional services, according to Article 43 (par. 2) of Law 3850/2010.
- The Unified Social Security Fund records all incidents of accidents resulting in more than three (3) days' absence from work. This recording is harmonized with Phase III of Eurostat's European Statistics on Accidents at Work (ESAW) project methodology, which describes the place of the accident and provides information about the victim and the time of the accident.
- The Hellenic Statistical Authority has been collecting data on OAs since 1998, as part of the Public Health and Occupational Health and Safety sectors. The reference period is defined by the year in which the accident occurred.

The aim of this study was to record data on occupational and compensable accidents involving the insured workforce in the area of Alexandroupolis (capital of Evros Prefecture) from 2017 to 2023, focusing on the provision of safety measures

[1]Presidential Decree 17/96 (Government Gazette 11/A [18.1.1996]) on "Measures to Improve the Safety and Health of Workers at Work in Compliance with Directives 89/391/EEC and 91/383/EEC".

[2]Law 3850/2010 (Government Gazette 84/A [2.6.2010]) on "Ratification of the Code of Laws on the Health and Safety of Workers".

[3]Ministerial Decision 34331/Δ9.8920/2016 (Government Gazette 2458/B [10.8.2016]) on the "Simplification of Labor Inspectorate Body (LAB) Procedures through the Integrated Information System of the LAB (IIS-LAB)".

[4]Law 4670/2020 (Government Gazette 43/A [28.2.2020]) on "Social Security Reform and Digital Transformation of the Unified Social Security Fund (e-USSF) and Other Provisions".

[5]Joint Ministerial Decision 49876/14967/2020 (Government Gazette 5497/B [14.12.2020]) on "Definition of the Electronic Procedure for the Granting of Sickness—Accident Benefit by e-USSF".

[6]E-Unified Social Security Fund: General Document 549811/22-11-2022 "Inclusion in the Electronic Application for the Granting of Sickness Benefits a) of Insured Persons of IKA-ETAM of Special Categories and Insured Persons of TAYTEKO and b) of the Electronic Submission of the Accident Declaration of Insured Persons of IKA-ETAM, TAXI and OAEE of e-EFKA.

and education in Occupational Health and Safety (OHS). Additionally, it aimed to identify demographic, social, and occupational factors that correlate with OAs and/or contribute to their severity.

2. Materials and Methods

Study type, population, and sample selection criteria

This study employed a retrospective observational design. The study population comprised workers insured by the Unified Social Security Fund in the region of Thrace. Sample selection criteria included:

- Workers insured by the Unified Social Security Fund
- Age: 18 - 64 years
- Occupational and non-occupational compensable accidents resulting in at least 3 days of absence from work. Accident cases were classified as occupational if they occurred at work, on the way to work, or when leaving work, and as non-occupational otherwise
- Time period: 2017-2023

2.1. Data Collection Methods

Data for all compensable accidents meeting the sample selection criteria were collected from accident records from the emergency department (ED) of the University General Hospital of Alexandroupolis.

After compiling data from all eligible accidents, a personal telephone interview was conducted with all accident victims (or their relatives in the case of fatal accidents) to collect personal and qualitative data. The response rate for this phase was 73.9%.

2.2. Study Variables and Statistical Analysis Methods

The demographic and personal variables were "age", "gender", "nationality (Greek/non-Greek)", "level of education", smoking habits, height, and body weight (to calculate Body Mass Index—BMI). The occupational variables included "occupation", "employment status", "sector of the employer's economic activity", "number of employees at local unit", "length of service with the employer" and "safety measures and education in Occupational Health & Safety (OHS)". The accident-related variables included "place (occupational/non-occupational)", "mode" and "type" of injury, "affected body part", "material agent for injury" (all as classified by ILO), "hospitalization", "means of transport to healthcare", "motor-vehicular accidents", "medication (due to the accident)", "accident outcome", "duration of absence from work" and "personal perception of the underlying cause of the accident". The variables "age", "BMI", "number of employees", "length of service" and "duration of absence" were recorded both as absolute numbers and as ordered categories.

Statistical calculations and analysis were performed using SPSS version 29 (SPSS Inc., Chicago, IL, USA). Descriptive statistics included frequency and

percentage. For statistical hypothesis testing, normality test, Kruskal-Wallis' test, Chi-square test (with Monte Carlo Exact Test to estimate the exact significance level) and binary and ordinal logistic regression were applied. The level of statistical significance was set at a p-value ≤ 0.05.

3. Results

In the study population, 489 accidents were recorded from 2017 to 2023, of which 385 (78,73%) occurred at work, or on the way to/from work. There was fluctuation in the number of cases reported from year to year as shown in Table 1 and Figure 1.

Table 1. Accidents of insured workers aged 18 - 64 years, in Alexandroupolis, 2017-2023.

Year	Occupational Accidents	Non-Occupational Accidents	Total
2017	57	8	65
2018	42	12	54
2019	50	19	69
2020	55	5	60
2021	68	17	85
2022	55	29	84
2023	58	14	72
Total	**385**	**104**	**489**

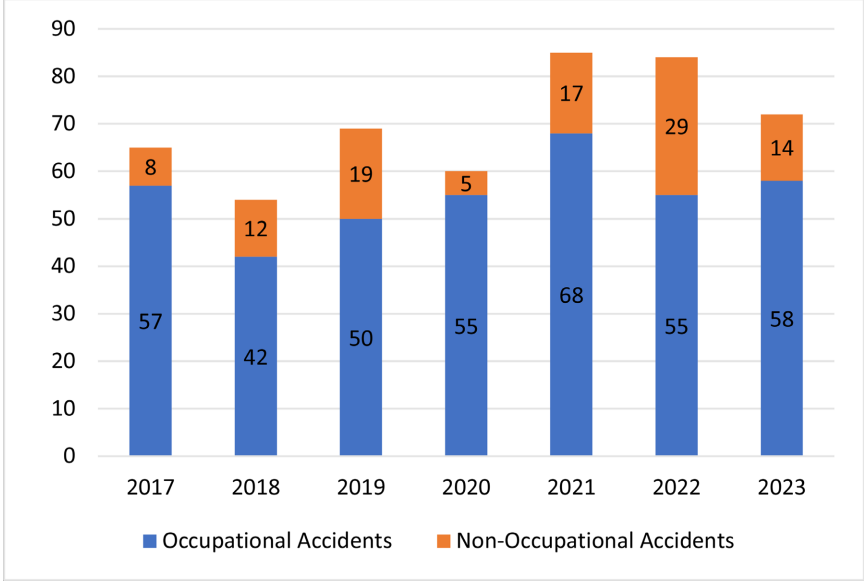


Figure 1. Accidents of insured workers aged 18 - 64 years, in Alexandroupolis, 2017-2023.

Most of the reported cases involved early-to-late middle-aged workers (mean age 43 years old), men (63% of the total sample and 66.5% of the OAs only), and

individuals with mainly primary education, with more than 95% of them being Greek (Table 2).

Table 2. Demographics of the studied population.

	Total (n = 489)	only OAs (n = 385)
Gender [n (%)]	**(n = 486)**	**(n = 382)**
Men	306 (63%)	254 (66.5%)
Women	180 (37%)	128 (33.5%)
Age-groups [n (%)]	**(n = 468)**	**(n = 369)**
18 - 24	32 (6.8%)	26 (7%)
25 - 34	105 (22.4%)	80 (21.7%)
35 - 44	115 (24.6%)	83 (22.5%)
45 - 54	136 (29.1%)	111 (30.1%)
55 - 64	80 (17.1%)	69 (18.7%)
Level of education [n (%)]	**(n = 482)**	**(n = 381)**
Primary	225 (46.7%)	197 (51.7%)
Secondary	174 (36.1%)	125 (32.8%)
Post-secondary non-tertiary	37 (7.7%)	28 (7.4%)
Tertiary	46 (9.5%)	31 (8.1%)
Nationality [n (%)]	**(n = 486)**	**(n = 385)**
Greek	468 (96.3%)	368 (95.6%)
Non-Greek	18 (3.7%)	17 (4.4%)

Abbreviations: OA—Occupational Accidents. Note: all the % frequencies were calculated according to the valid cases, which are presented on top of each column.

Eight fatal accidents were registered, all of which were occupational, as they happened in work (n = 3), and while traveling to (n = 1) or from (n = 4) work. Of the non-fatal accidents (n = 481), over 22,937 days of work absencewere caused (with 4 missing cases for this variable). In terms of the "sector of economic activity", most accidents occurred in "Manufacturing Industries" (28.3% of the OAs and 28.6% of the total sample),"Other activities" (22.7% & 23.9%, respectively), and "Wholesale and Retail Trade" (19.5% & 19.7%, respectively). Elementary occupations were the most at risk (27% of OAs and 26.5% of the total), followed by service and sales workers (20.5% & 22.2%) and clerical support workers (18.4% & 19.1% respectively). The descriptive statistics for the occupational variables are presented in Table 3. Two occupational variables "Number of employees at local unit" and "Length of service with the employer"- and one accident-related variable, "Material Agent" (which is the cause that led to injury), are presented in a separate table, because they are particularly relevant for OAs (Table 5). Personal habits and characteristics (namely smoking and BMI) did not differ significantly

between the OAs and non-OAs groups or the total sample, especially considering the high percentage of missing data (non-response). The BMI data was missing for over 28% in the OAs group, the total sample, and 26% in the non-OAs group (data not shown).

Table 3. Absolute and relative frequencies of occupational variables.

	Total (n = 489)	only OAs (n = 385)
Occupation [n (%)]	**(n = 487)**	**(n = 385)**
Professionals	37 (7.6%)	21 (5.5%)
Technicians and associate professionals	8 (1.6%)	6 (1.6%)
Clerical support workers	93 (19.1%)	71 (18.4%)
Service and sales workers	108 (22.2%)	79 (20.5%)
Craft and related trades workers	55 (11.3%)	51 (13.2%)
Plant and machine operators, and assemblers	56 (11.5%)	52 (13.5%)
Elementary occupations	129 (26.5%)	104 (27%)
Unknown	1 (0.2%)	1 (0.3%)
Employment status ([n (%)]	**(n = 489)**	**(n = 385)**
Salaried employees	446 (91.2%)	342 (88.8%)
Self-employed	40 (8.2%)	40 (10.4%)
Trainee/Apprentice	1(0.2%)	1 (0.3%)
Other	2 (0.4%)	2 (0.5%)
Sector of economic activity [n (%)]	**(n = 476)**	**(n = 375)**
Manufacturing/Production	136 (28.6%)	106 (28.3%)
Construction	44 (9.2%)	38 (10.1%)
Wholesale & Retail Trade, Repair of motor vehicles and motorcycles	94 (19.7%)	73 (19.5%)
Transportation & Storage	22 (4.6%)	19 (5.1%)
Accommodation & Food Service Activities	66 (13.9%)	54 (14.4%)
Other	114 (23.9%)	85 (22.7%)
Safety measures and education in OHS [n (%)]	**(n = 477)**	**(n = 376)**
No	344 (72.1%)	266 (70.7%)
Minimal/Inadequate	63 (13.2%)	56 (14.9%)
Yes	70 (14.7%)	54 (14.4%)

Additional Abbreviations: OHS, Occupational Health and Safety.

Motor-vehicular accidents accounted for 15.7% of OAs and the 13.4% of the total. The two most prevalent causes of accidents (the "mode of injury") were "falls from the same height" (48.8% of OAs and 52.8% of the total) and "collisions with immobile objects and falling against or being struck by moving objects" (22.9% &

21.9% respectively). The most frequent type of injury (74.8% of OAs and 77.9% of the total) was "bone fractures", followed by "dislocations, sprains and strains" (14.8% & 13.5% respectively). Regarding the injured body part, most accidents affected the upper and lower extremities with relative frequencies ranging from 34.4% to 42.3%. The predominant material agent that caused the injury in OAs was "other material agents" (76.1%), followed by "transport vehicles and lifting equipment" (9.9%). In 96.7% of all accidents and 96.6% of OAs, first aid was administered directly after the accident at the hospital's ED. 17.6% & 19% of the workers who sustained accidents and OAs respectively, were hospitalized after first aid was administered. However, only 1% received continuing medication due to the accident after being discharged from the ED or Hospital. The main means of transport for injured individuals to a first aid unit or hospital was by private car and ambulance accounting for 75.2% and 23.8% for OAs, and 77% and 22.2% for the total, respectively. Continuing physical symptoms, disabilities and/or incapacity were reported in 23% of OAs and 21% of all accidents. The mean duration of work absence due to the accident was 48 days. Most accidents took place in small and medium-sized enterprises; in fact, 66.2% occurred in enterprises employing up to 49 employees (Table 4 & Table 5).

Table 4. Absolute and relative frequencies of accident-related variables.

	Total (n = 489)	only OAs (n = 385)
Mode of injury [n (%)]	**(n = 489)**	**(n = 385)**
Fall of person from a height	41 (8.4%)	36 (9.4%)
Falling of person—on the same level	258 (52.8%)	188 (48.8%)
Slipping, collapse and being struck, struck by falling objects	23 (4.7%)	20 (5.2%)
Collision with immobile objects and falling against or being struck by moving objects	107 (21.9%)	88 (22.9%)
Trapping, being crushed—inside or between objects	19 (3.9%)	18 (4.7%)
Physical strain/over-exertion	7 (1.4%)	5 (1.3%)
Exposure to or contact with hazardous substances, electric current, extreme temperatures or radiation	7 (1.4%)	6 (1.6%)
Other types of injury not included in this list	27 (5.5%)	24 (6.2%)
Type of injury [n (%)]	**(n = 489)**	**(n = 385)**
Wounds and superficial injuries	13 (2.7%)	13 (3.4%)
Bone fractures	381 (77.9%)	288 (74.8%)
Dislocations, sprains and strains	66 (13.5%)	57 (14.8%)
Traumatic amputations	9 (1.8%)	8 (2.1%)
Concussion and internal injuries	11 (2.2%)	11(2.9%)

Continued

Burns, scalds and frostbites	4 (0.8%)	3 (0.8%)
Other	5 (1%)	5 (1.2%)
Body site injured [n (%)]	**(n = 489)**	**(n = 385)**
Whole body and multiple sites	20 (4.1%)	17 (4.4%)
Lower extremities	207 (42.3%)	153 (39.8%)
Upper extremities	168 (34.4%)	136 (35.3%)
Torso and organs	52 (10.6%)	42 (10.9%)
Back	14 (2.9%)	9 (2.3%)
Neck	3 (0.6%)	3 (0.8%)
Head	25 (5.1%)	25 (6.5%)
Motor/Vehicular accident [n (%)]	**(n = 485)**	**(n = 381)**
No	420 (86.6%)	321 (84.3%)
Yes	65 (13.4%)	60 (15.7%)
Means of transport to HC [n (%)]	**(n = 487)**	**(n = 382)**
Ambulance	108 (22.2%)	91 (23.8%)
Private car	375 (77%)	288 (75.2%)
Taxi	4 (0.8%)	4 (1%)
Place of first aid provision [n (%)]	**(n = 489)**	**(n = 385)**
Hospital ED	473(96.7%)	372 (96.6%)
Primary Health Care Unit	16 (3.3%)	13 (3.4%)
Hospitalization [n (%)]	**(n = 488)**	**(n = 384)**
No	402 (82.4%)	311 (81%)
Yes	86 (17.6%)	73 (19%)
Medication due to the accident [n (%)]	**(n = 481)**	**(n = 380)**
No	468 (97.3%)	368 (96.8%)
Yes	5 (1%)	4 (1.1%)
Death	8 (1.7%)	8 (2.1%)
Duration of absence from work (days) [n (%)]	**(n = 477)**	**(n = 374)**
≤3	12 (2.5%)	11 (2.9%)
4 - 6	50 (10.5%)	43 (11.5%)
7 - 13	30 (6.3%)	26 (7%)
14 - 20	35 (7.3%)	27 (7.2%)
21 - 30	72 (15.1%)	55 (14.7%)

Continued

31 - 60	157 (32.9%)	119 (31.8%)
61 - 90	63 (13.2%)	47 (12.6%)
91 - 180	48 (10.1%)	37 (9.9%)
>180	10 (2.1%)	9 (2.4%)
Accident outcome [n (%)]	**(n = 481)**	**(n = 379)**
No consequences	372 (77.3%)	284 (74.9%)
Related Health problems/Disability/Incapacity	101 (21%)	87 (23%)
Death	8 (1.7%)	8 (2.1%)

Additional Abbreviations: ED—Emergency Department.

Table 5. Size of enterprise (number of employees at local unit), length of service with the employer and material agent of contact/mode of injury (only occupational accidents).

Number of employees at local unit [n (%)]	**(n = 364)**
1 - 3	50 (13.8%)
4 - 9	68 (18.7%)
10 - 19	53 (14.6%)
20 - 49	70 (19.2%)
50 - 99	49 (13.5%)
100 - 249	27 (7.4%)
250 - 499	18 (4.9%)
500 - 999	14 (3.8%)
>1000	15 (4.1%)
Length of service with the employer (months) [n (%)]	**(n = 281)**
<12	90 (32%)
12 - 36	65 (23.1%)
37 - 60	45 (16%)
61 - 120	35 (12.5%)
121 - 180	13 (4.6%)
181 - 240	16 (5.7%)
>240	17 (6.1%)
Material Agent of contact/mode of injury [n (%)]	**(n = 385)**
Machinery	25 (6.5%)
Transport vehicles and lifting equipment	38 (9.9%)
Other equipment	16 (4.2%)
Materials, substances and radiation	5 (1.3%)
Working environment	4 (1%)
Other material agents	293 (76.1%)
Other material agents not classified in this list	4 (1%)

Considering the 8 fatal OAs, the predominant gender and age -range were men (87.5%, n = 7), individuals aged 45 - 54 years (57.1%). The occupation categories most affected were "service and sales workers" and "elementary occupations," each accounting for 37.5%, while "plant and machine operators and assemblers" accounted for the remaining 25%. In the "Manufacturing/Production" sector, 37.5% of fatal accidents occurred, followed by 25% in both the "Construction" sector and "Wholesale & Retail Trade, Repair of Motor Vehicles and Motorcycles" sector. The remaining 12.5% occurred in the "Transportation & Storage" sector. Half of these fatal accidents were motor/vehicular accidents, and in 62.5% of the cases, the mode of injury was "collision with immobile objects and falling against or being struck by moving objects". The predominant material agent of contact and mode of injury was "other material agents" (75%). All fatal accidents involved concussions and internal injuries, with 87.5% affecting the head and 12.5% affecting the head and multiple body parts.

Considering the victims' perception of the underlying cause of the accident, which was recorded during the phone interviews, "carelessness" was mentioned by 47.3% of the OAs group and 83% of the non-OAs group. "Working conditions" was the second most mentioned cause in the OAs group (27.7%) and third in the non-OAs group (7%). "Human error/third-party fault" was mentioned by 17.3% of OAs, ranking third in OAs and second in non-OAs (10%). Finally, three causes were mentioned only by the OAs group: "Lack of preventive/protective measures" (3.5%), "Damage/malfunctions" (2.9%), and "Other causes" (1.3%) (Figure 2).

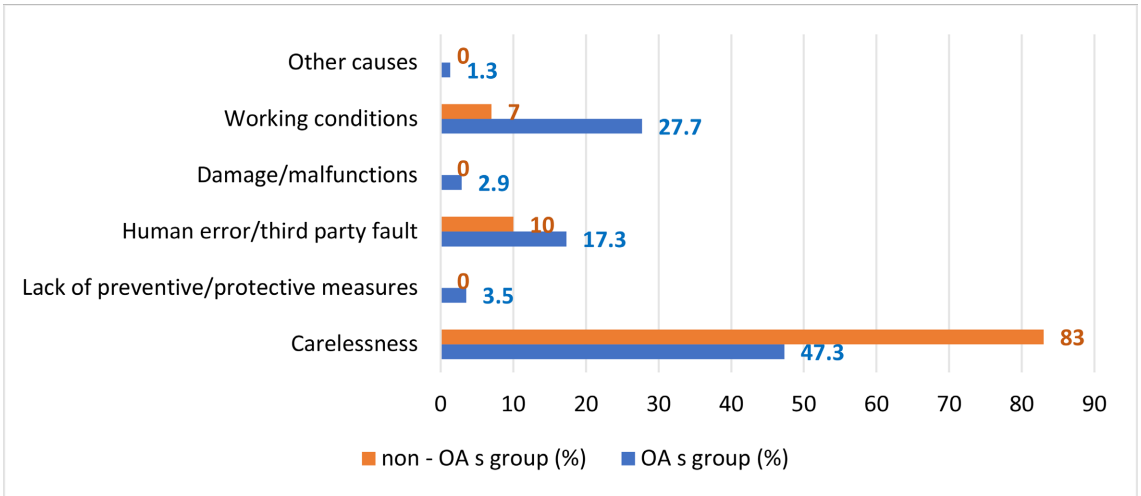


Figure 2. Victims' perception on the underlying cause of the accident.

Inferential Statistical Analysis

The inferential statistical analysis, conducted to test the research hypothesis, demonstrated several correlations (Table 6).

First, the "place of the accident" variable, which represents the probability of an OA, correlates with Gender—men having twice the risk for OA compared to

Table 6. Statistically significant correlations' summary.

Variable (1)	Variable (2)	Test method	OAs sample		Total sample	
			n	p-value	n	p-value
Place of accident (OA/non-OA)	Gender	Chi-square with Monte Carlo exact test			486	<0.05
	Age (years)*	Mann-Whitney U			471	<0.05
	Occupation	Chi-square with Monte Carlo exact test			487	<0.001
	Accident outcome	Chi-square with Monte Carlo exact test			481	<0.05
Days of absence from work*	Type of injury	Kruskal-Wallis	374	<0.001	477	<0.001
	Body site injured	Kruskal-Wallis	374	<0.001	477	<0.001
	Accident outcome	Kruskal-Wallis	368	<0.001		
Age (years)*	Mode of injury	Kruskal-Wallis	372	<0.001	471	<0.001
Number of employees at local unit*	Material Agent of contact/mode of injury	Kruskal-Wallis	364	<0.05	460	<0.05
	Safety measures and education in OHS	Kruskal-Wallis	357	<0.001	452	<0.001
Mode of injury	Gender	Chi-square with Monte Carlo exact test	382	<0.001		
	Level of education	Chi-square with Monte Carlo exact test	382	<0.05		
	Occupation	Chi-square with Monte Carlo exact test	385	<0.05		
	Sector of economic activity	Chi-square with Monte Carlo exact test	375	<0.05		
	Age (range)	Chi-square with Monte Carlo exact test	369	<0.001		
	Accident outcome	Chi-square with Monte Carlo exact test	379	<0.05		
Material agent	Gender	Chi-square with Monte Carlo exact test	382	<0.001		
	Occupation	Chi-square with Monte Carlo exact test	385	<0.05		
	Sector of economic activity	Chi-square with Monte Carlo exact test	375	<0.05		
	Safety measures and education in OHS	Chi-square with Monte Carlo exact test	376	<0.05		
Type of injury	Gender	Chi-square with Monte Carlo exact test	382	<0.05		
	Sector of economic activity	Chi-square with Monte Carlo exact test	375	<0.001		
	Duration of absence from work	Chi-square with Monte Carlo exact test	374	<0.001		
	Accident outcome	Chi-square with Monte Carlo exact test	379	<0.001		
	Safety measures and education in OHS	Chi-square with Monte Carlo exact test	376	<0.05		
Body site injured	Level of education	Chi-square with Monte Carlo exact test	381	<0.05		
	Sector of economic activity	Chi-square with Monte Carlo exact test	375	<0.05		
	Duration of absence from work	Chi-square with Monte Carlo exact test	374	<0.001		
	Accident outcome	Chi-square with Monte Carlo exact test	379	<0.001		
Sector of economic activity	Number of employees at local unit	Chi-square with Monte Carlo exact test	354	<0.001		
	Safety measures and education in OHS	Chi-square with Monte Carlo exact test	366	<0.001		

women (OR = 1.94, CI 95%, $p < 0.05$)—Age ($p < 0.05$), Occupation ($p < 0.001$) and Accident outcome ($p < 0.05$). The median age in the OA category was 4 years higher than in the non-OA category (44 versus 40), while 48.8% of the OAs involved the age-range 45 - 64 years, compared to 35% in the non-Oas group. In-non-OAs, the predominant age-range was 35 - 44 years (31%). Regarding occupation, the main differences were observed in the "Craft and related trades workers" and "Plant and machine operators, and assemblers" which made up 13.2% & 13.5% of OAs respectively, compared to 4% in both occupation categories among non-OAs. On the other hand, the "professionals" category constituted 16% of non-OAs but only 5.5% of OAs. Continuing accident-related health problems and disabilities/incapacity were reported in23% of OAs, compared to 14% in non-OAs, while, as previously mentioned, all fatal accidents were occupational (2.1% of OAs and 1.7% of the Total).

As continuing variables, the *Duration of absence of work(in days)* correlates with the "Type of injury" ($p < 0.001$), "Body site injured" ($p < 0.001$), and "Accident outcome" ($p < 0.001$), "*Age (in years)"* correlates with "Mode of injury" ($p < 0.001$), and "*Number (absolute) of employees at the local unit"* correlates with "Material Agent of contact/mode of injury" ($p < 0.05$) and "Safety measures and education in OHS" ($p < 0.001$).

By implementing the Chi-square test with the Monte-Carlo exact test for valid estimation, interesting correlations were identified in the OA sample between key accident-related variables (namely "mode" and "type of injury", "body site injured" and "material agent" causing the injury) and demographic, occupational and accident-related outcome variables (such as "duration of absence" and "accident outcome").Additionally, the same statistical methods confirmed expected correlations between "sector of employer's economic activity" and "number of employees at local unit", as well as between "safety measures and education in OHS".

Table 6 summarizes all the aforementioned results.

Ordinal and binary logistic regressions were performed with "duration of absence" (in its ordinal form) and "accident outcome" (for the non-fatal cases only) as dependent variables, respectively. These variables were used as measures of the accident's severity, and the regression aimed to examine whether selected occupational variables (such as "sector of economic activity", "occupation", and "length of service with the employer"), accident-related variables (such as "mode of injury" and "material agent"), and age had predictive value. The analysis did not result in a valid predictive model for either of the two severity measures.

4. Discussion

The results are largely in agreement with official national data on OAs. According to the e-USSF's ESAW Reports for Greece, for the years 2017 to 2021 (the most recent year with available data), 58% - 59% of the OAs occurred at the age-range 35 - 54 years old each year, with a mean rate of 30% for each one of the 35 - 44 and 45 - 54 years old age categories. In this study, the corresponding relative

frequency for the 35 - 54 age range was 52.6% for the total time period.

The findings of our study showed that the number of occupational accidents in the region of Thrace ranged from 42 (2018) to 68 (2021) annually. Taking the average population from the active labor force, according to the 2021 national census in the regional unit under consideration, we can estimate a prevalence rate between 0.9 and 1.5 per 1000 workers annually (with a mean prevalence of 1.4 per 1000 workers over the seven-year period from 2017-2023). The national prevalence rate per 1000 workers was 2.4 for the years 2017 and 2018, 2.3 for 2019 and 2 for 2020. As noted in the Eurostat report for 2021: "*low incidence rates for non-fatal accidents may reflect an under-reporting problem linked to*: *poorly-established reporting systems*, *little financial incentive for victims to report*, *non-binding legal obligations for the employers*" [19] among other factors.

A high rate of occupational accidents was observed among male workers (66.5%), as men are more likely to be employed in labor, intensive and high risk industries such as construction and manufacturing. In fact, most occupational accidents occurred in the manufacturing sector (28.3%), while in analytical national ESAW reports the corresponding sector was "Wholesale & Retail Trade, Repair of motor vehicles and motorcycles" (25%, 25.7% & 26.8% for the years 2017, 2018 & 2019 respectively). In this study, the latter sector accounted for 19.5%, ranking third, while the "other activities" sector ranked second (22.7%). The primary cause of occupational accidents was "falling from the same level" (48.8%). In the national reports falls in general accounted for nearly30% (28.3% - 30.6% for the 2017-2019 time period). The main mode of injury was "Slipping, collapse and being struck, struck by falling objects" in 2017 (39%) and "Collision with immobile objects and falling against or being struck by moving objects" in 2018 and 2019 (38.3% and 37.9% respectively). Upper and lower extremities were the primary body parts injured, and fractures were the most common type of injury, in both this study and in the national reports. The mean duration of absence from work of 1.5 months, in both this study and the national reports confirms the significant productivity losses caused by OAs.

An important observation is that higher frequency and most serious accidents were recorded in the year 2021. This could be attributed to changes in the way workers submit accident reports. Until 21/01/2021, occupational accidents were reported to the social security agency by a handwritten accident report filed by the employee with the written consent of the employer, or by the employer themselves. This often resulted in accidents going unreported when there was disagreement with the employer.

As of 22/01/2021, the electronic submission of workers' accident declarations via the platform of the Unified Social Security Fund came into effect following a joint ministerial decision.

According to Article 2: "The employee's treating physician fills in the electronic-prescription application of the 'e-Government Center for Social Security S.A (IDIKA S.A)' the certificate of incapacity for work, which includes indicative

data such as: the date of issue, the physician's identification data, the insured's ID information, the insured's Social Security Number, details of the illness according to the ICD-10 coding, and the proposed days of sick leave. In the event of an accident, the doctor enters free text descriptive data including: the date and time of the accident, whether it was a traffic accident, place of the accident, and the date of report submission."

Another noteworthy issue is the nearly complete lack of safety measures and training in OHS (85.6% overall), which makes it impossible to draw conclusions regarding their correlation with the frequency and severity of OAs. However, the results confirmed the inadequacy of safety measures and training in small and medium-sized enterprises, which constitute the majority in Greece. The fact that almost half (47.3%) of OA victims, when interviewed by phone, cited "carelessness/inattention" as the main cause of the accident—considering it their own responsibility—relates both to ignorance of OHS rules and to low reporting rates of OAs. However, based on the existing perceptions, "working conditions" were considered a contributing cause by nearly one-third of the injured workers (27.7%). Given that "third-party fault/human error" is one of the primary factors targeted by occupational accident prevention strategies, our results suggest that at least 45% of OAs could be prevented.

5. Limitations

This study has several limitations. First, to ensure the analysis complied with the statistical classifications of the ILO and the European Commission for the Statistics of Accidents at Work (and to make the results comparable), our data exhibited large dispersion and variability across many variables. This resulted in the inability to develop a predictive model. However, this issue is common in similar surveys, and the use of qualitative data, rather than quantitative, is often suggested. Second, because the study population was drawn from the ED, the cases encompassed a variety of workplaces from different sectors, making it unfeasible to investigate workplace-specific factors that contribute to accidents.

6. Conclusion

Occupational accidents can have a disastrous impact on employees, business operations, and the productivity of the national economy. Significant efforts are needed in their prevention through the implementation of safe practices, provision of proper training and equipment, and fostering a culture of safety awareness. Thorough and systematic examination and improvement of working conditions must be a priority, regardless of the size of the enterprise.

7. Study Ethics and Approvals

Throughout the conduct of this study, data collection and processing were in compliance with the General Personal Data Regulation (GPDR). Participation in the phone interviews was voluntary, and participants gave informed consent for the use

of their data. The study was approved by the Scientific Council of the University General Hospital of Alexandroupolis, with protocol number 1332 on 12-01-2023.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] (2024) ILOSTAT/Occupational Safety and Health Statistics (OSH) Database: Occupational Injuries, Concepts and Definitions. https://ilostat.ilo.org/methods/concepts-and-definitions/description-occupational-safety-and-health-statistics/

[2] International Labour Office (ILO) (2015) Global Trends on Occupational Accidents and Diseases. World Day for Safety and Health at Work, ILO. https://webapps.ilo.org/static/english/osh/en/story_content/external_files/fs_st_1-ILO_5_en.pdf

[3] Heinrich, H.W. (1931) Industrial Accident Prevention: A Scientific Approach. McGraw-Hill.

[4] Bird, F.E. and Germain, G.L. (1996) Practical Loss Control Leadership. Det Norske Veritas (U.S.A.).

[5] Anderson, M. and Denkl, M. (2010) The Heinrich Accident Triangle—Too Simplistic a Model for HSE Management in the 21st Century? *SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production*, Rio de Janeiro, 12-14 April 2010. https://doi.org/10.2118/126661-ms

[6] Hill, J.M.M. and Trist, E.L. (1953) A Consideration of Industrial Accidents as a Means of Withdrawal from the Work Situation. *Human Relations*, **6**, 357-380. https://doi.org/10.1177/001872675300600404

[7] Gordon, R., Flin, R. and Mearns, K. (2005) Designing and Evaluating a Human Factors Investigation Tool (HFIT) for Accident Analysis. *Safety Science*, **43**, 147-171. https://doi.org/10.1016/j.ssci.2005.02.002

[8] Lundberg, J., Rollenhagen, C. and Hollnagel, E. (2009) What-You-Look-For-Is-What-You-Find—The Consequences of Underlying Accident Models in Eight Accident Investigation Manuals. *Safety Science*, **47**, 1297-1311. https://doi.org/10.1016/j.ssci.2009.01.004

[9] Zhou, Z., Irizarry, J. and Li, Q. (2014) Using Network Theory to Explore the Complexity of Subway Construction Accident Network (SCAN) for Promoting Safety Management. *Safety Science*, **64**, 127-136. https://doi.org/10.1016/j.ssci.2013.11.029

[10] Haslam, R.A., Hide, S.A., Gibb, A.G.F., Gyi, D.E., Pavitt, T., Atkinson, S., *et al.* (2005) Contributing Factors in Construction Accidents. *Applied Ergonomics*, **36**, 401-415. https://doi.org/10.1016/j.apergo.2004.12.002

[11] Hale, A., Walker, D., Walters, N. and Bolt, H. (2012) Developing the Understanding of Underlying Causes of Construction Fatal Accidents. *Safety Science*, **50**, 2020-2027. https://doi.org/10.1016/j.ssci.2012.01.018

[12] Win, K.N., Trivedi, A., Lai, A., Hasylin, H. and Abdul-Mumin, K. (2021) Non-Fatal Occupational accidents in Brunei Darussalam. *Industrial Health*, **59**, 193-200. https://doi.org/10.2486/indhealth.2020-0174

[13] Ganesh, C.S. and Krishnan, R. (2016) A Review of Occupational Injury Research in Malaysia. *The Medical journal of Malaysia*, **71**, 100-104.

[14] Ministry of Labour, Social Security and Welfare (2014) Hellenic Labour Inspectorate Yearly Report 2013.

[15] E-Unified Social Security Fund, General Directorate of Strategic Planning and Development—Directorate of Statistical Studies and Data Analysis (2019) Employees' Accidents at Work Report Year 2017. e-USSF.

[16] E-Unified Social Security Fund, General Directorate of Strategic Planning and Development—Directorate of Statistical Studies and Data Analysis (2021) Employees' Accidents at Work Report Year 2018. e-USSF.

[17] E-Unified Social Security Fund, General Directorate of Strategic Planning and Development—Directorate of Statistical Studies and Data Analysis (2021) Employees' Accidents at Work Report Year 2019. e-USSF.

[18] E-Unified Social Security Fund, General Directorate of Strategic Planning and Development—Directorate of Statistical Studies and Data Analysis (2023) Employees' Accidents at Work Report Year 2020. e-USSF.

[19] Eurostat (2024) Accidents at Work Statistics. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Accidents_at_work_statistics