La Medicina del Lavoro

Original article

Med. Lav. 2025; 116 (1): 16609
DOI: 10.23749/mdl.v116i1.16609

# Diagnosing and Reporting Occupational Diseases: An Assessment Study of Reports from an Italian Workplace Safety Prevention Program Service

Luigi Isaia Lecca[1], Sergio Pili[1,*], Michele Lai[2], Alessandro Murru[1], Giuseppe Campo[3], Antonio Pizzuti[3], Stefano Mattioli[4], Marcello Campagna[1]

[1] Department of Medical Sciences and Public Health, University of Cagliari, Italy
[2] Department of Hygiene and Health Prevention, ASL Oristano, Italy
[3] Department of Work and Environmental Medicine, Epidemiology and Hygiene, National Institute for Insurance against Accidents at Work (INAIL), Italy
[4] Department of Environmental and Prevention Sciences, University of Ferrara, Italy

**Keywords:** Occupational Disease; Compensation; Diagnostic Criteria

## ABSTRACT

**Background:** *The criteria for diagnosing and compensating for occupational diseases vary significantly between countries. The lists of occupational diseases often include diagnostic and attribution criteria that are usually not very specific. As a result, the quality of occupational disease reports is frequently subpar. The aims of this study were to assess the quality of diagnosis and reporting, as well as to evaluate the causal link between reported occupational diseases and occupational risk factors.* **Methods:** *Four occupational physicians assessed the quality of diagnosis by blindly applying Spreeuwers' performance indicators for diagnosis and reporting. Following Violante's criteria, the four evaluators also tested the levels of evidence to evaluate the quality (and associated likelihood) of the diagnosis and the quality of exposure to occupational risk factors in a sample of 104 occupational disease reports, grouped by diagnosis and examined by the local Workplace Safety Prevention Service. Separate scores for each performance indicator and the Total Quality Score (TQS, ranging from 0 to 10), along with the progressive levels of evidence, were then assigned for each occupational disease report.* **Results:** *The mean TQS was below the threshold of sufficiency (<6) for 28% of the diagnoses, while an almost sufficient score (>6) emerged for 72% of the diagnoses, primarily including musculoskeletal disorders, pulmonary silicosis, and noise-induced occupational hearing loss. When applying Violante's criteria for the level of evidence of the diagnosis, it was insufficient for 13.5% of the reported cases, while the level of evidence for exposure to occupational risk factors was deemed insufficient for 19% of the cases, and no cases demonstrated a level of evidence that was highly probable or nearly certain.* **Conclusions:** *Despite the overall quality of the reported cases of occupational diseases being reasonably good, improvements in the quality of diagnosis and reporting could be achieved through strict adherence to standardized diagnostic criteria and by training health personnel to collect data regarding occupational and non-occupational risk factors properly.*

## 1. Introduction

In Italy, as in many European countries, the registration and reporting of occupational diseases serve as a vital source of information for both epidemiological and preventive purposes. Most national registration systems in various countries are based on compensation schemes for occupational diseases,

Received 22.11.2024 – Accepted 09.01.2025
*Corresponding Author: Sergio Pili; E-mail sergiopili.medlav@gmail.com

while a few countries also implement voluntary registration schemes alongside their national registries. The primary goal of most registries is to provide information on the incidence and distribution of occupational diseases, which is crucial for developing preventive policies. A limited number of registries are mainly established to gather information focused on preventive policy; examples include SENSOR in the United States, THOR in the United Kingdom, RNV3P in France, SUVA in Switzerland, MALPROF in Italy, and SIGNAAL in Belgium and the Netherlands. A key factor affecting the quality of occupational disease registration is the availability of diagnostic criteria or case definitions. Most compensation systems follow strict criteria for recognizing occupational diseases, while alternative reporting schemes tend to apply these criteria less rigorously, allowing for the reporting of suspected cases. Although recognizing an occupational origin for a disease should meet the general criteria of evidence—specifically, evidence of exposure and evidence of a causal relationship—there are no universally valid algorithms available for assessing the evidence of causality. Utilizing criteria from diverse sources, such as the Bradford-Hill criteria, methodologies from the International Agency for Research on Cancer (IARC), and techniques used by epidemiologists, may produce similar results, potentially rendering the causality between work-related exposure and a specific disease either more or less clear plausible.

Despite the establishment of a European list of occupational diseases intended for harmonization, its effectiveness is notably limited. Significant discrepancies in diagnostic guidelines, criteria for notification, and broader cultural, legislative, and social security regulations may explain the restricted efficacy of this list. A critical factor is the considerable variation in the degree of underreporting of occupational diseases. The reliability of most national incidence figures for occupational diseases is generally considered poor due to this underreporting, which arises from various factors such as limited awareness of occupational diseases among the working population, employees' fears about reporting illnesses to supervisors or physicians, restricted access to medical care, insufficient recognition by physicians, and limited notification channels. Given that registries are an important informational resource for policymakers, enhancing their completeness and quality can significantly improve informed decision-making in preventive policies in Italy and across Europe. The underreporting of occupational diseases poses a significant challenge on a global scale. Conversely, certain factors may lead to the opposite phenomenon, resulting in the overreporting of occupational diseases. Elements like the compensation system, precautionary reporting in anticipation of future complications, and numerous institutional norms may encourage claims of an occupational origin for specific diseases, which can commonly be seen in an aging workforce, such as musculoskeletal issues disorders.

### 1.1. Italian Reporting System

In Italy, occupational diseases are managed through the Social Security and Public Health Care Systems. The National Institute for Insurance against Accidents at Work (INAIL) oversees these conditions, primarily those caused by work-related risk factors. Risk factors must gradually act on the body and can primarily or exclusively result in disease. While non-work-related causes are allowed, they should not disrupt the causal connection. Employer contributions support INAIL, which serves employees, students, domestic workers, professional athletes, and specific self-employed individuals.

The reporting system involves three key information flows: the diagnosing physician sends a medical certificate to INAIL; if the disease is listed under Italian law (art. 139 DPR 1124/65), a report is submitted to the local health authority, where experts compile data in the MALPROF database for epidemiological and preventive purposes. Consequently, INAIL and MALPROF datasets partially overlap, each having distinct criteria for evaluating the causal link in occupational diseases. INAIL focuses on compensation claims, while MALPROF assesses the occupational connection more broadly, categorizing the connection as highly probable, probable, unlikely, or highly unlikely.

Victims must report the disease to their employer within fifteen days, including the occupational

disease certificate and ongoing treatment details. Employers must notify INAIL within five days, and INAIL's medical doctor verifies the diagnosis and the disease's occupational origin. INAIL standardizes the reporting form, which details the physician's identification, the worker's personal information, job details, the disease and its causal agent, the diagnosis date, risk factors, and the physician's signature.

Diagnosis and compensation criteria vary globally. Many nations maintain lists of occupational diseases that may lack specific diagnostic criteria. In Italy, INAIL provides these lists, yet claims can also be made for non-listed conditions. This mixed system complicates reporting and compensating for occupational diseases, sometimes compromising report quality and causal link attribution.

### 1.2. Objectives

The main objective of this study is to assess the quality of occupational disease diagnosis and reporting and evaluate the causal link between reported occupational diseases and occupational risk factors, not available in the MALPROF dataset but derivable from the INAIL first certificate, in a sample of Italian suspected occupational disease reports notified to the local Workplace Safety Prevention Service of the public local health authority.

## 2. Methods

### 2.1. Population

A sample of 104 reports of suspected occupational diseases notified to the Workplace Safety Prevention Service within the local public health authority, included in the MALPROF database by an occupational physician from said service, were randomly selected from the database of 843 reports, covering the period from December 16, 2020, to December 15, 2021.

Each report must have the corresponding INAIL first certificate for the inclusion criteria, adhering to the double-flow information described separately. The random selection comprised 96 reports of occupational musculoskeletal diseases (92%), 7 reports of noise-induced occupational hearing loss (6%), 1 report of pulmonary silicosis, and 1 record of angioneurosis (1.0%). All reported diseases were categorized according to ICD-10 classification system.

### 2.2. Procedures

#### *2.2.1. Assessment of the Quality of Diagnosing and Reporting: Spreeuwers Criteria*

We assessed the quality of diagnosis following Spreeuwers method [22]. Spreeuwers developed performance indicators specifically for diagnosing and reporting noise-induced hearing loss and occupational adjustment disorder. For each performance indicator, we calculated the percentage of cases in which the criteria were met for each disease. As proposed by Spreeuwers, a score of 60% for a performance indicator indicated a need for quality improvement. Next, we determined a score per case by summing all the performance indicators that were met for the disease. In this calculation, all performance indicators carried the same weight, scoring 1 if the criteria were satisfied and 0 if they were not satisfied. Then, we calculated the total quality score (TQS, range 0–10) as the mean score for all cases of a specific disease. The mean score is obtained by dividing the row score by the number of performance indicators and multiplying it by 10. Adapting Spreeuwers' criteria, we applied his performance indicators to assess the quality of all types of occupational disease reports, including musculoskeletal disorders, using the same method. Four occupational physicians with similar experience calculated scores for each of the 104 reported occupational diseases without knowledge of each other's scores. As suggested by the author, we adopted this criterion to evaluate the quality of each performance indicator, categorizing reports with a mean TQS ≥6 as sufficient and those with a mean TQS <6 as insufficient.

#### *2.2.2. Diagnosing and Exposure Assessment: Violante's Levels of Evidence*

For each case of occupational disease, the same four occupational physicians evaluated the levels of evidence defined by Violante on the criteria for the quality (and the associated likelihood) of diagnosing musculoskeletal diseases, as well as the requirements

for the quality (and associated likelihood) of exposure to occupational biomechanical risk factors. We applied Violante's criteria for all types of occupational disease, considering the specificity and sensitivity of each clinical finding and the presence of a reference test assumed to be the "gold standard" for a particular disease. In cases where no reference test was available, all relevant evidence, including therapeutic interventions, was considered.

Criteria for diagnosis were assigned a probability of disease presence based on progressive levels of evidence (e.g., insufficient, possible, probable, very probable, near certain) that reflect a literature review guided by evidence-based approaches for evaluating literature, such as the GRADE system. Violante's criteria for the quality of diagnosing musculoskeletal disease encompass pertinent symptoms, clinical examination findings, and other tests, including imaging and instrumental examinations, while adhering to clinical classifications based on guidelines and information derived from evidence-based reviews of relevant scientific literature.

The criteria for assessing the quality of exposure to occupational risk factors were structured in the same manner, providing progressive levels of evidence from both a qualitative perspective (e.g., insufficient, possible, probable, very probable, near certain) and a quantitative perspective (based on measures obtained through validated methods). Data concerning occupational risk factor exposure was collected from the INAIL first certificate linked to the report of denunciation.

## 3. Results

### 3.1. Descriptive Statistics

The sample of 104 reports of occupational diseases belonged to 61 workers, 57 males (93.4 %) and 4 females (6.6%), with a median age of 62 years (range 38-92 years, IQR 56-64). Among 104 reports, 36 included a single disease per worker (59.0%), 15 included two diseases for the same worker (24.6%), 4 included three diseases for the same worker (6.6%), 4 reports included four diseases for the same worker (6.6%) and finally 2 reports included five diseases for the same worker (3.3%).

The distribution by production sector showed that the services and construction sectors are the most represented (N = 22, 36.1% for both). Among the 22 cases in the service sector, 1 was a butcher in a butcher shop, 12 worked in the transport sector (bus and truck drivers), 4 worked in the garbage collection sector, 2 worked in food catering services, 2 in the cleaning sector and 3 in the logistic sector. Among the 22 cases in the construction sector, 3 worked in the plant engineering sector (electrical and hydraulic plant engineering), 17 worked in the civil construction sector (builders), 1 worked in the demolition sector. Secondly, the industrial and craft sectors are equally distributed (N = 6, 9.8% for both), followed by agriculture (N = 3, 4.9%) while the health sector is the least represented (N = 2, 3.3%). Most of the reports of denunciation are represented by patronage physicians (N = 49, 80.3%), while general practitioners and freelance physicians accounted for only 3.3% (N = 2). Reports presented by occupational physician accounted for 13.1% (N = 8).

### 3.2. Characterization and Risk Factors of Occupational Diseases

Table 1 presents the absolute number and percentage of occupational diseases reported in this study. Among the musculoskeletal diseases, lumbar intervertebral disc diseases (lumbar disc herniation 26%, lumbar spondylodiscopathy 13.5%) and shoulder pathologies (tendinitis of the supraspinatus 17.3%, periarthritis of the shoulder 3.8%) are most represented. Of the 15 cases of elbow tendinopathies, 10 are Epicondylitis, and 5 are mixed medial and lateral elbow tendinopathy.

Table 2 shows the risk factors linked to occupational disease reports. Microtrauma, incongruous postures of the upper limb (41.3%), and manual handling (39.4%) are the risk factors most involved in the pathogenesis of shoulder and spine diseases.

Table 3 presents the median age, interquartile range (IQR), and gender distribution for each reported occupational disease. Among the most prevalent musculoskeletal diseases, the median age of cases reported for lumbar disc herniation was 60 years (range 41-68 years). Of these cases,

**Table 1.** Absolute number and percentage of reported occupational diseases.

| Reported occupational diseases N = 104 | | N (%) |
|---|---|---|
| Musculoskeletal diseases N = 95 (92%) | Bilateral rhizoarthrosis and bilateral radio-carpal arthrosis of the hands | 1 (1.0%) |
| | Carpal tunnel syndrome | 5 (4.8%) |
| | Cervical disc herniation | 2 (1.9%) |
| | Degenerative meniscopathy | 6 (5.8%) |
| | Periarthritis of the shoulder | 4 (3.8%) |
| | Elbow tendinopathies | 15 (14.4%) |
| | Lumbar disc herniation | 27 (26.0%) |
| | Lumbar spondylodiscopathy | 14 (13.5) |
| | Arthrosis of the hands | 1 (1.0%) |
| | Quadriceps tendinopathy | 1 (1.0%) |
| | Tendinitis of the long head of the biceps brachii | 1 (1.0%) |
| | Tendinitis of the supraspinatus | 18 (17.3%) |
| Noise induced occupational hearing loss N = 7 (6.7%) | | 7 (6.7%) |
| Pulmonary silicosis N = 1 (1.0%) | | 1 (1.0%) |
| Raynaud's phenomenon N = 1 (1%) | | 1 (1 %) |

**Table 2.** Risk factors linked to the study's occupational disease reports.

| Risk factors N = 104 | N (%) |
|---|---|
| Microtrauma and incongruous postures of the upper limb | 43 (41.3%) |
| Manual handling | 41 (39.4%) |
| Microtrauma and incongruous knee postures | 7 (6.7%) |
| Harmful noise | 7 (6.7%) |
| Unknown risk factors (ICD-10 off-list diseases) | 3 (2.9%) |
| Hand-arm vibration | 2 (1.9%) |
| Free crystalline silica | 1 (1.0%) |

26 were men (96%) and 1 was a woman (4%). The median age for cases reported for tendinitis of the supraspinatus was 63 years (range 45-72 years). Of those cases, 15 were men (83%), and 3 were women (17%). For noise-induced occupational hearing loss, we identified 7 cases involving male workers with a median age of 63 years (range 50-65). The single case of pulmonary silicosis was a man aged 92 years.

### 3.3. Quality of Diagnosis

Table 4 presents the mean values of the total quality scores, calculated following the Spreeuwers' method, in the range 0-10. Quadriceps tendinopathy and noise-induced occupational hearing loss reports received good total quality scores (8.3 and 7.1, respectively). The worst mean quality score, 3.7, was related to Raynaud's phenomenon case.

The overall data relating to the 104 reported occupational diseases show that 72.1% of the reports (N = 75) have a sufficient total quality score (≥6). In contrast, 27.9% of the reports (N = 29) have an insufficient total quality score (<6). The mean total quality score for all musculoskeletal disorders reports (N = 96) was 6.0. Among musculoskeletal diseases (N = 95), the percentage with a mean total quality score ≥6 (N = 68) resulted to be 70.8%, while the percentage with a mean total quality score <6 (N = 27) resulted to be 29%.

### 3.4. Evidence by Violante's Criteria for the Quality of Diagnosis and Exposure Assessment

The evidence for the diagnosis was insufficient in 13.5% of the examined reports, possible in 7.5% of cases, probable in 7.5% of cases, very likely in 68.8%, and near-certain in 2.2% of cases (Figure 1). The evidence for exposure to risk factors was insufficient in 19.5% of the examined reports, possible in 63.5% of cases, and probable in 17.1%. No cases show a very likely or near-certain level of evidence of exposure (Figure 1).

The four physicians assigned a "very probable" level of evidence to ≥ 50% of the reported cases for the quality of diagnosis of the following diseases: bilateral

**Table 3.** Median age, IQR, and gender distribution for each class of the 104 reported occupational disease.

| Suspected work-related diseases | | N (%) | Median age | IQR | Gender |
|---|---|---|---|---|---|
| Musculoskeletal diseases N = 95 (92%) | Bilateral rhizoarthrosis and radio-carpal arthrosis | 1 (1.0%) | 68 years | - | 1 F (100%) |
| | Carpal tunnel syndrome | 5 (4.8%) | 61 years | 38-72 | 5 M (100%) |
| | Cervical disc herniation | 2 (1.9%) | 63.5 years | - | 2 M (100%) |
| | Degenerative meniscopathy | 6 (5.8%) | 63 years | 48-64 | 5 M (83.3%)<br>1 F (16.7%) |
| | Periarthritis of the shoulder | 4 (3.8%) | 57 years | 52-60 | 3 M (75.0%)<br>1 F (25.0%) |
| | Epicondylitis | 15 (14.4%) | 63 years | 50-68 | 14 M (93.3%)<br>1 F (6.7%) |
| | Lumbar disc herniation | 27 (26.0%) | 60 years | 41-68 | 26 M (96.3%)<br>1 F (3.7%) |
| | Lumbar spondylodiscopathy | 14 (13.5) | 63 years | 48-72 | 12 M (85.7%)<br>2 F (14.3%) |
| | Arthrosis of the hands | 1 (1.0%) | 63 years | - | 1 M (100%) |
| | Quadriceps tendinopathy | 1 (1.0%) | 63 years | - | 1 M (100%) |
| | Tendinitis of the long head of the biceps brachii | 1 (1.0%) | 64 years | - | 1 M (100%) |
| | Tendinitis of the supraspinatus | 18 (17.3%) | 63 years | 45-72 | 15 M (83.3%)<br>3 F (16.7%) |
| Noise induced occupational hearing loss | | 7 (6.7%) | 63 years | 50-65 | 7 M (100 %) |
| Raynaud's phenomenon | | 1 (1.0%) | 63 years | - | 1 M (100%) |
| Pulmonary silicosis | | 1 (1.0%) | 92 years | 92 | 1 M (100%) |

**Table 4.** Mean values of the Total Quality Scores from Spreeuwer method (mean of the four evaluators) for 104 cases of suspected, mostly musculoskeletal (N=95 or 92%), work-related diseases.

| Suspected work-related diseases | | | Spreeuwer's total quality score (mean) |
|---|---|---|---|
| Musculoskeletal diseases | Quadriceps tendinopathy | 1 (1.0%) | 8.3 |
| | Lumbar spondylodiscopathy | 14 (13.5) | 6.9 |
| | Arthrosis of the hands | 1 (1.0%) | 6.7 |
| | Tendinitis of the long head of the biceps brachii | 1 (1.0%) | 6.7 |
| | Degenerative meniscopathy | 6 (5.8%) | 6.3 |
| | Tendinitis of the supraspinatus | 18 (17.3%) | 6.3 |
| | Epicondylitis | 15 (14.4%) | 6.2 |
| | Lumbar disc herniation | 27 (26.0%) | 5.7 |
| | Periarthritis of the shoulder | 4 (3.8%) | 5.3 |
| | Bilateral rhizoarthrosis and bilateral radiocarpal arthrosis | 1 (1.0%) | 5.0 |
| | Carpal tunnel syndrome | 5 (4.8%) | 4.7 |
| | Cervical disc herniation | 2 (1.9%) | 4.6 |
| Noise induced occupational hearing loss | | 7 (6.7%) | 7.1 |
| Raynaud's phenomenon | | 1 (1.0%) | 3.7 |
| Pulmonary silicosis | | 1 (1.0%) | 6.7 |

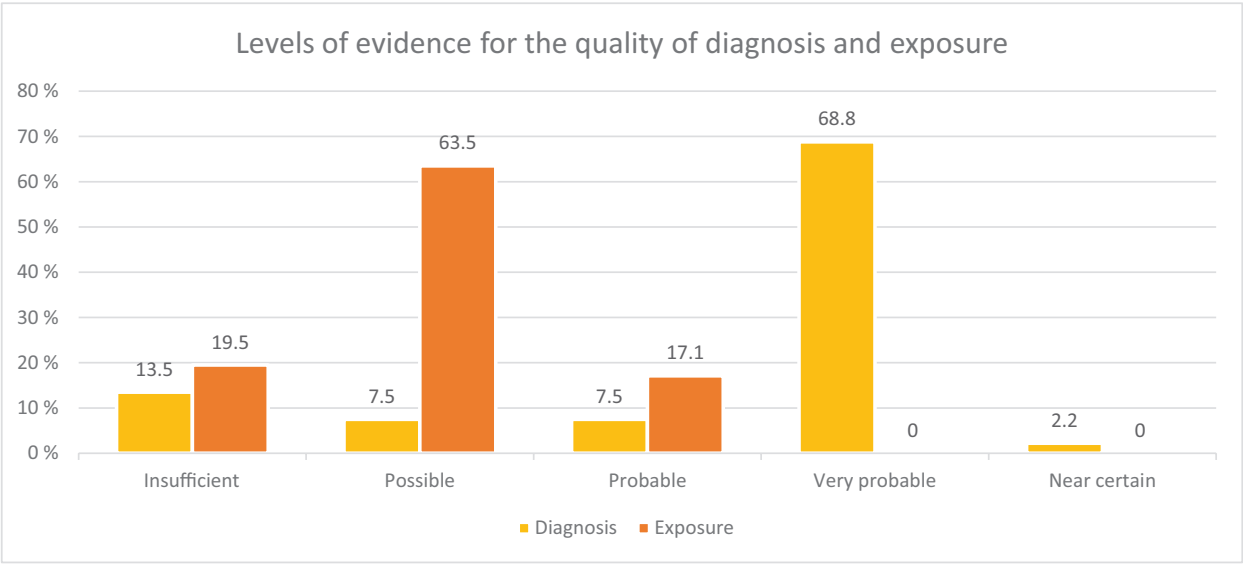


**Figure 1.** Levels of evidence for the quality of diagnosis (orange bars) and exposure (yellow bars) following Violante's criteria.

rhizoarthrosis and bilateral radio-carpal arthrosis of the hands, cervical disc herniation, degenerative meniscopathy, epicondylitis, lumbar disc herniation, lumbar spondylodiscopathy, noise-induced occupational hearing loss, osteoarthropathies (wrist, elbow, shoulder), pulmonary silicosis, quadriceps tendinopathy, tendinitis of the long head of the biceps brachii, tendinitis of the supraspinatus. In these cases, symptoms

were present, clinical findings were present, and written documentation of a reference test was assumed to be the "gold standard" for each disease.

The level of evidence according to Violante's criteria for diagnosis was deemed "insufficient" in several reported cases of these diseases: lumbar disc herniation (18.5%), supraspinatus tendinitis (11.1%), elbow tendinopathies (11.7%), noise-induced occupational hearing loss (21.5%), degenerative meniscopathy (16.7%), carpal tunnel syndrome (35%), and Raynaud's phenomenon (100%). In only a few reported cases was the level of evidence for diagnosis considered "near certain" for lumbar disc herniation (3.7%), lumbar spondylodiscopathy (7.1%), and supraspinatus tendinitis (5.6%) due to the documentation of surgical intervention. Detailed data on the level of evidence for each diagnosis can be found in the supplementary material (Table S1).

The four physicians assigned a "possible" level of evidence, per Violante's Criteria, to ≥ 50% of the reported cases regarding the quality of exposure to risk factors for the following conditions: bilateral rhizoarthrosis, bilateral radio-carpal arthrosis of the hands, cervical disc herniation, degenerative meniscopathy, periarthritis of the shoulder, elbow tendinopathies, lumbar disc herniation, lumbar spondylodiscopathy, noise-induced occupational hearing loss, tendinitis of the long head of the biceps brachii, and supraspinatus tendinitis. No case of reported occupational disease has been assigned a "very probable" or "near certain" level of evidence in evaluating the quality of exposure to risk factors. Extensive data on the level of evidence for the quality of exposure are available in the supplementary material (Table S1).

## 4. Discussion

The current study indicates that the quality of the reports is generally adequate (72%). However, further improvement can be made by refining the assessment of exposure to risk factors and enhancing the collection of non-occupational history. Inadequate medical histories also hinder the identification of non-occupational causes for the same disease. While some typical occupational diseases, such as occupational hearing loss, demonstrated good quality of reporting, several musculoskeletal disorders and Raynaud's phenomenon exhibited a low mean quality score (<6). This discrepancy may be attributed to the multifactorial nature of these diseases. The quality of diagnosis and reporting could be improved by gathering data on other potential non-occupational causes and obtaining a comprehensive medical history of the patient.

The level of evidence for diagnosis predominantly resulted in a very probable estimation (68.8%), mainly when specific symptoms, clinical findings, and written documentation of a reference test, considered the gold standard, are available. Conversely, the poor performance in assessing exposure to risk factors suggests that, despite a clearly defined disease, a lack of documentation regarding exposure prevents establishing a clear cause-effect relationship. In most cases, the reports included administrative employment documentation, job title, and written information about the work that could at least qualitatively suggest exposure. Although the quality of diagnosis and the work history is adequate for establishing a causal link in the MALPROF system, the absence of precise information on exposure to specific occupational risk factors may impact the accuracy of causal attribution. A written evaluation conducted by a safety professional, including a documented exposure assessment or an appropriate checklist, could enhance this aspect. A job-exposure matrix can be used when such data are unavailable, or only the job title is included in the report. Furthermore, it would be beneficial to consider epidemiological criteria, where the evidence of exposure can reach a high level of probability. In this regard, data on occupational exposures serve as critical information for establishing a relationship between specific job tasks and the emergence of an occupational disease.

Our results further confirm that several factors—such as a lack of understanding of the dose-response relationship between exposure levels and detrimental effects on target organs, coupled with a lack of data on exposure to specific risk factors—can influence the attribution of a causal link in suspected work-related diseases. Additionally, our study emphasizes that the quality of reports is often insufficient due to inadequate detail in certification.

Possible explanations for this phenomenon include the non-mandatory assessment of non-professional risk factors, lack of time, and the absence or incompleteness of documentation regarding exposure to risk factors. This underscores the need to increase the number of reports from occupational physicians who prioritize risk assessment and the etiological diagnosis of occupational diseases. Moreover, adherence to standardized collection systems for occupational diseases, such as MAREL provided by the national compensation system (INAIL), could enhance the quality assessment of the causal link between exposure to occupational risk factors and the development of multifactorial diseases. To accomplish this goal, it is essential to establish a network of occupational medicine clinics that workers can access upon referral from general practitioners, occupational physicians, and other specialists.

Data on professional exposures, along with the specific details characterizing them (level and type of exposure, use of any personal protective equipment, causal link), represent central information and the added value of the Marel system. This data facilitates the integration of information collected by the MALPROF system, which enables the determination of causal links between illness and work history concerning sectors of economic activity and professional qualifications, though not relating to specific exposure agents. In MAREL, a team of experts categorized the "exposure agent" variable into four macro-groups: biological agents, biomechanical overload agents, chemical agents, physical agents, jobs, and psychosocial risk factors. Each macro-category lists specific exposure agents, totaling 439 names.

### 4.1. Limitations and Strengths of the Study

Some limitations affect the current study: first, the small sample size of the analyzed occupational disease reports. Applying the criteria proposed by Spreeuwers and Violante to a larger number of reports may allow for attributing a specific quality level to the evaluation of the disease and the exposure. It would also provide a clear framework for linking a particular disease to workplace exposure, considering non-occupational factors that may be causally relevant. Second, the Spreeuwers performance indicators were developed for two occupational diseases: noise-induced hearing loss and occupational adjustment disorder. The Spreeuwers criteria have also been applied and adapted in our study to evaluate musculoskeletal disorders and pulmonary silicosis. Therefore, validating the Spreeuwers criteria for application across all types of occupational pathologies is essential. The strengths of our study include using standardized methods to evaluate the quality of occupational disease diagnosis and providing clear criteria for establishing a causal role. Moreover, our study offers specific recommendations for improving the quality of diagnosis and reporting. In contrast, most studies only observe that the recognition and reporting of occupational diseases is inadequate, without addressing the issues that require quality improvement.

## 5. Conclusions

Knowledge of diagnostic criteria, case definitions, and national or international evidence-based guidelines is necessary for occupational physicians' daily practice. The results of this quality assessment study could help the clinical figures involved in the prevention, diagnosis, and reporting of occupational diseases to improve and facilitate the reporting process, focusing their attention on an in-depth collection of all performance indicators, especially on the assessment of exposure to risk factors and non-occupational history. The training and periodical updating of physicians in the field of etiological diagnosis and the promotion of a culture of prevention in the workplace, including medical staff in hospitals, should be considered to reach better quality standards.

It will be interesting to follow a new data collection system like MAREL implemented in INAIL. Here, the homogeneous and systematic collection of information from more specialized centres can produce massive amounts of information of great utility for knowledge and prevention. It also allows for the consideration of cases of pathology that, by their nature or their particular relationship with unrecognized professional risk factors, are not yet listed in the tables or in the lists of current rules.

**Supplementary Materials:** The following are available in the online version: Table S1: The level of evidence for diagnosis and exposure as a percentage of the total, following Violante's criteria.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki. Due to the observational nature of our research, no formal approval of the Institutional Review Board or the Ethics Committee of Sardinia was required, as no additional procedure or therapeutic medication was involved.

**Informed Consent Statement:** Not applicable.

**Declaration of Interest:** The authors declare no conflict of interest.

**Author Contribution Statement:** L.I.L., S.P., and M.L. contributed to write the original draft and conducted the statistical analysis; M.L. and A.M. contributed to the investigation phase; G.C., A.P., S.M. and M.C. provided substantial comments to the results and contributed to the design and interpretation of the research; M.C. contributed to the study design, supervision and data curation; M.C. and S.M. contributed to the review and editing of the manuscript.

**Declaration on the use of AI:** None.

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**Table S1.** Level of evidence for diagnosis and exposure as percentage from the total, following Violante's criteria

| | Level of evidence for diagnosis (%) | | | | | | Level of evidence for exposure (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Evaluator** | **Insufficient** | **Possible** | **Probable** | **Very probable** | **Near certain** | **Evaluator** | **Insufficient** | **Possible** | **Probable** | **Very probable** | **Near certain** |
| Bilateral rhizoarthrosis and bilateral radio-carpal arthrosis of the hands, n. 1 (1%) | 1 | 0 | 0 | 0 | 100 | 0 | 1 | 0 | 100 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 100 | 0 | 2 | 0 | 100 | 0 | 0 | 0 |
| | 3 | 0 | 0 | 0 | 100 | 0 | 3 | 0 | 100 | 0 | 0 | 0 |
| | 4 | 0 | 0 | 0 | 100 | 0 | 4 | 0 | 100 | 0 | 0 | 0 |
| | **Mean** | **0** | **0** | **0** | **100** | **0** | **Mean** | **0** | **100** | **0** | **0** | **0** |
| Carpal tunnel syndrome, n.5 (4.8%) | 1 | 20 | 20 | 20 | 40 | 0 | 1 | 60 | 40 | 0 | 0 | 0 |
| | 2 | 40 | 0 | 20 | 40 | 0 | 2 | 60 | 40 | 0 | 0 | 0 |
| | 3 | 40 | 0 | 20 | 40 | 0 | 3 | 60 | 40 | 0 | 0 | 0 |
| | 4 | 40 | 20 | 0 | 40 | 0 | 4 | 60 | 40 | 0 | 0 | 0 |
| | **Mean** | **35** | **10** | **15** | **40** | **0** | **Mean** | **60** | **40** | **0** | **0** | **0** |
| Cervical disc herniation, n. 2 (1.9%) | 1 | 0 | 0 | 0 | 100 | 0 | 1 | 0 | 50 | 50 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 100 | 0 | 2 | 0 | 50 | 50 | 0 | 0 |
| | 3 | 0 | 0 | 100 | 0 | 0 | 3 | 0 | 50 | 50 | 0 | 0 |
| | 4 | 0 | 0 | 50 | 50 | 0 | 4 | 0 | 50 | 50 | 0 | 0 |
| | **Mean** | **0** | **0** | **37,5** | **62,5** | **0** | **Mean** | **0** | **50** | **50** | **0** | **0** |
| Degenerative meniscopathy, n.6 (5.8%) | 1 | 16,7 | 0 | 0 | 83,3 | 0 | 1 | 16,7 | 50 | 33,3 | 0 | 0 |
| | 2 | 16,7 | 0 | 0 | 83,3 | 0 | 2 | 16,7 | 50 | 33,3 | 0 | 0 |
| | 3 | 16,7 | 0 | 16,7 | 66,7 | 0 | 3 | 16,7 | 50 | 33,3 | 0 | 0 |
| | 4 | 16,7 | 0 | 0 | 83,3 | 0 | 4 | 33,3 | 33,3 | 33,3 | 0 | 0 |
| | **Mean** | **16,7** | **0** | **4,18** | **79,15** | **0** | **Mean** | **20,85** | **45,83** | **33,3** | **0** | **0** |
| Periarthritis of the shoulder, n.4 (3.8%) | 1 | 0 | 25 | 50 | 25 | 0 | 1 | 25 | 75 | 0 | 0 | 0 |
| | 2 | 0 | 50 | 25 | 25 | 0 | 2 | 25 | 75 | 0 | 0 | 0 |
| | 3 | 0 | 50 | 25 | 25 | 0 | 3 | 25 | 75 | 0 | 0 | 0 |
| | 4 | 0 | 75 | 0 | 25 | 0 | 4 | 25 | 75 | 0 | 0 | 0 |
| | **Mean** | **0** | **50** | **25** | **25** | **0** | **Mean** | **25** | **75** | **0** | **0** | **0** |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elbow tendinopathies, n. 15 (14.8%) | 1 | 0 | 20 | 0 | 80 | 0 | 1 | 20 | 66,7 | 13,3 | 0 | 0 |
| | 2 | 6,7 | 13,3 | 0 | 80 | 0 | 2 | 20 | 66,7 | 13,3 | 0 | 0 |
| | 3 | 20 | 6,7 | 13,3 | 60 | 0 | 3 | 20 | 73,3 | 6,7 | 0 | 0 |
| | 4 | 20 | 6,7 | 0 | 73,3 | 0 | 4 | 26,7 | 60 | 13,3 | 0 | 0 |
| | **Mean** | **11,68** | **11,68** | **3,33** | **73,33** | **0** | **Mean** | **21,675** | **66,68** | **11,65** | **0** | **0** |
| Lumbar disc herniation, n. 27 (26%) | 1 | 14,8 | 11,1 | 14,8 | 55,6 | 3,7 | 1 | 29,6 | 55,6 | 14,8 | 0 | 0 |
| | 2 | 22,2 | 3,7 | 18,5 | 51,9 | 3,7 | 2 | 33,3 | 51,9 | 14,8 | 0 | 0 |
| | 3 | 18,5 | 14,8 | 11,1 | 51,9 | 3,7 | 3 | 33,3 | 55,6 | 11,1 | 0 | 0 |
| | 4 | 18,5 | 22,2 | 0 | 59,3 | 0 | 4 | 29,6 | 51,9 | 18,5 | 0 | 0 |
| | **Mean** | **18,5** | **13,0** | **11,1** | **54,7** | **2,8** | **Mean** | **31,45** | **53,75** | **14,8** | **0** | **0** |
| Lumbar spondylodisco-pathy, n.14 (13.5%) | 1 | 0 | 0 | 0 | 92,9 | 7,1 | 1 | 0 | 85,7 | 14,3 | 0 | 0 |
| | 2 | 0 | 0 | 7,1 | 85,7 | 7,1 | 2 | 0 | 85,7 | 14,3 | 0 | 0 |
| | 3 | 0 | 0 | 7,1 | 78,6 | 14,3 | 3 | 0 | 92,9 | 7,1 | 0 | 0 |
| | 4 | 0 | 0 | 0 | 100 | 0 | 4 | 0 | 85,7 | 14,3 | 0 | 0 |
| | **Mean** | **0** | **0** | **3,55** | **89,30** | **7,13** | **Mean** | **0** | **87,5** | **12,5** | **0** | **0** |
| Noise-induced occupational hearing loss, n.7 (6.7%) | 1 | 14,3 | 0 | 0 | 85,7 | 0 | 1 | 14,3 | 57,1 | 28,6 | 0 | 0 |
| | 2 | 14,3 | 0 | 0 | 85,7 | 0 | 2 | 14,3 | 57,1 | 28,6 | 0 | 0 |
| | 3 | 14,3 | 0 | 14,3 | 71,4 | 0 | 3 | 14,3 | 57,1 | 28,6 | 0 | 0 |
| | 4 | 42,9 | 0 | 0 | 57,1 | 0 | 4 | 14,3 | 57,1 | 28,6 | 0 | 0 |
| | **Mean** | **21,45** | **0** | **3,58** | **74,98** | **0** | **Mean** | **14,3** | **57,1** | **28,6** | **0** | **0** |
| Arthrosis of the hands, n.1 (1%) | 1 | 0 | 0 | 0 | 100 | 0 | 1 | 0 | 100 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 100 | 0 | 2 | 0 | 100 | 0 | 0 | 0 |
| | 3 | 0 | 0 | 0 | 100 | 0 | 3 | 0 | 100 | 0 | 0 | 0 |
| | 4 | 0 | 0 | 0 | 100 | 0 | 4 | 0 | 100 | 0 | 0 | 0 |
| | **Mean** | **0** | **0** | **0** | **100** | **0** | **Mean** | **0** | **100** | **0** | **0** | **0** |
| Pulmonary silicosis, n.1 (1%) | 1 | 0 | 0 | 0 | 100 | 0 | 1 | 100 | 0 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 100 | 0 | 2 | 100 | 0 | 0 | 0 | 0 |
| | 3 | 0 | 0 | 0 | 100 | 0 | 3 | 100 | 0 | 0 | 0 | 0 |
| | 4 | 0 | 0 | 0 | 100 | 0 | 4 | 100 | 0 | 0 | 0 | 0 |
| | **Mean** | **0** | **0** | **0** | **100** | **0** | **Mean** | **100** | **0** | **0** | **0** | **0** |

Table S1 (*Continued*)

| | Level of evidence for diagnosis (%) | | | | | | Level of evidence for exposure (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Evaluator** | **Insufficient** | **Possible** | **Probable** | **Very probable** | **Near certain** | **Evaluator** | **Insufficient** | **Possible** | **Probable** | **Very probable** | **Near certain** |
| Quadriceps tendinopathy, n.1 (1%) | 1 | 0 | 0 | 0 | 100 | 0 | 1 | 0 | 0 | 100 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 100 | 0 | 2 | 0 | 0 | 100 | 0 | 0 |
| | 3 | 0 | 0 | 0 | 100 | 0 | 3 | 0 | 100 | 0 | 0 | 0 |
| | 4 | 0 | 0 | 0 | 100 | 0 | 4 | 0 | 0 | 100 | 0 | 0 |
| | **Mean** | **0** | **0** | **0** | **100** | **0** | **Mean** | **0** | **25** | **75** | **0** | **0** |
| Raynaud's phenomenon, n.1(1%) | 1 | 100 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 100 | 0 | 0 |
| | 2 | 100 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 100 | 0 | 0 |
| | 3 | 100 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 100 | 0 | 0 |
| | 4 | 100 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 100 | 0 | 0 |
| | **Mean** | **100** | **0** | **0** | **0** | **0** | **Mean** | **0** | **0** | **100** | **0** | **0** |
| Tendinitis of the long head of the biceps brachii, n.1 (1%) | 1 | 0 | 0 | 0 | 100 | 0 | 1 | 0 | 100 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 100 | 0 | 2 | 0 | 100 | 0 | 0 | 0 |
| | 3 | 0 | 0 | 0 | 100 | 0 | 3 | 0 | 100 | 0 | 0 | 0 |
| | 4 | 0 | 0 | 0 | 100 | 0 | 4 | 0 | 100 | 0 | 0 | 0 |
| | **Mean** | **0** | **0** | **0** | **100** | **0** | **Mean** | **0** | **100** | **0** | **0** | **0** |
| Tendinitis of the supraspinatus, n.18 (17.3%) | 1 | 11,1 | 5,6 | 0 | 77,8 | 0 | 1 | 11,1 | 72,2 | 16,7 | 0 | 0 |
| | 2 | 11,1 | 0 | 5,6 | 83,3 | 0 | 2 | 5,6 | 72,2 | 22,2 | 0 | 0 |
| | 3 | 11,1 | 5,6 | 11,1 | 66,7 | 5,6 | 3 | 5,6 | 77,8 | 16,7 | 0 | 0 |
| | 4 | 11,1 | 5,6 | 0 | 83,3 | 0 | 4 | 5,6 | 72,2 | 22,2 | 0 | 0 |
| | **Mean** | **11,1** | **4,2** | **4,18** | **77,78** | **1,4** | **Mean** | **6,98** | **73,6** | **19,45** | **0** | **0** |