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## A Review of Health and Safety Issues in Mariculture Industry in Greece

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### Authors' contributions

All authors contributed equally in the design of the study, the analysis and writing up of the present paper. All authors read and approved the final manuscript.

Review Article

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### ABSTRACT

**Aims:** To review the trend of occupational accidents and fatality in Greek Marine fish farms.

**Study Design:** Data on the occupational accidents in the Greek Mariculture industry are reviewed and compared with Occupational Accidents in Greece and in Europe.

**Place and Duration of Study:** Greece between 2009 and 2011.

**Methodology:** The study was carried out using reported data for occupational accidents from the ESAW 2001 (Eurostat, European statistics for accidents at work) and the Hellenic Labor Inspection Body (SEPE) and was analysed using descriptive and inferential statistics.

**Results:** The data presented in the study indicate that compared to other business sectors, workers of the Mari culture industry in Greece are exposed to higher risk of

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occupational accidents. The majority of accidents are attributed to slips and trips (39%) whereas in the general population of workers the majority of occupational accidents are associated with handling of objects (23%). Greek Aquaculture as a whole represents less than 2 per thousand of the total work force, 3 per thousand of all serious injuries and 16 per thousand of fatal injuries during 2009-2011.

**Conclusion:** The adoption of a campaign aiming in providing information to all stakeholders for practical steps which can prevent occupational accidents in the sector is urgently required. There are some examples in this matter which can be seen in the Aquaculture industries in other countries. The provision of health and training programs and generally the creation and maintenance of a healthy working environment is urgently required to prevent occupational accidents in the Greek Mariculture industry.

*Keywords: Occupational health and safety; hazards; human resources management; mariculture; Greece.*

## 1. INTRODUCTION

In the last few years, the Greek aquaculture industry faced significant financial problems, the volume of production fell for the first time over a period of 20 years, with a decrease of about 7% from 2009 to 2010. At the same time the wages and the working hours increased, while fish farms struggled to survive under limited access to loans from the banks. All these parameters may have had an impact on the workers' occupational stress and the occupational risk of the sector.

The goal of achieving work standards that will facilitate workers' health and safety is considered quite significant in all sectors in Greece, since fatal work-related accidents are higher in comparison to the international level [1]. Studies in different sectors in Greece, have emphasized the need for better training and education of the employees in health and safety issues, better health and safety provisions, occupational risk assessment policies and the provision of occupational doctors in companies [2-4].

In addition, Greece exhibits one of the lowest spending in social public policies compared to the EU average. On top of that, the country's national social policy is often criticized for its lack of preventive measures and actions towards treatment of occupational accidents and diseases once they occur [4].

Within the aquaculture sector there are five main categories of hazards: physiological, physical, chemical, biological and psychological [5]. Potential occupational hazards in aquaculture that have been associated with fatalities include: drownings, electrocutions, crushing-related injuries and head injuries, while non-fatal injuries have been associated with machine operation, chemicals and fires, lifting of heavy loads, slippery surfaces, rotting waste (hydrogen sulfide production), exposure to low temperatures, bacterial and parasitic infections, storm-related rushing water, diving conditions, night-time conditions, working alone and lack of training [6]. Potential health consequences to aquaculture workers who participate in manual works include: low back, neck and shoulder pain, cuts, burns, broken bones, amputation, hypothermia, hyperthermia, drowning, electrocution, allergy, asthma, burns, cancer and work related stress [5,6].

Eastern Mediterranean aquaculture activities have been rapidly expanded during the last 20 years, leading to an increase of both the number of fish farms and their production, reaching 100,000t (in 2011) while a three-fold increase is expected in near future years.

Greece is the largest Mari culture fish producer in the Mediteranean. In the Greek farming industries the total number of workers reaches almost the 0.2% of the total workforce of which the majority is employed within the Mariculture sector and in particular on floating fish cage farms.

A review of data on occupational accidents is considered to be an important tool for accident prevention policies [7]. The number of work related accidents varies according to specific working conditions, legislation and the characteristics of each business sector in different countries. Marine related jobs in particular, exhibit a higher number of occupational accidents compared to other sectors and this may change according to legislative and prevention initiatives [8-11]. Regarding Health and Safety in the Greek Mari culture industry, no systematic assessment or audit of Occupational Accidents in the sector has been undertaken before.

In the present paper data on the occupational accidents in the Greek Mari culture industry are reviewed and compared with Occupational Accidents in Greece and in Europe

## **2 METHOD**

The analysis of the present study was based on the reported data for occupational accidents from the ESAW 2001 (Eurostat, European statistics for accidents at work) and the Hellenic Labor Inspection Body (SEPE).

Prior to 2009, analyses on work accidents data in Aquaculture and Fisheries industry in Greece have been rather difficult to take place, since Greek authorities reported the corresponding data together with the processing and packaging of agricultural and fishery products.

In the present study, the total number of Aquaculture employees was taken into account in annual basis due to the fact that, amongst other factors, the number of mariculture workers is seasonally fluctuating.

Work related accident analysis in Mari culture Industry is presented, serving as a reference base for further improvement of health and safety working conditions.

This initial approach proposes, among others, indicators such as the seasonal distribution of accidents that also correlated with the annual variation in the production line of Mari culture.

The significance of differences was compared with chi-square using OXSTAT software.

## **3. RESULTS AND DISCUSSION**

During the period 2009-2011, workers in the Greek Mari culture sector have a lower ( $P<0.001$ ) absence rate from work compared to the general population of workers in Greece Fig. 1.

An analysis of the number of occupational accidents in the Greek Mari culture industry over the period of 2009-2011, indicates there is in average a risk of having each year about 25 accidents per 100,000 workers Fig.1. The risk of occupational accidents is below this average during the winter period ( $P<0.05$ ), a season in which Mari culture activities such as feeding and change of nets is reduced Fig. 2. There was no significant difference in the risk of accidents between the other seasons. This data indicate that the risk may increase when production is intensified.

This conclusion is also supported by a regression Fig.3. between the total volume of production and the total number of occupational accidents for the Greek Mari culture sector for a period between 1998 and 2011. During this period, the volume of production increased dramatically. The Greek Mari culture industry was producing, each year, less than 40.000 tones in the 1990s and the production reached levels higher than 100,000 tones in 2010. An analysis of the data indicates that there is a trend of increased risk of occupational accidents as a function of increased production volume. This is in agreement with other sectors where the risk of occupational accidents increases if production volume is increased [12].

A comparison in the rate of fatal occupational accidents in (i) Greece and (ii) European Union during the period 1995-2011 and (iii) the Greek Mari culture sector for the period between 2009-2011 is presented in Fig. 4. The data indicate that the risk of occupational accidents in the Greek Mari culture sector is higher ( $P<0.01$ ) than the general population of workers in the other sectors in Greece. This is in agreement with data from other countries, where analysis of data indicate that compared to other industries, employees involved in manual work in Mariculture have higher risk of occupational accidents [13-15].

This higher risk of the workers in Aquaculture may be influenced by differences in the nature of the job and the different risks involved in it. For example, workers in marine fish farms may be exposed to high risk of slips due to the wet surface of the walkways of floating fish cages or due to waves. This conclusion is supported by the fact that slips and trips are the most frequently reported causes of occupational accidents in the Mariculture industry, whereas in the general population of workers the majority of occupational accidents is attributed to the handling of objects. For example, an analysis of data for the year 2011, indicates that the majority of the general population of workers in Greece, is exposed to a risk of occupational accidents as a result of handling (23%), slips and trips (18%), and fallen objects (10%). In the Marine Aquaculture sector the risks are mainly attributed to three parameters: slips and trips (39%), fallen objects (16%) and handling (5%).

The difficult conditions and special requirements for the Mari culture workers is also reflected when comparing the accidents reported for workers in the fish farms and those on land based fish processing plants of the Mari culture industry in Greece. For the period studied in the present work (2009-2011) the number of accidents is higher in workers' involved in the operation of fish farms compared to the workers of land based operation of fish processing Table 1. The data indicate that the workers in Marine fish farms are exposed to higher risks of occupational accidents and that the pressure to increase the volume of production could further increase the number of occupational accidents and fatalities.

In light of this, the provision of health and training programs and generally the creation and maintenance of a healthy working environment is urgently required to prevent occupational accidents in the Greek Mari culture industry. What is of utmost importance is the organizational focus on Human Resources Management prevention strategies of work-related injuries rather than treatment strategies.

Throughout Europe, agriculture, forestry, and fisheries are the most hazardous sectors showing high rates for work related injuries. Hellenic Aquaculture as a whole represents less than 2 per thousand of the total work force, 3 per thousand of all serious injuries and 16 per thousand of fatal injuries during 2009-2011.

The data presented in the present work indicate that compared to other business sectors, workers of the Mari culture industry in Greece are in great risk due to slips and trips as this is the major cause of reported occupational accidents for this sector.

Health and safety at work is not just a legislative requirement for organizations. All stakeholders of Greek Mari culture have an interest in the prevention of occupational accidents. At the organizational level, the purpose of health and safety in the workplace is to ensure the protection of workers, improve working conditions and reduce disincentives and factors that have a negatively impact on the health and performance of employees [16]. There are legal, financial and moral implications that constitute occupational safety and health strategies at work a vital element towards effective human resources management. The financial cost of health and safety accidents include [17]: medical and pharmaceutical expenses/hospitalization, increasing spending (health care, compensation, sick leave, etc), legal fees due to civil actions/criminal proceedings, business closure, damage to machinery, infrastructure and property, recruitment and training of new/substitute workers, organization's negative publicity, loss of output. In the long term, occupational accidents can result in frequent changes of employer, reduced job satisfaction, efficiency, morale and employee loyalty [16,18,19].

Accidents in the workplace are often attributed to "bad luck" or "random" and unavoidable events". Nevertheless, what seems in almost every case, there are organisational measures for preventing accidents, protecting workers and improving work conditions. Human resources management policies such as; commitment, responsibility, communication and training affect the overall health and safety culture of an organisation [20].

Key organisational factors [21] in establishing an effective framework and conditions for health and safety within an organization include the Management support and commitment in workplace health and safety policies (staff training programs; the Creation and maintenance of a healthy work environment. Adverse economic conditions may affect the cost of implementing a health and safety program in organizations. The nature of the work performed, especially when influenced by working conditions as in the case of Mariculture Industry, may also affect the implementation of health and safety programs.

Accidents attributed to "unsafe acts" (caused mainly by human errors and omissions such as employees' failure to comply with safe work procedures) could be reduced or even avoided with the establishment of open communication and training of all employees: Proper handling of machinery, equipment and tools, practicing first aid, reducing fatigue (breaks down, using appropriate equipment, etc.) and the creation of good workplaces (adequate lighting, ventilation, etc).

Accidents caused by "unsafe conditions" (physical, chemical and mechanical conditions such as insufficient/defective protective equipment, noise, fumes, bad work environment) can be prevented to a large extent with the proper selection, installation and maintenance of equipment and the creation of a safe work environment; correct layout of workplaces alarm systems for fire or electrical leakage, exits, etc.

Especially in the Mariculture Industry, there are diverse workplaces with workers being exposed to different physical, chemical and biological hazards [22,23] such as noise, hot/cold working environment, working in isolation, cuts, sprain, fracture, occupational asthma and rhinitis, burns, skin irritation and allergies, parasitic infestation and pathogenic infections.

Measures that can additionally be taken in account could include the provision of personal protective gear and clothing (heat, water, etc), measures to prevent/minimize slips and trips accidents (right footwear, usage of right cleaning methods, electrical and machinery safety, sound management of chemicals).

Studies in different sectors in Greece have emphasized the need for better training and education of the employees in health and safety issues, better health and safety provisions, occupational risk assessment policies and the provision of occupational doctors in companies [2-4].

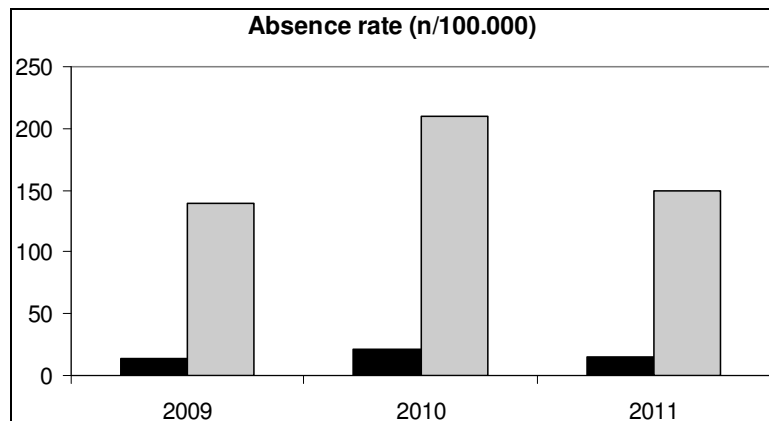
The issues of health and safety at work, should be implemented so as to protect the mental and physical well being of organizations' human resources, taking all necessary precautions and proactive policies that prevent and deter accidents and occupational diseases.

Such health and safety policies include: setting standards for health and safety at work, health and safety training programs, accidents' prevention policies, tackling work-related stress and burnout [21].

**Table 1. Work related accidents in marine floating fish cages and in land based packaging and storage plants of marine fish farms during 2009-2011**

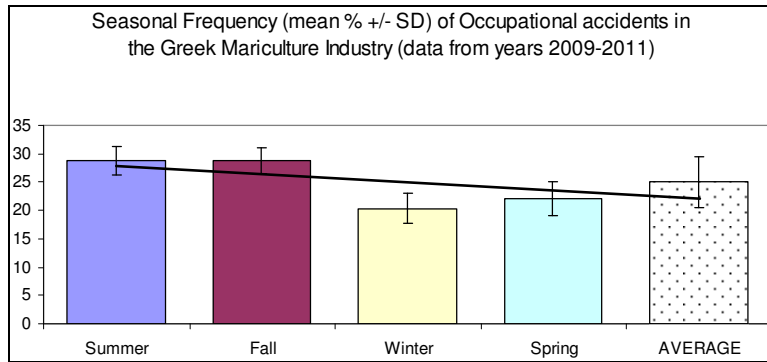
	2009	2010	2011
Total No of Occupational Accidents reported in Floating Marine Cages	14	22	26
Total No of Occupational Accidents reported in land based Packing and storage plants.	8	14	8
<i>Chi-square</i>	<i>P&lt;0.01</i>	<i>P&lt;0.01</i>	<i>P&lt;0.001</i>

Source: SEPE Annual Report 2011

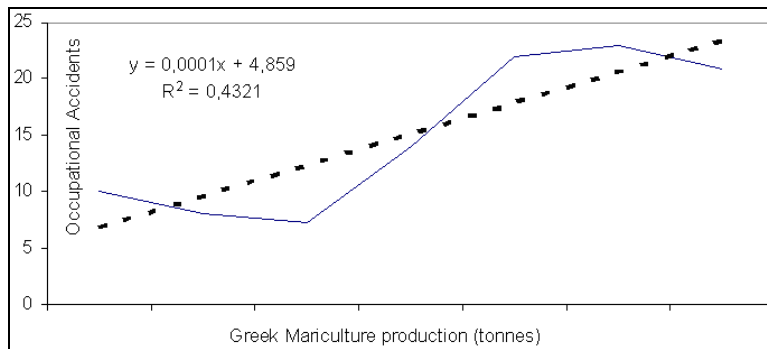


**Fig. 1. Absence rate (no of days>3) of workers in the general population (grey bars) and in the Mari culture industry (black bars) in Greece (period between 2009-2011)**

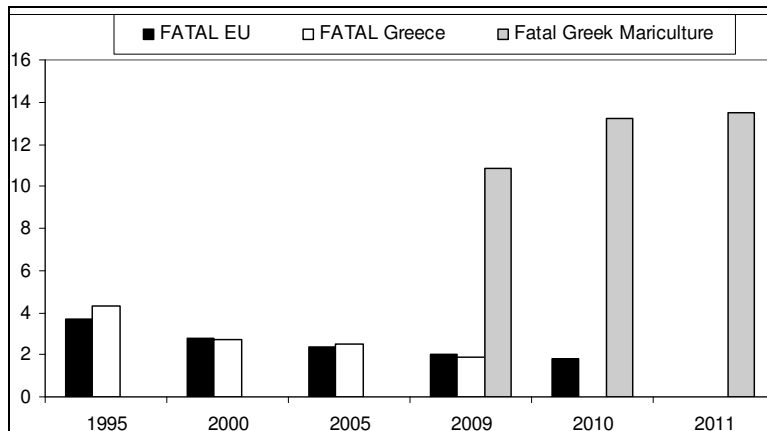
Data from SEPE Annual Report 2011



**Fig. 2. Seasonal frequency (mean%+/-SD) of occupational accidents in the Greek Mariculture industry (data from years 2009-2011)**  
 Data from SEPE internal database for Annual Report 2011



**Fig. 3. Linear regression between the volume of production and the number of Occupational accidents in the Greek Mariculture industry**  
 Data from year 1998 to year 2011 (Data from Eurostat and Elstat)



**Fig. 4. The rate of fatal occupational accidents (number per 100,000 employees) in Greece and in the European union during the period 1995-2011 for the period between 2009-2011 in the Greek Mariculture sector**  
 (Sources: Eurostat, Greek STAT).

#### **4. CONCLUSION**

The data presented in the present work indicate that compared to other business sectors, workers of the Mari culture Industry in Greece are in great risk due to slips and trips as this is the major cause of reported occupational accidents for this sector.

The adoption of a campaign aiming in providing information to all stakeholders for practical steps which can prevent occupational accidents in the particular sector is urgently required. There are some examples in this matter which can be seen in the Aquaculture industries in other countries [24,25]. The provision of health and training programs and generally the creation and maintenance of a healthy working environment is urgently required to prevent occupational accidents in the Greek Mari culture industry. Using the experience gained in other countries [12,24,25] the stakeholders of the Greek Mari culture industry should collaborate to the initiation of campaigns and training and review panels with aim to monitor and prevent occupational accidents in the sector. This is crucial, particularly if the volume of production is increased as it is anticipated for the next decade.

What is of outmost importance is the organizational focus on Human Resources Management prevention strategies of work-related injuries rather than treatment strategies

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#### **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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