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Occupational accidents in Malta and the role of the Occupational Health and Safety Authority: a twenty-year analysis

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Abstract

The Occupational Health and Safety Authority (OHSA) was established in Malta in 2002. Since then, trends indicate that non-fatal accidents have decreased in Malta, while changes in fatal accidents are less clear. Since these trends have not been statistically investigated before, this study aims to do so. The study also aims to analyse the link between specific OHSA deterrent measures and changes in non-fatal accidents. A database compiled by the OHSA on the frequency of accident statistics in Malta and OHSA deterrent measures between 2002 and 2022 was analysed. The study demonstrated that the incidence of fatal and non-fatal accidents decreased significantly during the analysed period. The incidence of non-fatal accidents was more common in the transport and storage sector, the construction sector and the manufacturing sector. Fatal accidents were most frequent within the construction sector. Fatal accidents were common among the self-employed and foreign workers. Deterrents, especially those related to inspections and fines, were significantly associated with a decrease in fatal and non-fatal accidents. The study underscores those accidents have declined significantly since the establishment of the OHSA and demonstrates the benefits of specific deterrent measures. Continued focus is required on specific areas, including the construction sector, self-employed workers and foreign workers.

1. INTRODUCTION

Occupational health and safety (OHS) is a key national consideration. While every country should endeavour to protect the health and safety of its workers for moral reasons, there are also economic and social arguments (OHSA, 2011a; Rosner & Markowitz, 2020). Workplace accidents and diseases can impact workers physically, psychologically and financially. They are costly for employers, who must deal with the costs of absent workers, lost production and potential enforcement and legal issues. They are also costly for society, which in Malta finances the national health service and social security, which support ill, injured and disabled workers. At the same time, the country's income is negatively impacted by lost production.

National legislative measures to improve health and safety standards in Malta can be traced back to the early twentieth century and were initially based on British standards (Fiorini & La Ferla, 2021). Despite this, it was not until Malta was preparing to join the European Union (EU) and introduced the Occupational Health & Safety (Authority) Act (Chapter 424, Act XXVIII of 2000), which was fully implemented in 2002, that Malta had legislation that applied to all sectors of activity, all workplaces and work activities, both public and private, with few exceptions. The Occupational Health and Safety Authority – Malta (OHSA) was established with the introduction of this Act. The following paper

aims to analyse how the frequency of fatal accidents and injuries has changed in the first twenty years since the establishment of the OHSA and will examine the factors associated with a change in such injuries.

1.1 Fatal and non-fatal accidents in Malta

Compared to other EU countries, the level of occupational safety (Eurostat, 2022a) and health (Fiorini, 2019) in Malta appears to be positive. EU statistics for 2020 reveal that the number of non-fatal accidents at work in Malta is below the EU average (Eurostat, 2022a). EU statistics indicate that while the total number of non-fatal accidents increased between 2012 and 2019, the incidence of such accidents (the number of accidents per 100,000 employed) decreased (Eurostat, 2022b). Whilst conflicting findings have been reported on trends in the accident rate in Malta until 2003 (Fiorini & La Ferla, 2021; Hämäläinen et al., 2009), the number and incidence of non-fatal injuries appear to have decreased since the establishment of the OHSA (Fiorini, 2018; Fiorini & La Ferla, 2021; Nowacki, 2021), with the annual number of non-fatal injuries being higher in every year before the establishment of the OHSA for which data are available (1991-2001) than in any year since its introduction (Fiorini & La Ferla, 2021). Nevertheless, the change in non-fatal accidents in Malta since the Authority's establishment has not been previously tested statistically, which the current study aims to investigate (Objective 1). About this objective, the following hypothesis is made:

H1: Workplace injuries in Malta have reduced significantly during the studied period.

Trends indicate that most accidents in Malta occurred in specific sectors. In terms of non-fatal accidents, descriptive data suggests that over the years, the most significant number have occurred in the manufacturing sector, followed by the construction sector, the transport and storage sector (which has at times recorded more injuries than the construction sector), the wholesale retail and repair sector, and the accommodation and food sectors (Fiorini, 2018; Fiorini & La Ferla, 2021). EU statistics are similar to those of Malta, but there are some differences, possibly due to the different shares of the sectors in Europe. Most non-fatal accidents (in 2020) occurred in manufacturing, human health, construction, wholesale and retail trade, and transport and storage (Eurostat, 2022a). Trends from Malta reveal that the number of non-fatal accidents has decreased in some sectors (Fiorini & La Ferla, 2021; Nowacki, 2021). However, the change in incidence and whether this change is statistically significant has not yet been investigated in Malta and is a focus of this paper (Objective 2). It is, therefore, unclear if such changes are linked to variations in employment in these sectors. EU incidence statistics reveal that non-fatal accidents incidence in the highest-risk sectors decreased between 2010 and 2020 (Eurostat, 2022a). The current paper, therefore, has the following hypothesis:

H2: Non-fatal accidents will vary by sector, with the incidence of non-fatal accidents most frequent in the manufacturing sector. Non-fatal accidents will decrease over the studied period in each sector.

Whilst EU statistics indicate a reduction in the number and incidence of fatal accidents in recent years (2012-2019) (Eurostat, 2022b), the picture in Malta is less clear. This is mainly due to the comparatively small labour market and the country's limited number of fatal accidents. Subsequently, the incidence of fatal accidents in Malta has sometimes surpassed the EU average and, in other years, has dropped below the EU average (Eurostat, 2022a, 2022b). The change in fatal accidents over time has not yet been statistically analysed and is examined in the current paper (Objective 3). Descriptive data provides a mixed picture but indicates that fatal accidents have decreased since the establishment of the OHSA (Fiorini & La Ferla, 2021; Hämäläinen et al., 2009). The paper thus has the following hypothesis:

H3: Occupational fatal accidents have reduced significantly during the studied period

In line with EU findings (Eurostat, 2022a), most fatal accidents in Malta occurred in the construction sector (Fiorini & La Ferla, 2021; National Statistics Office [NSO], 2022). Descriptive statistics also suggest that most people who died in a Maltese workplace were male (NSO, 2022) and increasingly foreigners, usually non-EU nationals (Fiorini &

La Ferla, 2021). In the EU, migrant workers represent a substantial percentage of the workforce. They are more likely to work in precarious conditions and carry out work that is unpopular with the native population, frequently because it is dangerous, dirty and demanding (3D jobs). Levels of safety in such jobs are often poor, and thus, non-native workers are often more likely to be injured (Porru & Baldo, 2022; Sterud et al., 2018). Fatalities in Malta also appear to be higher among the self-employed or those working in smaller organisations (NSO, 2022). This is not unique to Malta (Collie, 2024; Health and Safety Authority – Ireland, 2022; Liao & Chiang, 2022) and may be related to the fact that workers and organisations with fewer resources and knowledge of OHS are at a greater risk than employees of larger organisations. This is exacerbated in the case of the self-employed, who usually have lower levels of job security and protection (Liao & Chiang, 2022).

Several major hazards in construction include falls from height, being struck by falling objects, collisions with moving vehicles, electrocution and fire (Aneziris et al., 2012; Liao & Chiang, 2022). Safer building sites that have safety management systems in place and conduct more risk assessments are associated with fewer construction deaths (Mendeloff & Staetsky, 2014). Nevertheless, several factors may prevent the proper implementation of safety management systems within construction sites, including a lack of resources, training and a poor OHS culture (Buniya et al., 2021). Due to the ongoing global challenges related to rendering construction sites safe, it has been argued that the construction industry should adopt innovative safety practices that use advanced technology to enhance safety (Akinlolu et al., 2022; Okpala et al., 2020; Rao et al., 2022). UK statistics show that falls were the leading cause of workplace fatalities in 2022/3 (HSE, 2023), with statistics from several countries highlighting that falls are the leading cause of fatalities in the construction industry (Alsharef et al., 2023; CPWR, 2019; CPWR, 2021; Hu et al., 2011). In the EU, concussions and internal injuries were the most common type of injury leading to death in construction in 2020 (Eurostat, 2022b). This is even clearer in Malta, where between 2016 and 2021, only one workplace fatality was not secondary to concussions and internal injuries (NSO, 2022).

A statistical analysis of the extent to which different factors impact Malta's workplace fatalities has not been conducted. This study investigates whether factors including sector, cause of death, nationality, employment and working on more complex construction projects influence the incidence of fatalities in the construction industry in Malta (Objective 4). In this context, the study makes the following hypothesis:

> H4: Fatalities will be more common amongst construction workers, falling from height, foreign workers, self-employed, and working on more complex construction projects.

To promote good levels of health and safety within construction projects, Maltese legislation requires developers (termed the client) to appoint a project supervisor to oversee OHS during the design and execution stages of a construction project (Work Place (Minimum Health and Safety Requirements for Work at Construction Sites) Regulations, 2004, 2018). If the client is competent in OHS matters, they can act as the project supervisor. There are also exemptions to the need to appoint a project supervisor. For example, the concept of a 'domestic client' was introduced in 2018, where projects not carried out as part of the client's business and fulfilled certain conditions that indicated that the project was at a lower risk were exempt. The impact of the appointment of project supervisors on the number of occupational fatalities has not been previously researched and will be analysed in this study (Objective 5). On the assumption that most project supervisors are competent, the analysis assumes:

> H5: Fatal accidents will be more frequent in projects where project supervisors have not been appointed.

1.2 Impact of deterrents on accidents at work

The Occupational Health & Safety (Authority) Act (Chapter 424, Act XXVIII of 2000) confers several responsibilities on the OHSA. Many of these relate to its role in contributing to the development of OHS regulations, strategies and codes of practice, that the applicable laws are monitored and enforced, and that OHS is promoted via

education, training and the dissemination of information. The OHSA has a tripartite board and an executive to fulfil its many functions. A CEO heads the latter and includes inspectors and other senior individuals. In 2023, the OHSA had 13 inspectors, with most workplace visits focused on the construction sector (OHSA, 2023). As discussed below, studies have shown that inspectorates can substantially impact health and safety levels at both a sectoral level and a national level. However, the impact of different functions has been shown to vary. The topic has not yet been studied in Malta.

Properly implemented health and safety legislation provides organisations with an initial framework to prevent and control undesirable work occurrences (Salguero-Caparrós et al., 2020). Subsequently, regulations have helped cultivate positive OHS levels (Fan et al., 2020; Rosner & Markkdaowitz, 2020; Salguero-Caparrós et al., 2020). However, it has been argued that introducing new regulations, often to address new and emerging risks, has had limited positive impact on factors such as injury rates (Bulzacchelli et al., 2007; Tompa et al., 2016). Whilst the impact of OHS legislation in Malta on injuries is unclear, with international studies showing that the effectiveness of legislation and the ability to implement it may depend on several factors (Arocena & Nunez, 2009; Salguero-Caparrós et al., 2020), EU-OSHA (2022) indicates that legal obligations were a leading reason why the majority of enterprises in Malta addressed health and safety.

The evidence about the impact of inspections and penalties is clearer. There is strong evidence of the impact of inspections with citations and penalties on the reduction of injuries (Fan et al., 2022; Gray & Mendeloff, 2005; Haviland et al., 2012; Tompa et al., 2007; Tompa et al., 2016). Still, there is a lack of consensus regarding whether more significant penalties have added benefit (Fan et al., 2022; Gray & Mendeloff, 2023). The evidence on the impact of inspections without penalties is also unclear, but studies appear to agree that such inspections are less effective than when citations and penalties can be imposed (Foley et al., 2012; Gray & Mendeloff, 2005; Tompa et al., 2007; Tompa et al., 2016). The effectiveness of inspections can also be influenced by other factors, such as the relevance of the regulatory framework to the organisation (Hagqvist et al., 2020), the competence of inspectors, their ability to provide advice, and their insistence that management systems are implemented (Niskanen et al., 2014; Umeokafor et al., 2022). The positive impact of inspections cannot be understated. Reductions in injury rates are not limited to the inspected standards but also to unrelated standards, indicating that inspections may cause employers to take health and safety more seriously in general (Haviland et al., 2010; Mendeloff & Gray, 2005). Furthermore, the positive effects of inspections can be seen even years after an inspection (Gray & Mendeloff, 2023; Haviland et al., 2012). Studies indicate that compared to follow-up visits, initial inspections appear to have the most significant impact on compliance (Ko et al., 2010: Tompa et al., 2016). Statistics indicate that in Malta, around half of enterprises with five or more employees were visited by the OHSA in three years, whilst avoiding fines and sanctions by OHSA inspectors was a significant reason why most enterprises addressed OHS (EU-OSHA, 2022).

Another role carried out by inspectorates including the OHSA is to organise awareness campaigns. Studies suggest that workers and organisations value information and feedback from inspectors (Niskanen et al., 2014; Umeokafor et al., 2022). Furthermore, studies have shown that workers fail to recognise many hazards (Uddin et al., 2020), while a lack of knowledge is a barrier to implementing effective safety management (Buniya et al., 2021). Studies on such OHS campaigns are rather limited and often relate to very specific topics. Findings on their effectivity are mixed, with some individual studies finding that awareness campaigns can foster awareness (Bunting et al., 2017) and compliance with OHS regulations (Björkdahl et al., 2008; Mancini et al., 2005; Stokols et al., 2001). However, review articles have emphasised that limited evidence exists that such awareness campaigns lead to reduced injury rates (Tompa et al., 2016). Whilst studies on the effectiveness of such awareness campaigns have not been previously conducted in Malta, EU statistics show that a lack of awareness amongst management and staff of OHS topics was not common in Maltese organisations (EU-OSHA, 2022).

Whilst evidence in Malta is lacking and international evidence is often limited, previous studies suggest that the work of inspectorates can lead to positive OHS outcomes, including reduced workplace accidents. The current study will examine whether deterrents by the OHSA (including the number of inspections, income from fines, number of prosecutions, number of equipment certificates vetted and the number of hours spent carrying out awareness campaigns) are associated with a reduced incidence of injuries and fatalities (Objective 6). Given previous international research, it is hypothesised:

> H6: Inspections, fines, the value of fines, prosecutions, the vetting of certificates and carrying out awareness campaigns will be associated with a lower incidence of injuries and fatalities.

2. METHODOLOGY

The study is based on a national cross-sectional dataset collated by the OHSA from 2002 to 2022. The OHSA collects data on occupational deaths, whilst data on occupational injuries are collected by the Department of Social Security and passed on to the OHSA. Injury data is divided into two categories: injuries requiring three or fewer days of absence, thus representing less severe injuries, and injuries requiring four or more days of absence (indicating more serious injuries). These data are also categorised by sector from 2009 onwards. Data from the five most dangerous sectors are presented in the current study: manufacturing, construction, transport and storage, accommodation and food service, retail and wholesale. The data is available publicly via the National Statistics Office (NSO).

In terms of occupational deaths, the OHSA classifies these based on several factors, including the worker's nationality, the cause of death, the sector, the employment contract, and in the case of construction deaths, the presence of an appointed project supervisor, and if the fatality occurred at a notifiable construction project. The OHSA is to be notified of construction projects that are due to last longer than 30 working days, and where more than twenty workers are occupied simultaneously or where the scheduled volume of work is to exceed five hundred person-days (Work Place (Minimum Health and Safety Requirements for Work at Construction Sites) Regulations, 2018). Variables regarding the workers' nationality, cause of death, and employment were also created for those working solely in the construction industry. The OHSA also distinguishes between workplace deaths that fall under the OHSA Act and those that do not. Fatalities that are caused by activities that the Act does not explicitly regulate are various, and examples include construction deaths secondary to a building collapse where this was not being built according to the required skills and professional competence or vehicle accidents when driving to or from work. Other principal Acts of Parliament regulate these activities, although any fatality resulting from such an activity is classified as a work fatality.

Regarding deterrents, the study analyses information collected by the OHSA as part of its annual performance indicators. These include the yearly number of inspections, administrative fines, monetary value of fines (€), initiated prosecutions, vetted equipment certificates, and participant-hours awareness raising. This information is published publicly via the OHSA's annual reports.

2.1 Analysis

In line with the first objective, the trends in yearly injuries at work per 100,000 workers between 2002 and 2021 are investigated using regression models. These models are essential because they provide the trend's size and direction and indicate whether the relationship is significant. Regression models are also used for the second objective to investigate the trends in the number of injuries per 1000 workers between 2009 and 2021 in some sectors, including construction, transport and storage, manufacture, accommodation and food service, and wholesale, retail and repair. Analysis was conducted from 2009 onwards due to the availability of comparable sector-specific data. Moreover, the One-Way ANOVA test investigates how the mean yearly injuries per 1,000 workers (averaged from 2009 to 2022) vary between the five sectors.

In the second part of the analysis, occupational fatalities are explored. In line with the third objective, regression models are used to investigate the trends in the number of deaths per 100,000 workers between 2002 and 2022. For the fourth objective, the One-Way ANOVA test is used to examine how the mean yearly fatalities per 100,000 workers vary between ten working scenarios. In line with the fifth objective, descriptive statistics and regression were used to determine the relationship between the annual number of fatal construction accidents and the number of project supervisors appointed to the construction site where the fatality occurred. As the work of such supervisors can have a delayed effect, the relationship is also re-analysed, and the number of fatal construction accidents lagged by one year. Data on the appointment of project supervisors was available from 2005.

In the final part of the study, and line with the sixth objective, correlation analysis is used to investigate how the yearly injuries and yearly fatalities per 100,000 workers are related to several deterrents, including the number of inspections, the number of administrative fines, the monetary value of fines, number of vetted equipment certificates, number of initiated prosecutions, duration of staff development and awareness raising. As deterrents can have a delayed effect, the correlation between annual injuries and annual fatalities lagged by one year is also conducted. A 0.05 level of significance is used for all statistical tests and models.

3. RESULTS

3.1 Non-fatal injuries at work

Three regression models were fitted to relate the yearly injuries at work per 100,000 workers with time between 2002 and 2021. Total yearly injuries at work, yearly injuries requiring three days of absence at most, and yearly injuries requiring four days at least were the dependent variables in the three models.

Table 1 shows a reduction of 121.8 injuries each year in the total number of yearly injuries at work per 100,000 workers between 2002 and 2021. It also shows a decrease of 26.5 injuries each year in the number of annual injuries per 100,000 workers requiring three days of absence at most and a reduction of 95.3 injuries each year in the number of yearly injuries per 100,000 workers requiring four days of absence at least.

Table 1. Regression models for yearly injuries at work per 100,000 workers between 2002 and 2021

Dependent Variable		Reg. Coef.	St. Error	t-value	p-value
Total yearly injuries at work	Constant	3169.971	67.805	46.751	<0.001
	Time	-121.760	6.101	-19.956	<0.001
Yearly injuries requiring three days of absence at most	Constant	768.586	72.293	10.631	<0.001
	Time	-26.456	6.505	-4.067	<0.001
Yearly injuries requiring four days of absence at least	Constant	2401.543	52.071	46.121	<0.001
	Time	-95.331	4.686	-20.346	<0.001

All reductions were found to be significant. Figure 1 shows a fairly linear trend between the two variables. The One-Way ANOVA test was used to compare the mean yearly injuries per 1,000 workers between the five investigated sectors. These averages were computed by using all the available data from 2009 to 2022.

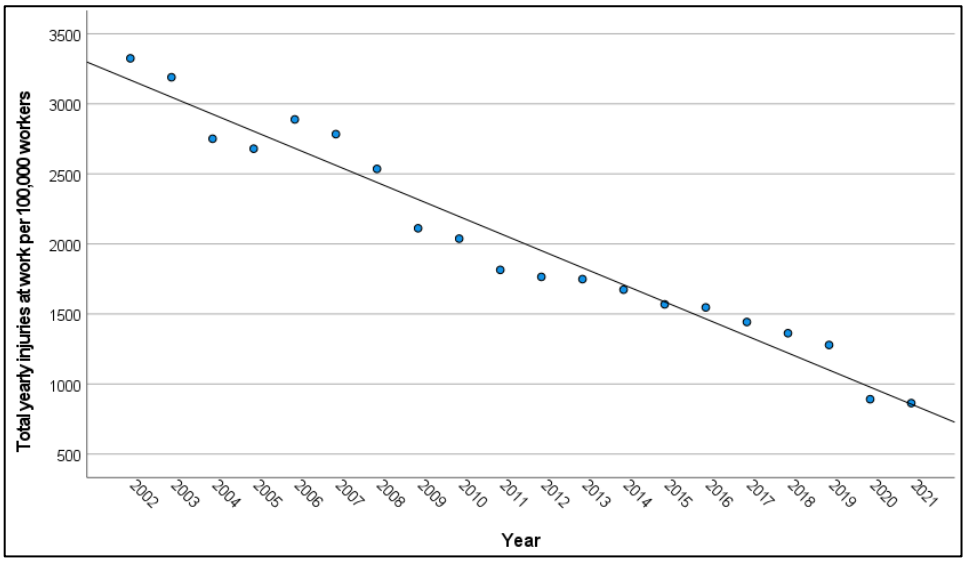

Figure 1. Trend of total yearly injuries at work per 100,000 workers

Table 2 shows that the average yearly injuries per 1,000 workers in the construction and transport & storage sectors (approx. 36.2 and 36.4 injuries each year, respectively) are significantly more significant than the average annual injuries in the manufacturing (approx. 27.2 injuries each year), which in turn is considerably more significant than the average yearly injuries in the food and accommodation sectors and wholesale, retail and repair sector (approximately 19.2 and 11.0 injuries each year respectively).

Table 2. Mean yearly injuries per 1000 workers, grouped by sector

Sector	Mean yearly injuries per 1000	Std. Dev.	95% Conf. Int. for Mean	
			Lower Bound	Upper Bound
Construction	36.15	8.112	31.25	41.06
Transport & Storage	36.38	8.780	31.08	41.69
Manufacturing	27.15	9.625	21.34	32.97
Accommodation & Food Service	19.15	7.093	14.87	23.44
Wholesale, Retail & Repair	11.00	2.739	9.35	12.65

$F(4, 60) = 26.819$, $p < 0.001$

Five regression models were fitted to investigate the trends in the number of injuries per 1000 workers between 2009 and 2021 in the five investigated sectors.

Table 3 shows that the most significant reduction in the yearly injuries was in the manufacturing sector (2.451 injuries each year), followed by the construction sector (1.962 injuries each year), transport and storage sector (1.665 injuries each year), accommodation and food sector (1.664 injuries each year), and wholesale, retail and repair sector (0.643 injuries each year). All these reductions are significant and not attributed to chance.

3.2 Fatalities at work

Two regression models were fitted to relate the yearly fatalities at work per 100,000 workers with time between 2002 and 2022. Total yearly fatalities at work and total yearly fatalities at work under the OHSA Act were the dependent variables in the two models.

Table 3. Regression models for yearly injuries at work per 1000 workers between 2009 and 2021

Dependent Variable		Reg. Coef.	St. Error	t-value	p-value
Yearly injuries in the construction sector	Constant	47.923	1.494	32.068	<0.001
	Time	-1.962	0.211	-9.281	<0.001
Yearly injuries in the transport and storage sector	Constant	46.374	3.241	14.308	<0.001
	Time	-1.665	0.458	-3.632	0.004
Yearly injuries in the manufacturing sector	Constant	41.857	0.684	61.171	<0.001
	Time	-2.451	0.097	-25.324	<0.001
Yearly injuries in the accommodation and food sector	Constant	29.143	1.574	18.511	<0.001
	Time	-1.664	0.223	-7.477	<0.001
Yearly injuries in the wholesale, retail and repair sector	Constant	14.857	0.608	24.449	<0.001
	Time	-0.643	0.086	-7.480	<0.001

Table 4 shows that the reduction in the total number of yearly fatalities at work per 100,000 workers is around 0.16 fatalities each year between 2002 and 2022. These reductions apply to all the cases examined and the cases under the OHSA Act and are significant at the 0.05 significance level.

Table 4. Regression models for yearly fatalities at work per 100,000 workers between 2002 and 2022

Dependent Variable		Reg. Coef.	St. Error	t-value	p-value
Total yearly fatalities at work (all cases)	Constant	4.942	0.783	6.311	<0.001
	Time	-0.157	0.067	-2.344	0.030
Total yearly fatalities at work (cases under the OHSA Act)	Constant	4.635	0.713	6.503	<0.001
	Time	-0.156	0.061	-2.556	0.019

Figures 2 and 3 display negative relationships between the total number of yearly fatalities and the reported year. Moreover, these relationships are significant despite considerable fluctuations in yearly fatalities between successive years.

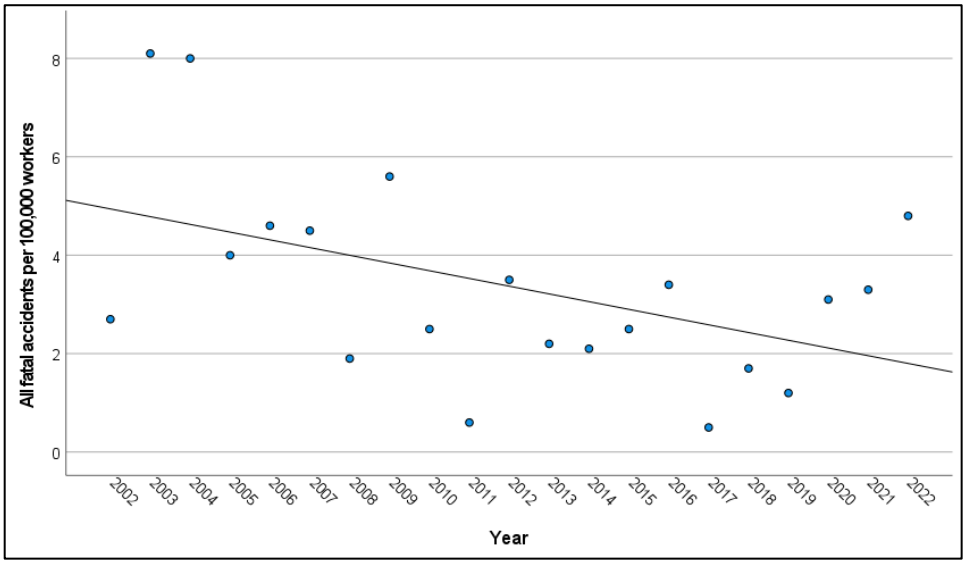

Figure 2. Trend of yearly fatalities per 100,000 workers

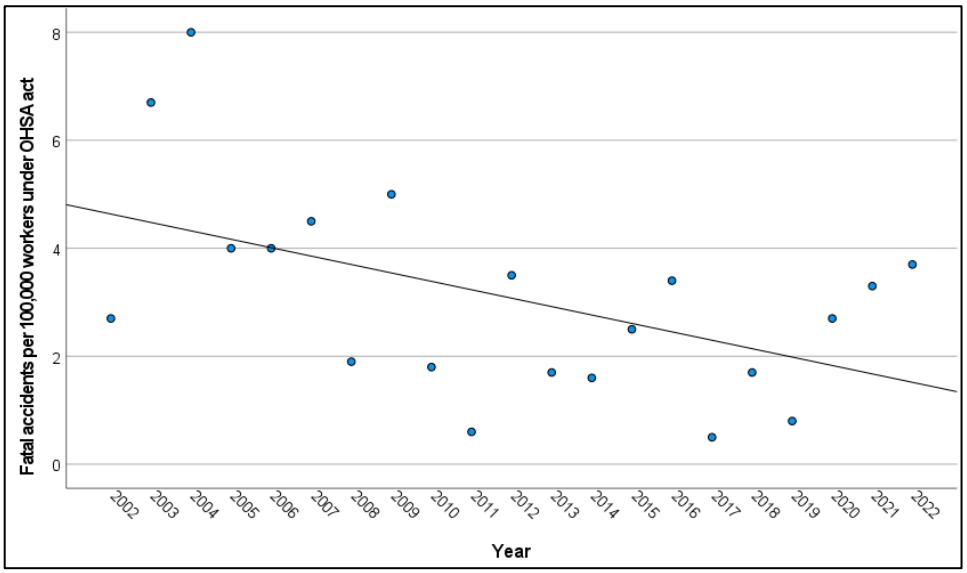

Figure 3. Trend of yearly fatalities at work, per 100,000 workers (under OHSA Act)

Since the number of yearly fatal accidents per 100,000 workers is relatively small, further analyses were conducted by grouping the years into three 7-year periods. Table 5 shows the total number of fatalities per 100,000 workers across 7-year periods. The One-way ANOVA test and the Tukey post hoc test show a significant drop in the total number of deaths between the 2002-2008 and 2009-2015 periods and a marginal decline between the 2009-2015 and 2016-2022 periods.

Table 5. Total fatalities at work per 100,000 workers across 7-year periods

	All fatal accidents		**Fatal accidents under OHSA act**	
Period	Mean	Std. Dev.	Mean	Std. Dev.
2002 - 2008	33.8	2.405	32.0	2.144
2009 - 2015	19.0	1.536	17.0	1.455
2016 - 2022	18.0	1.494	16.1	1.303
	F(2, 18) = 4.193, p = 0.032		F(2, 18) = 4.033, p = 0.036	

Table 6 displays the mean yearly fatalities per 100,000 workers for ten different working scenarios. These averages and 95% confidence intervals were computed by using all the available data from 2002 to 2022. Around 60% of all fatal accidents at work occur in the construction sector. 34.7% of these accidents occur from fatal falls and 18.1% from lack of harness. Moreover, 29.4% of all fatal accidents occur to foreign workers, while 32.9% of all fatal accidents occur to self-employed workers.

Data between 2005 and 2022 revealed that from a total sample of 60 construction deaths, project supervisors had been appointed 29 times (48% of fatal accidents). The percentage of appointed project supervisors increased over time; between 2005 and 2010, 18 fatal accidents were recorded, only one of which had an appointed project supervisor (5.6%). Between 2011 and 2015, from 12 fatal accidents, 7 had an appointed project supervisor (58.3%). Between 2016 and 2022, from a total of 30 fatal accidents, 21 had an appointed project supervisor (70.0%).

Table 6. Mean yearly fatalities per 100,000 workers for different scenarios

			95% confidence interval	
Working Scenario	Mean	Std. Dev.	Lower limit	Upper limit
Number of fatal accidents	3.37	2.068	2.43	4.31
Fatal accidents outside applicability of the OHSA Act	0.30	0.406	0.11	0.48
Fatal accidents in construction	2.02	1.389	1.39	2.65
Fatal falls from height in construction	1.17	0.841	0.79	1.55
Fatal falls from height in construction (lack of harness)	0.61	0.548	0.36	0.86
Fatal accidents occurring to foreign workers	0.99	0.757	0.65	1.34
Fatal accidents occurring to self-employed workers	1.11	1.185	0.57	1.65
Fatal accidents in construction of foreign workers	0.75	0.616	0.47	1.03
Fatal accidents in construction of self-employed	0.46	0.673	0.15	0.76
Fatal accidents in notifiable construction projects	1.04	0.774	0.69	1.39

$F(9, 200) = 15.936$, $p < 0.001$

The study investigated the impact of the number of project supervisors on the frequency of fatalities within the construction industry. In years when more construction fatalities occurred, more project supervisors were appointed. This association was found to be significant (Table 7a).

Table 7a. Regression model relating number of construction fatalities to the number of supervisors

Dependent Variable		Reg. Coef.	St. Error	t-value	p-value
Number of fatalities in the construction sector	Constant	-0.167	0.698	-0.239	0.814
	Time	0.533	0.180	2.960	0.009

Since the number of appointed inspectors and their inspective actions may have a delayed effect on the number of fatalities, it was decided to lag the number of deaths by one year and relate it to the number of appointed inspectors. Table 7b shows that the number of construction fatalities decreased with an increase in the number of project supervisors; however, this relationship was not found to be significant.

Table 7b. Regression model relating the number of supervisors to the number of fatalities in construction lagged by one year

Dependent Variable		Reg. Coef.	St. Error	t-value	p-value
Number of fatalities in the construction sector	Constant	3.518	0.696	5.051	<0.001
	Time	-0.133	0.374	-0.357	0.726

3.3 Impact of deterrents on the number of accidents at work

Correlation analysis was used to investigate how the yearly injuries and yearly fatalities per 100,000 workers are related to some deterrents.

Table 8a shows that the yearly injuries are negatively and significantly related to the number of inspections, administrative fines, monetary value of fines, and vetted equipment certificates. This implies that an increase in the number of inspections, administrative fines, the monetary value of fines and the number of vetted equipment certificates results in a significant reduction in yearly injuries. The duration of awareness raising and some initiated prosecutions are weakly related to the number of annual

injuries. On the other hand, the number of yearly fatalities is negatively and significantly related to the number of vetted equipment certificates; however, it is weakly related to the other deterrents.

Table 8a. Relationship between deterrents and yearly injuries/fatalities

Deterrents		Number of Injuries per 100,000 workers	Number of fatal accidents per 100,000 workers
Number of inspections	Correlation Coefficient	-0.872	-0.372
	P-value	0.000	0.129
Number of administrative fines	Correlation Coefficient	-0.720	-0.127
	P-value	0.019	0.726
Monetary value of fines (€)	Correlation Coefficient	-0.766	-0.001
	P-value	0.010	0.999
Number of initiated prosecutions	Correlation Coefficient	0.263	0.004
	P-value	0.307	0.988
Number of vetted equipment certificates	Correlation Coefficient	-0.612	-0.628
	P-value	0.007	0.005
Participant-hours awareness raising	Correlation Coefficient	-0.321	-0.214
	P-value	0.194	0.395

Since a number of implemented deterrents may have a delayed effect on the number of fatalities, it was decided to lag the number of deaths by one year and relate it to each deterrent. Table 8b shows similar results as Table 8a; however, some relationships are stronger. In particular, the negative association between fatal accidents, the number of inspections, and the monetary value of fines are now significant.

Table 8b. Relationship between deterrents and yearly injuries/fatalities lagged by one year

Deterrents		Number of Injuries per 100,000 workers	Number of fatal accidents per 100,000 workers
Number of inspections	Correlation Coefficient	-0.601	-0.492
	P-value	0.008	0.038
Number of administrative fines	Correlation Coefficient	-0.695	-0.594
	P-value	0.018	0.054
Monetary value of fines (€)	Correlation Coefficient	-0.700	-0.682
	P-value	0.016	0.021
Number of initiated prosecutions	Correlation Coefficient	-0.205	0.004
	P-value	0.414	0.988
Number of vetted equipment certificates	Correlation Coefficient	-0.642	-0.509
	P-value	0.005	0.031
Participant-hours awareness raising	Correlation Coefficient	-0.311	-0.389
	P-value	0.209	0.111

4. DISCUSSION

The study set out to analyse how occupational health and safety levels have varied in Malta over twenty years. The trends are overwhelmingly positive and suggest that levels of health and safety have improved substantially during the first twenty years of the OHSA. Regarding non-fatal accidents, and in line with Hypothesis 1, the study demonstrates that the incidence of such injuries per 100,000 workers has reduced significantly over the studied period. This mirrors findings from other EU countries (Eurostat, 2022b). This significant reduction applied to both injuries resulting in short-term absence and those resulting in longer-term absence. However, the reduction in injuries resulting in long-term absence was substantially more significant than in short-term injuries. This may reflect organisations prioritising hazards with a more significant risk profile and the OHSA's focus on more dangerous sectors. As occupational accidents are expensive for employees, employers and the state alike (EU-OSHA, 2017; OHSA, 2011a), this reduction benefits both the micro and macro levels.

In line with the second hypothesis, non-fatal accidents varied by sector. However, contrary to expectations, the incidence of such accidents was greatest in the construction and the transport and storage sectors. The findings highlight that whilst the greatest number of non-fatal accidents in Malta are consistently reported in the manufacturing sector (Fiorini & La Ferla, 2021), this is partially due to the high employment levels in this sector. Conversely, the findings reflect the elevated risk profile of the construction and the transport and storage sectors. Whilst the dangers associated with construction are well known (Aneziris et al., 2012; CPWR, 2019) and are frequently the subject of newspaper and social media reports in Malta, the dangers associated with the transport and storage sector receive much less attention. The findings justify why the OHSA focuses much of its resources on the construction industry (OHSA, 2023). Still, they also suggest that additional resources may need to be allocated to provide a similar focus on the transport and storage sector.

The data demonstrated a significant reduction in non-fatal accidents in all five studied sectors. This was in line with the study's second hypothesis. Reductions in sectors were not equal, with manufacturing, construction and the transport and storage sectors showing the greatest reduction. The finding may reflect the greater number and incidence of accidents in these sectors, thus providing a more significant opportunity for change and improved standards. Despite this, improvements were greater in manufacturing than in sectors with a higher incidence of injuries, namely the construction and the transport and storage sectors. The current study did not analyse the reasons for this. However, this may be because Malta has several larger manufacturing organisations that dominate the sector and can dedicate more funds to OHS matters. Multinational parent companies and clients often constrain such companies to implement complex OHS management systems. For the inspectorate, inspections on key manufacturing organisations may have more far-reaching consequences than visiting a single construction organisation.

On the other hand, construction may intrinsically remain a riskier sector, whereas funds and resources for OHS matters may be more limited (Sousa et al., 2014). Organisations in this sector and the transport sector are often smaller than those in manufacturing, whereas their operations are, by their very nature, usually spread around the country. This could make it more difficult for the OHSA to impact these sectors.

In line with the third hypothesis, it was found that the number of fatal accidents per 100,000 workers also decreased significantly during the studied period. The finding aligns with previous local studies (Fiorini & La Ferla, 2021) and European trends (Eurostat, 2022b). However, progress appears to be plateauing, with most progress being made in the earlier years of the study. The study aimed to analyse the factors associated with these deaths. Unsurprisingly, most fatal accidents occur in the construction sector, with fatalities also common in larger construction projects that involve more labour hours. The results mirror previous Maltese findings (Fiorini & La Ferla, 2021) and European results (Eurostat, 2022a). This suggests that while the incidence of accidents in construction is similar to the transport and storage sector, and the total number of accidents is lower than in manufacturing (Fiorini & La Ferla, 2021),

accidents in this sector are potentially the most severe. Malta has experienced a boom in the construction sector over the last decade, and the sector has met increased demand by employing many third-country nationals. This may have contributed to the slowing of progress in reducing the number of fatal accidents per 100,000 workers. The great impact of falls was also revealed. Falls from height are a leading global cause of death among workers and are also largely preventable with the correct planning, equipment, and training (OSHA, 2015). Whilst some falls were classified as those lacking a harness, a large percentage were attributed to other reasons, indicating that proper fall prevention management is not limited to harnesses. The findings suggest that the construction industry, particularly Falls, requires continued attention by employers and the inspectorate alike.

Almost a third of fatal accidents involved self-employed workers. Employment in Malta has grown substantially over the years; whereas total full-time employment was around 150,000 in 2012, this rose to around 250,000 in 2022 (NSO, 2013, 2023). The number of registered self-employed workers has also grown considerably during this period, and their share of total employment appears to be increasing slightly: from 13% in 2012 to 15% of total employment in 2022 (NSO, 2013, 2023). As has previously been reported (Collie, 2024), the self-employed appear to be at an added risk of fatal accidents considering their proportion of the labour market. Self-employed individuals often do not have the health and safety resources in terms of time, equipment, support and training as those working for larger organisations. Self-employed workers are also difficult to target for inspectors; they are often challenging to locate and distinguish from on-site employees (European Commission, 2015). Some, however, have argued that the self-employed are not at a higher risk of fatal injury but rather are overrepresented in industries where such injuries occur (Driscoll et al., 2003). Whilst a breakdown of various years is not available, 22% of registered employees within the construction sector were self-employed in 2022 (NSO, 2023). The statistics only reflect those legally employed and thus may not provide the complete picture of employment in the industry. However, the current study shows that during the studied period, 22% of fatal accidents involved self-employed workers. Therefore, it is possible that within construction, the self-employed and employed have a similar fatality risk. Despite this, public OHS initiatives which target the self-employed should be prioritised and may include the free provision of information and training, as well as government subsidies for the self-employed that support the uptake of formal safety education and the purchase of related equipment.

Being a foreign national was also linked to fatalities at work in Malta. Malta's foreign workers have increased dramatically (Jobsplus, 2023a). Between 2012 and 2022, the percentage of foreign nationals rose from an 8% share of total employment to a 33% share of total employment (Jobsplus, 2023b). In 2022, 63% of total foreign employment was Third Country Nationals (TCNs), with the rest primarily from EU member states (Jobsplus, 2023a). As the current study analyses 20 years of data, many years of which foreign workers were only a small percentage of the labour force, this suggests that foreign workers are at greater risk of occupational death than local workers. Previous findings have also highlighted that the total number of foreigners dying in the place of work in Malta has been increasing over the years (Fiorini & La Ferla, 2021), further highlighting that this is an important topic. Foreign workers are often at greater risk of injury due to various reasons, including language barriers, a lack of training and more precarious employment (Schenker, 2008). The precarious nature of their employment also often makes it more difficult for OHS inspectors to tackle the issue (European Commission, 2015). Foreign workers are more likely to take up hazardous work unpopular with the local population (Porru & Baldo, 2022; Sterud et al., 2018), and Jobsplus data (2023a, b) indicates that TCNs are over-represented within construction, with their numbers rising from 5% of registered employment within the sector to 42% over ten years. The current study, which analyses 20 years of data, shows that foreign workers made up 37% of deaths in construction. The topic, therefore urgently requires more attention and research in Malta.

Regarding construction fatalities, the study also analysed the impact of project supervisors. Although project supervisors had been appointed in less than half of the

analysed fatal accidents, their numbers increased in the latter years of the dataset. Appointment of a project supervisor is a legal requirement on many construction projects (Work Place (Minimum Health and Safety Requirements for Work at Construction Sites) Regulations, 2004, 2018) and amendments to this law in 2018, which had several objectives, also aimed to define better the role of clients in appointing project supervisors (OHSA, 2011b). This may explain their increasing numbers over the years. The study uncovered a positive association between fatalities at work and the appointment of a project supervisor. The association was not expected and may suggest that the appointment of these individuals did not have the desired impact on workplace fatalities, possibly because some did not perform the expected tasks to prevent accidents. However, as the available statistics were limited to the presence of project supervisors at the sites where fatalities occurred, the statistics do not reveal how many accidents project supervisors may have prevented.

Furthermore, the number of project supervisors increased when the construction industry was booming, foreign employment increased dramatically, and construction-related deaths appeared to increase. These factors will likely affect the association, as is the legal requirement to appoint a project supervisor for many construction projects. As the work of project supervisors can have a delayed effect, an analysis of their appointments and construction deaths lagged by one year was also conducted. In this case, a negative association between the variables was identified. However, this was not statistically significant. The topic, therefore, requires more research.

The study also examined the impact of deterrents. In line with Hypothesis 6, several of the deterrents, including the number of inspections, administrative fines, the monetary value of fines and the number of vetted equipment certificates, were significantly associated with a reduction in non-fatal accidents per 100,000 workers; both when the comparison was conducted with injuries in the same year and in injury numbers the following year. Whilst the study does not distinguish between inspections that resulted in a fine and those that did not, inspections in Malta can result in a fine if regulations are not adhered to. The findings thus add to previous studies that have highlighted the positive impact of inspections (Niskanen et al., 2014; Mendeloff & Gray, 2023) and fines (Gray & Mendeloff, 2005; Tompa et al., 2007; Tompa et al., 2016), and indicate that they are an essential component of an inspectorates' toolbox.

While more fines and their value were linked to reduced injuries, prosecutions were not significantly associated. This is interesting when considering that prosecution can result in an excellent cost for organisations and would exceed the cost of administrative fines. It has previously been argued that the link between legislation and a reduction in injuries was unclear (Tompa et al., 2016), and the current findings are possibly due to the length of the process. Whereas administrative fines are given on the spot, prosecutions are a slow process in Malta, often taking several years to complete. This could reduce their impact, whilst the length of the process could also make their impact less evident statistically. The duration of awareness raising was also not significantly linked to the incidence of injury. Whilst studies have previously indicated that they can lead to better compliance (Björkdahl et al., 2008; Mancini et al., 2005), the link with injury rates has been questioned (Tompa et al., 2016). The findings thus suggest that inspections and fines are more effective than measures that aim to foster self-regulation, where employees and employers do not always have the same interests at heart (MacEachen et al., 2016). However, it must be noted that the statistic used in this study only relates to hours of awareness raising by the OHSA, and awareness and self-regulation may also be promoted via other means, including the media, unions, educational institutions and via OHS professionals who are not employed by the inspectorate (Debono & Fiorini, 2023; Fiorini & La Ferla, 2023). Therefore, this study has not analysed several other factors that can contribute to self-regulation. However, inspections and fines are likely to be more effective than other means to protect at-risk groups such as the self-employed and foreign workers.

Whilst several factors were associated with a reduction in non-fatal accidents, only the vetting of equipment certificates was linked with a decrease in fatalities per 100,000 workers during that year and the following year. It is unclear why equipment certificates

were the only factor to influence fatalities during the same year. However, the small number of yearly fatalities likely impacted the strength of associations. Most of the certificates vetted relate to lifts, cranes, boilers and forklift trucks (OHSA, 2022), all of which may instigate serious accidents if substandard. In comparison, inspections and their associated fines may also focus on factors that have a less immediate impact on worker safety. Inspections and the monetary value of fines were linked to a reduction in fatalities the following year. Inspections (Grey & Mendeloff, 2023) and larger fines (Song & Won, 2020) have previously been linked with reduced occupational fatalities. Contrasting findings have also been presented, with Grey and Mendeloff (2023) reporting limited evidence that higher penalties led to fewer fatalities. National differences, however, may have led to these differing conclusions, with the latter study being conducted in the United States of America, where both the penalties and organisations are typically larger.

The study analysed a large dataset that generally covered twenty years of data. Despite this, the study was based on a cross-sectional analysis; thus, causality cannot be ascertained. Furthermore, whilst the positive impact of OHSA measures is evident, other factors may have contributed to the reduction in injuries and fatalities in Malta, which were not the focus of the current study. Before establishing the OHSA, the Occupational Health and Safety Unit within the Department of Industrial and Employment Relations and the Industrial Hygiene Unit under the Ministry of Health contributed positively to health and safety levels in Malta (Fiorini & La Ferla, 2021). Additionally, the Centre for Labour Studies, University of Malta, has been running undergraduate courses in OHS since 1997 and thus has fostered competence in the field (Fiorini & La Ferla, 2023). Private organisations that offer OHS services have flourished, whilst enterprises may have improved their OHS levels for reasons other than the regulator, such as standards imposed by multinational parent companies and tender requirements.

Furthermore, it is known that there is substantial under-reporting of occupational injuries and ill health in Malta (OHSA, 2011a). This is certainly not a unique occurrence to Malta (Kyung et al., 2023), and whilst the number of non-fatal accidents reported is likely an underrepresentation of the situation, there is no evidence to suggest that the degree of nonreporting has changed over time.

5. CONCLUSIONS

The study demonstrated that the incidence of occupational injuries and fatalities in Malta has decreased significantly over twenty years. Whilst accidents are more frequent in some sectors than others, there has been a significant decrease in all sectors studied. Construction is the most dangerous sector in Malta, with one of the highest number of injuries per capita and the highest number of fatalities. However, the transport and storage sector recorded a similar incidence of non-fatal accidents. Both sectors, therefore, require special attention.

The study demonstrated that OHSA measures have significantly reduced the number of accidents at work. Not only have non-fatal and fatal accidents decreased since its inception, but the study also showed that several of its activities were directly associated with the decrease in accidents, with variables related to inspections and fines proving to be the most effective.

Construction workers, the self-employed and foreign workers appear to be at particular risk of occupational fatalities. Further research is needed in Malta to determine the reasons for this. However, given the impact of inspections and fines, measures that could increase the number of inspections and value of fines targeted at these at-risk groups are likely beneficial. Addressing employment issues, such as precarious employment, is also likely to aid, and therefore, continued and enhanced coordination between various other labour inspectorates is needed.

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