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Original article

# Covid-19 Occupational Risk Incidence and Working Sectors Involved During the Pandemic in Italy

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*Summary:* During the Covid-19 pandemic in Italy, the level of occupational fraction of infecion cases was high in the beginning phase. Healthcare and related services were continuously hit but the incidence was generally decreasing in 2021, except for transportation and storage sectors. The need to continuously adapt the prevention measures including a comprehensive epidemiological surveillance system integrating occupational risk factors was underlined.

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ABSTRACT

*Background:* Starting from March 2020 until December 2021, different phases of Covid-19 pandemic have been identified in Italy, with several containing/lifting measures progressively enforced by the National government. In the present study, we investigate the change in occupational risk during the subsequent pandemic phases and we propose an estimate of the incidence of the cases by economic sector, based on the analysis of insurance claims for compensation for Covid-19.
*Methods:* Covid-19 epidemiological data available for the general population and injury claims of workers covered by the Italian public insurance system in 2020–2021 were analyzed. Monthly Incidence Rate of Covid-19 compensation claims per 100,000 workers (MIRw) was calculated by the economic sector and compared with the same indicator for general population in different pandemic periods.
*Results:* The distribution of Covid-19 MIRw by sector significantly changed during the pandemic related to both the strength of different waves and the mitigation/lifting strategies enforced. The level of occupational fraction was very high at the beginning phase of the pandemic, decreasing to 5% at the end of 2021. Healthcare and related services were continuously hit but the incidence was significantly decreasing in 2021 in all sectors, except for postal and courier activities in transportation and storage enterprises.
*Conclusion:* The analysis of compensation claim data allowed to identify time trends for infection risk in different working sectors. The claim rates were highest for human health and social work activities but the distribution of risk among sectors was clearly influenced by the different stages of the pandemic.


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## 1. Introduction

Although the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was declared a pandemic by the World Health Organization in March 2020, Italy already recognized the first case on February 22, becoming the first among the western countries to face the Covid-19 disease [1]. After three years, about 26 million cases have been registered in the general population with a median age of 44 years (46.5% male and 53.5% female) and more than 183,000 deaths [2].

During the first period, the Italian government has progressively adopted several containment measures based on social distancing, hand hygiene, and face masks use (upon availability). A lockdown was declared from the beginning of March for about two months, when non-essential businesses were temporarily suspended, schools were closed and other working activities were performed from home [3,4]. The second wave of Covid-19 was recognized in the autumn 2020 also due to the introduction of SARS-CoV-2 Alpha variant (B.1.1.1.7), linked with high transmissibility and increased rate of mortality [5]. In 2021 three further pandemic waves were identified in the whole country, due to the subsequent co-circulation of other SARS-CoV-2 variants Beta (B.1.351), Gamma (P.1), Delta (B.1.617) and Omicron (B.1.1.529) [6,7].

The epidemiological data show differences in the risk of infection and outcome by gender [8], older age [9], and comorbidity [10]. Furthermore, the work dimension has been recognized as a key determinant [11]. Several types of working conditions have been associated with the risk of infection and the study of transmission dynamics represented a challenge for occupational health [12]. Healthcare workers dramatically faced the exposure to Covid-19: the growing number of cases among the general population followed by the rapid increased demand for healthcare services made them one of the occupational groups at the highest risk level [13].

In general, essential workers who cannot work remotely were considered at greater risk of SARS-CoV-2 infection due to their working conditions bringing them into closer contact with those already infected. Other risk factors may impact in different ways the vulnerability with respect to the severity of Covid-19 illness (i.e., stressful working and low-income living conditions which may increase the risk of comorbidity conditions) [14].

Different indicators have been proposed in literature for the risk identification by occupational groups such as compensation claims [15,16], specific surveillance systems [17], cluster analysis [18], or job-exposure matrices [19]. The occupational risk of Covid-19 has been investigated in Germany [20], UK [21], Norway [22], Finland [23], Belgium [24], and France [16] showing some differences per professions and sectors also comparing different pandemic periods. In Italy, the use of compensation claim applications was found to be effective for monitoring the occupational component of Covid-19 [25] and the relations with the “a priori” classification of occupational risk per economic sector, developed to guide the strategy of the decision makers for lifting the containment measures [26], were convincing.

On such basis, the present study aims to use the nationwide insurance claims for compensation for Covid-19 in Italy in 2020–2021 for estimating the incidence of the disease in the workplace per economic sectors compared to the general population and to analyze the change in the occupational risk during the subsequent pandemic phases.

## 2. Materials and methods

Covid-19 compensation data collected by the Italian Workers' Compensation Authority (INAIL) have been explored. INAIL receives claims for occupational injuries compensation of about 90% of the national workforce, except some categories for which specific insurance systems are in place (e.g., armed forces, firefighters and police workers, air transport personnel, tradespeople, general practitioners, and independent contractors).

During the pandemic emergency, INAIL introduced the notation of Covid-19 work-related infection as an occupational injury. In fact, according to the Italian workers compensation rules, the pathogen agent virulence is equivalent to the violent cause even if its effects occur later in time.

For healthcare workers and workers with frequent contact with the public (i.e., cashiers and retail workers), there is a presumption of occupational cause (more likely). For all other workers, the causal relationship has to be demonstrated. At the date of the present study, more than 80% of compensation claim applications have been recognized as occupational injury from Covid-19 (almost all compensated cases) [27].

In the present study, compensation claims applications of workers in Industry and Services covered by INAIL public insurance system (n = 184,585) were analyzed by sector, according to the National economic activities classification (ATECO2007) (i.e., the equivalent of European Classification of Economic Activities (NACE Rev.2)) [25].

Covid-19 daily epidemiological data for the general population were extracted by the Italian Governmental database [28] in the period from February 24, 2020 to December 31, 2021, including total number of cases (n = 6,119,422, out of these 4,065,628 in the age group 20–70 years), Intensive Care Unit (ICU) patients (n = 901,083) and deaths (n = 137,402).

Five different periods of the pandemic have been classified including major mitigation/lifting measures in Italy as reported in Table A1.

Daily series of injury claims were compared using 7-day moving averages [29] with most important indicators of the pandemic for general population: Covid-19 cases, admissions in ICU, and deaths.

In order to compare the injury claims trend among different sectors, Monthly Incidence Rate per 100,000 workers (MIRw) was calculated as the rate of new cases of Covid-19 injury claims observed in a month in relation to the total of workers within which these cases have arisen. This rate was calculated for all ATECO2007 sections and divisions; for the latter only MIRw >20 were reported.

Monthly Incidence Rate per 100,000 inhabitants was also calculated for the general population (MIRp). It represents the rate of new Covid-19 cases observed in a month in the general population in relation to the whole Italian population.

The calculation of Daily Incidence Rate of injuries per 100,000 workers/day (DIRw), allowed the comparison of injury claims trend between 2020 (312 days from February, 24$^{th}$ to December, 31$^{st}$) and 2021 (365 days).

In order to estimate the variability for the incidence rates, 95% Confidence Intervals (CI) were calculated by the following equation:

$$95\%\ \mathrm{CI} = \mathrm{p} \pm 1.96\sqrt{\frac{\mathrm{p}(1-\mathrm{p})}{\mathrm{n}}}$$

where $p$ represents the incidence rate.

## 3. Results

The distribution of Covid-19 injury claims per gender, class of age, geographical area, and economic sector according to the ATECO2007 classification is reported in Table A2. In the period between February 24, 2020 and December 31, 2021, 184,585 cases of injury claims have been analyzed, approximately corresponding to 5% of all cases in the working age. Most claims concern women

(68.8%) and the age group 50–59 years (33.4%). Regions with higher percentages of injury claims were Lombardia (25.6%), Piemonte (13.2%) and Veneto (10.4%). Mainly represented economic activity sector is “Human health and social work activities” reported in 48.4% of cases. It is worth to be noted that in this sector higher percentages of women are employed, according to the national employment statistical data. All other sectors have percentages lower than 10%. About 25% of injury claims received by INAIL were not classified in any sector.

Fig. 1 reports time series of Covid-19 injury claims and cases in general population in 2020 and 2021, both expressed with moving averages at 7 days: five different pandemic periods are also highlighted, as defined in Table A1. Both indicators show a similar trend during the first year with two peaks in the middle of March and November 2020. Major differences between two curves are highlighted starting from the beginning of 2021 until the end of the observation period, as confirmed also by the ratio between injury claims for Covid-19 and cases in general population reported in Fig. A1.

Moreover, injury claims are compared with ICU admissions and deaths in general population in Fig. A2. Also in this case the indicators show the same trend during the first, second, and third periods, otherwise they decrease in the fourth and fifth ones starting from the middle of 2021.

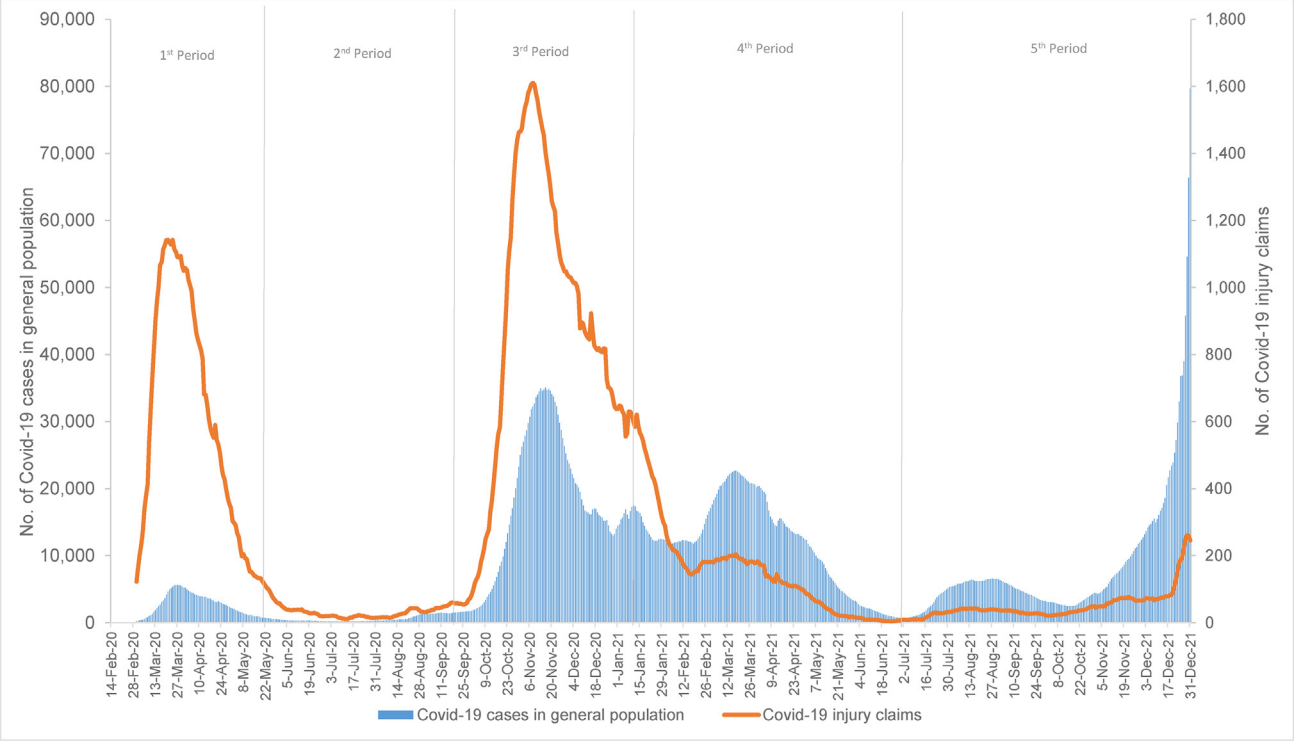
Fig. 2 shows the MIRw by economic sector based on numeric values reported in Tables A3 and A4. Highest values of 2007.7 cases per 100,000 workers (CI 1980.4–2035.0) were registered in “Human health and social work activities” (Q) sector in November 2020.

In Fig. 3 ATECO2007 divisions (2nd digit) with MIRw greater than 20 are reported, corresponding to the numeric values reported in Tables A5 and A6. “Residential care activities” (Q87) report highest MIRw in the first (2903.3, CI 2812.5–2994.2) and third (3611.3, CI 3510.3–3712.3) periods. Also the incidence rate in “Employment activities” (N78) division, which includes activities of employment placement agencies, temporary employment agency activities, and other human resources provision, was significantly high in the same periods.

Further analysis has been conducted by comparison of DIRw per ATECO2007 division as reported in Table 1. It clearly shows a decreased DIRw in 2021 for all divisions, except for “Postal and courier activities” (H53) that report a higher incidence rate in 2021 compared to the previous year.

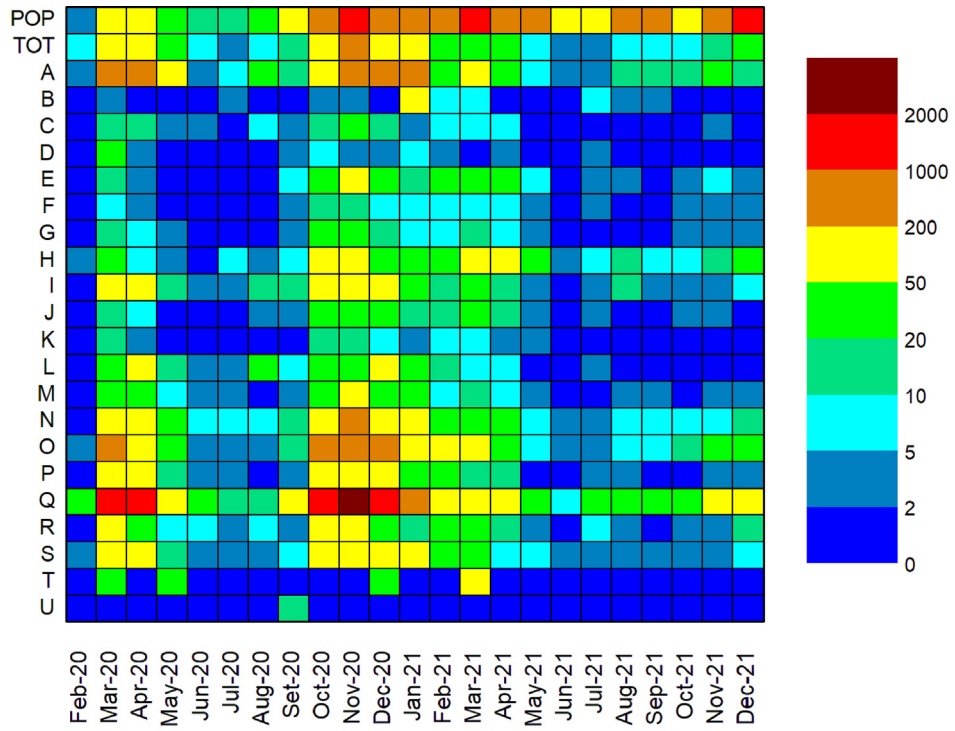
## 4. Discussion

During the first, second, and third pandemic periods, injury claims and cases in general population show a similar trend. Starting from March 2020 the containment measures adopted by the Italian Government produced 75% reduction in the number of workers present in their workplaces (including remote workers too) [30] and most likely the national lockdown was successful in achieving a major slowdown in the spread of the virus in terms of epidemiological effectiveness also reducing the impact on injury claims. Since November 2020, the Italian Government introduced a modular system of physical distancing measures organized in progressively restrictive tiers (coded as yellow, orange, and red) imposed on a regional basis according to real-time epidemiological risk assessment. As a result, orange and red tiers were associated with a decreasing incidence whereas the most permissive tier (yellow) was sufficient to reduce the reproduction number to values close to the epidemic threshold [31]. Although in this period testing capacity increased influencing the number of reported cases and also injuries at work, tier system resulted in a much lower




*1st period – 24-Feb-20 to 18-May-20; 2nd period – 19-May-20 to 14-Sep-20; 3rd period – 15-Sep-20 to 11-Jan-21; 4th period – 12-Jan-21 to 1-Jul-21; 5th period – 2-Jul-21 to 31-Dec-21. .

**Fig. 1.** Covid-19 cases in general population and injury claims for Covid-19 (secondary axis) trends. Moving averages at 7 days and main containment/lifting measures in five periods.*




**A.** Agriculture, forestry and fishing; **B.** Mining and quarrying; **C.** Manufacturing; **D.** Electricity, gas, steam and air conditioning supply; **E.** Water supply, sewerage, waste management and remediation activities; **F.** Construction; **G.** wholesale and retail trade; repair of motor vehicles and motorcycles; **H.** Transportation and storage; **I.** Accommodation and food service activities; **J.** Information and communication; **K.** Financial and insurance activities; L. Real estate activities; **M.** Professional, scientific and technical activities; **N.** Administrative and support service activities; **O.** Public administration and defence; compulsory social security; **P.** Education; **Q.** Human health and social work activities; **R.** Arts, entertainment and recreation; **S.** Other service activities; **T.** Activities of households as employers; undifferentiated goods - and services - producing activities of households for own use; **U.** Activities of extraterritorial organisations and bodies; **TOT**. Total of working population with public insurance coverage; **POP**. General population.

**Fig. 2.** Monthly Incidence Rate per 100,000 workers (MIRw) by economic sector (A–U ATECO2007 sections) and by total working population with public insurance coverage (TOT). Monthly Incidence Rate for general population (MIRp) calculated per 100,000 inhabitants (POP).

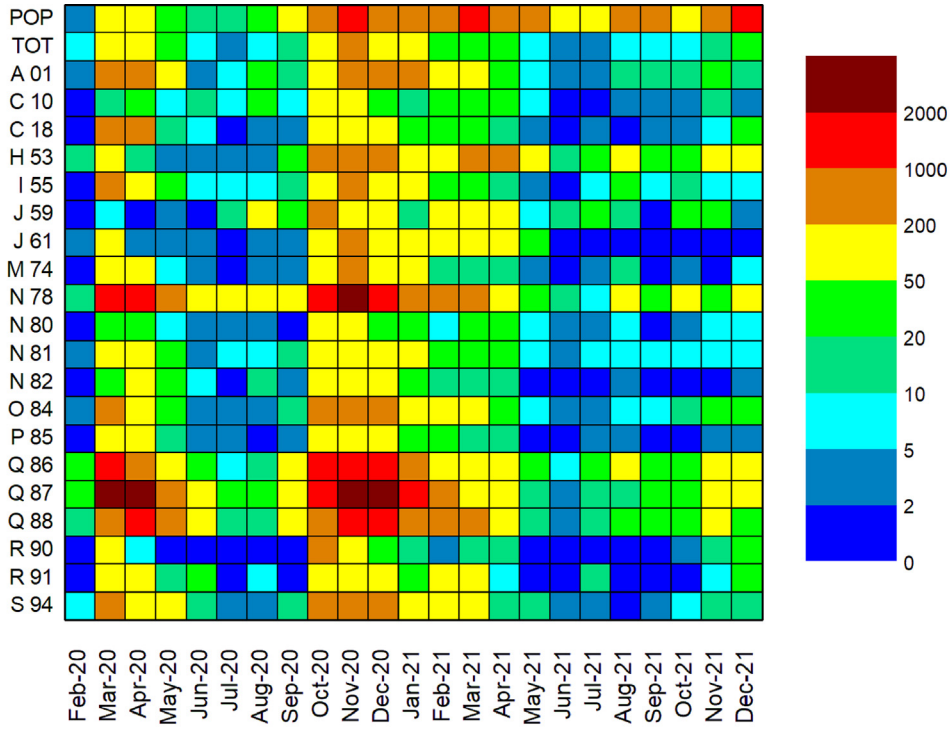
impact on human activities compared to lockdown but a large reduction in injury claims was observed.

In 2020, the injury claims trend reflected also the ICU admissions and deaths for the general population, otherwise, it showed a clear decrease in 2021, when further pandemic waves were associated with the new virus variants circulation, with higher risk of developing Covid-19 compared to the original virus. In fact, the average viral loads in hosts infected with the SARS-CoV-2 Delta variant were unprecedentedly high and the Omicron one satisfied the principles of rapidly spreading respiratory viruses, but the impacts on ICU admissions and deaths in Italy were contained also thanks to the vaccinations effects [32]. Since such severity indicators may be less influenced by the bias due to the different testing capacity by period, the reported figures confirm that the strength of the third period of Covid-19 was comparable to the first one.

Major differences in the pandemic impact at the workplace have shown between 2020 and 2021. In fact, starting from December 27, 2020, non-pharmaceutical measures were integrated with the vaccination campaign was rolled out in progressive phases through various priority groups. Furthermore, a specific vaccination program for workplaces has been launched based on the basic prioritization criteria already defined for the general population (i.e., age and comorbidity), taking also into account the risk and injury incidence by economic sector. Elderly people, residents and personnel of long-term care facilities, healthcare workers, social care personnel, and people with comorbidities were primarily prioritized also for the doses administration. The effects of such vaccination strategy seem to be reflected also in a strong reduction of injury claims for Covid-19 as confirmed by the trend of ratio with cases in general population.

The analysis of the incidence by activity sector confirms that essential workers were at great risk of SARS-CoV-2 infection due to their working activities in closer contact with others potentially infected. In the first period of the pandemic in Italy healthcare workers mainly contributed to the Covid-19 incidence in the workplace. Such figures are in line with other studies in UK and Europe [21,22,25]. Other essentials activities such as “Public administration,” “Agriculture, forestry and fishing,” and “Administrative and support service activities” reached a significant MIRw value up to 1,000 in this period. High public administration values may be influenced also by employees in public health services who are included in this group. Relevant MIRw values (up to 200) were also registered in “Professional, scientific and technical activities” and “Education,” despite the high percentage of remote workers belonging such sectors [33].

MIRw and MIRp shows similar values during the first period, while lower values in workers than in general population can be




**A01.** Crop and animal production, hunting and related service activities; **C10**. Manufacture of food products; **C18.** Printing and reproduction of recorded media; **H53.** Postal and courier activities; **I55.** Accommodation; **J59.** Motion picture, video and television programme production, sound recording and music publishing activities; **J61.** Telecommunications; **M74.** Other professional, scientific and technical activities; **N78.** Employment activities; **N80.** Security and investigation activities; **N81.** Services to buildings and landscape activities; **N82.** Office administrative, office support and other business support activities; **O84.** Public administration and defence; compulsory social security; **P85.** Education; **Q86.** Human health activities; **Q87.** Residential care activities; **Q88.** Social work activities without accommodation; **R90.** Creative, arts and entertainment activities; **R91.** Libraries, archives, museums and other cultural activities; **S94.** Activities of membership organisations. **TOT**. Total of working population with public insurance coverage; **POP**. General population.

**Fig. 3.** Monthly Incidence Rate per 100,000 workers (MIRw) by total working population with public insurance coverage (TOT) and ATECO divisions (2nd digit) with average MIRw per 100,000 > 20. Monthly Incidence Rate for general population (MIRp) calculated per 100,000 inhabitants (POP).

observed starting from the second period and in the following ones. These findings are consistent with the existing literature [13] confirming that the high number of infections registered in the healthcare sector mainly contributed to the incidence among the working population in the first pandemic period. Since the same features of circulating variants may be assumed during 2020, after which a rapid change due to the higher transmissibility of Alpha variant started [5], the figures confirm the primary contribution of non-pharmaceutical measures in contrasting Covid-19 at enterprise level, also in other sectors than the healthcare [34,35]. It should be noted that starting from May 2020 a specific protocol against Covid-19 in the workplace was enforced at national level and transferred to all economic sectors. It included administrative measures to manage times and spaces at work (e.g., by fostering remote work), general collective and personal hygiene practices, preventive and protective measures, specific measures for vulnerable workers, and information/communication strategies involving all occupational safety and health (OSH) actors. Based on the difference in incidence values between workers and general population, it could be estimated that the application of such specific protocol for workplaces integrated with the other containment measures, avoided a consistent number of Covid-19 injuries in Italy in the period May–December 2020.

In general, all sectors report higher incidence during the first and third periods compared to the following ones, except for "Transportation and storage" that reach high MIRw values also in the fourth one (March–April 2021). This sector takes up a high rank for number of claims (and also for number of deaths), and these data are further growing up even from the end of 2021 [27].

The different trend of cases between general and working population and the strong reduction of MIRw in each economic sector (and thus for total working population) observed since the beginning of 2021, may be attributed to the combination of multiple factors. The vaccination strategy development reduced the risk of infection for general population [36] at workplace level, even in the context of Delta variant circulation. Furthermore, the lowering of the median age recorded for cases in the general population may be reflected also in a decreased impact on injury rates, considering that the sample of working population is characterized by a higher median age as compared to the general population. It should be noted that injury claims data are referred to a subset of the general population which includes also elderly and young people out of the working age. In this regard, the mean age of Covid-19 injury claims population on December 31$^{st}$, 2021 was 46 years for both male and female gender groups; the median age was 48 years, whereas in the general population was 42 years in

**Table 1**
Daily Incidence Rate of injuries per 100,000 workers/day (DIRw) with 95% Confidence Interval (CI) per ATECO2007* divisions

| | Daily Incidence Rate (95% CI) | |
|---|---|---|
| | 24 Feb 2020–31 Dec 2020 (days no. 312) | 1 Jan 2021–31 Dec 2021 (days no. 365) |
| A01–Crop and animal production, hunting and related service activities | 5.88 (5.60–6.16) | 1.64 (1.50–1.77) |
| C10–Manufacture of food products | 1.08 (1.02–1.14) | 0.36 (0.33–0.39) |
| C18–Printing and reproduction of recorded media | 3.66 (3.41–3.92) | 0.33 (0.26–0.40) |
| H53–Postal and courier activities | 3.56 (3.39–3.73) | 4.76 (4.58–4.94) |
| I55–Accommodation | 3.46 (3.29–3.64) | 0.69 (0.62–0.76) |
| J59–Motion picture, video and television programme production, sound recording | 2.66 (2.27–3.04) | 1.14 (0.91–1.37) |
| J61–Telecommunications | 1.39 (1.25–1.52) | 0.94 (0.84–1.05) |
| M74–Other professional, scientific and technical activities | 2.22 (2.05–2.39) | 0.47 (0.40–0.55) |
| N78–Employment activities | 29.50 (28.22–30.78) | 5.76 (5.23–6.28) |
| N80–Security and investigation activities | 1.00 (0.86–1.14) | 0.48 (0.39–0.57) |
| N81–Services to buildings and landscape activities | 2.30 (2.19–2.42) | 0.69 (0.63–0.75) |
| N82–Office administrative, office support and other business support activities | 1.60 (1.49–1.71) | 0.27 (0.23–0.31) |
| O84–Public administration and defence; compulsory social security | 4.65 (4.55–4.74) | 1.13 (1.09–1.17) |
| P85–Education | 1.44 (1.34–1.54) | 0.34 (0.30–0.39) |
| Q86–Human health activities | 20.35 (20.17–20.53) | 3.96 (3.89–4.04) |
| Q87–Residential care activities | 44.13 (43.48–44.77) | 5.56 (5.35–5.77) |
| Q88–Social work activities without accommodation | 20.11 (19.69–20.53) | 3.82 (3.65–3.99) |
| R90–Creative, arts and entertainment activities | 1.75 (1.47–2.04) | 0.26 (0.16–0.36) |
| R91–Libraries, archives, museums and other cultural activities | 2.12 (1.72–2.53) | 0.71 (0.49–0.92) |
| S94–Activities of membership organisations | 4.77 (4.52–5.03) | 1.04 (0.93–1.15) |

* Divisions with average Monthly Incidence Rate per 100,000 workers (MIRw) $> 20$.

the same period. Starting from December 2021, the mean age of workers' cases dropped to 42.5 years and the median one to 44 years, while the median age recorded for general population was 37 years, witnessing the different impact by age group of new virus variants [27]. Other factors, such as the increasing use of remote work in some sectors and his connection with a lower recourse to the injury claim could be further investigated.

By analyzing ATECO2007 divisions, we found that major contributions to MIRw for section Q were associated with "Residential care activities" (Q87) compared to "Social work activities without accommodation" (Q88) and to the majority of health personnel working in hospitals referred to "Human health activities" (Q86) division, taking into account that injury claims data of this sector do not include general practitioners. "Employment activities" (N78) which include temporary and contract workers employed also in service cooperatives in healthcare sector, reports high MIRw values during both first and third period. Occupational SARS-CoV-2 infection risk analyses during the first pandemic wave in Germany and UK confirmed the higher infection risks among workers in essential occupations and personal-related services, with specific reference to the healthcare sector [21,22]. In the agriculture sector, "Crop and animal production, hunting and related service activities" had high MIRw values witnessing an increased risk of developing Covid-19 probably associated with animal farming industries [37]. Relevant incidence values in "Manufacture of food products sector" could be associated also to the outbreaks in meat and poultry plants that happened in Italy, as in other countries [38]. Similar reasons have influenced "Postal and courier activities" MIRw values. The significant growth in demand for delivery services during the pandemic also affected the increase of courier and postal activities with raised Covid-19 risk in this sector [39].

Further analysis to support this point may be conducted by comparison of DIRw per ATECO2007 division (with average calculated MIRw $>20$) in 2020 and 2021 clearly showing a decreased DIRw in 2021 for all divisions, except for "Postal and courier activities" that reports a higher incidence rate in 2021 compared to the previous year. Furthermore, DIRw by activity division confirms the agreement with the "a priori" Covid-19 risk classification aimed at identifying the general integrated occupational risk levels for different sectors [25,26] in particular for the healthcare-related divisions and in the first year of the pandemic.

A possible limitation of the present study may be due to the overestimation of injury figures given that only 80% of claims for Covid-19 have been finally recognized and compensated by INAIL after the administrative and insurance evaluation of acceptance. Furthermore, some categories of workers are not included in the dataset used for the present study and a percentage of Covid-19 injury claims were unclassified by economic sector. In addition, active versus suspended activities related to the limitations imposed by National Decrees during the different pandemic periods were not considered for MIRw calculation, as well as the percentage of remote workers per each sector.

In any case, since MIRw has been calculated in relation to the effective working population with public insurance coverage, it could be considered a sound indicator to compare Covid-19 risk among different sectors in the same time lapse.

## 5. Conclusion

The study confirms that the Covid-19 occupational risk dimension was relevant during the pandemic in Italy. Healthcare workers and related activity sectors have been mainly involved in Italy as in other countries worldwide, but clusters of occupationally exposed subjects have been reported in a large spectrum of other essential activities such as transportation and storage services. The distribution of Covid-19 incidence by occupational sector changed significantly during the different phases and the risk was significantly decreasing in 2021, except for some specific sectors, such as postal and courier workers who reported an increasing average injury incidence rate.

The OSH prevention system enforced over time in Italy at national and corporate levels offered the natural infrastructure for the

adoption of an integrated approach to manage the risk associated with the pandemic emergency. In particular, in 2020, the prevention activity in the workplace, both during the lockdown phase and during the following progressive reopening of production activities with the adoption of health and safety protocols, had the result of protecting both workers and general population, by helping to avoid a consistent number of Covid-19 cases.

The economic sectors at risk of infection for workers resulted strongly influenced by the different pandemic stages. As a consequence, the management and control measures have to be continuously adapted to improve the effectiveness of prevention policies.

In conclusion, the Italian experience in monitoring and contrasting the pandemic demonstrates the substantial extent of the occupational fraction of this disease, according to the compensation claims figures, highlighting the need for a comprehensive epidemiological surveillance system. In this view, the experiences of occupational diseases surveillance systems with individual assessment of exposure (such as mesothelioma regional registries) could represent a model to develop a systematic and nationally coordinated active search of Covid-19 cases including the anamnestic analysis of the circumstances in which the infection was acquired.

## Conflict of interest

The authors declared no conflict of interests.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2023.10.011.

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