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Beyond the Balance Sheet: The Human Cost of Neglecting Occupational Health

A chilling wind is blowing across the United States, carrying the dust of shattered protections for the people who built the nation: its workers. Under the guise of efficiency and fiscal responsibility, a brutal wave of layoffs is sweeping through essential agencies, including the National Institute for Occupational Safety and Health (NIOSH). The gutting of NIOSH branches, particularly the Pittsburgh, Cincinnati, and Morgantown facilities, is a particularly egregious act, a slap in the face to generations of dedicated researchers and professionals who have tirelessly championed worker health and safety.

For decades, the Morgantown NIOSH branch has stood as a beacon of hope for workers in hazardous jobs. Its research has been instrumental in developing life-saving safety protocols and mitigating the risks miners, construction workers, and countless others face, including those risking bronchiolitis to make popcorn. To dismantle such a vital institution, to cast aside its expertise and legacy, is nothing short of reckless.

Layoffs of civil servants and scientists are not merely about balancing budgets; they fundamentally devalue human life and prioritize profit over the well-being of those who work in often hazardous conditions. They convey a troubling message: workers are expendable, and their health and safety are secondary to the bottom line. The consequences of this shortsighted policy will be devastating. We can anticipate an increase in workplace injuries, illnesses, and fatalities. The hard-won gains in worker safety, achieved through decades of research and advocacy, are now at risk of erosion. The ripple effects will be felt not only in the US but across the globe.

This dangerous trend threatens to spill across the Atlantic. Here in Europe, we must be vigilant. The winds of war are blowing, and the temptation to divert funds from social protection to military spending is a real and present danger. We cannot allow the pursuit of military security to come at the expense of the workers' and citizens' health and security. We must resist attempts to dismantle the institutions and protections safeguarding their health and well-being.

This situation presents a critical opportunity for reflection for the Italian Society of Occupational Medicine. To view Occupational Health as a mere cost, a burden to be slashed in pursuing short-term gains, is a profound error. Occupational Health is not an expense; it is an investment. It invests in human resources' integrity, the workforce's well-being, and our economies' long-term productivity and stability. To compromise Occupational Health is to compromise the foundation upon which our societies are built. It is a false economy that will ultimately lead to increased costs in healthcare, lost productivity, and human suffering. The responsibility of the Italian Society of Occupational Medicine is to uphold and tirelessly advocate for the recognition of Occupational Health as a core tenet of a just and thriving society.

Furthermore, we must vigorously denounce the dangerous tide of negationism that seeks to undermine the proven benefits of vaccinations and green policies. To deny the importance of vaccinations in combating infectious diseases and to reject green policies aimed at mitigating climate change is to embrace a path of reckless self-destruction. Such positions are not only scientifically unfounded but morally reprehensible. They endanger our communities' health and safety and jeopardize our planet's future. As guardians of worker health, we must stand firm against these forces of denial and misinformation. We must champion evidence-based policies that protect both the health of individuals and the health of the environment in which we all live and work.

The discrepancy in life expectancy between the United States and Italy is a stark reminder of the importance of prioritizing public health, worker protections, and the constitutional safeguard of the people's right to health. While Italy boasts a significantly higher average life expectancy, partly due to its robust social safety net and emphasis on preventative care, the US lags, struggling with access to healthcare and inadequate protections for its workforce. The threats to Medicare and Medicaid added to the erosion of worker protections in the US, which risks further widening this gap and perpetuating a system where the health and well-being of its citizens are compromised in the name of economic expediency.

We must recognize the stark disparity around us and defend Occupational Health in times of global uncertainty. We are urged to reaffirm our commitment to policies that promote longevity, enhance the quality of life for everyone, and dismantle the undue influence of a privileged few. It is time to prioritize the well-being of the many over the insatiable interests of the superwealthy who manipulate political support to evade fair taxation.

According to a directive from the Trump Administration, companies abroad, including those in the European Union, must dismantle diversity, equity, and inclusion (DEI) initiatives. This policy poses a threat to an essential function of Occupational Medicine, which is committed to an inclusive approach at work, and to occupational physicians, who are responsible for creating tailored work plans for individuals with disabilities and chronic illnesses. Occupational Medicine remains steadfast in its commitment to promoting inclusivity principles, fostering equitable workplaces, embracing diversity, and upholding the rights and dignity of all individuals.

When Occupational Cancer Recognition Falters

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SUMMARY

There are differences between epidemiology and legal medicine in addressing the problem of under-reporting occupational cancers. Epidemiology focuses on systematically gathering data and identifying patterns of under-reporting, which is not deemed to pose ethical dilemmas, as its goal is to improve public health outcomes. Conversely, legal medicine investigates individual cases and ensures compliance with legal standards, presenting more complex ethical challenges. Considering workers' frustrations when dealing with unrecognized occupational diseases is essential. These workers experience significant physical and emotional distress and should not have to face a complicated compensation claims process. There is a need for ethical approaches that support workers in navigating their rightful claims for compensation, not challenging their mental and emotional well-being.

Under-reporting and under-compensation of occupational cancers are well-known issues in occupational medicine, which could be partly due to the lack of expertise of physicians in the assessment of occupational exposures and the long latency period between exposure and cancer occurrence, resulting in very scanty knowledge of past exposures.

In this journal issue, two articles, one in France and the other in Italy, aim to address the problem. They are both based on the advanced use of occupational history in cancer cases. The French study deals with hematopoietic neoplasms, while the Italian one deals with lung cancer. There are remarkable differences in the outcomes of the studies. The Italian research resulted in compensation by the responsible authority (INAIL) for 18 out of 82 cases identified in the surveillance evaluation (21.9%) [1]. The proportion of compensated cases was much higher in the French paper (14 out of 18 cases, or 77.8%) [2]. However, a direct comparison between the two studies is impossible because of the different cancers being evaluated. To overcome such a problem, we compared the Italian research with a French paper published in 2023 by the same authors dealing with underreporting occupational lung cancers using the

same methodology [3]. In the study, 1251 patients were asked to complete a validated questionnaire on occupational exposure to carcinogens. The response rate was 33.5%. Out of the 462 respondents, occupational physicians interviewed 150, 88 of them received a certificate of occupational disease. Of the 65 patients who had forwarded it to the responsible authority, 38 were compensated (57%), a proportion much more significant than the one shown in the Italian study. It should be mentioned that 36 out of the 38 compensated cases in the French study were attributed to asbestos exposure, compared to the 7 (possibly 8) cases reported in the Italian study.

Results were not dissimilar in another, more extensive Italian study on 1522 thoroughly interviewed patients; in 395 cases, causation was attributed to their occupation (26% of interviewed patients). The main etiological agents were silica, asbestos, polycyclic aromatic hydrocarbons, truck driving, painting, and multiple exposures, with a compensation rate of 39% [4].

The compensation rate (No. of compensated cases/No. of study participants x 100) was 8.2% (38/462) in the French study compared to 3.9% (18/453) in the Italian study, more than 2-fold. A possible

explanation of such striking difference could be due to more stringent criteria adopted by the Italian INAIL or, considering that 36 out of 38 compensated cases in the French study were attributed to asbestos exposure, the prevalence of such exposure could be different in the study areas. In both countries, asbestos-related occupational cancers are included in an official list, and the compensation is easily recognized without any further exposure assessment. On the contrary, workers must prove the cause-effect relationship between exposure and disease for carcinogens not included in the official list to get compensated. This is hard to establish, given the scant information about occupational exposure (sufficiently intense and prolonged) to relevant risk factors.

The OCCAM project developed another approach aimed at reducing the underreporting of occupational cancers based on the record linkage between the cohort of exposed workers (defined according to their job and the job-related Ateco code) and the database of incident cancers provided by the Italian cancer registries' network [5]. This procedure would be cost-effective because it is fully computerized and does not require additional steps, such as the involvement of consulting occupational physicians. However, it did not gain the scientific community's support, as many professionals remained skeptical about its implementation due to the frequent misclassifications occurring when extrapolating occupational exposures from job titles.

While the OCCAM project can be considered just an exploratory tool, inadequate for occupational cancer recognition, a substantial improvement could be based on the record linkage between the cancer registry database and the database held by INAIL, which contains data on occupational exposure to carcinogens [6]. Such a registry (named SIREP) was prescribed in art. 70 of DLgs 626/94 (eventually canceled and replaced by art. 243 of the DLgs 81/2008). INAIL released the first SIREP report in 2023 [7]. In the database, around 200,000 workers exposed to selected carcinogens are reported; herein, only exposures involving more than 7000 workers are listed: 74.003 to wood dust, 33922 to benzene, 22383 to hexavalent chromium, 15165 to formaldehyde, 12413 to PAH, 10.600 to 1,3 butadiene, 7.754 to silica, 7,057 to asbestos, etc.). The authors explicitly acknowledged the presence of a reporting bias,

indirectly indicated by the substantial geographical difference, with very few data related to the southern regions. Nevertheless, linking the SIREP database with the network of regional cancer registries will result in reporting many occupational cancers otherwise bound to be lost. It is worth pointing out that in France, such a national database of occupational exposures to carcinogens is not available, and the only chance of improving the reporting of occupational cancer relies uniquely on *ad-hoc* screening programs, such as the one reported in the French papers [2, 3].

A specific procedure applies to radiation-induced occupational cancers [8]. The rule adopted by INAIL is based on the so-called probability of causation. Namely, if the likelihood of being occupationally related exceeds 50%, the occupational cancer is compensated. It is based on the use of NIOSH-IREP software, which "uses the upper 99 percent credibility limit to determine whether the cancer of employees was caused by their radiation doses" (User's guide for the interactive radio-epidemiological program NIOSH-IREP. August 2024). The 50% probability of causation is based on a relative risk of 2. The probability of causation is equal to the attributable risk among the exposed, which derives from the relative risk $(RR-1)/RR$. Using at the individual level, a principle (the relative risk) that applies to population data is questionable. Assuming that the claimant is randomly selected from the population that provides the relative risk is entirely arbitrary. One of the hidden assumptions (no interaction with background risk) cannot hold in all cases and is not necessarily recognized by using the upper 99 percent credibility limit. In addition, it seems unfair not to compensate for cancer, whose probability of causation is 49%, whereas, for other types of exposure (e.g., asbestos), compensation is recognized for any degree of exposure [9, 10]. The limit for using the probability of causation is well indicated, and caveats are well described in the updated Preamble to IARC monographs, underpinning a stronger and more transparent method for identifying carcinogenic hazards, the essential first step in cancer prevention, neither necessary nor sufficient in recognizing the occupational origin of a diagnosed cancer [11].

Going back to the papers published in this issue of the journal, in conclusion, while there is some

advantage in using surveillance methods to detect occupational cancer otherwise lost, it would be advisable to use record linkage between existing databases, if available, to be able to identify many more cases of occupational cancer. As mentioned before, for exposures not included in the official list, it is up to the worker to prove the cause-effect relationship between her/his exposure and cancer. Under the current regulations, such an effort is likely to fail, contributing to the underreporting of occupational cancers.

Critical ethical issues become more or less stringent when undertaking a program to tackle the underreporting and under-compensation of occupational cancers, depending on the context. Epidemiology focuses on identifying and quantifying patterns of under-reporting in occupational medicine through systematic data collection and statistical analysis, aiming to improve public health outcomes and, therefore, does not pose ethical issues. In contrast, legal medicine addresses underreporting by investigating individual cases, ensuring compliance with legal standards, and assessing causality in the framework of occupational health regulations. Therefore, workers' frustration when suffering from unrecognized occupational diseases should be considered in this context. These workers, already grappling with the physical and emotional toll of their conditions, should not be forced to navigate a complicated claims process for compensation. This prolonged struggle can cause them to experience self-doubt, even leading them to believe that they are imposters in their own right unfairly. Alternatively, they may think that occupational physicians encouraging them to claim compensation are incompetent, which is also unfair.

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Welding Fumes Exposure and the Risk of Head and Neck and Gastrointestinal Cancer: A Systematic Review and Meta-Analysis

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KEYWORDS: Occupational; Carcinogen; Oral; Pharynx; Larynx; Esophagus; Stomach; Colorectal; Liver; Pancreas

ABSTRACT

Background: *The association between welding fumes and cancers other than lung cancer remains undefined. We conducted a systematic review and meta-analysis on occupational exposure to welding fumes and the risk of head and neck cancer (HN, comprising oral, pharynx, and larynx) and gastrointestinal cancer (GI, comprising esophagus, stomach, colorectal, liver, and pancreas).* **Methods:** *A systematic search was performed in PubMed, Scopus, and Embase using PRISMA guidelines. Cohort studies on occupational exposure to welding fumes were identified. Study quality was assessed through the CASP score. Data were analyzed in random-effects models to calculate the relative risks (RR) and 95% confidence intervals (CI) of HN and GI cancer overall and stratified by cancer site.* **Results:** *Seven independent studies with data on oral, pharynx, larynx, esophagus, stomach, colorectal, liver, or pancreas cancer were identified. We observed the following associations: HN RR=1.10 (95% CI 1.00–1.22); GI RR= 1.03 (95% CI 0.97–1.10); oral and pharynx RR=1.06 (95% CI 0.93–1.20, eleven risk estimates); larynx RR=1.17 (95% CI 1.01–1.37, nine risk estimates); esophagus RR=0.98 (95% CI 0.83–1.15, three risk estimates); stomach RR= 1.10 (95% CI 1.02–1.19, five risk estimates); colorectal RR=0.99 (95% CI 0.85–1.15, seven risk estimates); liver RR=1.23 (95% CI 0.79–1.90, five risk estimates); and pancreas cancer RR=1.05 (95% CI 0.94–1.16, three risk estimates).* **Conclusions:** *We observed an association between occupational exposure to welding fumes and larynx and stomach cancer. No association was found for other HN or GI cancers. Our study stresses the need to investigate the risk of cancers other than lung following occupational exposure to welding fumes.*

1. INTRODUCTION

Welding is a process in which heat (over 4000°C) and/or pressure fuses two materials, typically metals, together [1]. When metals are heated to these high temperatures, welding fumes (WF) are produced, especially when the consumable metal electrode is volatilized. Welders are exposed to chemical

compounds and metals such as iron, aluminum, cadmium, copper, molybdenum, zinc, nickel, beryllium, lead, manganese, and hexavalent chromium [1]. The vaporized metals react with air, producing metal oxides that condense and form particles of respirable size [1]. Gases such as ozone, nitrogen dioxide, carbon dioxide, carbon monoxide, and hydrogen fluoride are also produced during welding [1]. Over 80

different types of welding and allied processes have been identified [2], and depending on the welding type, shielding gases, current, ventilation, and metals involved, the composition and rate of generation of WF can vary, especially in what concerns the particle size distribution, which is an essential factor in determining the likelihood of the particles being inhaled by welders [1].

Since 2017, the International Agency for Research on Cancer (IARC) has classified WF as an established human carcinogen [3, 4], following a previous classification as a possible carcinogen (Group 2B) [5]. This classification has mainly been driven by consistent data on the association between exposure to WF and lung cancer, based on results of over forty case-control and cohort studies [6]. In contrast, the evidence for kidney cancer was limited [7]. Furthermore, ultraviolet emissions from welding are included as a carcinogenic agent with sufficient evidence in humans about eye cancer [7].

However, the association between occupational exposure to WF and other cancers remains an open question. A systematic review and meta-analysis on gastrointestinal (GI) and head and neck (HN) cancers would be especially interesting. First, we hypothesize that the same compounds present in WF that cause lung cancer could also carry a carcinogenic risk for the upper respiratory tract. A 2020 case-control study concluded that the same mechanisms responsible for the WF lung carcinogenicity could play a carcinogenic role for other parts of the respiratory tract [8].

Similarly, we considered that WF and its compounds, once inhaled, could be redistributed from the upper respiratory tract to the upper GI tract and overwhelm the stomach's reductive capacity. Therefore, they could potentially reach the small intestine, colon, and rectum, ultimately increasing the risk of GI cancers. Thus, we aimed to conduct a systematic review and meta-analysis of cohort studies on the association between occupational exposure to WF and HN and GI cancers.

2. METHODS

This systematic review and meta-analysis were conducted according to COSMOS-E guidelines [9], and the report was based on the PRISMA guidelines. The protocol for the study was registered

in the PROSPERO database (Registration No. CRD42021252458). This work is part of a more extensive systematic review and meta-analysis on occupational exposure to WF and cancers other than the lungs.

The systematic review was based on the PECOS criteria: participants were workers occupationally exposed to WF, WF constituted exposure, the comparison was populations unexposed to WF (depending on the specific study, either the general population or an unexposed cohort), outcome was the incidence or mortality from oral, pharynx, larynx, esophagus, stomach, colorectal, liver or pancreas cancer, and the included study designs were prospective cohort studies, including nested case-control studies. We deliberately included only cohort studies, excluding case-control studies unless they were nested within a cohort. This decision was based on the higher methodological quality and reliability of data typically associated with cohort studies. Cohort studies generally provide more precise exposure information, better representation of occupational categories exposed to WF, and detailed data on the duration and intensity of exposure. These attributes enhance the evaluation of potential cause-effect relationships and reduce the likelihood of biases, such as recall and selection bias, which are more common in case-control studies. Furthermore, cohort studies offer a more robust framework for assessing temporal relationships between exposure and outcomes, making them more suitable for evaluating the research question.

Articles were identified by a scientific literature review conducted in June 2021 in PubMed, Scopus, and Embase and updated to the 11th of September 2024. The following string was used to identify studies: (Welding OR (Welding Fumes) OR Welder) AND (Cancer OR Neoplasm OR Leukemia OR Lymphoma OR Cohort). Two authors (GC, MH) independently searched for articles on welders and the risk of any type of cancer other than lung cancer, utilizing the method described above, and a third (PB) resolved any conflicts. If the same population was the subject of multiple reports, the one including the most significant number of cases or deaths was included. Studies were excluded if they assessed exposures to WF other than the occupational one, did not present any data on cancers other than lung cancer, and presented designs other than cohort or nested case-control.

The following data was extracted by two authors (GC, MH) and checked by a third author (PB) from the texts that met the inclusion criteria: publication year, period of follow-up, country, number of subjects and number of cancer cases, gender distribution of the population, cancer type, industry type, type of outcome (incidence or mortality), factors adjusted for in the analysis, the measure of association (odds ratio, risk ratio, rate ratio, standardized mortality ratio or standardized incidence ratio) and the corresponding CI.

Two authors (GC, MH) conducted a quality assessment of the studies individually using the CASP Cohort Study Checklist, based on 11 items for a total score of 14 points [10]. The median of the individually scored studies was utilized; studies scoring 10 points or less were considered low quality, and studies scoring higher than 10 points were regarded as high quality.

This work investigates occupational exposure to WF and HN and GI cancers.

In particular, we conducted a combined meta-analysis for the following types of HN cancers: larynx, oral cavity, and pharynx. Similarly, we conducted a parallel meta-analysis for the following types of GI cancers: esophagus, stomach, colorectum, liver, and pancreas. Summary relative risks (RRs) were calculated for each type of cancer, and the meta-analyses were conducted using the random-effects model [11]. We performed stratified analyses by studying quality, geographical region, type of outcome, and industry type. The heterogeneity for the summary RRs was assessed using the I^2 statistic. Subsequently, we performed a leave-one-out meta-analysis to evaluate whether the results would vary considerably if single studies were included or excluded from the meta-analyses. Publication bias was assessed using funnel plots and Egger's test [12].

All the statistical analyses were performed on STATA, version 16.1 (Stata Corp., College Station, TX, US) [13]. The meta-analysis was reported according to PRISMA guidelines [14].

3. RESULTS

Figure 1 displays the selection process for all articles identified in a flow chart. Three thousand two hundred forty articles were identified through the initial search, and 1,349 duplicates were excluded.

Of the remaining 1,891 articles, 1,706 were excluded based on title and abstract, leaving 185 articles to be evaluated against the inclusion criteria, thus resulting in a further 152 articles being excluded. 33 suitable articles were identified, of which 24 were excluded because of overlapping data (most being articles relative to studies from Northern European countries whose data were included in the 2009 pooled analysis by Pukkala et al. [15]). Finally, two of the remaining nine studies were excluded as they presented no data on either HN or GI cancers; the present meta-analysis, therefore, includes seven articles (Table 1). Most of the included studies reported results on occupation as a welder as a proxy for exposure to WF.

The overall meta-analysis for HN cancer (Figure 2) resulted in a RR of 1.10 (95% CI 1.00-1.22). The individual analysis for oral and pharynx cancer resulted in a summary RR of 1.06 (95% CI 0.93-1.20) from eleven risk estimates. The summary RR for larynx cancer was 1.17 (95% CI 1.01-1.37) from nine risk estimates. With an I^2 of 0.0% and a p-value of 0.569, there was evidence of low statistical heterogeneity among the studies included in the overall HN meta-analysis.

The overall meta-analysis for GI cancers (Figure 3) resulted in a RR of 1.03 (95% CI 0.97-1.10). The analysis for esophagus cancer resulted in a summary RR of 0.98 (95% CI 0.83-1.15, three risk estimates). The summary RR for stomach cancer was 1.10 (95% CI 1.02-1.19, five risk estimates), that for colorectal cancer was 0.99 (95% CI 0.85-1.15, seven risk estimates), that for liver cancer was 1.23 (95% CI 0.79-1.90, five risk estimates), and that for pancreas cancer was 1.05 (95% CI 0.94-1.16, three risk estimates). With an I^2 of 28.3% and a p-value of 0.102, there was evidence of low statistical heterogeneity among the studies included in the overall GI meta-analysis.

The test for heterogeneity indicated $p=0.566$ for oral and pharynx cancer, $p=0.478$ for larynx cancer, $p=0.88$ for esophagus cancer, $p=0.417$ for stomach cancer, $p=0.023$ for colorectal cancer, $p=0.269$ for liver cancer and $p=0.744$ for pancreas cancer.

Visual inspection of the funnel plots for the HN and GI meta-analyses showed slight asymmetry (Figure 4), which was not supported by the results of Egger's test. In particular, Egger's test showed

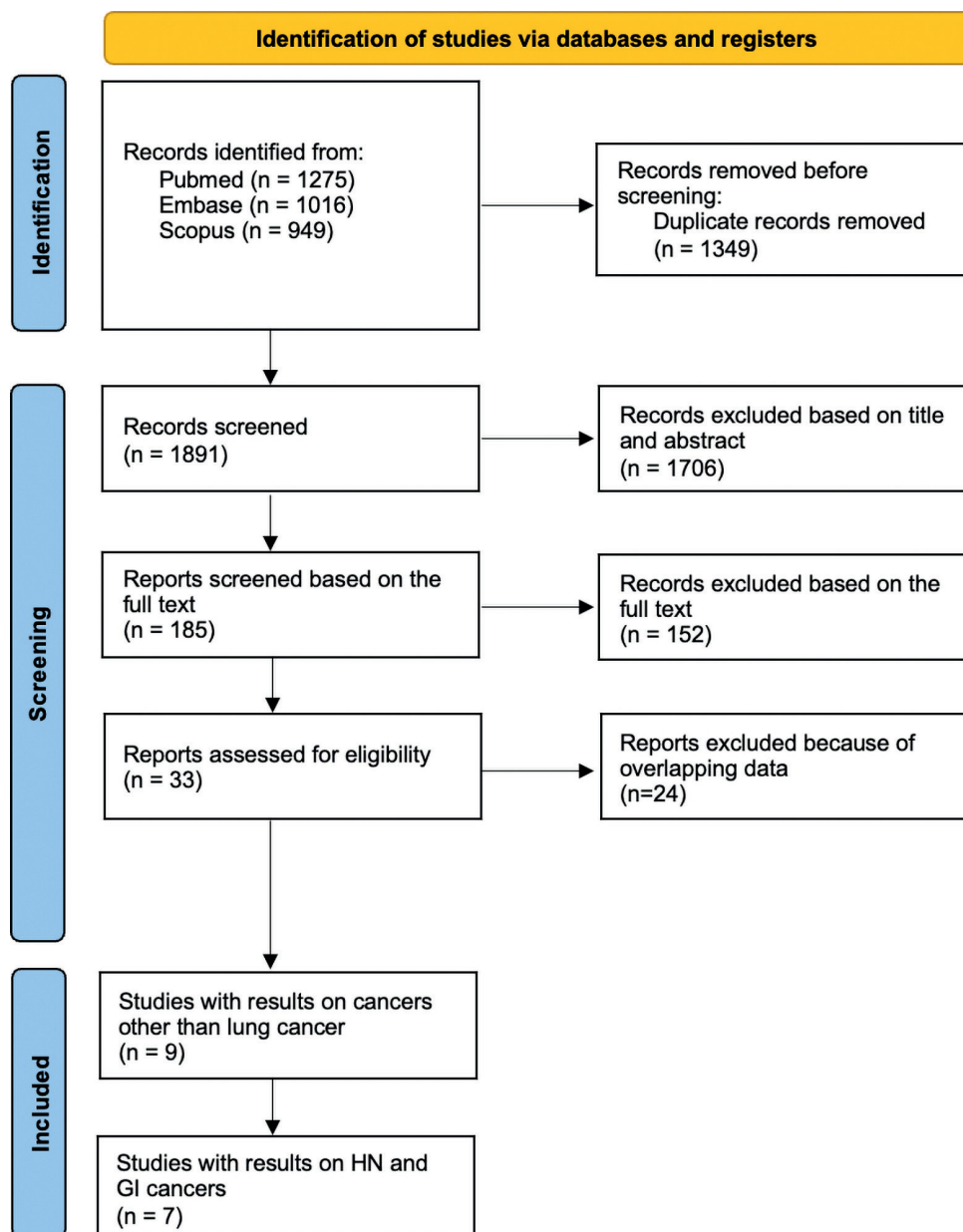


Figure 1. Flow-chart for the selection of studies included in the meta-analysis.

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71.

p-values of 0.967 for the overall HN meta-analysis and 0.349 for the overall GI meta-analysis. In contrast, for the specific cancer sites, the following p-values were found: 0.428 for oral and pharynx cancer, 0.468 for larynx cancer, 0.962 for stomach cancer, 0.784 for colorectal cancer, and 0.028 for liver cancer. Publication bias was not assessed for

cancer sites represented by fewer than five studies, such as the esophagus and pancreas, which had only three studies each. The site-specific funnel plots, which can be found in the supplementary section (Figures A1-A5), confirmed an asymmetry towards the right for liver cancer, which, together with the significant p-value of the relative Egger's

Table 1. Characteristics of studies included in the meta-analysis.

Study	Cancer type	Country	Follow Up Period	Cohort size (N=)	Industry	Cases (N=)	Adjustments (Other than age and calendar time)
Puntoni et al., 2001 [16]	Larynx Liver	Italy	1960-1996	3,984	Shipyard	2 3	N/A
Moulin et al., 1993 [17]	Oral and Pharynx Larynx Esophagus Stomach Rectal Liver	France	1975-1988	9,404	Factory and shipyard	6 3 4 6 2 3	Axelsson's indirect adjustment †
Becker, 1999 [18]	Oral and Pharynx Larynx Esophagus Stomach Colorectal Pancreas	Germany	1980-1995	1,221	Arc welders	1 1 3 5 2 4	N/A
MacLeod et al., 2017 [19]	Stomach	Canada	1991-2010	2,051,315	Construction and manufacturing	45	Province of residence and educational level
Pukkala et al., 2009 [15]	Oral and Pharynx Larynx Stomach Colorectal Liver Pancreas	Denmark, Finland, Iceland, Norway, Sweden	1961-2005	38,500,000	Welders	213 148 589 1355 123 357	N/A
Krstev et al., 2007 [20]	Oral and Pharynx Larynx	USA	1950-2001	184	Shipyard	5 7	Sex and race
Simonato et al., 1991 [21]	Oral and Pharynx Larynx	Denmark, Finland, Norway, Sweden, England, France, Germany	1950-1991	11,092	Factory and shipyard	21 12	N/A

† Reference: Axelsson O. Aspects on confounding in occupational health epidemiology. *Scand J Work Environ Health* 1978;4:85-9. [22].

test, suggests a possible publication bias in the case of liver cancer due to the absence of smaller studies showing a negative effect.

Stratified analyses by study quality (p for heterogeneity (p-het) for HN cancer = 0,51; p-het for GI

cancer = 0,94), geographical region (p-het for HN cancer = 0,44; p-het for GI cancer = 0,19), type of outcome (p-het for HN cancer = 0,82; p-het for GI cancer = 0,73) and industry type (p-het for HN cancer = 0,33; p-het for GI cancer = 0,41) yielded no

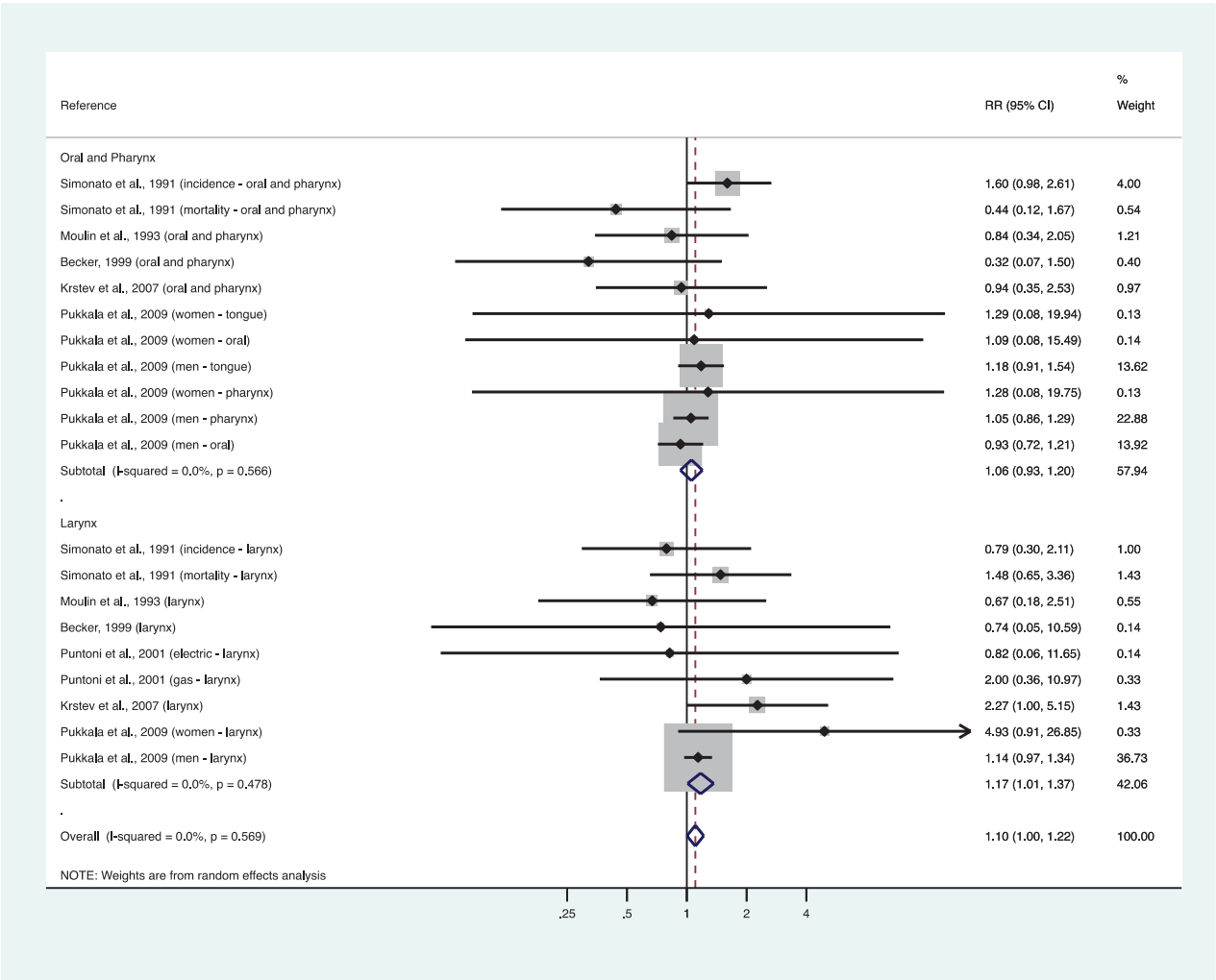


Figure 2. Results of the meta-analyses on HN cancers and occupational exposure to WF, including larynx and oral and pharynx cancer.

evidence of heterogeneity; however, they were impaired by low power of analysis (Figures A6-A13).

Based on the leave-one-out meta-analyses we performed, the association between occupational exposure to WF and larynx cancer seemed to be driven by the sizeable occupational cohort study by Pukkala et al. (2009) [15]. Similarly, the result for stomach cancer was driven by Pukkala et al. (2009) [15] and MacLeod et al. (2017) [19].

4. DISCUSSION

Based on this systematic review and meta-analysis of cohort studies, occupational exposure to

WF is associated with a 17% increased risk of larynx cancer and a 10% increased risk of stomach cancer. No association was detected with other HN or GI cancer sites. Our findings align with our initial hypothesis that compounds in WF known to cause lung cancer may also pose a carcinogenic risk to the upper respiratory and GI tracts as they migrate from the upper respiratory to the upper GI tract, affecting areas such as the stomach.

HN and GI cancers remain poorly investigated in welders; to date, results are conflicting. Several case-control studies found no significant association between HN cancers such as oral, hypopharynx, or larynx cancer and occupational exposure to WF [23-34].

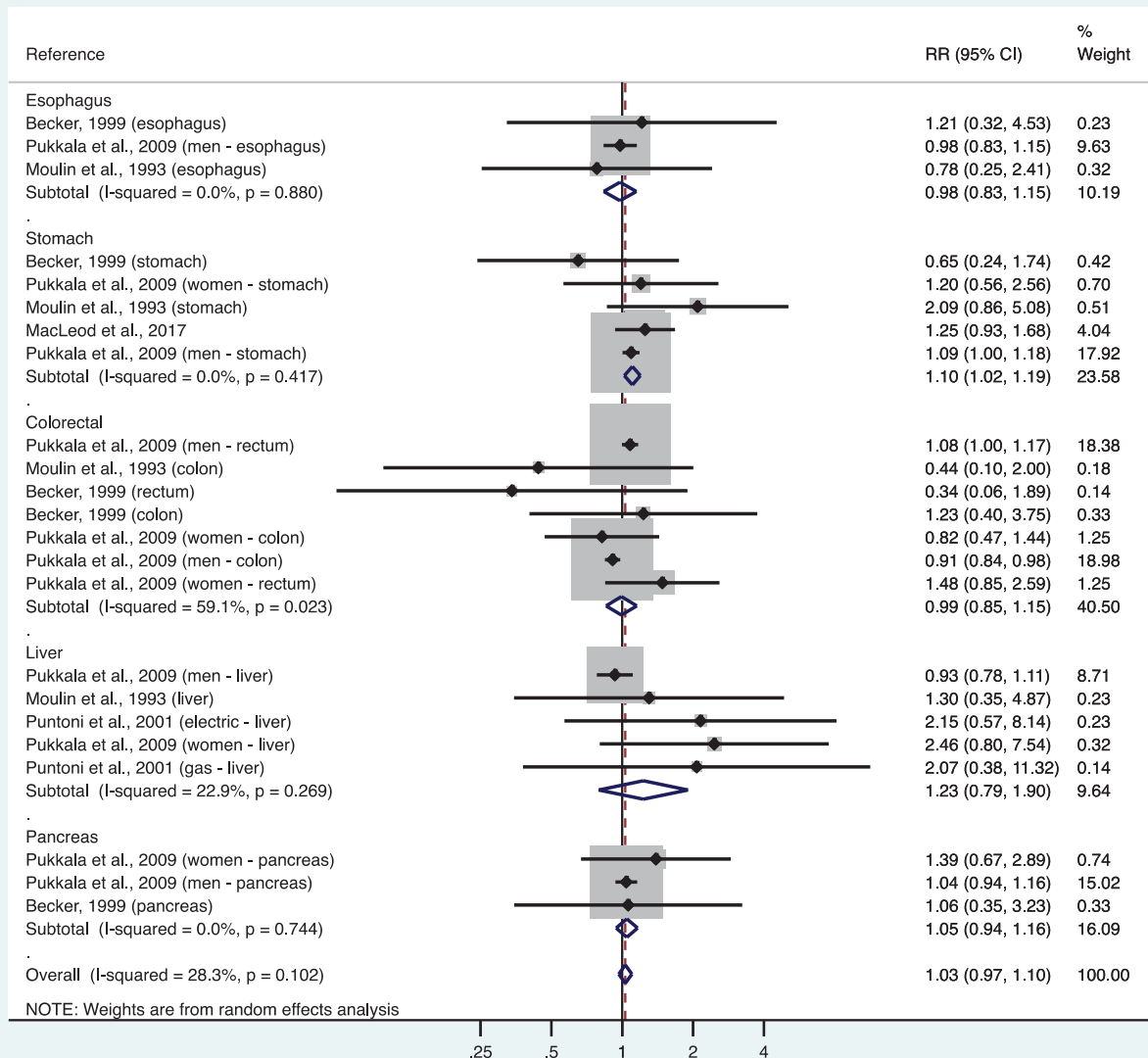


Figure 3. Results of the meta-analyses on GI cancers and occupational exposure to WF, including esophagus, stomach, colorectal, liver, and pancreas cancer.

On the other hand, previous literature has already reported an association between WF and respiratory tract cancers other than lung cancer, which is consistent with our findings. For example, a study by Gustavsson et al. found an association between pharynx [RR 2.3 (95% CI 1.1-4.7)] and larynx [RR 2.0 (95% CI 1.0-3.7)] cancer [35].

Next, Olsen et al. (1984) found that workers exposed to WF had a higher risk of larynx cancer

compared to age-matched controls [RR 1.6 (95% CI 1.0-2.4)] [36]. The RR was significantly high [RR 6.3 (95% CI 1.8-21.6)] for subglottic larynx cancer [36]. The authors found this association was limited considerably in cigarette smokers, although this result was considered to be affected by the small fraction of non-smoker cases [36].

Further, in a large 2019 study within the INHANCE consortium, Khetan et al. found HN

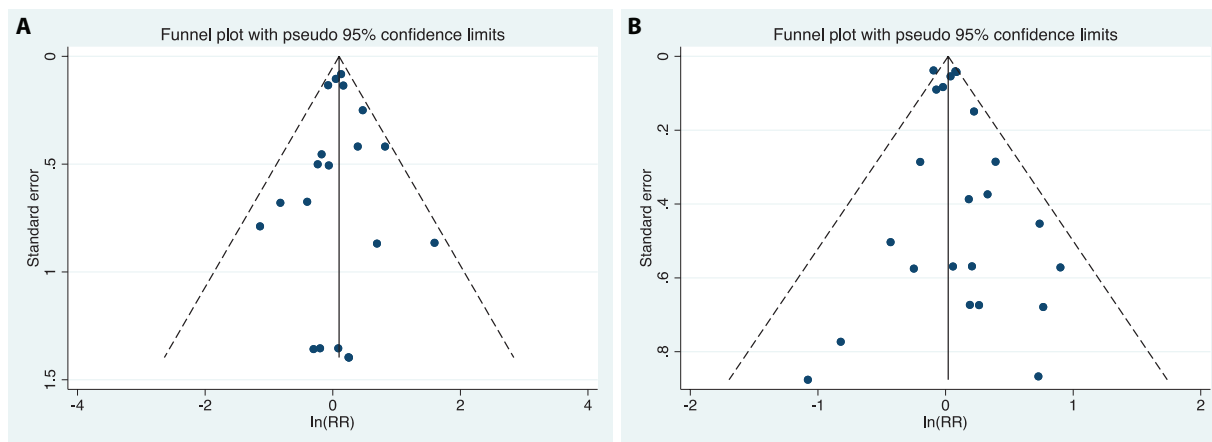


Figure 4. Funnel plots for (a) HN and (b) GI cancers.

cancers overall to be significantly associated with WF [OR 1.41 (95% CI 1.2-1.64)], particularly in the case of larynx cancer [OR 1.52 (95% CI 1.14-2.02)] [37].

A large case-control study from 2020 by Barul et al. on WF and HN cancer risk similarly found WF to be associated with an increased risk of HN cancer overall [OR 1.31 (95% CI 1.03-1.67)], with the association being strongest for larynx cancer [OR 1.66 (95% CI 1.15-2.38)] [8]. This study possessed the significant advantage of assessing welding as a job task rather than a job title, like census-based studies [8]. Furthermore, the analysis was adjusted for smoking and asbestos exposure, supporting the hypothesis of an independent role of WF on larynx carcinogenesis [8].

The literature does not provide as much evidence about WF and GI cancers. A 1993 case-control study by Keller et al. found stomach cancer to be positively associated with WF [OR 2.11 (95% CI 1.09-4.09)], consistently with our study, while colon cancer and WF presented a negative, albeit borderline significant, association [OR 0.54 (95% CI 0.29-1.00)] [38]. In another case-control study from 1992, heavy exposure to WF was associated with primary liver cancer in men after adjusting for alcohol consumption [OR 13.5 (95% CI 2.02-88.1)] [39].

Our systematic review and meta-analysis synthesized the data provided by cohort studies on the association between HN and GI cancer and occupational exposure to WF. Our findings suggest an association between both larynx and stomach cancer

and occupational exposure to WF. However, no association could be found between WF and oral and pharynx, esophagus, colorectal, liver, or pancreas cancer. Data were too sparse to perform any further analyses, as well as to report dose-response results. Similarly, the overall meta-analyses on GI and HN cancers and WF exposure yielded no significant results, with the weak association observed for HN cancers being primarily driven by the association observed for larynx cancer.

The two studies by Pukkala et al. (2009) [15] and MacLeod et al. (2017) [19], which drive the observed association between occupational WF exposure and larynx and stomach cancer, respectively, both assessed WF exposure based on the worker's census-recorded job title, something which might have limited the sensitivity of this data. While approximately 11 million workers worldwide hold the job title of "welder", a further 110 million are estimated to be exposed to welding-related occupational activities [3]. Therefore, a potential limitation of our analysis is that some of the studies, by including those workers holding the job title of welder (and hence using the profession of a welder as a proxy for the exposure to WF), likely include just a fraction of the potential number of the workers exposed to WF in the different industries [3, 6]. This may lead to misclassifying the exposure, with some exposed workers classified as non-exposed, and therefore partially hiding the effect of the investigated risk factor on the outcomes.

A significant limitation of our analysis is the fact that none of the included studies adjusted for tobacco smoking, asbestos exposure, or other potential confounders, including dietary factors, alcohol consumption, body mass index, physical activity, as well as other occupational risk factors and certain site-specific carcinogens such as *Helicobacter pylori* (important for stomach cancer) and diabetes (important for pancreas cancer) [40–42]. Smoking, a significant risk factor for both GI and HN cancers, including larynx and stomach cancer, was reported in one study to be more common in welders than in the general population [43]. On the other hand, asbestos is a significant occupational carcinogen to which welders working in industries such as shipyards or metallurgy can be directly or indirectly exposed [6]. Next to smoking, the association between exposure to WF and HN or GI cancer could also be subject to the confounding effect of alcohol [44, 45]. A further limitation is the inability to provide dose-response results, as the census-based nature of the exposure assessment in many of the included studies left little room for quantifying the exposure. Finally, our meta-analyses only include data from European and North American countries, limiting the potential to generalize the results globally.

Despite all the aforementioned limitations, our study possesses several elements of strength. First of all, this represents, to our knowledge, the first meta-analysis on occupational exposure to WF HN and GI cancers. This analysis provides novel and valuable insights into the relationship between WF and these specific cancer types, extending the findings of a previously published meta-analysis from our research group that examined genito-urinary cancers [46]. The meta-analyses conducted to support the importance of investigating the association between occupational exposure to WF and cancers other than lung cancer [46]. Moreover, we presented data on several cancer types, two of which were found to be significantly associated with occupational WF exposure.

Additionally, our literature review was based on strict inclusion criteria to focus on relevant types of exposures, and the meta-analysis incorporated several risk estimates. Furthermore, our research was conducted following a protocol based on the state-of-the-art established guidelines, including the

quality assessment of the selected studies. We could exclude publication bias through the visual inspection of funnel plots and the Egger's tests performed, except for the liver cancer publications, which showed an asymmetry towards the right, hinting at a possible publication bias. However, it should be noted that while the p values excluded publication bias, the statistical power of Egger's test might have been limited because of the low number of studies.

Although a causal link could not be established, our results support existing evidence of an association between occupational exposure to WF and larynx cancer [8]. While this can reasonably be attributed to the lack of adjustment for smoking status, it is also plausible that fumes inhaled during welding can damage the respiratory tract during their translocation to the lungs [8, 37]. At the same time, our results support an association between WF and stomach cancer, suggesting that the aforementioned WF compounds could indeed pose a carcinogenic risk to the stomach after being inhaled and redistributed to the upper GI tract.

5. CONCLUSION

In conclusion, our systematic review and meta-analysis provide evidence of an association between occupational exposure to WF and larynx and stomach cancers and no association with other HN or GI cancers. However, the causal nature of these associations cannot be established based on available information. Our findings align with our initial hypothesis that compounds in WF known to cause lung cancer may also pose a carcinogenic risk to the upper respiratory and GI tracts, affecting areas such as the stomach.

In light of our systematic review of the existing literature, we stress the importance of further studies to be conducted to clarify the role of WF on HN and GI cancers and confirm our findings. Such studies should account for important confounders, such as smoking, alcohol drinking, and other occupational risk factors, such as asbestos exposure. They should ideally be designed to assess the level of WF exposure quantitatively. Also, it would be essential to gather data from different populations, such as those from Africa, Asia, and Oceania, to obtain

solid, generalizable results. Workers and occupational physicians should be aware of the carcinogenic potential of WF for sites other than the lungs.

DECLARATION OF INTEREST: The authors declare no conflict of interest.

AUTHOR CONTRIBUTION STATEMENT: PB and G.C. contributed to the design and implementation of the research, A.C.S., G.C., and M.H. contributed to the analysis of the results, and A.C.S. and G.C. contributed to the writing of the manuscript.

DECLARATION ON THE USE OF AI: None.

SUPPLEMENTARY MATERIAL: Figures A1-A13

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SUPPLEMENTARY MATERIAL A

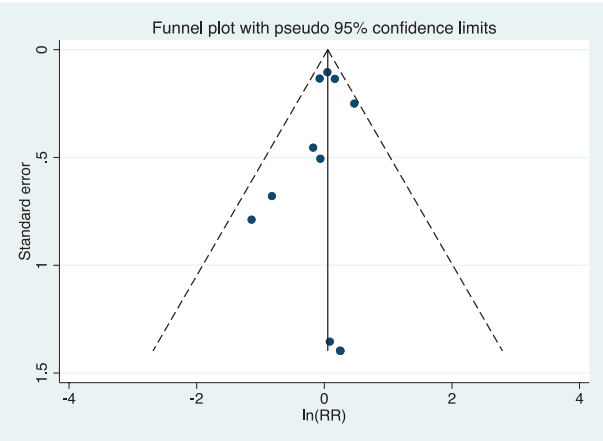


Figure A1. Funnel plot for oral and pharynx cancer.

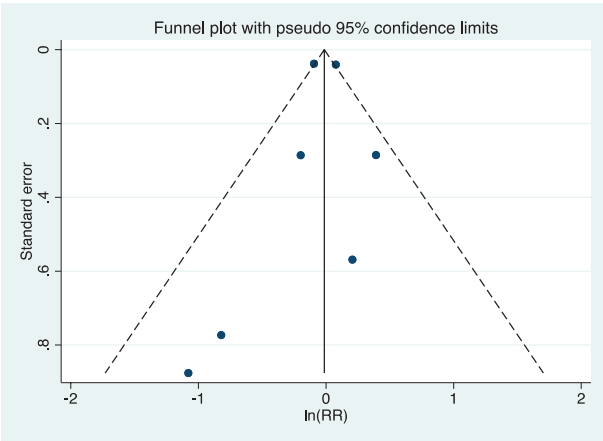


Figure A4. Funnel plot for colorectal cancer.

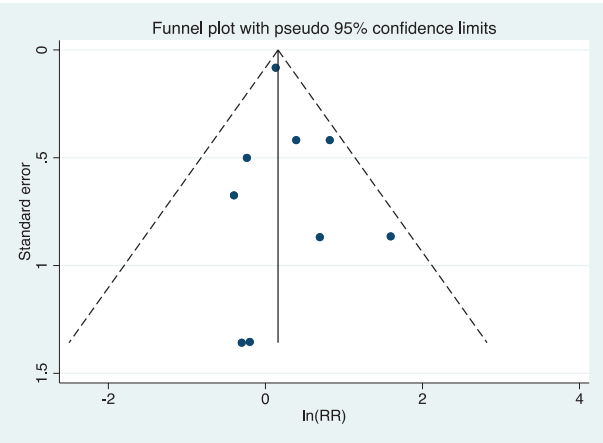


Figure A2. Funnel plot for larynx cancer.

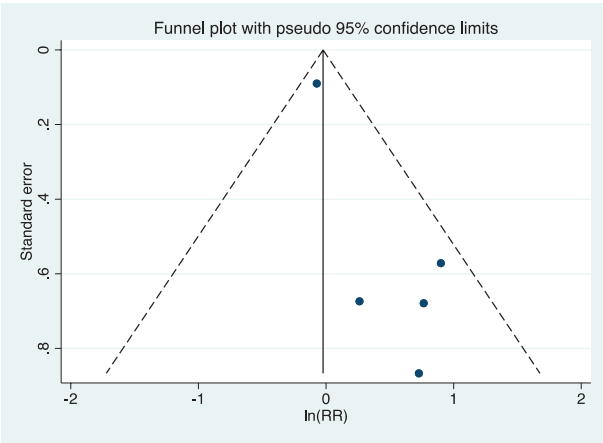


Figure A5. Funnel plot for liver cancer.

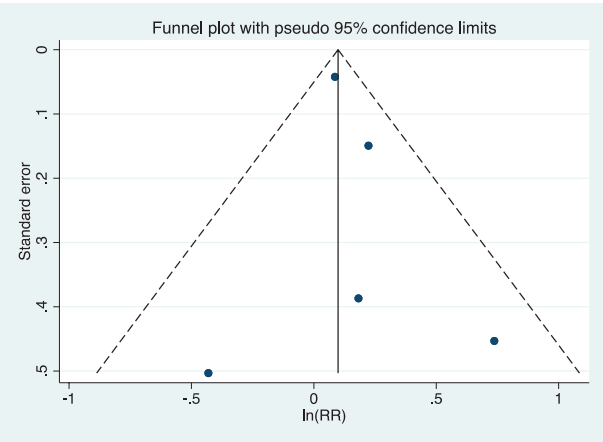


Figure A3. Funnel plot for stomach cancer.

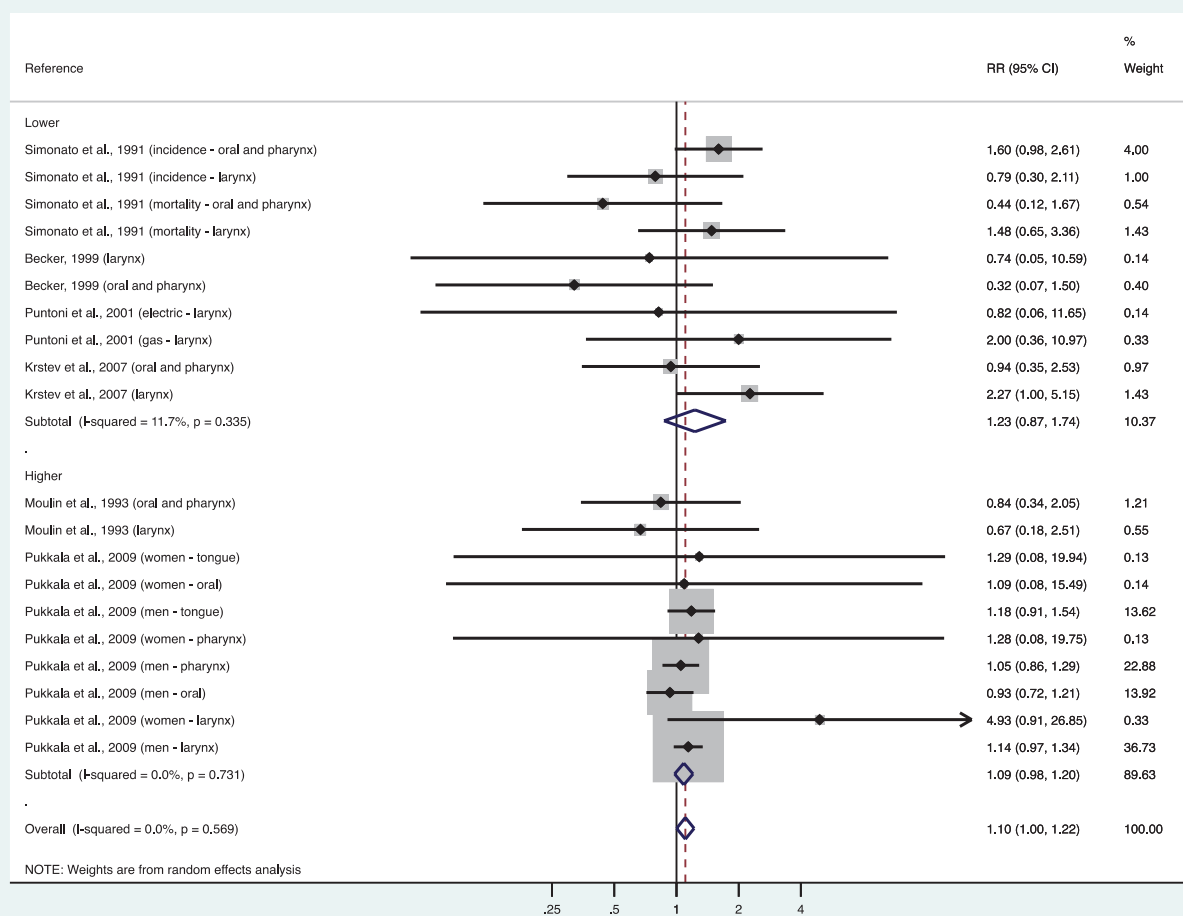


Figure A6. Stratified Analysis of HN Cancers by Study Quality.

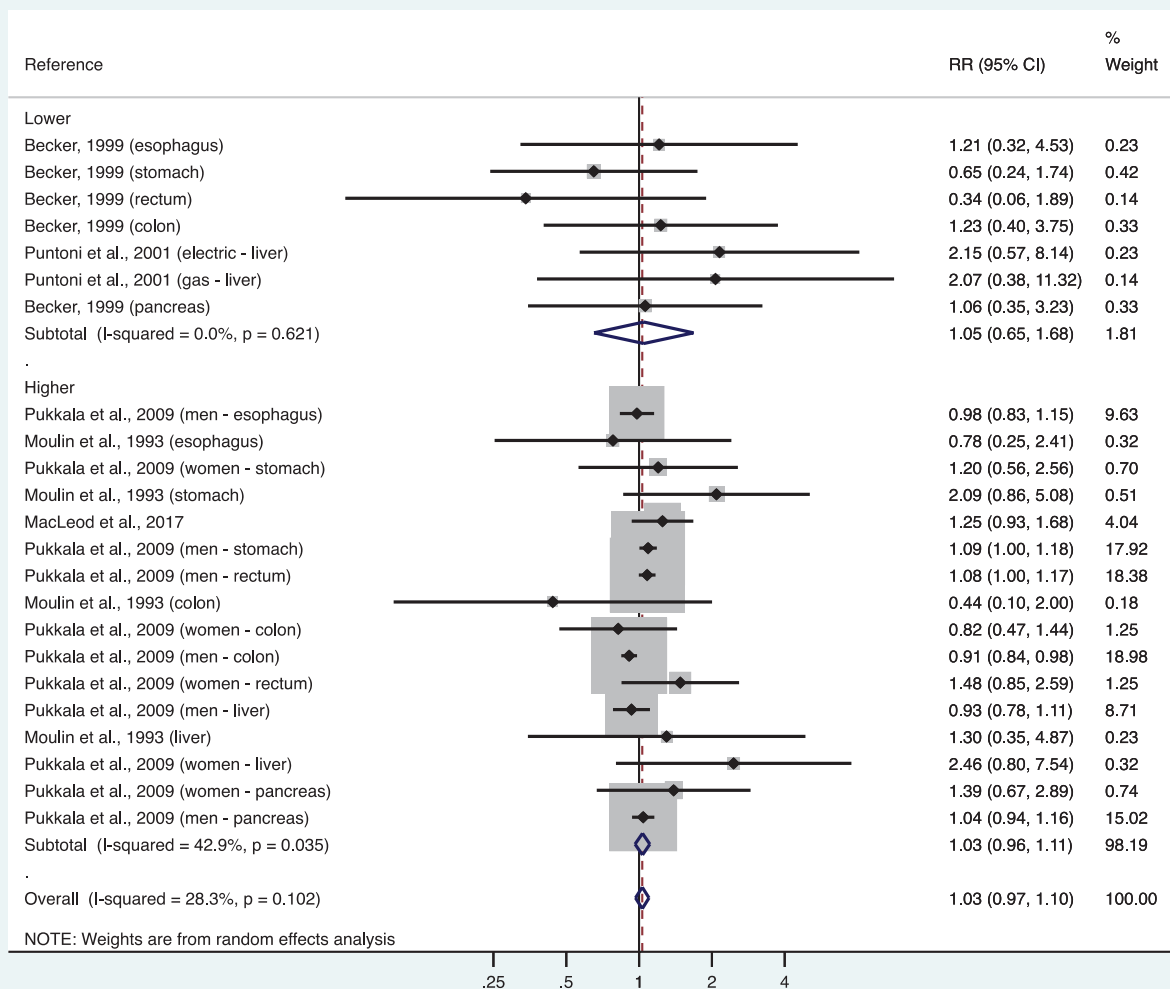


Figure A7. Stratified Analysis of GI Cancers by Study Quality.

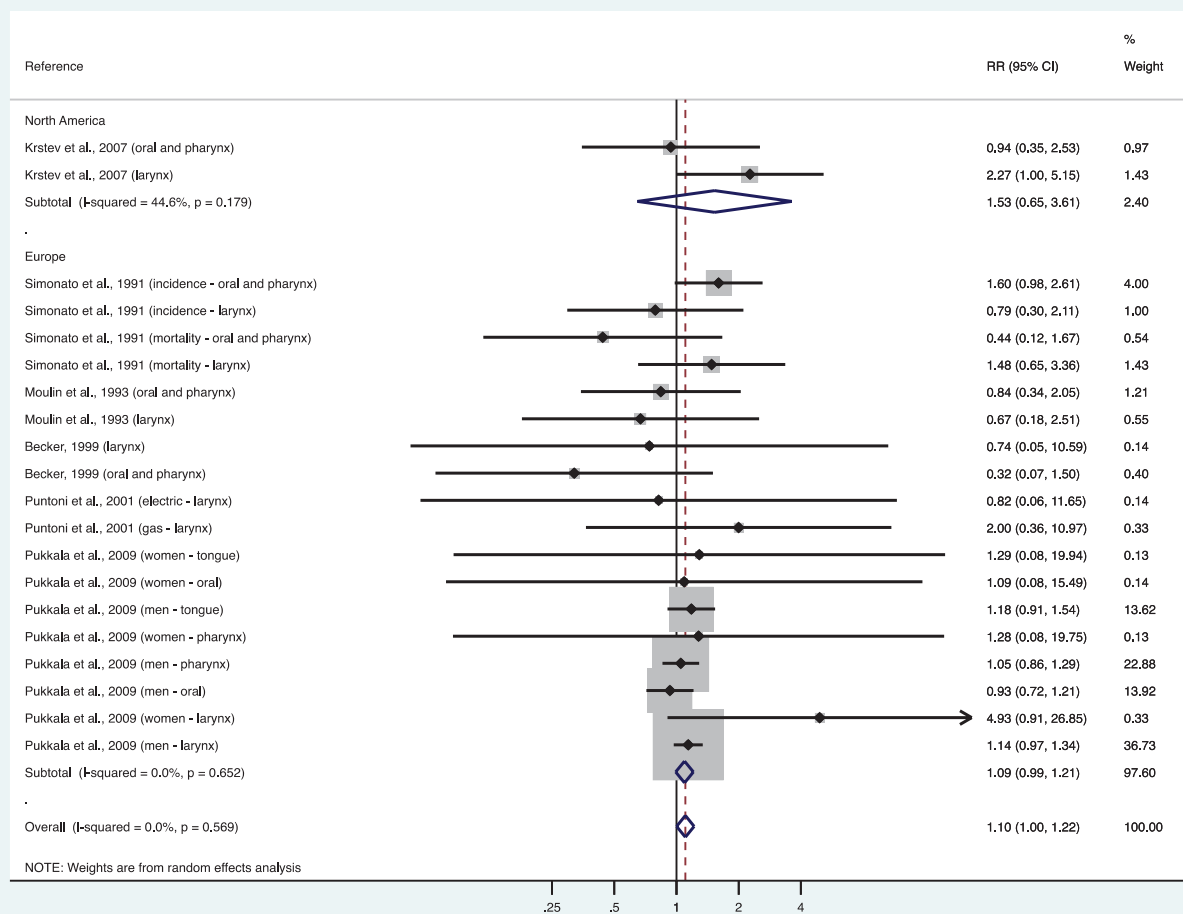


Figure A8. Stratified Analysis of HN Cancers by Geographical Region.

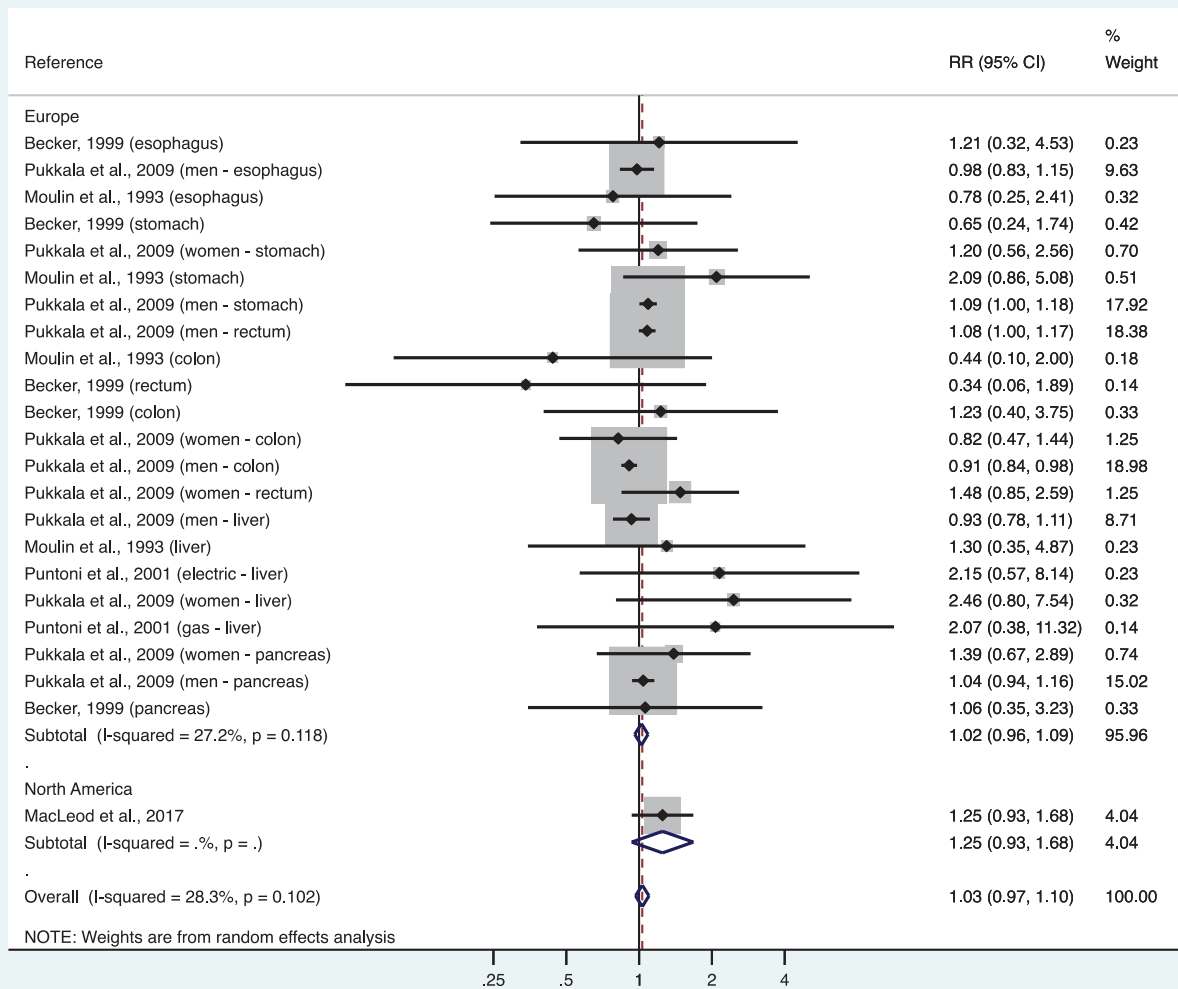


Figure A9. Stratified Analysis of GI Cancers by Geographical Region.

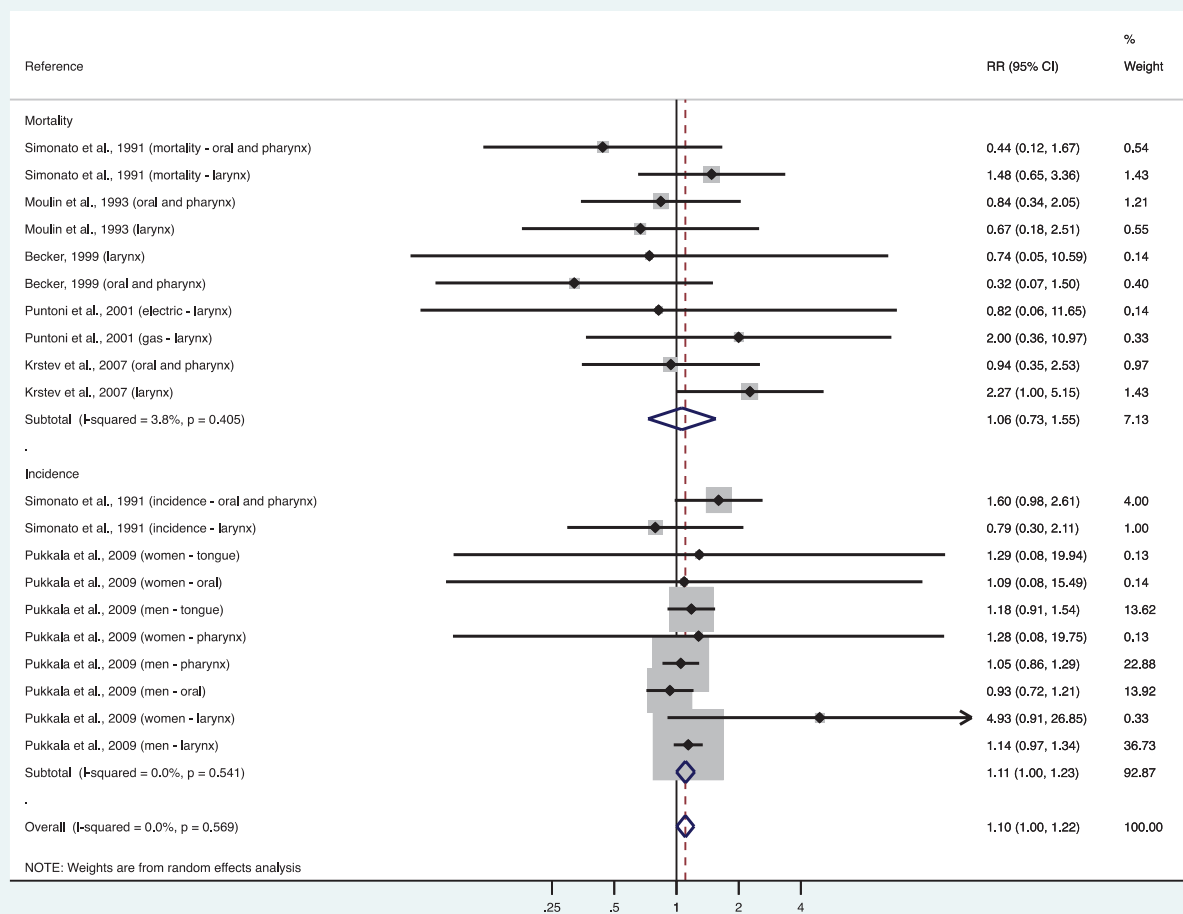


Figure A10. Stratified Analysis of HN Cancers by Type of Outcome.

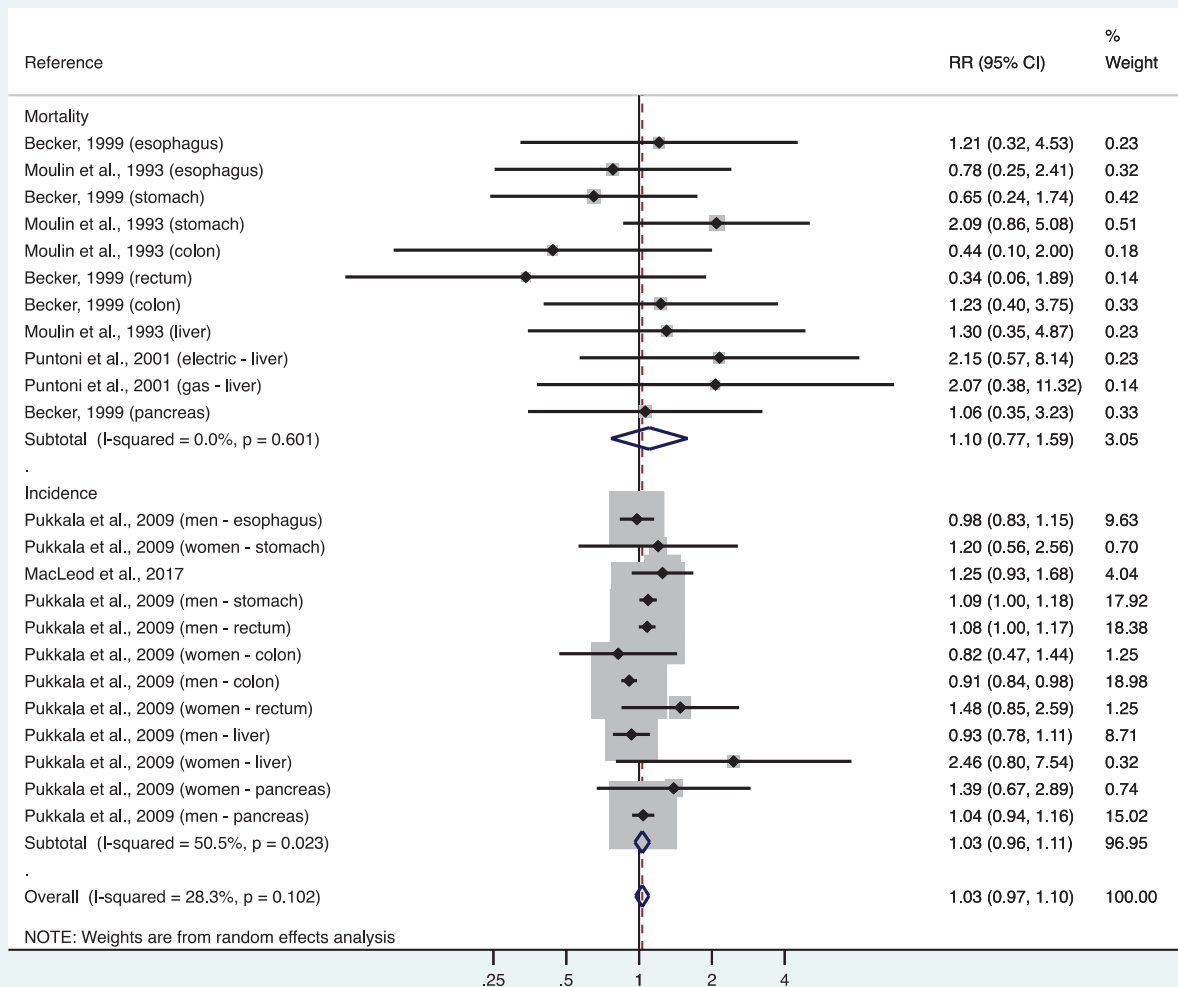


Figure A11. Stratified Analysis of GI Cancers by Type of Outcome.

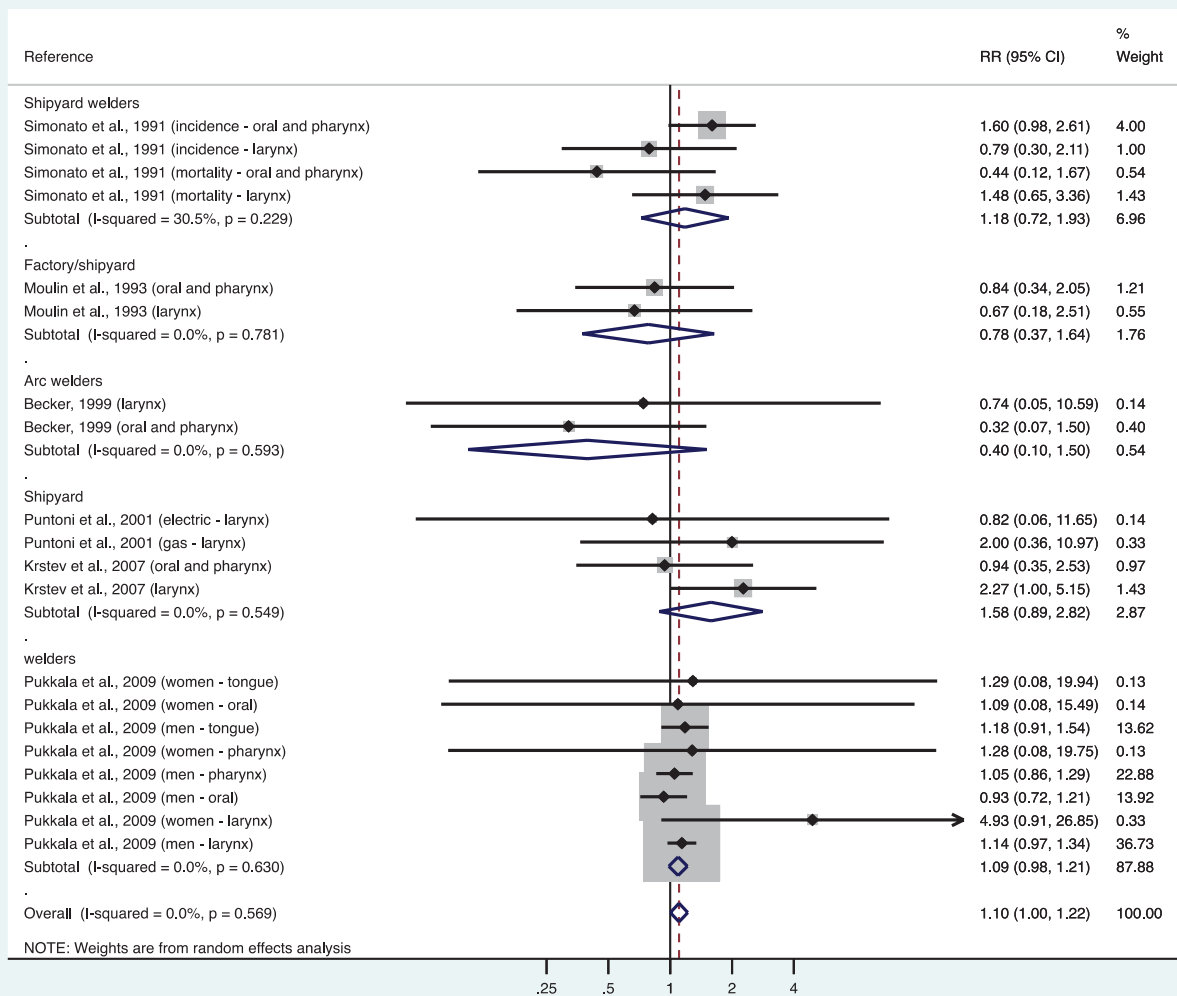


Figure A12. Stratified Analysis of HN Cancers by Industry Type.

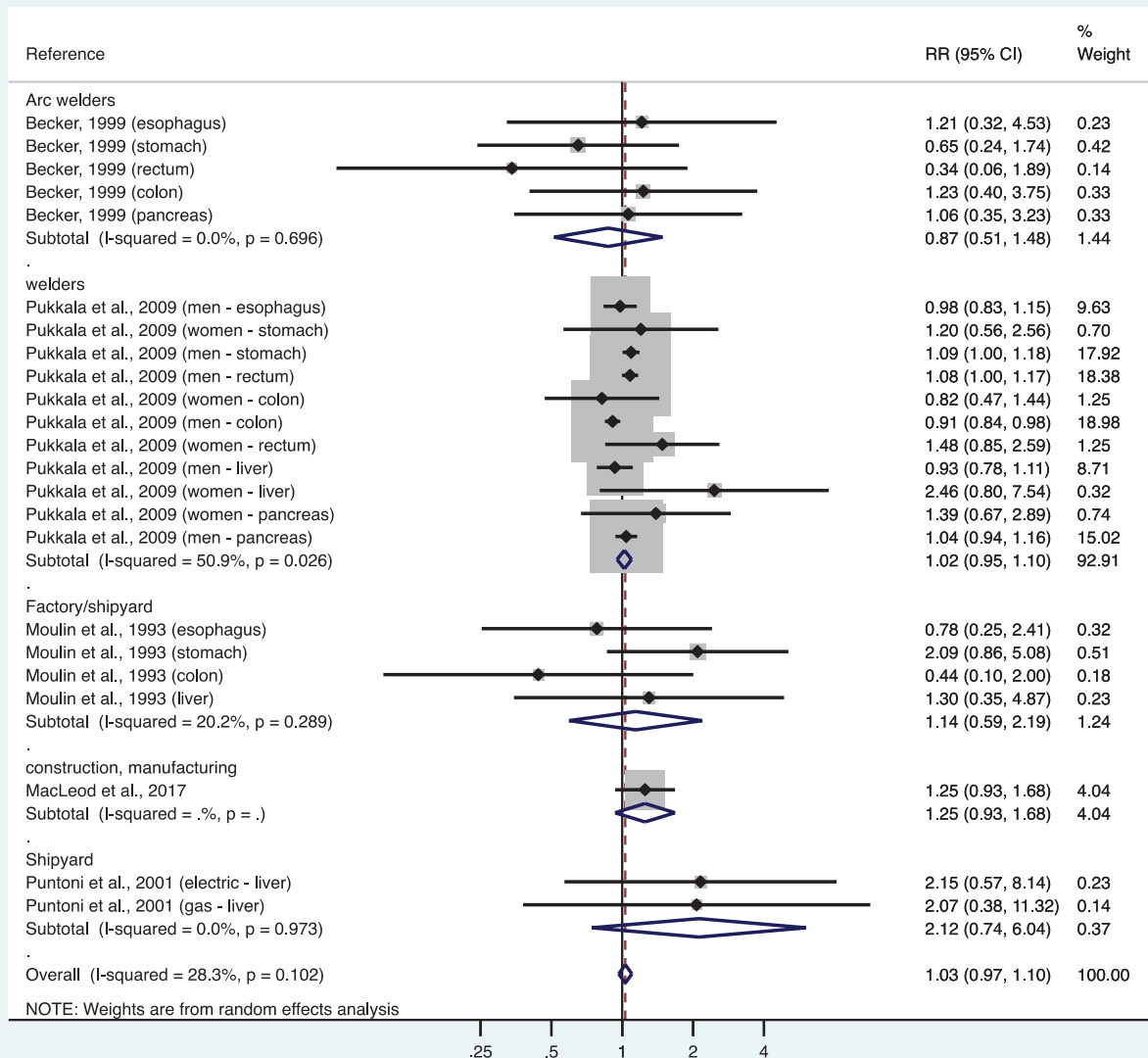


Figure A13. Stratified Analysis of GI Cancers by Industry Type.

A 7-Year Active Surveillance Experience for Occupational Lung Cancer in Bologna, Italy (2017-2023)

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KEYWORDS: Occupational Lung Cancer; Occupational Carcinogens; Active Systematic Search

ABSTRACT

Background: In Italy, lung cancer is the second most frequent neoplasm in men and the third in women. Exposure to carcinogens in workplaces plays a significant role. Still, cases attributable to occupational exposure are currently under-reported as occupational diseases: the current National Prevention Plan also encourages active research projects for the detection of cancers attributable to occupational exposure. **Methods:** The Unit of Prevention and Safety in the Workplace of Bologna Local Health Authority (Azienda Unità Sanitaria Locale-AUSL-) created a network for active surveillance of occupational lung cancer cases with the dedicated Diagnostic and Therapeutic Care Pathways (PDTA). Possible occupational exposure cases were selected within all incident PDTA cases using a self-completed patient filter form. Only patients selected through the form were interviewed; occupational physicians collected personal, occupational, and clinical history. Definition of a cooperation system with the local office of the National Institute for Insurance (INAIL) for monitoring the process during the medico-legal assessments conducted by the insurance institute up to resolution. **Results:** 453 cases completed the filter form, 177 had a potential occupational exposure. Of these, 140 accepted the direct interview with occupational physicians. One hundred eleven cases interviewed were assessed with sure or suspect occupational origin: for 82, a claim for recognition was sent to INAIL, while for the other 29 was sent to INAIL a report for epidemiological purposes. Out of 82 compensation claims, 18 individuals (4 females and 14 males) received compensation, while 4 cases remain under investigation. A total of 53 claims were rejected: 54.7% for lack of exposure to risk factors, 24.5% for insufficient exposure, 9.4% due to inadequate administrative documentation, 7.5% because of insufficient clinical documentation, and 3.8% for the absence of causal association. **Conclusions:** Several occupational lung cancers were found that otherwise would have been unrecognized. Asbestos was the most frequent agent occurring in the most widespread work sectors—construction and manufacture of metal-working products—and in the period of exposure from 1970 to 1980. Other relevant agents were welding fumes and polycyclic aromatic hydrocarbons. Active surveillance, direct patient interviews, and claims for recognition integrated by a complementary report are essential to increase the INAIL compensation rate.

1. INTRODUCTION

According to the latest estimates, lung cancer in Italy ranks as the second most common neoplasm

among men (15%, 30,000 new cases in 2023) and the third among women (6%, 14,000 new cases in 2023); mortality remains significant, though decreasing [1]. The primary risk factor is tobacco

smoking, which is attributed to approximately 80% of lung cancer cases in the Western population [2].

The proportion of cases linked to environmental and occupational factors varies over time and by location. An early estimate from 1981 [3] in the United States assigned 15% of men's cases to occupational exposure. Since then, several studies have sought to estimate the percentage of cancer cases attributable to such exposures. These studies indicate that for individuals who have historically worked in occupations involving multiple carcinogens, the percentage of lung cancer cases ranged from 2.8% to 17.3% for males and from 2% to 4% for females [4-10]. However, a consistent figure is not currently available due to variations in the types and number of carcinogens considered or known at different times, as well as difficulties in obtaining data on occupational exposure to these substances and changes in exposure conditions over time (both mode and extent) [11-16].

The most significant risks have been noted among construction and transport workers [7, 8, 11, 17, 18-19]. Construction workers are engaged in various activities and work environments that expose them to numerous carcinogens, including diesel engine exhaust, crystalline silica dust, and asbestos-containing materials. In contrast, transport workers primarily face exposure to diesel engine exhaust. This is followed by workers involved in painting activities across various sectors and by those in metal production who are exposed to multiple agents (aluminum, arsenic, beryllium, cadmium, chromium, nickel compounds, silica, and polycyclic aromatic hydrocarbons).

A problem of under-reporting is evident when comparing current estimates to the number of cancers recognized as occupational diseases by the INAIL. A significant cause for this disparity is that occupational cancers are often clinically indistinguishable from those caused by other factors. Additionally, there remains insufficient emphasis on the role of occupational hazards, and a patient's occupational history is typically not thoroughly investigated at the initial diagnosis stage. In Italy, most diagnoses of work-related illnesses are performed by occupational physicians or equivalent practitioners

(i.e., labor patronage physicians) and rarely by other types of physicians (specialists or general practitioners). Consequently, the diagnosis of work-related illnesses that arise during employment is more likely to occur with active occupational health surveillance. In the case of neoplasms, where clinical diagnoses are generally made when the patient is retired, the correlation to occupational exposure is less frequent [20-25].

Furthermore, since these conditions have a multifactorial etiology, the impact of non-work-related factors common in the population, such as smoking habits, is often overestimated at the expense of risk factors present in occupational settings. This phenomenon of under-reporting is also prevalent and studied at an international level [23-24].

To address the issue of under-reporting, the reference legislation (Article 244 of Decreto Legislativo 81/08) mandates the establishment of a registration system for cancers of occupational origin, including those with a low etiological fraction like lung cancer [18, 26-29].

The previous National Prevention Plan for 2015-2018 had already suggested the need for active regional research projects on cancers with a low etiological fraction. In this context, in 2017, Prevention and Safety in the Workplace Unit (Prevenzione e Sicurezza Ambienti di Lavoro-PSAL-) of the Bologna Local Health Authority (Azienda Unità Sanitaria Locale-AUSL-), launched a project to actively search for lung cancers due to occupational exposure by creating a collaborative network among different diagnosis and treatment hospital units, including Radiotherapy, Oncology, Pneumology, and Thoracic Surgery. This choice was driven not only by the epidemiological context (high incidence in the general population and diffusion across sectors with known lung carcinogen exposure) but also by the existence of a Diagnostic and Therapeutic Care Pathway (Percorso Diagnostico Terapeutico Assistenziale -PDTA-) for lung cancer in Bologna ASL. This project aims to outline a systematic method for identifying occupational lung cancers, improve etiological diagnosis, and increase both the quantity and quality of lung cancer cases notifications.

2. METHODS

According to the specific regional prevention plan, an initial pilot phase started in 2017, involving the PDTA staff (Radiotherapy, Oncology, Pneumology, and Thoracic Surgery Operational Units) in training on the project's purpose and methods to secure active collaboration. Several meetings with PDTA staff (physicians and nurses) supported the creation of a network that defined a practical, "low-effort" and "low-cost" reporting system.

A filter form to select cases with possible occupational exposures was developed and tested for completion by patients with the help of the trained PDTA staff. Eligible patients were identified as those diagnosed with primary lung cancer and residing in the Bologna AUSL area. The filter form consists of a list of occupational sectors, activities, or agents, from which the patient selects one or more items based on their work history, considering at least one year of work/exposure. This instrument, completed by the patients and then submitted to the PSAL occupational physicians, facilitates the selection of cases with potential occupational exposure to known or suspected lung cancer risk factors.

These selected patients are offered a direct interview to reconstruct their detailed lifetime work history, covering every job task and occupational sector, and focusing on exposure to all known or suspected lung carcinogens. Several instruments were developed for this purpose, including a general questionnaire for collecting anamnestic data, modeled after the standard questionnaires used by national surveillance systems for Mesothelioma (RENAM) and sinonasal cancer (RENATUNS), along with additional work-sector-specific sections (i.e., metalworking industry welding activities, construction, transportation, agriculture, painting activities, manufacturing of rubber and plastics products, foundries, etc.).

In cases of incomplete or questionable filter forms, it was decided to contact the patient by telephone to confirm whether the case should be excluded. For all enrolled cases with occupational exposure at companies within the Bologna ASL area, a thorough search for documentation in the PSAL archives was

conducted. Available industrial hygiene data, safety data sheets, risk assessment documents, and environmental surveys were utilized to evaluate exposure. During the interview, particular emphasis was placed on smoking habits, reconstructed according to the WHO definition.

At the end of the assessment and reconstruction, a compensation claim was sent to INAIL, accompanied by an additional report written by PSAL occupational physicians for cases identified as possibly occupational in origin. According to national legislation, the directly interested party must sign the compensation claim. If a patient refuses, only the epidemiological report is sent in accordance with the relevant legislation (Article 139 of DPR 1124/65).

A useful collaboration was then established with the INAIL local office through periodic meetings between ASL and INAIL physicians to discuss cases, monitor the outcomes of the claims, and analyze the causes of positive or negative INAIL responses.

3. RESULTS

A total of 507 completed filter forms were received between 2017 and 2023. At an initial check, 54 forms were directly excluded due to sending errors (subjects not resident in the ASL area or an unconfirmed diagnosis) and were not enrolled. The remaining 453 reports of lung cancer (206 women and 247 men) were then assessed, representing approximately 28% of the cases occurring in the region and under the care of the PDTA.

An analysis of the filter forms revealed that 177 patients had a potential occupational origin to be investigated, of whom 147 were men and 30 were women. Of these, 79% (140 patients) accepted the direct interview.

Table 1 describes the demographic profile, smoking habits, and histotypes found for the total number of patients interviewed (Group 1) and for the group of subjects for whom occupational origin was confirmed by PSAL occupational physicians (Group 2).

The 60-69 and 70-79 age groups represent 70% of both Group 1 and Group 2, with a prevalence

Table 1. Cases Distribution: interviewed and work correlated by gender, age, cigarette smoking, cigarette pack-years, lung cancer morphology.

Characteristic	Interviewed participants						Work Related Cases					
	women		men		total		women		men		total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	24	100	116	100	140	100	11	100	100	100	111	100
Age												
40-49	1	4.2	2	1.7	3	2.1	0	0.0	2	2.0	2	1.8
50-59	3	12.5	16	13.8	19	13.6	1	9.1	13	13.0	14	12.6
60-69	11	45.8	28	24.1	39	27.9	7	63.6	25	25.0	32	28.8
70-79	7	29.2	52	44.8	59	42.1	2	18.2	44	44.0	46	41.4
80-89	2	8.3	18	15.5	20	14.3	1	9.1	16	16.0	17	15.3
Cigarette smoking												
never	7	29.2	6	5.2	13	9.3	3	27.3	5	5.0	8	7.2
quit	6	25.0	66	56.9	72	51.4	2	18.2	56	56.0	58	52.3
current	11	45.8	44	37.9	55	39.3	6	54.5	39	39.0	45	40.5
Cigarette pack years												
0 (no smoker)	6	25.0	6	5.2	12	8.6	3	27.3	5	5.0	8	7.2
< 20	2	8.3	11	9.5	13	9.3	1	9.1	10	10.0	11	9.9
21-40	10	41.7	37	31.9	47	33.6	6	54.5	30	30.0	36	32.4
41-60	5	20.8	37	31.9	42	30.0	1	9.1	35	35.0	36	32.4
>60	1	4.2	18	15.5	19	13.6	0	0.0	14	14.0	14	12.6
missing	0	0.0	7	6.0	7	5.0	0	0.0	6	6.0	6	5.4
lung cancer morphology												
adenocarcinoma	15	62.5	66	56.9	81	57.9	7	63.6	56	56.0	63	56.8
squamous cell carcinoma	0	0.0	14	12.1	14	10.0	0	0.0	14	14.0	14	12.6
small cell carcinoma	2	8.3	4	3.4	6	4.3	1	9.1	3	3.0	4	3.6
neuroendocrine carcinoma	4	16.7	13	11.2	17	12.1	1	9.1	11	11.0	12	10.8
others	0	0.0	2	1.7	2	1.4	0	0.0	2	2.0	2	1.8
only imaging	3	12.5	17	14.7	20	14.3	2	18.2	14	14.0	16	14.4

of the 70-79 age group in males and the 60-69 age group in females.

For the quantification of smoking exposure, packs per year were used as a synthetic indicator of duration, number of years, and number of cigarettes smoked over a lifetime. Since packs per year represent a continuous variable, it was decided to divide the smoking habits into four classes, fully aware of

the fact that there is no exposure below which the risk of developing a neoplasm can be considered zero.

The most prevalent histological type was adenocarcinoma in both women and men, in line with literature data identifying it as the most common malignancy of the lung, both in the general population and among those of occupational origin. The

Table 2. Cases work-related: distribution of occupational cases by industry sector/activity, gender, and type of medico-legal measure for INAIL.

Economic Activity sector	Claim for compensation (No.)			Epidemiologic surveillance (No.)			Total
	F	M	Total	F	M	Total	
Metalworking industry	2	25	27	0	9	9	36
Construction	0	22	22	0	8	8	30
Transport	0	11	11	0	5	5	16
Services	1	5	6	0	4	4	10
Manufacture of rubber and plastics products	2	2	4	1	0	1	5
Chemistry	0	3	3	0	0	0	3
Manufacture of glass and pottery	2	1	3	0	0	0	3
Agriculture	1	0	1	0	2	2	3
Communications	0	2	2	0	0	0	2
Printing, publishing	0	1	1	0	0	0	1
Wood or wood products	1	0	1	0	0	0	1
Food manufacturing	1	0	1	0	0	0	1
TOTAL	10	72	82	1	28	29	111

category “others” includes one atypical carcinoid and one poorly differentiated carcinoma. We defined “only imaging” cases without histological definition due to age and/or clinical condition.

Through the interview and documentary research, 111 of the 140 patients interviewed, corresponding to about 80%, were considered to be occupationally exposed to certain or suspected lung cancer risk factors. Of these cases, 82 (74%) had the INAIL compensation claim drawn up. For the remaining 29 (of whom only one was a woman), a report was sent for epidemiological purposes (Article 139 of DPR).

Table 2 illustrates the distribution of occupational cases by industry sector/activity, gender, and type of medico-legal measure. The majority of cases were found to have worked in several sectors with possible exposure to lung carcinogenic agents; however, it was decided to consider the prevalent work sector using duration (the longest of those exceeding one year), the number of agents, and latency congruity (at least 10 years) according to the type of agent as criteria for the attribution of the causal link.

In calculating the duration, periods of work at different companies were also added if they belonged to the same work sector. Considering the total number

of cases, the most frequently represented sector is metalworking, followed by construction and transport. The patients in the latter two sectors are all male. Only one apparently anomalous case from the food sector emerged: it is represented by a woman who worked in a sugar refinery as an oiler, a job that involved activities in all departments, resulting in exposure to asbestos.

Table 3 reports the occupational carcinogens to which the group of 82 patients with claims for compensation was exposed. As multiple occupational exposures were found for almost all the patients in this group, data by individual agent have been reported to highlight those that are the most frequent. Asbestos appears to be the most represented agent and is also the most widespread in various sectors, followed by PAHs, silica, and welding fumes. The asbestos exposure was generally detected by documents from PSAL archives or by referring to evidence from the literature for specific work sectors.

Of the 82 cases with claims for compensation, 18 (4 females and 14 males) have been compensated by the Institute; four cases, sent at the end of 2023, are still under investigation. The periodic meeting

Table 3. Cases work correlated: occupational carcinogens by economic activity sector.

Economic activity sectors	Occupational Carcinogens													Coal tar pitch insecticides	
	Asbestos	PAHs	Silica dust	Welding fumes	Diesel Exhaust	Paintings	Cr(VI) compounds	Rubber	Cadmium	Nickel	Arsenic			Non-As	
Construction	19	9	17	10	5	7	6	0	0	0	0	0	1	0	
Metalworking industry	12	13	7	12	6	7	8	0	1	1	0	0	0	0	
Transport	7	2	1	2	9	0	0	0	0	0	0	0	0	0	
Manufacture of rubber and plastics products	2	2	1	1	0	1	0	3	0	0	1	1	1	0	
Agriculture	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
Chemistry	1	1	0	0	1	0	0	0	0	0	1	0	0	0	
Manufacture of glass and pottery	1	1	2	0	1	1	0	0	1	0	0	0	0	0	
Services	4	1	1	1	1	0	1	0	0	1	0	0	0	0	
Communications	1	1	0	2	1	0	0	0	0	0	0	0	0	0	
Food manufacturing	1	1	0	0	0	0	0	0	0	0	0	0	0	0	
Wood or wood products	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
Printing, publishing	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL	49	31	29	28	25	17	15	3	2	2	2	2	2	1	

held with INAIL physicians enabled the exchange of information on the compensated cases (Table 4) and the reasons for the rejection of those adversely defined (Table 5). The INAIL compensation scheme follows procedures for causal attribution that differ from ours due to differing INAIL purposes using appraisal systems[23]. INAIL applies medico-legal criteria that require the correlation to be documented with a high degree of certainty. For this reason, when we made a compensation claim, we did not give the patient too many expectations on INAIL recognition, especially in cases without additional evidence.

To evaluate the impact of our active research on the underreporting, it is currently possible to analyze the INAIL data, taking into account the cases of malignant lung cancer (ICDC34) reported, defined, and approved in the 2014-2022 period for the INAIL office in the AUSL Bologna. Comparing the number of reported and defined cases during the project activity period (2018-2022, not considering 2020 influenced by the COVID-19 pandemic) with those of the previous period (2014-2017), there is an increase in reported and defined cases of about 3 times. However, the impact is less significant when considering the percentage of recognized instances, which has increased from 31.6% to 33.8%. Overall, interesting data emerges in relation to the female gender using INAIL open data for the period 2018-2022: out of the total of 14 cases reported and defined at the regional level, 100% were reported by our Operating Unit, and of these, six have been accepted.

However, the main reason for rejection remains the absence of reliable documentation on exposure for each worker (55%). The long latency period between the time of exposure to the risk and the cancer diagnosis results in many companies having been closed or significantly changed. The second reason (25%) concerns the assessment of exposure as “not sufficient.” This conclusion is often linked to the absence of exposure measures relating to the reported working periods (not provided for by the legislation in force at the time), or, in the case of companies that still exist, only to the availability of current or recent exposure measures (presumably lower than past exposures).

4. DISCUSSION

Concerning the objective of contributing to knowledge on contexts and activities that expose people to carcinogens in the workplace, it should be borne in mind that in Italy, the majority of occupational carcinogens recognized in the literature as being associated with lung cancer are included in the list of occupational diseases in industry and agriculture (approved by law, the most recent revision is contained in the *Decreto Ministeriale* 10/10/2023), on which the insurance institute relies for the attribution of the percentage of biological damage and possible compensation.

Asbestos was the predominant exposure factor, consistent with the most frequent local work sectors, that is, the manufacture of metalworking products and construction, as well as the periods of exposure between 1970 and 1980. This finding is also consistent with the data in the literature [11, 17, 18, 23-25, 34]. Other relevant agents that have emerged are welding fumes and polycyclic aromatic hydrocarbons. This is in line with several studies currently available in the literature, taking into account the variability of the agents and periods considered by the different authors and, particularly for welding fumes, updates in the evidence of carcinogenicity over the years [8, 11, 12]. In our assessments, exposure to specific agents not included in the list (such as exposure to diesel fumes and gases or crystalline silica) was also identified as a contributory cause of illness in some cases, as it is well established in the literature [12, 35, 36] and incorporated into current occupational health and safety legislation.

However, even for agents not included in the list used by INAIL, it is of significant importance to submit certificates or reports for epidemiological purposes to raise awareness of possible effects due to exposure and for these substances to be evaluated by the technical-scientific committees when the tables are revised.

In our case history, the transmission of the claim of recognition has always been advocated, even if this was only for conceivable exposures or for non-listed carcinogens. However, in the latter instances, patients often preferred to forego the INAIL certificate, resulting in a higher frequency of reporting

Table 4. INAIL Compensated cases: occupational carcinogens by economic activity sector.

Economic activity sectors	Carcinogens												
	Asbestos	PAHs	Silica dust	Welding fumes	Diesel Exhaust	Paintings compounds	Cr(VI)	Rubber	Cadmium	Nickel	Arsenic	Coal tar pitch	Non-As insticides
Metalworking industry	1	3		2	1	1	3			2			
Construction	5	1	1	1		2	1						
Transport	1	1			2								
Manufacture of glass and pottery					1								
Manufacture of rubber and plastics products								1					
Services	1												
Total	8	5	1	3	4	4	4	1	0	2	0	0	0

Table 5. INAIL denied case: motivations for rejection.

	N.	%
Lack of exposure to risk	29	54.7
Insufficient exposure to risk	13	24.5
Insufficient administrative documentation	5	9.4
Insufficient clinical documentation*, histological type **	4	7.5
Lack of causal association	2	3.8
Total	53	100

* Cases without histological definition.

** Two neuroendocrine tumors that INAIL did not consider related to asbestos exposure.

for epidemiological purposes (Art. 139 of DPR 1124/1965).

Our estimate of the fraction of lung cancer attributable to occupational exposure over the 2017-2023 period was 6.2%, which is within the range of the most recent estimates for lung cancer [3-9]. However, it should be noted that, over the years, the percentage of reported lung cancer cases was not consistent, equivalent to an average of about 28% of the cases treated.

This experience has further confirmed that the region and the period of analysis must always be taken into account when evaluating estimates of the attributable fraction with reference to the various occupational sectors and occupational risk factors compared with the rates of recognition of occupational disease by the INAIL. There are regional specificities in terms of industries.

With regard to the objective of contributing knowledge about contexts and activities that expose people to carcinogens in the workplace, the data must be considered to be strongly influenced by the area's production characteristics.

The metalworking sector is the most represented for occupational male cases, followed by construction and transport. For women, it is more difficult to discern a prevalent sector since the number of cases is low: one or at most two cases (glass-ceramic processing and research) per sector. It should be noted that none of the women worked in the construction sector or in the other prevalent sectors for males.

The job tasks were found to be very diversified. However, among males, welders and machine-tool operators emerged as numerically prevalent in the metalworking sector. In the construction industry, bricklayers were predominant, followed by transport drivers. There is no prevalent distribution by specific job type among females. However, the cases are evenly distributed over various jobs, with just 1 or 2 individuals per type (glass ceramic worker).

Asbestos was the most represented carcinogen identified, which aligns with the occupational sectors that emerged as prevalent (construction and manufacture of metalworking products) and the working periods concerned (mainly the 1970-1980 period). Exposure to silica, the leading agent in the construction sector, followed asbestos in importance. Welding fumes and polycyclic aromatic hydrocarbons, present in numerous industries and occupational exposures, were other numerically relevant agents.

This experience represents an example of an active search for occupational lung cancer, and it seemed to have several strengths and positive effects:

- The construction of a network between PSAL occupational physicians and staff of the oncological treatment hospital units (Radiotherapy, Oncology, Pneumology, and Thoracic Surgery) involved the latter in information/training sessions and in sharing the Pilot Project and survey instruments (selection and enrolment criteria and tools, procedures, and survey questionnaires).
- The methodology employed facilitated the efficient selection of only those cases of suspect occupational origin, avoiding the misuse of resources to contact all cases. After applying the filter, only 35% of the cases were deemed appropriate for further investigation. The occupational origin was subsequently confirmed in 70% of respondent cases.
- The impact on the number of occupational lung cancer reported to INAIL increased by about 3 times.
- The ability to conduct direct interviews with workers and the additional information obtained from the PSAL archives enabled the

generation of supplementary reporting crucial in documenting exposure and facilitating acceptance and compensation by the INAIL.

- Cooperation with INAIL physicians was useful for monitoring the process from the medico-legal assessments conducted by the insurance institute to resolution.

A criticism is undoubtedly the inconstancy of the reporting flows activated and consolidated over the years and the need to activate further channels to recover, including from other hospital facilities, the totality of cases occurring in our region. In fact, due to staff shortages and/or organizational difficulties, there were some disruptions or reductions in the sending of filter forms, which were dealt with by organizing periodic updates both within the PSAL and with the departments involved.

The assessment of the causes of rejection by INAIL highlights the need to maintain a strong focus on past exposures but, even more so, to document and monitor those currently in progress. Finally, given the overall validity of the project, plans are also being made to extend it to other cancers, particularly bladder cancer.

5. CONCLUSIONS

The implementation of active surveillance for occupational lung cancer (LC) has proven to be both effective and efficient; a significant number of cases were identified that would otherwise have been overlooked. Asbestos emerged as the most common exposure factor, followed by welding fumes and polycyclic aromatic hydrocarbons.

A systematic approach, grounded in multidisciplinary collaboration among occupational physicians and hospital departments involved in lung cancer diagnosis and treatment, coupled with direct patient interviews and cooperation with INAIL, highlights a best practice that effectively minimizes the underreporting of occupational lung cancer.

SUPPLEMENTARY MATERIALS: The following are available online: Occupations and exposures of INAIL compensated cases; Filter form and examples of work-sector specific sections questionnaires; table describing INAIL compensated cases.

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INFORMED CONSENT STATEMENT: Informed consent was obtained from all subjects involved in the study.

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DECLARATION OF INTEREST: The authors declare no conflict of interest.

DECLARATION ON THE USE OF AI: None.

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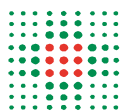
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SUPPLEMENTARY MATERIAL

Occupations and exposures of INAIL compensated cases

Work tasks	Exposures defined by INAIL	Availability of documentation in PSAL archive
Welder	Nickel, chromium, welding fumes	Not available (literature data)
Metalworker / machine tool operator	PAHs, Formaldehyde, Nitrites, N-Nitrosylenediamine, Tetrachloroethylene, Beryllium	Not available (literature data)
Water and gas network maintenance worker	Asbestos	Available
Welder and painter	Dust, mineral oils, lead, paints, welding fumes, inorganic compounds, asbestos	Not available (literature data)
Painter in construction	Painting and asbestos	Not available (literature data)
Plastic molding worker	Rubber processing in vulcanization activities	Not available (literature data)
Metalworker / machine tool operator	Toluene and PAHs	Available
Plumber in construction	Asbestos, welding fumes, tar fumes, lead paint, strong acids	Not available (literature data)
Construction worker and transporter	Probable exposure to PAHs, fuels, asbestos exposure not excluded	Available
Wood worker (furniture)	Wood dust, formaldehyde and paints	Available
Warehouse worker	Diesel exhaust	Available
Metalworker / machine tool operator	Nickel, chromium, asbestos, PAHs	Not available (literature data)
Welder	Welding fumes, chromium VI, PAHs	Not available (literature data)
Barman at railway rolling stock repair company	Asbestos (environmental exposure)	Available
Chrome plating worker	Chromium VI	Not available (literature data)
Metalworker / machine tool operator	Diesel exhaust and PAHs	Available
Construction worker	Asbestos, chromium, crystalline silica	Not available (literature data)
Toll booth attendant on the highway	Diesel exhaust (higher exposure than the general population)	Not available (literature data)



Dipartimento di Sanità Pubblica
Unità Operativa Prevenzione Sicurezza Ambienti di Lavoro (SC)

Progetto: EMERSIONE E RICERCA ATTIVA DI SOSPETTE PATOLOGIE OCCUPAZIONALI

SCHEDA SEGNALAZIONE CASI

Ambulatorio/reparto _____	Med/Op.Sanitario _____
Disposto Ricovero c/o _____	

Cognome _____ Nome _____ Nato il _____

Residente a _____ Recapito tel. _____

Familiare da contattare _____ tel. _____

Sez. A) Ha lavorato in produzione (come operaio /impiegato tecnico) per almeno 1 anno complessivamente, in uno dei seguenti settori /comparti produttivi?

Siderurgico/ metallurgico/metalmecanico	SI ☐	NO ☐
Trattamento superficiale metalli (Galvanica e altro)	SI ☐	NO ☐
Riparazione/demolizioni veicoli/garage	SI ☐	NO ☐
Costruzione/Riparazione veicoli ferroviari	SI ☐	NO ☐
Cantieristica navale	SI ☐	NO ☐
Edilizia o produzione manufatti per edilizia	SI ☐	NO ☐
Rimozione materiali contenenti amianto	SI ☐	NO ☐
Industria cemento amianto	SI ☐	NO ☐
Industria mineraria o estrattiva	SI ☐	NO ☐
Industria Chimica	SI ☐	NO ☐
Produzione o lavorazione Gomma-Plastiche	SI ☐	NO ☐
Produzione/lavoraz. tessuti o Concia pelli	SI ☐	NO ☐
Agricoltura	SI ☐	NO ☐
Trasporti	SI ☐	NO ☐
Altro ☐ specificare settore e mansione _____		

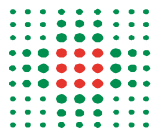
Sez. B) Durante la sua vita lavorativa:

- ☐ è stato esposto ad AMIANTO? SI ☐ NO ☐ Non so ☐
- ☐ è stato esposto a Radiazioni ionizzanti? SI ☐ NO ☐ Non so ☐
- ☐ è stato esposto a SILICE? SI ☐ NO ☐ Non so ☐ (Ha la silicosi? SI ☐ NO ☐)
- ☐ è stato esposto a OLI MINERALI (Idrocarburi Policiclici Aromatici)? SI ☐ NO ☐ Non so ☐
- ☐ ha svolto attività di saldatura? SI ☐ NO ☐
- ☐ ha svolto attività di verniciatura? SI ☐ NO ☐
- ☐ è stato esposto a fibre ceramiche? SI ☐ NO ☐
- ☐ è stato esposto a gas di scarico di motori diesel? SI ☐ NO ☐ Non so ☐
- ☐ è stato esposto a Radon? SI ☐ NO ☐ Non so ☐

sez.C) Abitudine al FUMO: Sì, FUMO ☐ Ho fumato IN PASSATO ☐ NON HO MAI FUMATO ☐
☐ esposizione a FUMO PASSIVO

Sono stato informato delle finalità della presente raccolta anamnestica ed esprimo il consenso ad essere contattato telefonicamente da parte del Servizio Prevenzione Sicurezza Ambienti di Lavoro (PSAL) dell'Azienda USL destinataria di tale comunicazione

Data compilazione _____ firma _____



SCHEDA n. 2- COMPARTO LAVORAZIONE METALLI

A.Tipo di produzione/prodotti finiti _____

B. Metalli utilizzati

Rame ☐ Bronzo ☐ Ottone ☐ Alluminio ☐ Piombo ☐ Ghisa ☐ Acciaio ☐ Acciai speciali ☐ Acciaio inox ☐ Metalli cromati ☐ Altro ☐
(specificare) _____
Leghe specifiche (contenenti *cadmio*) ☐ Leghe di alluminio ☐ Leghe di rame ☐ Leghe di nichel ☐ Leghe d'oro bianco ☐
Altro ☐ (specificare) _____

C. Operazioni/lavorazioni cui era addetto

Operazioni/lavorazioni svolte	Se SI, in quali ditte o periodi?	Con quale frequenza?	Per quanto tempo complessivamente (mesi o anni)	NOTE su PRESENZA PROTEZIONI Aspirazione postaz/attrezzature Utilizzo DPI vie respiratorie
Lavorazioni a secco (molatura, levigatura, foratura, etc.) ☐		Occasionale ☐ Più volte al mese/anno ☐ Una/più volte al giorno ☐		
Lavorazioni con fluidi da taglio* ☐ Fresatura ☐ Tornitura ☐ Trapanatura ☐ Altro _____ _____		Occasionale ☐ Più volte al mese/anno ☐ Una/più volte al giorno ☐		

Manutenzione impianti ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Manutenzione macchine, attrezzature e strumenti ☐		Occasionale ☐ Più volte al mese/anno ☐ Una/più volte al giorno ☐		
Altri compiti (specificare) _____ _____ _____		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		

* Tipo di lubrificanti utilizzati: olii interi/ emulsionati e NOTE sulla presenza di nebbie nei locali ecc. _____

D. Esposizione diretta a materiali/sostanze e/o esposizione indiretta da fattori organizzativi.

1. Durante il lavoro ha usato o è venuto a contatto con:

amianto in fiocchi ☐; materiali contenenti amianto ☐; lane /fibre minerali ☐; solventi ☐; vernici ☐; abrasivi ☐; silice ☐ agenti fisici/radiazioni ☐
 Altro ☐ (specificare) _____

2. La sua esposizione alle sostanze/materiali di cui sopra è stata determinata/favorita da:

ambienti comunicanti ☐; lavorazioni di altri (ad es. sull'amianto o con amianto) in locali non separati ☐; organizzazione del lavoro ☐; assenza di misure di prevenzione e DPI ☐

Descrizione _____

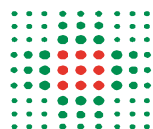
3. Ha mai sagomato, applicato o rimosso materiale isolante di cui non conosce la composizione? SI ☐ NO ☐

Se sì, descriva i materiali e/o indichi il nome commerciale e i tempi complessivi di utilizzo _____

4. Effettuava operazioni di pulizia dei locali e/o degli strumenti? SI ☐ NO ☐ Utilizzava aria compressa? SI ☐ NO ☐

Se sì con che modalità? _____

[illegible]



SCHEDA n°11- CIRCOSTANZA LAVORATIVA: **SALDATURA**

A. Tipologia metalli oggetto di saldatura e utilizzati:

Rame ☐ Bronzo ☐ Ottone ☐ Alluminio ☐ Stagno ☐ Ghisa/Ferro ☐ Acciaio ☐ Acciai speciali ☐ Acciaio inox ☐
Metalli cromati ☐ Leghe di alluminio ☐ Leghe di rame ☐ Leghe di nichel ☐ Leghe specifiche ☐ _____
Altro ☐ (specificare) _____

B. Operazioni/lavorazioni cui è stato addetto

Operazioni/lavorazioni svolte	Se SI, in quali ditte e in quali periodi ?	Con quale frequenza?	Per quanto tempo complessivamente (mesi o anni)	NOTE su PRESENZA PROTEZIONI Aspirazione postazione /su attrezzature Utilizzo DPI vie respiratorie ecc
Preparazione e manutenzione delle attrezzature, in particolare rettifica degli elettrodi ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Saldatura ad arco elettrico ☐ A filo MIG ☐ A filo MAG ☐ A elettrodo rivestito ☐ Altro ☐ _____ _____		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		

Saldatura a torcia/ossiacetilenica ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Saldatura al plasma ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Saldatura per punti (puntatura / punzonatura) ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Altre tipologie di saldatura (laser, per attrito, brasatura, a fasci di elettroni) ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Controllo qualità (raggi x, raggi γ) ☐		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		
Altri compiti (specificare) _____ _____		Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐		

C. Ha effettuato **saldatura su materiali verniciati**? Se *Si*, specificare se: Occasionale ☐ Più volte al mese/anno ☐ Più volte al giorno ☐

D. Esposizione diretta a materiali/ sostanze e/o esposizione indiretta da fattori organizzativi

1. Durante il lavoro ha usato o è venuto a contatto con:

amianto in fiocchi ☐; materiali contenenti amianto ☐; lane /fibre minerali ☐; solventi ☐; vernici ☐; abrasivi ☐; silice ☐ agenti fisici/radiazioni ☐

Altro(specificare) _____

2. La sua esposizione alle sostanze/materiali di cui sopra è stata determinata/favorita da:

ambienti comunicanti ☐; lavorazioni di altri (ad es. sull'amianto o con amianto) in locali non separati ☐; organizzazione del lavoro ☐; assenza di misure di prevenzione e DPI ☐

Descrizione _____

E. Durante il lavoro lei ha usato *più volte al mese* **DPI in amianto** (grebiuli, guanti , ghette...) ☐

Se Sì, descrivere stato di conservazione/manutenzione _____

F. Ha mai utilizzato (*rimosso o installato*) materiali isolanti o ignifughi? SI ☐ NO ☐

Se Sì, di quale materiale si trattava ? _____

Se Sì, in quali ambiti lavorativi (rotabili ferroviari, costruzione/ riparazione macchine industriali)? _____

NOTE (indagare sull'organizzazione del lavoro nelle varie realtà, riferita all'esposizione ad amianto e altri cancerogeni)

Assessment of a Systematic Screening of Occupational Exposures in Malignant Hemopathies in the Rhone-Alpes Area: Prolymphome Study

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KEYWORDS: Malignant Hemopathies; Self-Administered Questionnaires; Occupational Exposures; Occupational Disease; Social Vulnerability

ABSTRACT

Background: Several studies have highlighted the role of environmental exposures in malignant hemopathies etiology. Some patients with malignant hemopathies can be compensated as occupational diseases. The Prolymphome research aimed to assess a systematic screening of occupational exposures in patients with lymphoma or myeloma treated in three hospitals in the Rhône-Alpes region. **Methods:** Patients received a self-administered questionnaire to fill in at home to collect their job history and potential occupational exposures to carcinogens. A physician assessed the questionnaire to determine if a dedicated consultation was required and the possibility of claiming compensation. Patients were systematically assisted by a social worker for administrative procedures. **Results:** In 12 months, 754 patients were enrolled in the study, and 361 (48%) returned the questionnaire. A specialized consultation was proposed for 123 patients, and 98 patients attended the consultation. Overall, a compensation claim was proposed to 18 patients: 11 have been occupationally exposed to pesticides and seven to trichloroethylene. **Conclusions:** Our results confirmed the feasibility of the systematic screening procedure. Barriers were observed at every step of the process, and it underlined that patients are rarely informed about occupational exposures. As the prevalence of occupational exposures in malignant hemopathies remains scarce, a systematic targeted screening could be relevant in this population.

1. INTRODUCTION

In 2018, France estimated 45,000 new cases of hematological malignancies, accounting for 12% of new cancer cases, making them the sixth most common type of cancer [1]. These cancers occur slightly more frequently in men (55%) than in women (45%), with around two-thirds of cases classified as lymphoid hemopathies. Over the past 30 years, the global trend for hematological malignancies has

been rising, with projected cases estimated to exceed 4,600,000 by 2030 [2-3]. Unlike the USA, where the incidence remained at 37.2 per 100,000 in 2017, Europe and Asia have seen increased incidence across various subtypes, including non-Hodgkin's lymphoma (NHL), leukemia, and myeloma [4-6]. NHL's varied forms, treatments, and prognoses create a highly heterogeneous population (approximately 55% have aggressive forms, while 45% are indolent). Assessing the incidence and evolution of

hematological malignancies requires consideration of specific factors, including gender and age group, as these vary significantly. Occupational exposures are linked to an increased risk of hematological malignancies [7]. Research has identified several substances associated with these cancers, such as benzene, ionizing radiation, pesticides, and organic solvents [8-9]. Certain occupations, such as farming and industrial work, exhibit heightened risks [10]. Exposure to mineral oils, excavation dust, and alkali compounds has been associated with NHL, whereas arsenic and lead compounds correlate with acute myeloid leukemia [11]. Organophosphate pesticides, especially diazinon and malathion, are linked with an increased risk of leukemia, lymphomas, and multiple myeloma, particularly among individuals with prolonged exposure [12]. These findings highlight the need for monitoring and implementing control measures for occupational exposure to prevent hematological malignancies in at-risk workers [8, 12]. In addition to rising incidence rates, variations in incidence and subtypes by region suggest that environmental and occupational factors may partly explain these disparities [7, 13-14]. A report from the International Agency for Research on Cancer (IARC) estimated that 2.2% of hematological malignancies (1.2% of NHL and 1.0% of leukemia) are attributable to occupational exposures [15].

Numerous studies and meta-analyses have quantified the risk of NHL associated with pesticide use among farmers [16-19]. Recently, the IARC has classified several pesticides as certain, probable, or possible carcinogens [20]. Considering these new data, a decree published on June 9, 2015, included NHL in the list of occupational diseases for agriculture (Table 59), mainly listing work usually exposing workers to organochlorine compounds, organophosphorus compounds, carbaryl, toxaphene, and atrazine. This list was modified in 2019 to cover chronic lymphocytic leukemia and multiple myeloma. In addition, the type of pesticides concerned is no longer specified in the list of work, allowing compensation for exposure to other molecules [21].

Other occupational exposures are known to be associated with an increased risk of NHL [19, 22], mainly chlorinated solvents such as trichloroethylene (IARC Group 1, limited level of evidence for

NHL). Ethylene oxide is also classified as Group 1, with limited evidence for NHL. 1,3-butadiene is classified with a sufficient level of proof for lymphoma and leukemia, "all subtypes", as well as for multiple myeloma. Other occupational or environmental exposures have sometimes been reported in the literature. Still, the evidence remains insufficient [23]. Due to the heterogeneity of NHL, obtaining significant findings regarding its association with occupational exposures is challenging. Additionally, with a 5-year survival rate of 54% for men and 56% for women across all types of NHL, and considering the high proportion of patients diagnosed who are still of working age, the question of returning to work in positions linked to proven or suspected occupational exposure to NHL may arise, even without any occupational pathology claims, to prevent secondary cancers.

Hodgkin's disease constitutes approximately 10% of lymphomas, predominantly affecting young adults. There is insufficient conclusive data regarding occupational exposure to Hodgkin's disease [23]. However, several studies and meta-analyses indicate a potential association between this disease and exposure to pesticide [24-25] and wood dust [26].

Despite this convincing evidence, there is a lack of awareness among both healthcare professionals and patients of the mechanisms for reporting and recognizing work-related cancers in France. Numerous barriers to the recognition of occupational cancers have been identified in the literature, including oncologists' lack of time to gather patients' occupational histories, multiple exposures, and a lack of knowledge and expertise, due partly to the long latency period between the exposure and the onset of cancer [27-29].

Considering this underreporting and underrecognition of work-related cancers [30] in 2010, the Léon Bérard Center implemented a systematic occupational exposure screening for bronchopulmonary cancers based on an occupational exposure screening questionnaire and specialized consultation [31-33].

Given the new challenges of reporting NHL as an occupational disease since June 2015, we were interested in evaluating this process of systematically identifying occupational exposures in patients with hematological malignancies in several hospitals.

2. METHODS

The study received a favorable opinion from the Comité Consultatif sur le Traitement de l'Information en matière de Recherche dans le domaine de la Santé (n°16-313) and was declared to the Comité National de l'Informatique et des Libertés (n° 2016181).

2.1. Design

The Prolymphoma study was a prospective, multi-centre study conducted over one year in the Rhône-Alpes region of France on patients with malignant hemopathy.

2.2. Study Population

The study was proposed to all patients (men and women of any age) treated for a histologically confirmed hematological malignancy at the Centre Léon Bérard (CLB), the Centre Hospitalier Universitaire Lyon Sud (CHLS), and the CH de Valence (CHV).

To ensure thoroughness, hematologists recruited patients through the weekly Multidisciplinary Consultation Board (MCB). The study population included incident, prevalent, and relapsed cases. The initial project focused on non-Hodgkin's lymphoma, but at the request of hematologists, it was extended to Hodgkin's disease and myeloma, thereby broadening recruitment to all hematological malignancies.

2.3. Systematic Detection and Assessment System

All eligible patients were sent a self-administered questionnaire for identifying occupational exposures at home, with an information note explaining the identification process and a T envelope for returning the questionnaire free of charge.

The self-administered questionnaire collected the following data: qualifications, complete occupational history including military period, jobs carried out, tasks performed for each job, duration, name, address and activity of the company. Through the self-administered questionnaire, the patient provided a

self-declaration of exposure to carcinogens to which he thought he had been exposed, according to a non-exhaustive list drawn up based on the nuisances covered by the tables of occupational diseases [21] and the classification of the IARC [20]. This questionnaire has been previously validated in lung cancer patients, and the nuisance section has been adapted for the study population [32].

One month later, when no reply was received, a clinical research associate systematically contacted patients by telephone and offered to help them complete the questionnaire. Once the questionnaires were returned, they were analyzed by an occupational pathology physician at the CLB or CHLS. Based on experience and the criteria for recognizing an occupational disease, the physician determined whether an occupational pathology consultation was necessary. Special attention was given to patients with occupational histories that involved exposure to pesticides and chlorinated solvents. Exposure could either be clearly stated by the patient or inferred by the physician from the questionnaire. If required, patients were scheduled for a consultation. Patients who did not need a consultation received a letter indicating that their pathology was assessed as unrelated to work. Patients were referred for consultation if they identified a known risk factor for hematological malignancies and/or jobs and tasks that might be associated with it in the self-administered questionnaire.

To assess patients' deprivation and its impact on systematic occupational exposure screening, patients were asked to complete the EPICES (Evaluation of Deprivation and Inequalities in Health Examination Centres) score simultaneously with the self-administered questionnaire. The EPICES is a validated composite index used to measure individual deprivation [34, 35].

The EPICES score consists of 11 binary items (yes/no) covering marital status, health insurance status, economic status, family support, and leisure activities. It ranges from 0 (no deprivation) to 100 (maximum deprivation), with a cut-off point 30.

2.4. Occupational Pathology Consultations

Occupational pathology consultations took place at the CLB or the CHLS (as the Valence hospital

does not offer this type of consultation, patients who requested an indication came to the CLB for a consultation).

During the occupational pathology consultation, the physician had to review the patient's work history in greater detail, complete the assessment of exposure to carcinogenic agents (including conditions, frequency, duration, level of exposure, and both collective and individual protective measures), and identify additional extrinsic risk factors (particularly, exposure to environmental pesticides from spraying around the home).

At the end of the consultation, when evidence in favor of an occupational origin was found, the patient was offered the possibility of a claim. These patients received an "initial medical certificate" and systematic support from a social worker to help them through the process.

2.5. Additional Data Collection

In addition to data from the self-administered questionnaire, the EPICES score, and the occupational pathology consultation, socio-demographic, clinical, and tumor data were collected from the patient's medical records. All consultations were recorded in the database of the Réseau National de Vigilance et de Prévention des Pathologies Professionnelles (RNV3P) [36].

2.6. Statistical Analysis

All eligible patients were included in the data analysis. The patient characteristics were analyzed descriptively, using means and standard deviations for quantitative data and frequencies and percentages for qualitative data. We compared patient demographic and clinical data and data from the tracking system across centers using t-tests or the Wilcoxon rank sum test for quantitative data and Chi-squared or Fisher tests for qualitative data. A 5% threshold was considered statistically significant for all statistical tests. Analyses were conducted using R software.

3. RESULTS

Between March 2016 and February 2017, 754 patients were treated for hematological malignancies

at CLB, CHLS, and CHV. All of them were included in the Prolymphoma study: 350 patients at CLB (47%), 356 at CHLS (47%), and 48 at CHV (6%). Recruitment began in March 2016 at CLB and in May 2016 at CHLS, concluding in December 2016 at these two centers. Systematic screening was conducted at CHV from September 2016 to February 2017. Recruitment lasted 11 months at CLB, eight months at CHLS, and five months at CHV. Self-questionnaire for identifying occupational exposure

The flowchart is described in Figure 1. The self-administered questionnaire was sent to the 754 patients recruited. Among them, 361 returned it (240 NHL, 94 myeloma, and 27 Hodgkin's disease), for an overall response rate of 48%.

3.1. Patient Characteristics

Table 1 summarizes patient characteristics. Men returned more of the self-administered questionnaire than women, and there was no difference in age between respondents and non-respondents.

The profile of patient care varied from one center to another. Patients at the CLB were more likely to be incident cases (43%) or patients receiving follow-up (32%), while at the CHLS and CHV, patients were more likely to have relapsed (56% and 42%, respectively).

Table 1 also presents the recruitment of patients based on histological type. The majority were diagnosed with NHL (63%), myeloma (27%), or Hodgkin's disease (9%). Incident cases returned the questionnaire more often than prevalent cases.

Table 2 shows the return data for the self-administered questionnaire from the recruitment center. Most patients who responded (37%) submitted the questionnaire spontaneously, while the remaining 11% returned it after receiving a reminder. Among the 393 non-responders (52%), 34% did not return the questionnaire, citing their main reason as feeling "unconcerned" about identifying occupational exposures. After three phone reminders, 17% were unreachable.

Patients from CHLS submitted the self-administered questionnaire more spontaneously, whereas those from CLB and CHV required more assistance in completing the form and received

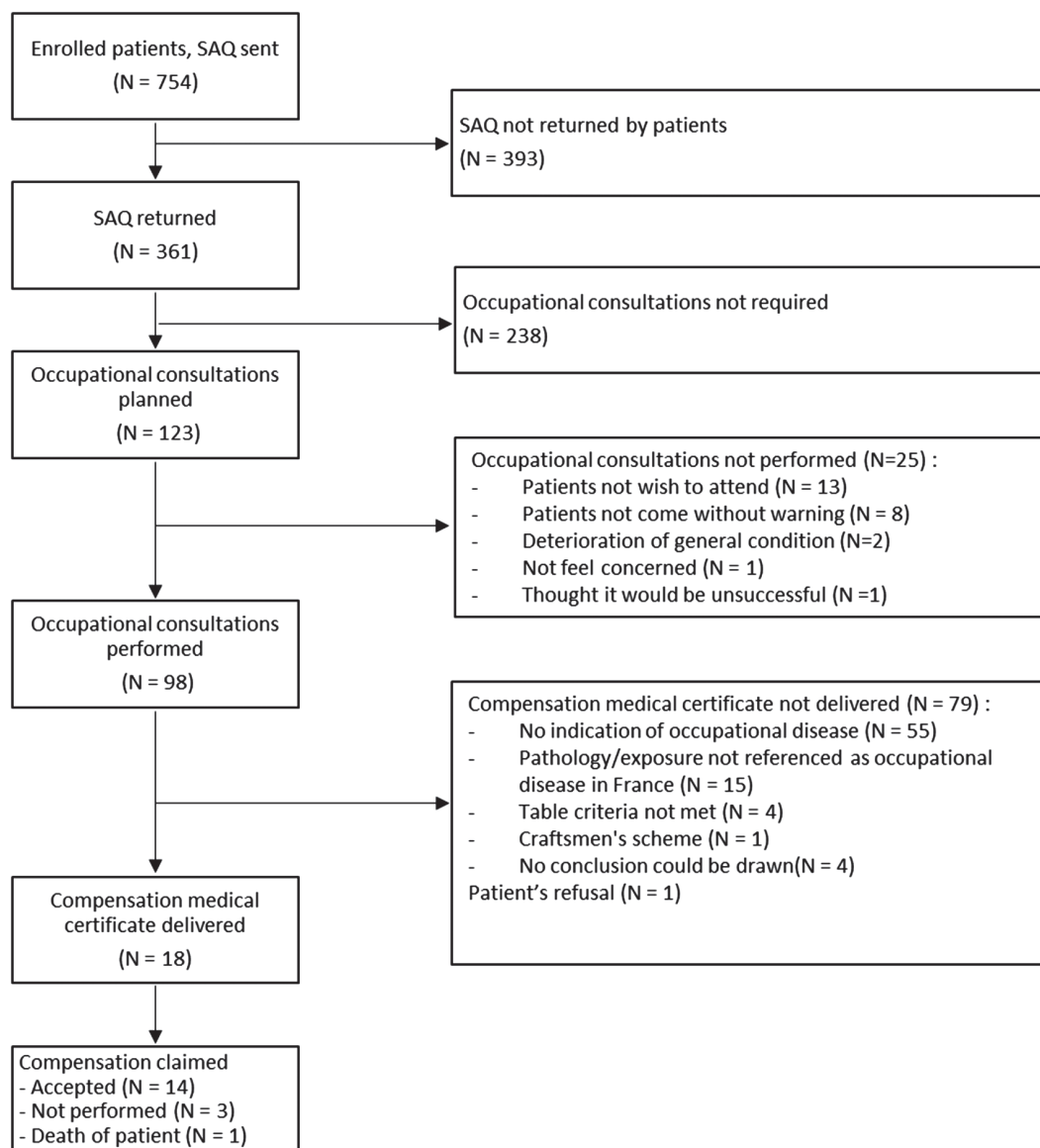


Figure 1. Study flow-chart.

additional phone reminders. There was a significant difference in response time across the various centers. On average, patients at CHLS returned their questionnaires more quickly (35 days) compared to those at CLB (45 days) and CHV (48 days) ($p=0.01$). The overall average delay was 41 days ($SD=35.3$).

Two-thirds of the responders had a General Certificate of Secondary Education or less. Regarding their occupational careers, the number of job changes

was low, with half of the patients holding fewer than four jobs. Nearly a quarter of patients reported having held a skilled job in the industrial or craft sectors throughout their careers (ISCO categories). Of the exposures covered by the questionnaire, 64 patients (18%) indicated exposure to trichloroethylene, 22 (6%) to perchloroethylene, 29 (8%) to benzene, and 62 (17%) to another solvent. Additionally, 53 patients reported pesticide exposure (15%).

Table 1. Characteristics of study population according to the self-administered questionnaire participation.

	Respondents N (%)	Non respondents N (%)	Total N (%)	p Value
Total	361 (48)	393 (52)	754 (100)	
Gender				
Male	226 (63)	217 (55)	443 (59)	p=0.04
Female	135 (37)	176 (45)	311 (41)	
Mean age at diagnosis (SD) ¹	62.1 (13.3)	60.6 (15.4)	61.7 (14.8)	p=0.14
Disease management				
Incident cases	160 (44)	133 (34)	293 (39)	p=0.01
Relapse	132 (37)	175 (45)	307 (41)	
Follow-up	69 (19)	77 (20)	146 (19)	
Missing data	0 (0)	8 (1)	8 (1)	
Histology				
Hodgkin Lymphoma	27 (7)	40 (10)	67 (9)	p=0.28
Non-Hodgkin lymphoma	240 (67)	239 (61)	477 (63)	
Myeloma	94 (26)	109 (28)	203 (27)	
Missing data	0 (0)	5 (1)	5 (1)	

3.2. Occupational Pathology Consultations

Among the 361 self-administered questionnaires assessed, 123 patients were invited to an occupational pathology consultation, and 98/123 consultations were carried out (80%). Of the 25 consultations that were not carried out, 13 patients did not wish to attend (11%), eight patients did not come to the consultation without warning (6%), two patients had a deterioration of their general condition (1%), one patient did not feel concerned by the process (1%) and one patient thought that it would not be successful (1%).

At the end of the consultations, 19/98 patients (19%) were deemed eligible for compensation for an occupational disease. An initial medical certificate was finally issued to 18 patients, one of whom did not finally wish to proceed. Of the 18 initial medical certificates issued, ten were related to exposure to the pesticides listed in Table 59 of the Agricultural Insurance (AI), seven were not listed in a dedicated table (NHL with exposure to trichloroethylene and myeloma with exposure to pesticides) and one patient did not meet the criteria of Table 59 of the AI.

A claim for recognition was not considered for 79/98 patients (80%): there was no indication of an

occupational disease for 55 patients; for 15 patients, there were scientific arguments for a link with occupational exposure, but the pathology and exposure were not referenced in an occupational disease table according to the French regimen; and for four patients the table criteria were not met. One patient came under the craftsmen's scheme and was not eligible for compensation as an occupational disease. No conclusion could be drawn for four patients based on the available evidence.

Overall, 14 out of 18 patients (82%) received compensation for their claim as an occupational disease; three patients did not seek recognition, and one patient died before completing the process. Details of the occupational disease compensation are presented in Table 3.

3.3. Social Vulnerability

The median EPICES score was 20.7. A vulnerability situation (EPICES score ≥ 30) was identified in 122 patients (34%). This situation was more prevalent among patients at CLB (24.19) than at CHLS (21.53) and CHV (17.4; $p=0.04$). On average, patients identified in a vulnerable situation needed more time to complete the self-administered

Table 2. Self-administered questionnaire return, overall and by recruiting center.

	CLB N (%)	CHLS N (%)	CHV N (%)	Total N (%)
Self-administered questionnaire returned	350 (100)	356 (100)	48 (100)	754 (100)
Return by patient without reminder	123 (35)	141 (40)	17 (35)	281 (37)
Return after phone call reminder	55 (16)	15 (4)	10 (21)	80 (11)
by patient	44 (13)	15 (4)	4 (9)	63 (8)
self-administered questionnaire completed during the call	3 (1)	0 (0)	3 (6)	6 (1)
self-administered questionnaire completed at hospital	8 (2)	0 (0)	3 (6)	11 (2)
Self-administered questionnaire non-returned	124 (35)	126 (35)	7 (15)	257 (34)
Patient not concerned	40 (11)	44 (12)	2 (4)	86 (11)
Patient should have returned the self-administered questionnaire but did not	51 (15)	18 (5)	3 (6)	75 (10)
Patient deceased	4 (1)	18 (5)	1 (2)	23 (3)
Fatigue	13 (4)	20 (6)	0 (0)	33 (4)
Patient did not wish to complete the self-administered questionnaire	12 (3)	24 (7)	1 (2)	37 (5)
Problems with French language	4 (1)	0 (0)	0 (0)	4 (1)
Patient managed in another hospital	0 (0)	2 (1)	0 (0)	2 (0)
Patients could not be reached (after 3 attempts)	48 (14)	74 (21)	5 (10)	127 (17)
Call reminder not performed	0 (0)	0 (0)	10 (21)	10 (1)
Delay to complete the self-administered questionnaire	178 (100)	156 (100)	27 (100)	361 (100)
< 1 month	92 (52)	102 (65)	9 (33)	203 (57)
> 1 month	86 (48)	54 (35)	18 (67)	156 (43)

questionnaire than those who were not (50 days vs. 37 days; $p=0.003$). On the other hand, no significant difference in precarity was found in terms of age, sex, or proposal to declare an occupational disease.

4. DISCUSSION

Our study evaluated systematic screening for occupational exposures in lymphoma or myeloma patients at three hospitals in the Rhône-Alpes region. It aimed to enhance the identification and compensation of these conditions as occupational diseases. An initial medical certificate was issued to 18 patients (2% of the study population), and 14 received compensation for work-related pathologies. The results align with the literature on the proportion of

hematological malignancies linked to occupational exposures [37]. While the latency between occupational exposures and disease onset is shorter for hematological malignancies than solid cancers [15], the diversity of these malignancies and the complexity of occupational exposures pose challenges in pinpointing attributive factors.

Compensation claims for occupational diseases were proposed for 9% of the study patients, a percentage higher (15%) than in the RHELYPRO study [38]. However, this approach necessitated oncologist involvement before identifying occupational exposures, and limited time from oncologists was frequently noted as a barrier to identifying occupational cancers [28]. This multicenter study revealed population differences across centers regarding age,

treatment status, and vulnerability. The study population reflects the diversity of individuals with hematological malignancies in France. Identification via the Multidisciplinary Consultation Board ensures that all patients potentially concerned about their disease's occupational origin can be systematically informed and integrated into the care pathway without burdening hematologists' limited time.

It is also crucial to consider the French system regarding occupational compensation. There are tables that specify the required symptoms or pathological lesions, the types of work known to cause the condition, and the time limits for compensation claims. Any disease that meets these medical, occupational, and administrative requirements is systematically assumed to be work-related. When a disease is not listed in the table or when the criteria are not fully met, patients are examined by regional committees for occupational disease recognition, which typically base their assessment on the IARC Group 1 classification. In France, the current context is favorable since the creation of the occupational disease table related to occupational exposure to pesticides (RA n° 59). This table was revised in 2019 to include multiple myeloma among the list of pathologies eligible for recognition as an occupational disease. Furthermore, in 2020, the Pesticide Victims Compensation Fund was established to investigate the growing number of claims for recognition of occupational diseases related to pesticide exposure, also helping to standardize recognition practices [39].

Considering these findings compared to the same process in lung cancer patients in two studies conducted in 2015 and 2019 [33, 40] is interesting. Indeed, the results of Prolymphome show a response rate to the self-administered questionnaire slightly lower than in the pilot study (53%) but higher than in the multicentre study (37%). In both populations, the impact of vulnerability was observed in the time needed to return questionnaires. However, the prevalence of vulnerability was higher among lung cancer patients (46% and 37% versus 34% of respondents).

Finally, the frequency of occupational exposures related to the disease was more prevalent in patients with lung cancer (9% of the overall study population and 18% of self-administered questionnaire

responders) than for hematological malignancies (2% of the study population and 5% of self-administered questionnaire responders). Systematic screening seems more appropriate for patients with bronchopulmonary cancer than for hematological malignancies, where occupational exposure is less frequent and less diverse and requires a systematic but more targeted screening.

One of the strengths of this study is the relatively high response rate (48%), which underlines the patients' interest in occupational exposures. As patients with hematological malignancies generally have a good prognosis, the acceptance and implementation of occupational exposure investigation seem appropriate in this context. In addition, identifying occupational exposures will help to prevent them more effectively, particularly in the case of working patients. This system enables systematic screening for work-related cancers, with information and guidance where necessary, to reduce social disparities. Better reporting of occupational cancers will help patients claim their rights and better identify and register the carcinogens involved in these cancers.

According to self-administered questionnaire feedback, and consistent with the literature, exposure to solvents and trichloroethylene (IARC group 1, limited evidence for NHL) is the most frequently self-reported exposure in this population (18%), followed by pesticides reported by 15% of respondents. However, these exposures often lacked the intensity or duration required for compensation as an occupational disease. The systematic recording of consultation data in the national database of the occupational pathology network (RNV3P) enhances the understanding and prevention of occupational risks in France [36].

A limitation of our study is the lack of systematic feedback from the self-administered questionnaire. Additionally, a quarter of the recommended consultations were not completed; some patients declined to attend for logistical reasons (distance, organization), making it difficult to identify the occupational aetiologies of hematological malignancies. The dropout rate at each stage highlights patients' lack of awareness regarding occupational exposure and their rights. Supporting patients throughout the process, including the compensation claim

Table 3. Details of exposure assessments for patients who asked for compensation.

Histology	Occupation and condition of exposures	Occupational carcinogens		Compensation
		Pesticides	Social regimen	
Myeloma	Exposure to pesticides (insecticides and herbicides) for around ten days a year throughout professional career for 35 years until 2003. Treatment of cereals, potatoes, pastures and gardens. Parasite treatment of 35 cows twice a year.	Organochlorine compounds	GS	Accepted
Myeloma	From 1960 to 2009, winegrower. Exposure to pesticides for vine treatments 6 to 8 times / year. Pesticide application with protective suit and cartridge mask, but no protective equipment when re-entering crops, generally 2 to 3 days after treatment. Vineyard herbicide application twice a year, with gloves only.	Organochlorine compounds	AR	Accepted
Myeloma	From 1971 to 2000, winegrower. Handling of phytosanitary products for vineyard treatment 4 to 5 times a year. Herbicide application 2 times a year. Preparation, application of products and washing of equipment. Application by high-clearance tractor without protective equipment. Frequent re-entry into treated crops.	Organochlorine compounds	AR	Accepted
Marginal zone lymphoma	From 2004 to 2011, he worked as a castle groundskeeper. He carried out glyphosate herbicide spraying over an area of 5000 m2 (borders, driveways, embankments and ditches) 6 to 7 times a year using a backpack sprayer, generally without any protection. Each application lasted up to a day and a half.	Organophosphorus compounds	GS	Accepted
Marginal zone lymphoma	1986 to 1992 farm worker in vegetable and fruit growing. Regularly handled and prepared pesticides. 1992 to 2010 technical officer for a municipality. Herbicides used for at least two months a year. Pesticides used included glyphosate, paraquat and 2-4-D.	Organophosphorus compounds	AR	Accepted
Mantle cell lymphoma	Arboricultural worker since 1981. No direct preparation or handling of pesticides. However, was regularly in the orchards for maintenance or tree pruning while treatments were being applied by other workers. No personal protection. Fruit picking (apricots, apples, peaches, strawberries) and vegetable picking (asparagus, mushrooms, etc.) as well as grape harvesting every year.	Organophosphorus compounds	AR	Accepted
Diffuse large B-cell lymphoma	Farmer from 1978 to 2007. Tobacco growing, arboriculture, vegetable production and poultry farming. No direct exposure, but frequent re-entry for crop maintenance and picking, especially tobacco.	Organochlorine compounds	AR	Accepted

Table 3 (*Continues*)

Histology	Occupation and condition of exposures	Occupational carcinogens		Social regimen	Compensation
		Pesticides			
Diffuse large B-cell lymphoma	Winegrowing career from 1948 to 1994. Use of copper, sulfur and arsenic at the start of his career to treat grape berry worm. DDT (dichloro-diphenyl-trichloroethane) to treat grape berry worm. Herbicides used from the 70s.	Organochlorine and organophosphorus compounds		AR	Not done
Chronic lymphocytic leukemia	1967-1990 Farmer, fruit production (cherries, strawberries, peaches, pears, apples, etc.) some 30 days a year of organophosphorus insecticides, and occasionally organochlorine insecticides, carbaryl. 1990-2002 Multi-skilled landscape worker, mainly maintenance work (planting, pruning, mowing, small-scale masonry work, etc.) occasional exposure to insecticides on rosery plants and some herbicides (glyphosate).	Organophosphorus compounds		AR	Accepted
Follicular lymphoma	Farming since 1993. Numerous tasks related to sheep and cow breeding. Performed crop treatments, including product preparation. Until 2013, she reported applying herbicides to pastures and various crops (barley, maize, wheat) for around 4 half-days a year, without protection.	Organophosphorus compounds		AR	Accepted
Myeloma	From 1984 to 2004 farmer combining mixed farming of cereals, corn, beet, sunflowers and potatoes with cattle, sheep, pig and poultry farming. Treated crops several times a year with a variety of pesticides: organochlorines, organophorus and atrazine. Also treated livestock buildings with insecticides. Continued working as a family helper until 2014.	Organochlorine and organophosphorus compounds		AR	Not done
Myeloma	Farmer from 1960 to 2006. Cereals, corn, colza, sunflower and soy. Herbicides twice a year, insecticides and fungicides 6 times a year. Use of organochlorines including lindane, organophosphates, glyphosate and atrazine. Had no protection and only owned a tractor with a cab for the last 10 years. Associated livestock farming but no use of pesticides.	Organochlorine and organophosphorus compounds		AR	Not done
Solvents					
Mantle cell lymphoma	From 1971 to 1999, machinist and toolmaker for various metalworking companies. Regular use of organochlorine solvents for cold degreasing of parts prior to quality control. Alternative use of trichloroethylene and trichloroethane 111, depending on the period. Degreasing with detergent at the end of the career.	Trichloroethylene		GS	Accepted

Chronic lymphocytic leukemia	From 1967 to 1998, warehouseman in the chemical industry, transferring trichloroethylene from large containers into smaller drums. Daily handling of 150 liters/day. An open bin of trichloroethylene was permanently located near his workstation.	Trichloroethylene	GS	Accepted
Follicular lymphoma	From 1968 to 1980 machining technician. Machining with cutting oils, welding, painting and daily degreasing of parts in cold trichloroethylene baths. From 1980 to 2000, technician and engineer in various laboratories, with the same but decreasing exposure.	Trichloroethylene	GS	Accepted
Diffuse large B-cell lymphoma	1971-1981, automotive mechanic. Had a tub of trichloroethylene on the workbench to dip vehicle mechanical parts several times a day. Used a brush to apply trichloroethylene to degrease brake systems before blowing. One-hour daily exposure. 1982-1998 was team leader, decreasing exposure to trichloroethylene. Exposure to benzene through contact with gasoline-containing parts.	Trichloroethylene	GS	Accepted
Diffuse large B-cell lymphoma	From 1967 to 1979 pipe fitter and welder for several companies. Installation of industrial sites in the chemical sector and maintenance work on heating systems. Describes regular use of cold trichloroethylene to degrease parts. He was also exposed to benzene.	Trichloroethylene	AR	Not done

procedure, is crucial. The involvement of a social worker to assist with complex administrative procedures, which patients see as a barrier, is essential [29]. Furthermore, the introduction of teleconsultations may help to address organizational issues for occupational consultations.

Despite these efforts, systematic screening remains effective only for a minority of patients with specific profiles (e.g., those working in agriculture/viticulture or handling solvents like trichloroethylene). Given the substantial time needed to identify these patients, expanding this screening to all hematological malignancies is impractical. Targeting those affiliated with the agricultural regimen could be beneficial, making it essential to raise awareness among medical teams managing these patients to ensure they can identify and refer them for occupational pathology consultation.

5. CONCLUSION

Our study confirms the feasibility of the process for screening occupational exposure to diseases other than bronchopulmonary cancer, and its implementation through a multicenter approach. However, it appears that systematic screening is time-consuming in a context where occupational etiology is rarer for hematological malignancies than for lung cancer. Since screening for potential occupational exposures is valuable for the patients themselves, particularly in a context of long survival, it is essential to inform them about occupational exposures. Therefore, it seems more appropriate to identify patients by hematologists or their teams during treatment, with referral to the occupational pathology consultation. The necessity for information and education regarding occupational exposures for workers, patients, and healthcare professionals must be a public health priority.

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INSTITUTIONAL REVIEW BOARD STATEMENT: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board Comité Consultatif sur le Traitement de l'Information en matière de Recherche dans le domaine de la Santé (protocol code 16-313 on 12 May 2016).

INFORMED CONSENT STATEMENT: Informed consent was obtained from all subjects involved in the study.

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Workplace Violence in Tertiary Hospitals: Unraveling Its Detrimental Effects on Healthcare Workers' Job Engagement

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ABSTRACT

Background: Workplace (WPV) violence is a significant issue among healthcare workers (HCWs) in hospitals and negatively impacts the healthcare workforce. WPV can have more severe consequences, especially in tertiary hospitals with a concentrated, specialised workforce. In this regard, the study aimed to identify the dynamics of workplace violence exposure among HCWs in a tertiary hospital. It also investigated its impact on job engagement.

Methods: The study was designed as a descriptive cross-sectional study conducted between June and September 2023. The study involved 3,526 HCWs at a tertiary hospital in Turkey, all invited, with 390 participating.

The study examined healthcare workers' ability to handle WPV. It also examined their exposure to violence, their perception of safety against violence at work, and their engagement in their jobs. **Results:** Exposure to WPV among HCWs included in the study significantly predicts job engagement, with a negative relationship (β : -0.473). Additionally, as HCWs' skills in managing WPV increase, job engagement also increases (β : -0.279). Among younger and less experienced HCWs, WPV exposure and job engagement scores were significantly lower ($p < 0.05$).

Conclusions: WPV, common among health workers, is an essential factor that reduces work engagement. Identifying and controlling the dynamics of WPV is critical to enhancing job engagement among healthcare workers and preventing related adverse outcomes.

KEYWORDS: Workplace Violence; Healthcare Worker; Safety; Commitment; Management

1. INTRODUCTION

Hospitals play a crucial role in providing healthcare services. In these settings, healthcare workers (HCWs) face numerous workplace risks and hazards [1]. Incidents of violence in hospitals represent one of the most challenging situations that HCWs face among these risks and hazards [2]. The World Health Organization (WHO) emphasizes the significance of workplace violence (WPV) in the healthcare sector, highlighting that a significant portion of violent incidents occur in hospitals [3].

Incidents of violence in healthcare observed worldwide have taken on the characteristics of an epidemic, affecting nearly all HCWs in hospitals [4].

WPV, manifesting in various forms such as physical, verbal, or emotional assaults, emanates from patients, their families, or other individuals present within the hospital milieu. The repercussions of these acts extend beyond physical harm, permeating into HCWs' mental well-being and job performance [5]. HCWs may experience feelings of fear, anxiety, and helplessness in the face of such violence. [6,7] Such experiences can lead to burnout,

decreased job satisfaction, and absenteeism [6, 8, 9]. Furthermore, it can also lead to reduced patient safety and quality of care [6].

Work engagement for HCWs reflects a positive, satisfying, and energetic mental state experienced when deeply involved and enthusiastic about their work [10]. HCWs' job engagement is crucial as it directly influences healthcare services and quality of patient outcomes [6, 10]. When healthcare professionals are highly committed to their roles, they demonstrate deep dedication, enthusiasm, and positive energy towards their work [11]. This increased level of engagement is associated with higher job satisfaction, improved performance, and a desire to exceed above and beyond in patient care [10, 11]. HCWs are more likely to collaborate effectively with colleagues, communicate efficiently, and actively contribute to a positive workplace culture [12].

Significantly, high levels of work engagement serve as a buffer that prevents burnout and stress, contributing to HCWs' overall well-being [13]. In a demanding field like healthcare, where risks are high and challenges are constant, promoting work engagement becomes a cornerstone for maintaining a motivated, resilient, and effective workforce [14]. This situation contributes both to employee well-being and patient care.

The relationship between work engagement by HCWs and WPV is a complex and crucial aspect of the healthcare environment. WPV significantly undermines HCWs' engagement, affecting vitality, dedication, and focus [15]. Research demonstrates that WPV leads to reduced job satisfaction and performance, particularly impacting healthcare professionals, including nurses, who work in high-stress environments and show notably lower engagement levels when exposed to threats, harassment, or violence [16]. Specifically, psychological violence decreases engagement, vitality, dedication, and focus, with the organizational climate potentially influencing this effect [17]. However, a supportive organizational environment can help buffer these negative impacts, enabling HCWs to remain engaged despite challenging conditions. This underscores the importance of fostering a respectful and secure work environment to mitigate the adverse effects of WPV on the healthcare workforce [18]. WPV can negatively

impact HCWs' job engagement, reducing job satisfaction, performance, and the willingness to exceed above and beyond in patient care [19, 20]. Furthermore, WPV can make it challenging for HCWs to cope with burnout and stress, adversely affecting their overall well-being [6, 7]. In hospitals, the adverse effects of WPV on employees can lead to significant consequences that negatively impact the healthcare workforce. Therefore, WPV in hospitals is a phenomenon that requires detailed examination, especially regarding its outcomes on employees [21]. Our study aims to identify and describe the complex dynamics of WPV in the hospital setting, focusing on determining its role in affecting job engagement. In this context, the study seeks to answer the following research questions (RQ). **RQ1:** What are the variables affecting WPV dynamics and job engagement among HCWs? **RQ2:** To what extent do WPV dynamics impact job engagement among HCWs?

2. METHODS

2.1. Desing

This study had a descriptive and prospective design. The survey method was used between June and September 2023 to collect data.

2.2. Ethical Considerations

An ethics committee approval was obtained from Health Science University Gazi Yaşargil Training and Research Hospital before the study started (March 03, 2023, Number 341). All stages of the study were conducted under the Declaration of Helsinki. Participant data were collected voluntarily by the hospital that conducted the study. Permissions were obtained from the hospital that conducted the study. After accepting the voluntary consent form, participants were informed about the research and included in it. Both online (electronic form) and face-to-face methods were used for data collection.

2.3. Study Population

Participants in the study were directly involved in patient care and treatment at the Training and

Research Hospital where the research took place. The participants included physicians, licensed health professionals (nurses, midwives, physiotherapists, psychologists, etc.), and health technicians (such as medical imaging and emergency medical technicians). Employees engaged in administrative and technical services were excluded from the study. A total of 3,256 employees fell under this restriction, but only 390 chose to volunteer for the study. A convenience sampling method was employed for sample selection. An assessment of the representativeness of this sample was conducted using Epi Info (Version: 7.2.4). An evaluation of the sampling was performed after the study, revealing a frequency of 76% in the sample evaluation, with a 97% Confidence Interval for the representativeness of the 390 samples (α : 0.05).

2.4. Data Sources and Collection

The data were collected through the healthcare workers' information form, the Utrecht Work Engagement Scale (UWES), the Workplace Violence Scale (WVS), and Safety and Confidence Scale of Healthcare Professionals Against Violence prepared by the researchers.

2.4.1. Healthcare Workers' Information Form

A thoughtfully designed form was developed to collect data on the surveyed individuals' pertinent personal characteristics and occupational circumstances. This form comprised ten thoughtfully crafted questions designed to collect information about the individual attributes of employees, such as age, gender, and marital status. Furthermore, the questionnaire explored the working conditions experienced by respondents, including aspects like the number of shifts and hours they worked each month.

2.4.2. Utrecht Work Engagement Scale (UWES)

The scale, developed by Schaufeli et al. [22], measures healthcare workers' work engagement. The scale comprises three, six, and nine-item short forms. It has been reported in the Turkish version

of the scale that the three and six-item short forms exhibit superior structural validity than the nine-item form. Therefore, within the scope of this study, the six-item short form, validated and proven reliable in Turkish by Güler et al., was employed. Each of the three dimensions, Vigor (VI), Dedication (DE), and Absorption (AB), consists of two items, resulting in six statements. Each of these dimensions helps measure different aspects of an employee's engagement at work. Vigor refers to an employee who approaches work physically and mentally; dedication refers to finding work meaningful and valuable; and absorption refers to being completely focused on work, almost lost in it, without thinking about anything else. In this study, the Cronbach's Alpha reliability coefficient is 0.92 for the UWES total score, 0.90 for VI, and 0.93 for DE and AB. There is no cutoff point for evaluating both sub-dimension and total scale scores. Responses to the six Likert-scale questions, rated on a six-point scale, are interpreted so that higher scores indicate increased work engagement among healthcare workers [22].

2.4.3. Workplace Violence Scale (WVS)

The scale developed by Chen et al. [23] is designed to evaluate exposure to violence among healthcare workers. The Instrument for the Evaluation of WVS examines violence experienced by employees across three sub-dimensions: sexual (three questions), physical (four questions), and verbal (two questions), totaling nine items. The WVS assesses the level of violence exposure over the past year. Responses are given on a four-point Likert scale, with scores calculated for each sub-dimension by averaging responses, resulting in a score between 0 and 3. The overall WVS score, ranging from 0 to 9, is obtained by summing the three sub-dimensions, where a higher score indicates a greater frequency of violence exposure. The scale does not have any cutoff points. The Turkish validity and reliability study of the WVS was conducted by Tutan and Kökalan [24]. In our study, the Cronbach's Alpha reliability coefficient for the total WVS score is 0.871.

2.4.4. Safety and Confidence Scale of Healthcare Professionals Against Violence

The scale was developed by Kowalenko et al. to determine the behavioral patterns exhibited by healthcare workers when subjected to violence and the resulting stress on HCWs [25]. This scale development study encompasses two separate scales: the four-item Confidence Scale (CS) and the three-item Safety Scale (SS). The Turkish reliability and validity study of the scale was conducted by Şengül et al. [26]. Each item on the scale is responded to on a ten-point Likert scale. In the Turkish validity and reliability study, Cronbach's Alpha reliability coefficient was 0.84 for CS and 0.80 for SS. In this study, the Cronbach's Alpha reliability coefficient is 0.81 for CS and 0.79 for SS. CS A high score on the SS indicates that the healthcare worker does not feel safe from violence. In contrast, a high score on the CS is interpreted as healthcare workers being inadequate at managing a potentially violent incident. There are no specific cut-off points for evaluating the scales [25, 26].

2.5. Data Analysis

The data obtained from the study were transferred to and analyzed using the SPSS 23 software package. Descriptive statistical methods, including

frequency, percentage, arithmetic mean, and standard deviation, were employed in the data analysis. Skewness and Kurtosis values for the total scores of the scales obtained in the research fell within the range of -1.5 to +1.5, indicating a normal distribution of the data [27]. In addition, Histogram and Quantile-Quantile (Q-Q) graphs were evaluated using visual methods. Consequently, the normal distribution assumption was accepted. Independent samples t-test and one-way analysis of variance (ANOVA) were utilized to compare the descriptive characteristics of healthcare workers with the total scores of the scales. Multiple linear regression analysis assessed the impact of the WVS, SS, and CS total scores and working conditions on work engagement. Evaluations were conducted using total scores to address the issue of multicollinearity in the multiple linear regression analysis. To enhance the interpretability of the regression model, continuous and interpretable variables were included as independent variables. A p-value below 0.05 was considered significant in the test results.

3. RESULTS

Among 390 participants, the mean age was 34.71 ± 7.61 , the mean working year was 10.82 ± 7.63 , and the mean monthly working hours were 10.82 ± 7.63 (Table 1). The mean number of reported

Table 1. Descriptive Data and Scales Regarding HCWs.

Variables (n:390)	$\bar{x} \pm S.D$	Min-Max	Skewness	Kurtosis
Age (years)	34.71 ± 7.61	22-57	0.467	-0.515
Years of Employment	10.82 ± 7.63	1-37	0.699	-0.129
Monthly Working Hours	189.08 ± 33.04	150-360	1.349	1.441
SS	5.11 ± 1.94	1-10	-0.015	-0.340
CS	6.08 ± 2.43	1-10	-0.197	-0.622
WVS	3.85 ± 1.05	0-9	-0.515	-0.625
UWES	21.02 ± 7.45	6-36	0.030	-0.581
VI	6.42 ± 2.72	2-12	0.162	-0.687
DE	6.67 ± 2.93	2-12	0.180	-0.861
AB	7.92 ± 2.83	2-12	-0.299	-0.711

SS: Safety Scale; CS: Confidence Scale; WVS: Workplace Violence Scale; UWES: Utrecht Work Engagement Scale; VI: Vigor Sub-dimension; DE: Dedication Sub-dimension; AB: Absorption Sub-dimension.

exposures to violence was 3.85 ± 1.05 during the last six months (Table 1).

One hundred seventy-three participants were women, and 254 were married. All participants were healthcare workers, including 176 licensees (nurses, midwives, physiotherapists, dietitians, psychologists, etc.), 70 technicians (radiology, anesthesia, operating room, paramedic, etc.), and 144 physicians (Table 2).

As a result, males had a statistically significant higher mean CS (Confidence Scale) score than females ($p < 0.05$), while females had a significantly higher mean AB score ($p < 0.05$). Gender and other dependent variables did not differ significantly ($p > 0.05$). Compared to single healthcare workers, married healthcare workers had significantly higher mean scores in CS and AB (Absorption Sub-dimension) ($p < 0.05$). No significant differences in marital status were detected among other dependent variables ($p > 0.05$).

Healthcare workers aged 30–39 scored significantly higher on the SS (Safety Scale) than those aged 40 and above ($p < 0.05$). Workers aged 20–29 had higher CS and WVS (Workplace Violence Scale) scores than those aged 40 and above ($p < 0.05$). Meanwhile, those aged 40 and above scored significantly higher on the DE (Dedication Sub-dimension) and the UWES (Utrecht Work Engagement Scale) compared to those aged 20–29 ($p < 0.05$).

The mean CS scores of HCWs with high school graduates were significantly higher than those for postgraduate degree HCWs ($p < 0.05$). High school graduates had significantly higher mean scores in AB and UWES compared to postgraduate degree holders and in DE scores compared to both undergraduate and postgraduate degree holders ($p < 0.05$).

CS, VI (Vigor Sub-dimension), DE, AB, and UWES mean scores of health technicians and other workers were statistically significantly higher than those of nurses-midwives and physicians ($p < 0.05$). Among the participants, HCWs with 0–9 years of experience reported a statistically significant increase in violence exposure in comparison to those with 20 years and above of experience ($p < 0.05$). HCWs with 20 years and above experience had

significantly higher mean scores in VI (Vigor Sub-dimension), AB (Absorption Sub-dimension), and UWES (Utrecht Work Engagement Scale) than those with 0–9 years of experience ($p < 0.05$).

HCWs working more than 200 hours and those working 11 or more shifts per month had higher mean WVS (Workplace Violence Scale) scores than those with 180 hours and below or those working regular hours, respectively ($p < 0.05$).

HCWs in the emergency department had significantly higher mean WVS scores than those in diagnostic examination units and other units ($p < 0.05$). HCWs in other units had higher mean VI, DE (Dedication Sub-dimension), and UWES scores than those in internal and surgical units ($p < 0.05$). HCWs who perceived their workplace as providing sufficient support against WPV had statistically significantly higher mean scores in CS (Confidence Scale), WVS, VI, DE, and UWES compared to those who did not find the support sufficient ($p < 0.05$).

The regression model conducted with continuous data related to WPV and working conditions among participating HCWs yielded significant results ($F: 30.914, p: 0.000$). According to this outcome, the variables in the model explained 35.0% of the variance in work engagement among HCWs. Within the model, WVS ($\beta: -0.473$), CS ($\beta: -0.279$), and monthly average working hours ($\beta: -0.091$) scores were identified as significant predictors of UWES.

4. DISCUSSION

This study assessed healthcare workers' (HCWs) exposure to workplace violence (WPV), their ability to manage it, and their perceived safety. The findings suggest an association between WPV exposure, WPV management skills, working hours, and work engagement among HCWs (Table 4). Specifically, increased exposure to WPV is linked to reduced work engagement, supporting previous findings that workplace violence adversely affects engagement across various sectors [28, 29]. Given the significant levels of violence reported (Table 1), the negative impact of WPV on HCWs is unsurprising.

Increased exposure to WPV correlates with lower work engagement among HCWs (Table 4). Previous

Table 2. Comparison of Socio-Demographic Characteristics with Scale Score Averages. Values are reported as $\bar{x} \pm \text{S.D.}$

Variables	SS	CS	WVS	VI	DE	AB	UWES
Years of Employment							
0-9 ^{1a} (192)	5.30±1.91	5.89±2.38	3.98±.98	6.27±2.56	6.23±2.76	7.54±2.83	20.05±7.05
10-19 ^{1b} (140)	4.87±1.92	6.30±2.38	3.76±1.07	6.38±2.89	6.82±3.07	8.02±2.92	21.22±7.94
≥20 (58)	5.06±2.07	6.15±2.72	3.60±1.13	7.01±2.75	7.77±2.85	8.94±2.37	23.74±6.92
Test Values (t&p)	1.995&.137	1.159&.315	3.812&.023	1.682&.187	6.618&.001	5.690&.004	5.654&.004
Monthly Working Hours							
≤180 ^a (176)	5.02±2.02	6.37±2.37	3.63±1.11	6.57±2.73	6.65±2.97	7.96±2.92	21.20±7.56
180-200 ^b (133)	5.12±1.86	5.97±2.47	3.93±1.01	6.62±2.85	6.84±3.10	7.96±2.78	21.42±7.90
≥200 ^c (81)	5.30±1.92	5.62±2.44	4.18±.85	5.76±2.36	6.43±2.53	7.77±2.76	19.97±6.35
Test Values (t&p)	.574 & .565	2.363 & .058	8.781 & .000	3.052 & .058	.495 & .610	.138 & .871	1.050 & .351
Number of shifts							
No Shift Work ^a (129)	4.89±2.07	6.15±2.53	3.63±1.10	6.68±2.78	7.06±3.01	8.38±2.79	22.14±7.52
1-5 ^b (46)	4.89±1.87	5.61±2.42	3.95±1.05	6.56±2.92	7.26±2.71	7.82±2.83	21.65±7.34
6-10 ^c (163)	5.32±1.76	6.02±2.35	3.90±1.04	6.36±2.54	6.24±2.74	7.55±2.69	20.16±7.08
≥11 ^d (52)	5.20±2.18	6.50±2.44	4.13±.84	5.82±2.89	6.51±3.30	8.03±3.27	20.38±8.26
Test Values (F&p)	1.488&.237	1.121&.340	3.414&.018	1.313&.270	2.640&.051	2.140&.094	1.948&.121
Work unit							
Emergency Dpr ^a (69)	5.09 ±1.78	6.29±2.12	4.05±1.04	6.76±2.67	6.97±2.87	8.07±2.56	21.81±7.18
Internal Units (111)	5.30±1.79	6.02±2.42	3.91±.97	5.85±2.59	6.22±2.84	7.36±2.94	19.45±7.35
Surgical Units ^b (103)	5.32±1.83	5.70±2.66	3.92±1.04	6.01±2.74	6.18±2.81	7.86±2.88	20.12±7.16
Diagnostic Units ^c (26)	5.01±2.48	5.39±2.18	3.84±1.00	6.80±2.56	6.84±2.80	8.19±2.89	21.84±7.24
Others (Admin.) ^d (81)	4.65±2.17	6.68±2.99	3.34±1.11	7.23±2.74	7.60±3.07	8.55±2.75	23.39±7.69
Test Values (F&p)	1.751&.138	2.563&.068	3.322&.011	3.946&.004	3.710&.006	2.207&.068	4.055&.003
ISAV*							
Presence (95)	5.23±2.00	6.73±2.07	3.45±1.00	7.05±2.79	7.37±3.09	8.30±2.97	22.72±8.18
Absence (295)	5.13±1.92	5.86±2.51	4.00±1.02	6.11±2.79	6.35±2.93	7.72±2.92	20.20±7.49
Test Values (t&p)	.398 & .698	2.672 & .008	-4.035&.000	2.502 & .013	2.540 & .012	1.448 & .199	2.460 & .014

t: Student's *t* Test for independent samples; *F*: One Way ANOVA; *p*: Significant Value SS: Safety Scale; CS: Confidence Scale; WVS: Workplace Violence Scale; UWES: Utrecht Work Engagement Scale; VI: Vigor Sub-dimension; DE: Dedication Sub-dimension; AB: Absorption Sub-dimension.

Table 3. Comparison of Working Conditions with Scale Score Averages.

Variables	SS	CS	WVS	VI	DE	AB	UWES
	$\bar{x} \pm S.D$	$\bar{x} \pm S.D$	$\bar{x} \pm S.D$	$\bar{x} \pm S.D$	$\bar{x} \pm S.D$	$\bar{x} \pm S.D$	$\bar{x} \pm S.D$
Gender							
Female(173)	5.08 ± 2.02	5.78 ± 2.41	3.87 ± 1.02	6.69 ± 2.62	6.70 ± 3.05	8.23 ± 2.85	21.64 ± 7.54
Male(217)	5.14 ± 1.88	6.32 ± 2.43	3.82 ± 1.06	6.20 ± 2.78	6.64 ± 2.83	7.67 ± 2.80	20.53 ± 7.36
Test Values (t&p)	.335 & .738	2.865 & .004	-933 & .351	.581 & 1.562	1.077 & .282	2.330 & .020	1.521 & .129
Marital Status							
Married(254)	5.15 ± 1.98	6.34 ± 2.42	3.81 ± 1.067	6.48 ± 2.80	6.79 ± 3.00	8.16 ± 2.87	21.44 ± 7.56
Single(136)	5.05 ± 1.87	5.60 ± 2.39	3.91 ± 1.18	6.31 ± 2.55	6.45 ± 2.79	7.47 ± 2.72	20.24 ± 7.19
Test Values (t&p)	.475 & .635	2.865 & .004	458 & .647	.581 & .562	1.077 & .282	2.330 & .020	1.521 & .129
Age Groups (years)							
20-29 ^a (115)	5.07 ± 1.87	5.57 ± 2.28	4.01 ± 0.99	6.27 ± 2.57	5.97 ± 2.88	7.50 ± 2.83	19.75 ± 7.12
30-39 ^b (160)	5.40 ± 1.96	6.38 ± 2.29	3.86 ± 1.01	6.32 ± 2.65	6.66 ± 2.67	7.93 ± 2.79	20.92 ± 7.03
≥40 ^c (115)	4.75 ± 1.94	6.16 ± 2.70	3.66 ± 1.12	6.73 ± 2.93	7.40 ± 3.15	8.32 ± 2.87	22.46 ± 8.13
Test Values (F&p)	3.776 & .024 b>c	3.816 & .023 b>a	3.776 & .024 a>b	1.054 & .350	7.075 & .001 c>a	2.362 & .096	3.881 & .021 c>a
Education							
High School ^a (22)	4.24 ± 2.56	7.29 ± 2.19	3.59 ± 0.90	7.31 ± 2.69	8.36 ± 3.57	9.13 ± 2.88	24.84 ± 8.12
Associate Degree ^b (52)	5.16 ± 2.58	6.54 ± 2.20	3.82 ± 1.07	6.88 ± 3.00	7.05 ± 3.12	8.48 ± 2.97	22.42 ± 7.87
Undergraduate Degree ^c (183)	5.11 ± 1.84	6.04 ± 2.43	3.87 ± 1.05	6.37 ± 2.73	6.49 ± 2.95	7.89 ± 2.80	20.76 ± 7.40
Postgraduate ^d (133)	5.25 ± 1.64	5.75 ± 2.50	3.87 ± 1.05	6.16 ± 2.56	6.49 ± 2.61	7.54 ± 2.76	20.21 ± 7.05
Test Values (F&p)	1.707 & .165	3.299 & .020 a>d	.505 & .679	1.717 & .163	3.184 & .024 a>c,d	2.825 & .039 a>d	3.165 & .025 a>d
Occupation							
M.D. ^a (144)	5.32 ± 1.56	5.50 ± 2.38	3.88 ± 1.03	6.11 ± 2.33	6.36 ± 2.54	7.44 ± 2.57	19.93 ± 6.50
Nurse, Midwife ^b (176)	5.11 ± 1.87	6.17 ± 2.34	3.92 ± 1.03	6.31 ± 2.89	6.39 ± 3.00	7.82 ± 2.93	20.53 ± 7.85
Technician ^c (70)	4.70 ± 2.66	7.04 ± 2.47	3.60 ± 1.09	7.34 ± 2.86	8.00 ± 3.14	9.17 ± 2.78	24.51 ± 7.32
Test Values (F&p)	2.347 & .097	10.096 & .000 c>a,b	2.495 & .084	5.158 & .006 c>a,b	9.088 & .000 c>a,b	9.309 & .000 c>a,b	10.051 & .000 c>a,b

t: Independent Simple t Test; F: One Way ANOVA; p: Significant Value; SS: Safety Scale; CS: Confidence Scale; WVS: Workplace Violence Scale; UWES: Utrecht Work Engagement Scale; VI: Vigor Sub-dimension; DE: Dedication Sub-dimension; AB: Absorption Sub-dimension.

Table 4. Determining Predictors of Work Engagement in Healthcare Workers.

Variables	β	t	P
CS	.279	6.556	.000
SS	-.002	-.052	.958
WVS	-.473	-10.669	.000
Age	.050	.461	.645
Years of Employment	.026	.238	.812
Monthly Working Hours	-.091	2.065	.040
Monthly Average Number of Shifts	-.043	-.978	.329

R: 0.362 R²: 0.350 F: 30.914 p:0.000 Durbin Watson:1.861

SS: Safety Scale; CS: Confidence Scale; WVS: Workplace Violence Scale; UWES: Utrecht Work Engagement Scale; VI: Vigor Sub-dimension; DE: Dedication Sub-dimension; AB: Absorption Sub-dimension.

studies in various sectors, including healthcare, have found similar relationships between adverse workplace conditions and decreased engagement [19, 20, 28, 29]. However, it is also possible that workers with lower engagement may face higher WPV exposure, as reduced engagement could impact work quality and interactions with patients and visitors, potentially increasing the risk of conflict and violence.

According to the regression model, the level of exposure to workplace violence (WPV) was the variable with the highest beta coefficient, negatively impacting work engagement among healthcare workers (HCWs) (Table 4). This situation crucially illustrates the destructive effect of WPV exposure on work engagement. Behavioral and psychosocial problems are known to arise in HCWs who experience WPV [30]. A systematic review reported that violence exposure among HCWs leads to numerous issues affecting both psychological and physical health, including burnout, anxiety, stress, anger, and diminished trust [6]. These issues contribute to a complex interplay of factors where WPV can amplify existing stressors, potentially accelerating burnout—often viewed as the opposite of work engagement [31, 32]. WPV appears to be strongly associated with reduced work engagement and may add to other psychosocial risks among healthcare workers. The potential direct and indirect effects of

WPV highlight its significance as an important factor affecting work engagement.

The WPV that has assumed global pandemic status among HCWs can lead to significant individual and organizational consequences [33, 34]. The adverse effects on employee health negatively impact work performance and hinder healthcare services delivery [35]. As far as these aspects are concerned, WPV continues to undermine healthcare systems [36]. Therefore, a systematic approach to addressing risk factors in combating WPV among HCWs is essential [37]. Consistent with the literature, this study identifies risk factors for WPV exposure, such as working in the ED, young age, lack of experience, and night shifts with heavy workloads [37–39]. Solving the problem requires specific organizational measures to address these risk factors. However, it is noteworthy that young and inexperienced HCWs and those working in EDs also tend to have lower work engagement (Table 2). The coexistence of WPV and low work engagement among these HCWs highlights the potential causal relationship between the two. Furthermore, the findings related to young HCWs are particularly significant, as they underscore a potential threat to the future of the healthcare workforce.

HCWs demonstrating WPV management capability exhibited higher work engagement levels (Table 4). The healthcare sector is identified as one of the most common settings for WPV (WHO 2002), and in this respect, it is considered one of the riskiest work environments [40]. Especially in high-risk units such as emergency and psychiatry, WPV has become almost routine for those directly involved in patient care [6, 41]. In the healthcare sector, the source of WPV is often the patient or their family members, who directly receive the service [7, 42]. Therefore, implementing primary prevention methods, such as eliminating WPV among HCWs, may not always be feasible. Secondary prevention methods, such as managing violent incidents and employing effective communication, can be crucial to mitigating violence's effects. Indeed, a systematic review has demonstrated that developing violence management skills, including appropriate communication and tension reduction, can minimize the impact of WPV [43]. Our findings support the

idea that HCWs can mitigate negative outcomes by developing skills in managing WPV. One of the study's most relevant findings is that skills in managing WPV can support work engagement among HCWs.

According to the study findings, younger HCWs exhibit a lower average score in managing WPV than their older counterparts (Table 2). In this regard, it can be observed that, similar to exposure to WPV, younger HCWs are more threatened by their ability to manage WPV. In addition to being young, another prominent risk factor in managing violence is the gender of HCWs. The lower average score in the ability to manage violence for female HCWs is significant in the healthcare sector, where female labor is predominant (Table 2). Female HCWs may experience gender discrimination and harassment from patients at work [44]. Especially considering the societal gender roles that work against women in the professional environment,[45] specific measures need to be taken for female and young employees among HCWs in terms of skills in managing WPV.

The study also found that working hours are a significant predictor of work engagement. Healthcare workers' increase in working hours reduces work engagement (Table 4). The adverse effects of overwork were most acutely felt during the recent COVID-19 pandemic. Research conducted during this period indicates that overwork threatens HCW health in various ways [46]. In general, increasing working hours among HCWs plays a mediating role, contributing to increased burnout and decreased work engagement [13]. A negative impact of overwork on work engagement is also reported by research in other sectors [47]. Literature evidence supports our finding (Table 2) that HCWs who work more than 200 hours have significantly lower VI (Table 2). Our study also found that overtime and extra shifts increase WPV (Table 2). In addition to the known adverse effects of overwork, our findings suggest that it may reduce work engagement by increasing WPV exposure.

In the study, physicians and nurses had lower total and subdimension scores for UWES (VI, DE, AB) than other healthcare workers (Table 2). In recent years, the emigration of Turkish physicians has become a prominent issue, with workplace violence

(WPV) believed to have a significant impact on this trend [48]. The emigration of nurses from Turkey is also notable, though it receives less coverage in the media and literature [49]. One of the primary reasons employees leave their jobs is a decline in work engagement [50]. The study found that healthcare workers with higher education levels (postgraduate graduates) exhibited weaker skills in managing violence and lower work engagement (Table 3). These findings indicate that exposure to WPV may contribute to the emigration of Turkey's qualified healthcare workforce; however, more evidence is needed to confirm this hypothesis.

Institutional support against violence enhances the skills of healthcare workers (HCWs) in handling violence and fosters higher levels of work engagement (UWES). Consistent with these findings, participants who reported receiving sufficient institutional support experienced lower exposure to violence (Table 3). Social and institutional supports are vital in preventing the negative consequences of violence among HCWs [9]. In this context, developing and implementing institutional policies to address workplace violence (WPV) in health facilities is necessary.

4.1. Strengths and Limitations

The research was conducted at a tertiary hospital. Different violence dynamics may exist in secondary and primary healthcare institutions. Further, as the study HCW participants were those who voluntarily chose to participate. This situations may limit the generalization of the results to all HCWs. The study could affect data accuracy due to participants' recollections. The study data were collected within a specific time frame. This provided limited information on how WPV impacts job commitment changes in the long term. Additionally, the fact that the study was conducted at a single center may moderately affect the results based on cultural and societal changes. WPV exposure assessment was based on HCWs' expressions. HCWs were reluctant to discuss their WPV exposure, leading to significant data loss. Moreover, convenience sampling was used in the study, which limited its inclusion of subgroups such as gender.

5. CONCLUSION

This study highlights the significant association between workplace violence (WPV) exposure, WPV management skills, working hours, and work engagement among healthcare workers (HCWs). The findings underscore that increased exposure to WPV and inadequate management skills are key factors potentially diminishing work engagement and contributing to adverse psychosocial outcomes. Furthermore, the data suggest that extended working hours may also play a role in reducing engagement by amplifying stress and increasing WPV exposure.

Notably, WPV management skills emerge as a critical component for supporting HCWs' engagement and resilience in high-risk environments. This underscores the importance of equipping HCWs with practical skills for managing WPV, which may not only improve their engagement but also mitigate the negative effects of violence in healthcare settings. Addressing these issues through institutional policies and support systems is essential to fostering a safer, more supportive work environment for HCWs.

In sum, while the study's cross-sectional design limits causal conclusions, the findings indicate that WPV and related workplace conditions warrant priority attention in efforts to support HCW engagement and well-being. Future research, particularly longitudinal studies, is essential for clarifying these relationships and informing interventions that can enhance healthcare work environments.

INSTITUTIONAL REVIEW BOARD STATEMENT: The study was conducted according to the guidelines of the Declaration of Helsinki. An ethics committee approval was obtained from Health Science University Gazi Yaşargil Training and Research Hospital before the study started (March 03, 2023, Number 341).

INFORMED CONSENT STATEMENT: Informed consent was obtained from all subjects involved in the study.

DECLARATION OF INTEREST: The authors declare no conflict of interest.

AUTHOR CONTRIBUTION STATEMENT: H.B and M.Ö designed and implemented the study together. The results were

analysed and reported by H.B. The final version of the manuscript was prepared jointly by H.B and M.Ö. to the analysis of the results.

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Presenteeism and Its Associated Factors Among Teachers

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KEYWORDS: Presenteeism; Teachers; Health Problems; Job Demands; Job Control

ABSTRACT

Background: Teaching is a mentally and physically demanding profession, often performed under challenging and stressful conditions. In Egypt, the lack of school resources, low teacher salaries, poor organizational climate, and high work pressures represent just a few challenges faced by the educational system. These difficulties can adversely affect teachers' health, leading to negative outcomes such as presenteeism. Despite this, no studies have assessed presenteeism among Egyptian teachers. Therefore, this study aimed to estimate the prevalence of presenteeism and identify associated factors among public school teachers. **Methods:** A cross-sectional study was conducted involving 373 teachers using an interview-administered questionnaire to gather information on their sociodemographic, occupational, and medical characteristics, along with their Stanford Presenteeism Scale scores and responses to the Job Content Questionnaire. **Results:** The prevalence of presenteeism among the teachers studied over the last 12 months was 70.8%. Of these, 74.6% had lower presenteeism scores, reflecting diminished performance in work activities. Key independent predictors of presenteeism included being a female teacher, having additional jobs, experiencing musculoskeletal and/or respiratory health issues, facing high job demands, and possessing low job control. The Adjusted Odds Ratios (AOR) for these factors were 4.1, 5.1, 3.1, 11.7, and 11.7, respectively. **Conclusion:** Presenteeism is highly prevalent among public school teachers in Egypt. Therefore, teachers with significant predictors of presenteeism should be given increased attention.

1. INTRODUCTION

An individual's health is considered a valuable possession. Without it, basic life activities such as work can be limited or impossible [1]. Absenteeism among workers has been used as an indicator to assess their health. Evaluations are based on the assumption that workers in the workplace are fully healthy and productive. These results do not precisely reflect overall health since workers are often present at work when they are not feeling well and not functioning to their full capacity, which reduces

productivity below normal quality, a phenomenon known as presenteeism [2-4].

Presenteeism is a global phenomenon that has attracted research interest in recent years due to its increasing prevalence and impact on health, public health, and labor productivity [3, 5]. The causes of presenteeism are complex and may be work-related or organizational, including job insecurity, fear of losing income, strict absence policies, downsizing, understaffing, work overload, overtime, elevated job demands, employee-employer relations, job dissatisfaction, and experienced stress [1, 5-8]. Personal

factors such as age, sex, occupation, education, and state of health can also contribute to presenteeism [2]. Presenteeism-related exposures differ by sector and are common in occupations that require extensive social and interpersonal communication skills, including workers in education, care, and welfare sectors (e.g., teachers, nursing and midwifery professionals, and nursing home aides) [6, 9].

Teaching is carried out under unfavorable and stressful circumstances, in which teachers mobilize their physical, cognitive, and affective capacities, as well as their psychophysiological functions, to achieve teaching production objectives, leading to various physical and mental health problems [10]. A study conducted by Aronsson et al. [6] found the highest prevalence of presenteeism in the education sector (46.0%), followed by health care and welfare (44.0%). According to Olejniczak et al., [11] the teaching profession exhibits the highest level of presenteeism compared to nurses and private sector office workers.

The quality of work is usually affected by presenteeism since it can result in errors or omissions, leading to lower productivity and higher costs. The costs associated with lost productivity due to presenteeism exceed the sum of those associated with absenteeism and medical care [12]. The implications of presenteeism are sharper in the school context since the on-site educational model relies on teacher-student interaction. Disruptions in that interaction due to the teachers' sickness can result in lower performance, motivation, and connections between teachers and students [13].

In Egypt, the number of pre-university education teachers was estimated at 1,025,842 in 2019/2020 [14]. A lack of school resources, low teacher salaries, poor organizational climate, and work pressure are just a few challenges facing the Egyptian educational system [15]. The prevalence of presenteeism has been documented in earlier studies conducted on intensive care nurses [16] and train drivers [17]. However, to the authors' knowledge, there is a lack of data on presenteeism among school teachers. Therefore, to address this research gap, the current study aimed to estimate the prevalence of presenteeism and identify its associated factors among public school teachers in Egypt.

2. METHODS

2.1. Study Design and Setting

A cross-sectional study was conducted in public schools in Aga City, Dakahlia governorate, about 150 km northeast of Cairo, Egypt, from February to March 2024.

2.2. Sample Size

The sample size was calculated using Open-Epi software (<https://www.openepi.com/SampleSize/SSPropor.htm>). Based on a prevalence rate of 65.2% among public school teachers [3], with a precision level of 5.0% and a confidence level of 95.0%, the minimum required sample size was 349 participants.

2.3. Study Population and Sampling Method

The study targeted teachers employed in public schools. Eligible criteria included full-time school teachers with at least one year of teaching experience, currently on duty, and teaching any school subject. Using stratified random sampling, a frame of all public schools was obtained from the Aga Educational Administration. Aga City includes 14 public schools. Egypt's educational system classified schools into primary, preparatory, general, and technical secondary schools. One school was selected randomly from each section. The total number of teachers employed at the Dakahlia Directorate of Education is approximately 55,211, of which 35,263 are female and 19,948 are male [14]. In the Aga district, which includes both urban and rural areas, there are around 3,068 public school teachers. Approximately one-third of these teachers, or 1,020, work in public schools in Aga City. All eligible teachers working in the enrolled schools were invited to participate in the data collection process, with 406 teachers. Of these, 373 participants completed the questionnaire, resulting in a response rate of 91.9%.

2.4. Study Tools

An interviewer-administered questionnaire involved the following sections.

- Sociodemographic, occupational, and medical data, including sex, age, residence, marital status, teaching qualifications, smoking habits, years spent in the teaching profession, school level (primary, preparatory, general secondary, or technical), participation in additional jobs besides the current ones, and self-reported health issues within the last 12 months.
- The Arabic-validated version of the Stanford Presenteeism Scale (SPS-6) was utilized to gather data on presenteeism. It had been employed in a prior study conducted in Egypt to evaluate presenteeism among nursing staff in intensive care units, where its reliability was determined to be 0.80 [16]. The scale comprises two parts. In the first part, presenteeism prevalence is assessed by posing the following question: "In the past 12 months, have you ever come to work despite feeling unwell or having a health issue (physical/mental) that hindered you from performing your tasks normally?" When presenteeism was identified in the first part, the second part was completed. It included two distinct dimensions: completing work (items 2, 5, and 6), which refers to the amount of work carried out despite presenteeism, and avoiding distraction (items 1, 3, and 4), which determines the level of concentration needed to perform effectively while unwell. Both dimensions were evaluated using a five-point Likert-type response scale ranging from 'strongly disagree' to 'strongly agree', with 'uncertain' serving as the neutral, third option. In the completed work dimension, a score of 5, "totally disagree", indicates the least favorable condition, whereas, in the avoided distraction domain, it corresponds to a score of 1, "totally agree". The total score on SPS-6, ranging from 6 to 30, is calculated by summing all responses across the two dimensions. Lower scores (from 6 to 18) signify diminished performance in work activities due to presenteeism, while higher scores (from 19 to 30) indicate better work performance despite the presence of presenteeism [18].
- The job content questionnaire utilized a demand control model and was rated on a 4-point Likert scale: strongly disagree (1), disagree (2), agree (3), and strongly agree (4). It included psychosocial job demands (5 items: working quickly, working hard, excessive workload, insufficient time, and conflicting demands) and job control (9 items) encompassing decision authority (3 items: ability to make decisions, limited decision freedom, and significant input) as well as skill discretion (6 items: learning new skills, high skill level, repetitive tasks, requiring creativity, various tasks, and developing personal abilities). Both the psychosocial job demands and job control scores were dichotomized using median cut-off points to categorize them as high ($\geq$ median score) and low ($<$ median score) values for each scale [19]. A validated Arabic version of the Job Content Questionnaire was employed, adapted from a study conducted in the United Arab Emirates, which showed a reliability of 0.86 for psychological job demand and 0.70 for job control [20].

2.5. Statistical Analyses

Data were coded, tabulated, and analyzed using SPSS version 22. Categorical data were expressed as numbers and percentages, whereas continuous data were presented as mean $\pm$ standard deviation. The Chi-square test was used to test significance in bivariate analysis, and crude odds ratios (COR) and their 95% Confidence Interval (CI) were calculated. The Fisher Exact Test was used for categorical variables when the expected cell count was less than 5 in four cell tables. A multivariate logistic regression model using the enter method was applied to create a model that included only the most relevant and significant predictors of presenteeism. The adjusted odds ratio (AOR) and their 95% CI were calculated. Independent t-test and one-way ANOVA were used to compare the means of the Stanford Presenteeism Scale (SPS-6) score. Post hoc Tukey test was used to detect pair-wise comparison for continuous variables following a significant ANOVA test. Multiple

linear regression analysis was performed to identify independent predictors of SPS-6 among teachers with presenteeism. p -value ≤ 0.05 was considered to be statistically significant.

3. RESULTS

Table 1 illustrates that the mean age of the studied teachers was 48.6 ± 6.7 years. More than half of the participants were female and rural residents. The majority of teachers were married, educated up to the university level, and non-smokers. The mean teaching experience of the teachers studied was 22.8 ± 7.1 years, with (27.9%) of them working in primary school. Nearly (40.0%) of the studied teachers gave private tuition after the end of the school day, while only (12.6%) had a second evening job apart from teaching, such as working in retail shops, bookstores, and printing presses. More than half of the participants reported experiencing one or more health problems in the last 12 months, with musculoskeletal system problems being the most prevalent, followed by respiratory system problems and voice problems.

Table 1. Sociodemographic, occupational, and medical profiles of the studied teachers (No. = 373).

Variable		No. (%)
Sex	Female	198 (53.1)
	Male	175 (46.9)
Age (years), mean $\pm$ SD		48.6 ± 6.7
Residence	Rural	196 (52.5)
	Urban	177 (47.5)
Marital status	Single	6 (1.6)
	Married	351 (94.1)
	Widow	13 (3.5)
	Divorced	3 (0.8)
Qualification	Secondary technical school	3 (0.8)
	Intermediate institute	11 (2.9)
	University	359 (96.2)
Current smoking	Smoker	55 (14.7)
	Non-smoker	318 (85.3)

Variable		No. (%)
Teaching experience (years), mean $\pm$ SD		22.8 ± 7.1
School level	Primary	104 (27.9)
	Preparatory	92 (24.7)
	Secondary	81 (21.7)
	Technical	96 (25.7)
Additional jobs	Private tuition after the end of the school day	148 (39.7)
	Others ^a	47 (12.6)
One or more health problem	Yes	201 (53.9)
	No	172 (46.1)
Type of health problems ^b	Musculoskeletal	107 (28.7)
	Respiratory	28 (7.5)
	Voice	18 (4.8)
	Gastrointestinal	15 (4.0)
	Hypertension	15 (4.0)
	Headache/migraine	14 (3.8)
	Genitourinary	7 (1.9)
	Diabetes mellitus	4 (1.1)
	Depression	3 (0.8)
	Dental	3 (0.8)
	Auditory	2 (0.5)
	Hypothyroidism	1 (0.3)

^aothers including retail shops, bookstores, and printing presses;

^bcategories are not mutually exclusive.

Table 2 shows that the prevalence of presenteeism among teachers in the last 12 months was (70.8%). Among them (74.6%) had lower presenteeism scores, while only (25.4%) had higher presenteeism scores. The mean scores for SPS-6, completing work, and avoiding distraction were 14.4 ± 5.7 , 7.1 ± 2.9 , and 7.3 ± 3.0 , respectively.

In Table 3, significant risk factors associated with presenteeism among the studied teachers in the bi-variate analysis include being under the age of 49, being female, having less than 23 years of teaching experience, working as basic education teachers, having additional jobs, giving private tuition, experiencing health problems, facing high job demands,

Table 2. Presenteeism among teachers (No. = 373) in the last 12 months.

Variable		No. (%)
Presenteeism		264 (70.8)
SPS-6 score	Lower scores ^a (6-18)	197 (74.6)
	Higher scores ^b (>18)	67 (25.4)
	mean $\pm$ SD	14.4 $\pm$ 5.7
SPS-6 dimensions	Completing work, mean $\pm$ SD	7.1 $\pm$ 2.9
	Avoiding distraction, mean $\pm$ SD	7.3 $\pm$ 3.0

^aLower scores denote reduced work performance due to presenteeism.

^bHigher scores denote better work performance despite presenteeism.

and having low job control. The multivariate logistic regression analysis demonstrated that the significant independent predictors of presenteeism were female teachers, having additional jobs, experiencing musculoskeletal and/or respiratory health problems, high job demands, and low job control.

Table 4 reveals that the mean SPS-6 score was significantly lower among teachers who were younger than 49, had fewer than 23 years of teaching experience, held additional jobs, provided private tutoring, experienced musculoskeletal and/or respiratory health problems, faced higher job demands, and had lower job control. A lower SPS-6 score reflects a reduced ability to concentrate and perform work effectively.

Table 5 presents the results of the multiple linear regression model analyzing independent predictors of the SPS-6 among teachers experiencing presenteeism. Higher job demand ($\beta = -0.44$, $p < 0.001$), lower job control ($\beta = 0.28$, $p < 0.001$), and the presence of musculoskeletal and/or respiratory health problems ($\beta = -0.16$, $p = 0.028$) were independently associated with lower SPS-6 score.

4. DISCUSSION

Presenteeism is a critical issue in occupational health, adversely affecting workers' health and organizational productivity. It is more prevalent in occupations that require high attendance, and teachers are no exception [21, 22]. In the present study, the

prevalence of presenteeism among teachers was 70.8%. This rate is higher compared to that reported among teachers in Germany (57.1%)[23], Brazil (42.8%)[24], and León, Nicaragua (65.2%)[3]. The increased prevalence in our study may be attributed to several factors. First is the sense of duty and commitment to students; thus, teachers strive to minimize canceled lessons to enhance quality and improve the educational system's ranking. Egypt's education system is ranked very low, at 133 out of 137 in terms of the quality of primary education and 130 in the overall quality [25]. Second, there are strong work ethics, as teachers' absences place excessive burdens on their colleagues with additional workloads. Third, public employees in Egypt are allowed only a limited number of paid sick days per year, and exceeding this limit results in pay reductions. Lastly, there is a staffing shortage since many teachers have reached retirement age without being replaced. In contrast, this presenteeism rate was lower than that reported by de Perio et al., who found that (77.0%) of American school employees with influenza-like illnesses reported working while ill [26].

One risk factor for presenteeism among teachers in the current study was being under 49 years old, consistent with previous studies [27, 28], highlighting that presenteeism is more prevalent among younger to middle-aged workers. This finding likely resulted from stricter attendance requirements for junior staff. Conversely, our result opposed the findings of Dudenhöffer et al. [23] and Rojas-Roque & López-Bonilla [3], who did not identify a significant association between age and presenteeism among school teachers.

Consistent with previous studies [28, 29], female teachers were significantly more likely to experience presenteeism than their male counterparts, although other studies found no correlation between gender and presenteeism [3, 23, 26]. This gender difference may be attributed to women's multiple roles compared to men, who do not have to manage the overwhelming household responsibilities associated with being mothers, wives, sisters, and daughters-in-law [15]. Furthermore, many women are compelled to work at the expense of their health due to financial stress, as they cannot afford to stay home and lose their salary. Another possible explanation could be the

Table 3. Factors associated with presenteeism and its independent predictors among studied teachers.

		Total	Presenteeism				
Risk factor / Category		No.	No. (%) ^a	Bivariate analysis		Multivariate analysis	
Overall		373	264 (70.8)	p-value	COR (95%CI)	p-value	AOR (95%CI) ^e
Sociodemographic							
Age (years)	< 49	174	148 (85.1)	< 0.001	4.1 (2.5- 6.7)	0.353	0.5 (0.1- 2.1)
	≥ 49	199	116 (58.3)		ref		ref
Sex	Female	198	157 (79.3)	< 0.001	2.4 (1.5-3.9)	0.002	4.1 (1.8-10.2)
	Male	175	107 (61.1)		ref		ref
Residence	Rural	196	136 (69.4)	0.535	0.9 (0.6-1.3)	0.101	0.6 (0.3-1.1)
	Urban	177	128 (72.3)		ref		ref
Marital status	Married	351	248 (70.7)	0.836	0.9 (0.3-2.4)	0.384	0.5 (0.1-2.2)
	Unmarried	22	16 (27.7)		ref		ref
Qualification	Less than university	14	9 (85.7)	0.368	2.5 (0.6- 11.6)	0.117	4.5 (0.7-29.7)
	University	359	252 (70.2)		ref		ref
Current smoking	Smoker	55	36 (65.5)	0.347	0.7 (0.4- 1.4)	0.783	1.1 (0.4-3.1)
	Non-smoker	318	228 (71.7)		ref		ref
Occupational							
Teaching experience (years)	< 23	173	149 (86.1)	< 0.001	4.6 (2.7-7.7)	0.186	2.5 (0.6-9.7)
	≥ 23	200	115 (57.5)		ref		ref
School level ^b	Basic	196	148 (75.5)	0.034	1.6 (1.1- 2.5)	0.222	1.6 (0.8-3.2)
	Secondary	177	116 (65.5)		ref		ref
Additional jobs ^c	Yes	196	152 (77.6)	0.002	2.0 (1.8- 3.1)	0.008	5.1 (1.5- 17.3)
	No	177	112 (63.3)		ref		ref
Private tuition	Yes	148	117 (79.1)	0.004	2.0 (1.2- 3.2)	0.248	0.5 (0.2-1.6)
	No	225	147 (65.3)		ref		ref
Medical							
Health problem	Musculoskeletal and/or respiratory	133	107 (80.5)	< 0.001	2.7 (1.6- 4.5)	0.029	3.1 (1.1- 8.6)
	Others ^d	67	52 (77.6)	0.013	2.2 (1.2-4.3)	0.383	0.6 (0.2- 1.8)
	No	173	105 (60.7)		ref		ref
Psychosocial							
Job demands	High (≥ 13)	205	188 (91.7)	< 0.001	13.4 (7.5-23.9)	< 0.001	11.7 (4.6- 29.4)
	Low (< 13)	168	76 (45.2)		ref		ref
Job control	Low (< 20)	177	168 (94.9)	< 0.001	14.4 (9.4- 40.2)	< 0.001	11.7 (5.0 – 27.0)
	High (≥ 20)	196	96 (49.0)		ref		ref

ref: reference category; *COR*: crude odds ratio; *AOR*: adjusted odds ratio; *Bold values highlight the significant results*

^aPercentages were calculated using row totals.

^bBasic comprised primary and preparatory schools, whereas secondary included general and technical schools.

^cAdditional jobs besides teaching include private tuition or others like working in retail shops, bookstores, and printing presses.

^dOther health problems include voice, gastrointestinal, hypertension, headache/migraine, genitourinary, diabetes mellitus, depression, dental, auditory, and hypothyroidism.

^eModel $\chi^2 = 212.2$, $p < 0.001$, % correctly predicted = 86.3%, and constant = -6.64.

Table 4. Distribution of Stanford Presenteeism Scale score according to teachers' sociodemographic, occupational, and medical characters.

Variable / Category		Total No. 264	SPS-6 score mean ± SD	p-value
Sociodemographics				
Age (years)	< 49	148	13.0 ± 5.3	< 0.001
	≥ 49	116	16.1 ± 5.6	
Sex	Female	157	13.9 ± 5.9	0.098
	Male	107	15.1 ± 5.3	
Residence	Rural	136	14.5 ± 5.5	0.688
	Urban	128	14.2 ± 5.9	
Marital status	Married	248	14.3 ± 5.6	0.921
	Unmarried	16	14.5 ± 6.7	
Qualification	Less than university	12	16.8 ± 5.1	0.123
	University	252	14.2 ± 5.7	
Current smoking	Smoker	36	15.2 ± 4.5	0.330
	Non-smoker	228	14.2 ± 5.8	
Occupational				
Teaching experience (years)	< 23	149	12.9 ± 5.3	< 0.001
	≥ 23	115	16.3 ± 5.6	
School level	Basic	148	14.8 ± 5.5	0.149
	Secondary	116	13.8 ± 5.8	
Additional jobs	Yes	152	13.7 ± 5.1	0.039
	No	112	15.2 ± 6.3	
Private tuition	Yes	117	13.0 ± 4.7	< 0.001
	No	147	15.5 ± 6.2	
Medical				
Health problem	Musculoskeletal and /or respiratory ^a	107	13.1 ± 5.6	0.037
	Others [*]	52	14.0 ± 6.0	
	No ^a	105	15.4 ± 5.2	
Psychosocial				
Job demands	High (≥ 13)	188	12.8 ± 4.8	< 0.001
	Low (< 13)	76	18.1 ± 5.7	
Job Control	High (≥ 20)	168	16.3 ± 5.8	< 0.001
	Low (< 20)	96	13.3 ± 5.3	

assignificant difference between groups within the same column using ANOVA with the post hoc Tukey test.

**Other health problems include voice, gastrointestinal, hypertension, headache/migraine, genitourinary, diabetes mellitus, depression, dental, auditory, and hypothyroidism.*

higher prevalence of women in the teaching profession in Egypt [15, 30, 31], as observed in our study, where more than half of the surveyed teachers were female.

Dual employment, long workdays, and excessive overtime can negatively impact an individual's quality of life, putting their physical and mental health at risk and leading to unfavorable outcomes

Table 5. Multiple linear regression of independent predictors of the Stanford Presenteeism Scale among teachers with presenteeism (n=264).

Variable	Univariate linear regression		Multiple linear regression	
	β (95% CI)	p-value	β (95% CI)	p-value
Age (years)	0.31 (0.17 - 0.37)	< 0.001	-0.09 (-0.41 - 0.25)	0.630
Sex	0.10 (-0.22 - 2.58)	0.098	0.07 (-0.71 - 2.34)	0.296
Residence	-0.02 (-1.66 - 1.10)	0.688	-0.08(-2.10 - 0.19)	0.101
Marital status	-0.006 (-3.04 - 2.75)	0.921	-0.04(-3.31 - 1.36)	0.412
Qualification	-0.09 (-5.88 - 0.71)	0.123	-0.06(-4.45 - 1.41)	0.308
Current smoking	-0.06 (-3.0 - 1.01)	0.330	0.03 (-1.38 - 2.27)	0.630
Teaching experience (years)	0.34 (0.19 - 0.38)	< 0.001	0.16 (-0.19 - 0.46)	0.415
School level	-0.09 (-2.40 - 0.37)	0.149	0.03 (-0.98 - 1.56)	0.648
Additional jobs	0.13 (0.08 - 2.84)	0.039	0.003 (-1.88 - 1.95)	0.974
Private tuition	0.22 (1.12 - 3.83)	< 0.001	0.17 (0.26 - 3.72)	0.054
Musculoskeletal/respiratory health problems	-0.15 (-3.01 - -0.31)	0.017	-0.16 (-3.42 - -0.19)	0.028
Other health problems	0.06 (-0.67 - 2.06)	0.363	-0.07 (-2.34 - -0.70)	0.275
Job demands	-0.55 (-1.37 - -0.94)	< 0.001	-0.44 (-1.18 - -0.67)	< 0.001
Job Control	0.35 (0.40 - 0.78)	< 0.001	0.28 (0.29 - 0.65)	< 0.001
Constant			22.44	
Significance			F=12.68, p<0.001	
R ²			0.384	

β : regression coefficient; CI: Confidence Interval; Model F: Model Analysis of Variance F test; Model R²: Model R square. Age (years), teaching experience (years), job demands, and job control were entered into the regression model as continuous variables. Qualitative variables were included in the model as dummy variables, coded as follows: sex (female = 0, male = 1), residence (rural = 0, urban = 1), marital status (unmarried = 0, married = 1), qualifications (less than university = 0, university = 1), current smoking status (yes = 0, no = 1), school level (basic = 0, secondary = 1), additional jobs (yes = 0, no = 1), private tuition (yes = 0, no = 1), Musculoskeletal and/or respiratory health problems (yes = 0, no = 1), and other health problems (yes = 0, no = 1).

like presenteeism [32, 33]. Additional jobs besides teaching were a significant independent predictor of presenteeism among school teachers in this study. This was in close agreement with a survey conducted among Japanese workers where presenteeism was associated with overtime hours (OR: 0.91; 95% CI, 0.843–0.989) [34]. Also, in Egypt, Elsherbiny et al. [16] demonstrated a significantly higher prevalence of presenteeism among the studied nurses who had an additional job. Furthermore, nearly (40.0%) of the teachers in the present study gave private tuition after the end of the school day. This figure was higher than previous studies conducted in Egypt by Abo-Hasseba et al. [35] (12.9%) and Fahmy et al. [31] (32.3%). The poor status of teacher salaries in Egypt

may explain the observed results since the average annual salary for Egyptian teachers is only 460 \$, which is less than half the country's average annual per capita income, forcing them to double their work hours and also work as private tutors to increase their incomes. They do this since they need to be able to live off of their occupation. As they studied for this occupation earlier in life, they cannot switch careers to more successful ones now [15, 30].

The present study indicates that over half of the teachers reported one or more health problems in the last 12 months. The multivariate analysis revealed a significant association between presenteeism and musculoskeletal and/or respiratory health issues, contributing to a higher rate of presenteeism

among teachers in this study. These findings are consistent with earlier research by Coledam et al. [24], showing that teachers with musculoskeletal pain had a higher presenteeism rate ratio (RR (CI 95%) = 2.62 (1.53–4.48)). Another Brazilian study found that teachers self-rating their health poorly had higher presenteeism rates in both bivariate and multivariate analyses (RR = 3.44 and 1.74, respectively) [36]. Our results may reflect Egyptian teachers' challenges in public schools, such as overcrowded classrooms exceeding 40 students and inadequate facilities, adversely affecting their performance. Furthermore, teachers must navigate interactions with children, administrators, and colleagues, which requires them to fulfill multiple roles [15]. These factors contribute to unfavorable work conditions, leading to various physical and mental health issues among teachers. Consequently, employees are often forced to choose between sickness absence, or presenteeism. If presenteeism stems from these choices, more frequent health problems will lead to more instances of presenteeism [37]. In agreement with several studies [34, 38–41], this survey found that high job demands predict presenteeism among teachers. Limited substitutes, heavy workloads, and strict deadlines pressure employees to show up even when sick [38].

In our study, the adjusted regression model revealed that low job control significantly predicts presenteeism among the participants. This result is highlighted in the literature [40, 42]. In contrast to our findings, Janssens et al. [39] reported no association between job control and presenteeism. At the same time, Gerich [43] concluded that high levels of job control correlate with an increased need for presence despite sickness. This discrepancy regarding the connection between job control and presenteeism may stem from the notion that low-control jobs are typically viewed as less healthy, negatively impacting job engagement, suggesting that presenteeism could reflect the worker's health status [39, 44]. Another potential explanation for this association might come from avoidance motives, such as the fear of punishment or job loss due to frequent absenteeism [43]. Conversely, high-control jobs could pose a risk for presenteeism since workers can adapt their work conditions to match their current physical and mental abilities [39].

5. CONCLUSIONS AND RECOMMENDATIONS

Presenteeism is highly prevalent among public school teachers in Egypt, with more than two-thirds having lower scores, indicating a reduced performance in work activities. Different individual, occupational, medical, and psychosocial factors were significant predictors of presenteeism, including female teachers, having additional jobs, experiencing musculoskeletal and/or respiratory health problems, facing high job demands, and having low job control. Therefore, these findings emphasize the necessity of appropriate interventions by the relevant Egyptian authorities to reduce or prevent presenteeism and mitigate its impacts. These interventions should include periodic medical surveillance and evaluation, especially for teachers with higher rates of presenteeism. Both teachers and administrators should be educated about the factors contributing to presenteeism and the harmful influence of presenteeism on work and health. Finally, A large-scale national study with a representative sample is highly recommended for future research.

5.1 Limitations

While our study's cross-sectional design enabled us to reveal associations between risk factors and presenteeism among school teachers, it cannot establish causality since the temporal relationships between the independent variables and the outcomes remain unknown. This limitation emphasizes the need for further investigation into the factors most significantly contributing to presenteeism.

Although this study was conducted at a single center, its insights provide valuable evidence that can inform strategies for effectively addressing presenteeism. Our data, drawn solely from public school teachers, offer a focused understanding of this demographic while also urging caution in generalizing the findings. Lastly, since our variables were assessed through self-reporting, there is an inherent risk of recall bias. Utilizing internationally validated tools such as the SPS-6 and job content questionnaires enhances the credibility of our findings and underscores the critical issues at hand.

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INSTITUTIONAL REVIEW BOARD STATEMENT: The study protocol was approved by the Institutional Review Board (IRB), Faculty of Medicine, Mansoura University, (code number: R.24.02.2500).

INFORMED CONSENT STATEMENT: Following the assurance of confidentiality and anonymity of data, which are never to be used for any other purpose than scientific research, informed written consent was obtained from teachers who agreed to participate in the study.

AUTHOR CONTRIBUTION STATEMENT: HS contributed to the conception and design of the study, wrote the protocol, obtained ethics committee approval, collected, analyzed, and interpreted the data, and drafted the manuscript. AE also contributed to the study's conception and design, revised the data analysis and interpretation, and critically reviewed the final draft of the manuscript. All authors have reviewed and approved the final version of the manuscript.

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Assessing the Impact of Asthma: A Cross-Sectional Study in Workers Undergoing Therapy

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KEYWORDS: Asthma; Work Productivity; Activity Impairment; Employment

ABSTRACT

Background: This study aimed to investigate the impact of asthma on work productivity among adults receiving asthma therapy. **Methods:** A cross-sectional study involving 101 asthmatic patients treated at the Pulmonology Department of University Hospital in Mahdia (Tunisia) who had been employed for at least six months was conducted over the course of a year. Recruited patients were asked to complete a self-administered questionnaire that consisted of the Simplified Medication Adherence Questionnaire (SMAQ), the Work Productivity and Activity Impairment (WPAI), and the Pichot questionnaire. **Results:** The study's participants had a sex ratio of 0.51 and a mean age of 44.1 ± 13.2 years. Exposure to aerocontaminants was high among 64.4% of patients. The majority of the patients were treated with inhaled corticosteroids (ICS) and long-acting beta-agonists (LABA) (54.4%), and nearly half were classified as having moderate asthma. Our findings revealed significant challenges faced by these patients, with 62.4% experiencing poorly controlled or uncontrolled asthma. Additionally, 69.3% were non-adherent to treatment, and 71.3% reported worsening symptoms while at work. They worked an average of 38.3 ± 16.4 hours per week. The impact of general health status on work productivity was measured at 3.3 ± 2.5 . Absenteeism and presenteeism rates were 4.2% and 33.1%, respectively, resulting in a productivity loss of 30.4%. Activity impairment was associated with factors such as gender, alcohol consumption, and uncontrolled asthma. **Conclusion:** Addressing asthma control, working conditions, and mental health emerges as essential strategies to enhance workplace productivity. When evaluating the effectiveness of interventions among active asthmatic patients, presenteeism, absenteeism, and productivity loss should be considered.

1. INTRODUCTION

Asthma is a heterogeneous disease, usually characterized by a chronic inflammation of the airways [1]. It is defined by a history of respiratory symptoms such as wheezing, chest tightness, dyspnea, and cough, that vary in frequency and intensity, associated all along with expiratory airflow limitation

(confirming that when FEV1 is reduced, FEV/FVC is reduced in spirometry) [2]. It is considered the world's most common chronic respiratory disease, currently affecting almost 300 million people worldwide [3].

This serious pathology affects individuals of all age groups, and its frequency is clearly on the rise, especially in developing countries [2]. Its prevalence

worldwide is estimated to range from 1% to 18% in both adults and children [2, 3]. In fact, the mortality rate during the period from 2006 to 2012 reached 0.19 deaths per 100,000 people globally [4]. In Tunisia, it poses a significant public health issue due to its high prevalence and considerable socio-economic impact [5]. Despite the development of effective treatments and new management paradigms, asthma has a substantial effect on patients' personal and professional lives. Indeed, it is estimated that over 45% of asthmatics are poorly controlled [6, 7].

The latest recommendations from the Global Initiative for Asthma (GINA) indicate that asthma management should lead to effective clinical control [8]. This involves managing the asthmatic condition, which includes controlling daytime symptoms, preventing nocturnal awakenings, reducing the impact of symptoms on daily activities, and minimizing the use of rescue medication [8]. Achieving optimal clinical control continues to be a primary goal of asthma management. Although various clinical studies show that reasonable control can be attained among most asthmatics, many patients still experience uncontrolled symptoms in real-life situations, revealing a significant gap between the expected treatment goals and the actual level of asthma control in the general population [9, 10]. Research indicates that in 50% of cases, asthma patients tend to underestimate the severity of their condition by believing their symptoms are under control [11]. Nonetheless, uncontrolled or poorly controlled asthma leads to more frequent exacerbations and increased absenteeism from work [12]. Furthermore, economic evaluations of asthma from several sources highlight that decreased productivity at work and school contributes to morbidity, adding to the indirect health costs associated with this chronic lung disease [13, 14]. To effectively evaluate work-related health issues, it is crucial to first consider the time lost from work, known as absenteeism, and secondly, the growing productivity losses at work, referred to as presenteeism [15].

Numerous recent publications have motivated this work, which aims to investigate the impact of asthma on work productivity in adults treated for asthma.

2. PATIENT AND METHODS

2.1. Study Design

This cross-sectional study was conducted between January 2020 and February 2021. It involved asthmatic patients with full-time or part-time employment who were investigated and followed up in the Pulmonology Department of Taher Sfar teaching hospital in Mahdia, Tunisia.

2.2. Study Population

This study exhaustively included asthmatic patients who had been employed for at least six months and were aged 18 to 65 years. A total of 101 patients were included in this study. Their socio-professional characteristics are described in Table 1.

Most patients (66.3%) were women with a mean age of 44.1 ± 13.2 years. Of the 101 patients, 67.3% were married and had dependent children, with an average of three. Thirty-five patients (34.7%) had comorbidities mainly diabetes (12.9%).

The majority of patients (89.1%) were non-smokers, 6.93% were active smokers and 3.9% had quit smoking. Nearly half of the patients (42.6%) had a primary school education.

The most important sector of activity was textile manufacturing, with a prevalence of 29.7%, and the mean age at recruitment was 23.9 ± 7.7 years. The median job tenure at the time of diagnosis was four years. Eighty-one patients (80.2%) had typical work schedules, with an average number of hours per week of 43.5 ± 12.5 . Exposure to aerocontaminants was reported in 64.4% of cases, mainly textile dusts (24.4%), cereals and flour (5.9%) and wood dusts (7%).

Clinical data and/or spirometry results, using GINA 2019 criteria, confirmed the diagnosis of asthmatic disease [16].

Patients with any other chronic lung disease associated with asthma, psychiatric illnesses, or psychotropic medication that might affect their ability to answer the questionnaire were excluded from this study.

Table 1. Socio-professional characteristics of the study population.

Variables	N (%)
Age (years) mean $\pm$ SD	44.1 $\pm$ 13.2 [19–65]
Gender	
Male	34 (33.7)
Female	67 (66.3)
Marital status	
Married	68 (67.3)
Single	29 (28.7)
Divorced	2 (2.0)
Widowed	2 (2.0)
Having children in charge	68 (67.3)
Having a medical history	
Diabetes	13 (12.9)
Hypertension	3 (3.0)
Dyslipidemia	4 (4.0)
Glaucoma	6 (5.9)
Others	8 (7.9)
Having a surgical history	16 (15.8)
Smoking status	
Active smoker	7 (6.93)
Weaned smoker	4 (3.97)
Non-smoker	90 (89.1)
Level of education	
Illiterate	6 (5.9)
Primary	43 (42.6)
Secondary	36 (35.6)
Superior	16 (15.9)
Activity field	
Textile	30 (29.7)
Cleaning	14 (13.9)
Health	12 (11.9)
Food	8 (7.9)
Education	6 (5.9)
Security	5 (5.0)
Other Activities	26 (25.7)
Average age at hiring (years)	23.9 $\pm$ 7.7
Median job tenure since the diagnosis	4
Presence of an occupational doctor	44 (43.5)

Variables	N (%)
Schedule type	
Typical	81 (80.2)
Rotation by night shift	17 (16.8)
Fixed night	3 (3)
Average working hours/week	43.5 $\pm$ 12.5
Thermal stress	52 (51.5)
Exposure to airborne contaminants	65 (64.6)
Type of air contaminants	
Textile dusts	25 (24.4)
Cereals & Flour	6 (5.9)
Others	70 (69.7)

2.3. Study Instrument

A survey form was completed based on the patient's medical records.

2.3.1. The Survey Form Involved Three Parts

- Sociodemographic characteristics: Age, gender, marital status, number of dependent children, medical (cardiovascular, psychiatric, etc.) and surgical history, lifestyle habits (smoking, alcohol, sports, leisure activities, etc...);
- Professional characteristics related to School-leaving diploma, age at recruitment, sector of activity at the time of asthma diagnosis, job tenure at the time of recruitment, name of the company, presence of an occupational physician in the current company, work position, number of hours worked per week, work schedule, the existence of thermal stress in the company and occupational exposure to aero-contaminants;
- Characteristics of asthmatic disease:
 - *General characteristics* related to diagnosis age, disease progression duration, and current treatment.
 - *Spirometry performed at the last consultation and interpreted with reference to GINA*

2019 measures FEV1 (forced expiratory volume in one second), Tiffeneau ratio ($RT = FEV1 / \text{Forced Vital Capacity (FVC)}$), Obstructive ventilatory disorder (diagnosed if the Tiffeneau ratio is < 0.7) and Reversibility after administration of beta-2-agonists (defined by an increase of 200 ml and 12% in FEV1) [16].

- *Non-specific bronchial provocation test with methacholine* is a diagnostic method designed to reveal bronchial hyperreactivity. The test generally involves inhalation of an irritant (methacholine) in increasing doses. After each methacholine dilution dose, spirometry is performed. A decrease of at least 20% in FEV1 confirms bronchial hyperreactivity [17].
- *Allergic skin test (prick test)*: an examination carried out when an allergic etiology of asthma is suspected. It consists of testing the skin's reaction to a small quantity of allergen: the epidermis is superficially pricked with a drop of allergenic extract placed on the forearm, along with a negative and a positive control. The reading is taken within 15 minutes by measuring the largest diameter of the papule. The main allergens tested are: *Pneumallergens: House dust mites; DPT (Dermatophagoides farinae), DF (D. pteronyssinus) pollens from gaminia, herbaceous plants and trees, animal dander (cat, dog, etc.), molds (c-albicans), and trophallergens (food allergens).*
- *Determination of specific Ig E*: performed by blood sampling. The serum is brought into contact with the product to be tested (pneumallergen or trophallergen) to determine the level of specific Immunoglobulins.
- *Etiologies*: Allergic or non-allergic asthma (occupational, hormonal, gastroesophageal reflux, drug-induced) or asthma with undetermined cause.
- *The severity of asthmatic disease*: Asthma severity is assessed retrospectively based on the level of treatment required to control symptoms and attacks, according to GINA 2019. A distinction is made between intermittent, mild, persistent, moderate, and

severe asthma. Acute exacerbations (AE) and duration of absenteeism during the previous year were determined.

- *Asthmatic disease control*: Asthma symptom control is based on a GINA 2019 assessment comprising four items covering the last 4 weeks, determining if it is a controlled asthma, a poorly controlled asthma, or an uncontrolled asthma [16].

Afterward, the patients answered a self-administered questionnaire.

2.3.2. The Questionnaire Included Three Validated Questionnaires

- *Assessment of productivity and work impairment*: it was carried out using a validated Work Productivity and Activity Impairment (WPAI) questionnaire in its version used for asthma and other pulmonary pathologies [21]. It is a self-administered questionnaire comprising six questions covering the last seven days, quantitatively measuring presenteeism, absenteeism, reduced productivity, and impairment of usual daily activities due to health problems [22]. Overall, three parameters were calculated:
 - Absenteeism: percentage of hours that have not been worked due to illness.
 - Presenteeism: presence at work with a loss of productivity due to illness.
 - Reduced work productivity reflects both absenteeism and presenteeism [22].
- *Therapeutic compliance questionnaire*: Compliance was assessed using the Simplified Medication Adherence Questionnaire (SMAQ) (18). This short, simple tool, based on questions asked directly to the patient about his or her medication-taking habits, was initially validated for measuring adherence in patients on antiretroviral therapy [19]. It contains six questions assessing the patient's compliance with treatment: forgetfulness, routine, adverse effects, and quantification of omissions. The patient responds to each question on a binary yes/no scale [18].

- Fatigue assessment: a feeling of physical or mental weakness following sustained effort and indicating the need to rest. It is considered pathological if the individual feels handicapped about his or her usual level of fitness, enabling him or her to carry out daily activities [23].

The Pichot self-questionnaire, translated into Arabic, was used in the study population to assess the extent of this handicap. It is organized into eight items, each describing a state in which the individual may perceive him/herself [23].

The patient chooses a response on a five-choice Likert scale, rated from 0 to 4 (not at all, a little, moderately, a lot, extremely). A total score of over 22 indicates excessive fatigue [24].

2.4. Statistical Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS 21.0) software. The Shapiro-Wilk Test verified the normality of quantitative variables. Qualitative variables were calculated as percentages, and quantitative variables as mean $\pm$ standard deviation (SD) or median and interquartile range. Means were compared using the Student's t-test or U Mann-Whitney test, and percentages were compared using the Chi 2 test. Factors associated with productivity and work impairment were determined by Pearson's correlation test for quantitative variables and Student's t-test for qualitative variables. A multiple linear regression model analyzed variables significant at the 20% level. A P-value below 0.05 was considered statistically significant.

2.5. Ethical Considerations

The research was conducted in accordance with current legislative and regulatory provisions as well as good clinical practice. A request for authorization was submitted, and the Ethics Committee of Taher Sfar University Hospital issued a favorable opinion. An information letter was provided to subjects during an objective individual interview, and it was explained in simple terms throughout the course of the

Table 2. Clinical features of asthmatic disease in the study population.

Variables	N (%)
Average age at diagnosis (years) $\pm$ SD	29.1 $\pm$ 14.9
Average duration of symptoms (years) $\pm$ SD	18.3 $\pm$ 13.2
Spirometry performed	68.3
FEV1(%)	81.0 $\pm$ 21.3 [31-130]
FVC(%)	82.9 $\pm$ 21.6 [11-136]
FEV1/FVC	80.8 $\pm$ 12.1 [39-100]
Normal spirometry	60 (86.9)
Obstructive ventilatory deficit	9 (13.1)
Bronchial provocation test performed	10 (9.9)
Mild hyper reactivity	6 (60)
Moderate hyper reactivity	4 (40)
Allergy skin tests present	38 (37.7)
Positif test : DPT/DF	16 (42.6)
Positif test : Mold	7 (18.4)
Negatif test	15 (39.4)
Etiologies of asthma	
Allergic	85 (84.2)
Occupational	13 (12.8)
Hormonal	1 (1)
Gastroesophageal reflux disease (GERD)	1 (1)
Widal syndrome	1 (1)
Treatment	
ICS only	1 (0.9)
ICS + LABA	55 (54.4)
Anticholinergics	11 (10.9)
Antileukotrienes	5 (4.9)
Severity of asthma	
Intermittent	24 (23.8)
Light persistent	29 (28.7)
Moderate persistent	42 (41.6)
Severe persistent	6 (5.9)
Asthma disease control	
Controlled asthma	38 (37.6)
Poorly controlled asthma	38 (37.6)
Non controlled asthma	25 (24.8)

(Continued)

Variables	N (%)
Adherent patients	31 (30.7)
Acute exacerbations in the previous year	66 (65.3)
Asthma and work	
Aggravation during work	72 (71.3)
Improvement during vacations	74 (73.3)
Declaration of occupational disease	11 (10.9)
Professional Reclassification	5 (4.9)

FEV1: forced expiratory volume in seconds, FVC: forced vital capacity, DPT: Dermatophagoides pteronyssinus, DF: Dermatophagoides farinae, GERD: gastroesophageal reflux disease, ICS: inhaled corticosteroids, LABA: long-acting beta 2 agonists.

study. Signed informed consent was obtained from each subject before their participation in the study.

3. RESULTS

3.1. Characteristics of Asthmatic Disease

The mean age at diagnosis of asthma in the study population was 29.1 ± 14.9 years, with a mean duration of symptoms of 18.3 ± 13.2 years (Table 2).

Over half of the patients (68.3%) had a spirometry test, and the majority of cases (86.9%) had expected results. A bronchial provocation test was performed in 9.9% of cases. Bronchial hyperreactivity was observed in all cases. Allergy was the most common etiology (84.2%), followed by professional etiology (12.8%).

The majority of patients (54.4%) had been treated with inhaled corticosteroids (ICS) and long-acting beta2 agonists (LABA) in combination with short-acting beta2 agonists as rescue therapy. Almost half of the patients (41.6%) had moderate persistent asthma. Disease control assessment revealed that 37.6% of patients had controlled asthma, and 24.8% had uncontrolled asthma.

Only 31 patients (30.7%) adhered to their treatment. Over half of the patients (65.3%) had experienced acute exacerbations, with an average of two

Table 3. Productivity scores of the study population.

Variables	Values
Number of hours missed for health reasons per week	2.5
Number of hours missed for other reasons per week	2.9
Number of hours worked per week	38.3 ± 16.4
Impact of health on work productivity	3.3 ± 2.5
Impact of health on day-to-day activities	2.9 ± 2.4
Absenteeism	4.2%
Presenteeism	$33.1 \pm 25.9 \%$
Pourcentage of activity impairment	$30.4 \pm 22.2 \%$

acute exacerbations per year. 71.3% of cases reported a worsening of symptoms during professional exposure. Eleven patients (10.9%) had benefited from an occupational disease declaration. Five patients had been reclassified (Table 2).

3.2. Activity Impairment and Fatigue

Of the patients included in the study, 82.2% were gainfully employed. Patients worked an average of 38.3 ± 16.4 hours per week, and the average number of hours missed due to health status was 2.6 hours per week. The impact of general health status on work productivity and current activities was 3.3 ± 2.5 and 2.9 ± 2.4 , respectively.

Absenteeism was 4.2%, while presenteeism was $33.1 \pm 25.9\%$. The resulting drop in activity was estimated on average at $30.4 \pm 22.2\%$ (Table 3). The mean Pichot score of the population was 13.5 ± 7.6 . Nineteen patients (18.8 %) had excessive fatigue.

3.3. Analytical Study

3.3.1. Univariate Study of Productivity

Female gender ($p = 0.02$), alcohol consumption ($p < 0.001$), occupational etiology ($p = 0.01$), and uncontrolled asthma ($p < 0.001$) were factors associated with impaired productivity, as well as worsening of symptoms in the workplace ($p < 0.001$).

The declaration of an occupational disease was associated with productivity loss, with a p-value of 0.03.

Table 4. Socio-professional and clinical factors associated with productivity.

Variables			<u>Absenteeism</u>	<u>P</u>	<u>Presenteeism</u>	<u>P</u>	<u>Productivity Loss</u>	<u>P</u>
Age			r = 0.054	0.60	r = 0.09	0.3	r = 0.10	0.33
Gender	Female		5.6	<u>0.04</u>	37.6 ± 26.9	<u>0.01</u>	34.1 ± 22.7	<u>0.02</u>
	Male		1.7		24.1 ± 21.6		23.5 ± 19.7	
Medical history	No		1.2	<u>0.04</u>	28.3 ± 24.6	0.6	28.07 ± 23.4	0.3
	Yes		8.1		38 ± 26.8		32.6 ± 20.5	
Life habits	Alcohol	Yes	0	0.5	50	<u><0.001</u>	50	<u><0.001</u>
		No	4.3		32.7 ± 26.4		30 ± 22.3	
	Smoking	Yes	0	0.1	26.4 ± 23.3	0.3	26.3 ± 23.3	0.5
		No	4.8		33.9 ± 26.3		30.9 ± 22.2	
Age at hiring			r = - 0.2	<u>0.04</u>	r = 0.14	0.15	r = - 0.06	0.53
Number of working hours			r = 0.1	0.1	r = 0.03	0.69	r = - 0.07	0.46
Type of working hours	Typical		5.1	0.6	34.7	0.4	32.3	0.09
	Atypical Night shift rotation		0.6		25.9		19.1	
	Atypical Night shifts only		0		30		40	
Thermal stress	No		2.6	<u>0.05</u>	29.2 ± 22.0	0.14	27.6 ± 19.7	0.25
	Yes		5.6		36.7 ± 28.9		32.8 ± 24.1	
FEV1			r = 0.109	0.4	r = - 0.07	0.5	r = - 0.04	0.7
Bronchial provocation test	Mild hyperreactivity		0	0.08	11.7 ± 11.5	0.5	11.6 ± 4	0.5
	Moderate hyperreactivity		2		45 ± 49		47.5 ± 33.8	
Etiology of asthma	Allergic		0.6	<u><0.001</u>	27.9 ± 21.7	<u><0.001</u>	28.3 ± 21.6	<u>0.01</u>
	Professional		2.6		66.4 ± 26.2		44.8 ± 21.1	
Asthma control	Controlled		0.1	<u>0.02</u>	18.9 ± 17.8		19.07 ± 17.7	<u><0.001</u>
	Uncontrolled		5.1		37.4 ± 25.6		33.1 ± 19.5	
	Poorly controlled		7.5		48 ± 27.08		43.4 ± 24.5	
Acute exacerbation	No		4.1	0.2	22.6 ± 21.7	<u><0.001</u>	21.8 ± 19.3	<u>0.01</u>
	Yes		4.3		38.6 ± 26.4		34.4 ± 22.5	
Number of exacerbations			R = 0.1	0.1	r = 0.5	<u><0.001</u>	r = 0.5	<u><0.001</u>
Severity	Intermittent		0	0.1	22.9 ± 17.8	0.08	23.9 ± 17.5	0.1
	Mild persistent		1.3		32.4 ± 17.2		32.07 ± 17.03	
	Persistent		7.1		36 ± 31.7		30.7 ± 27.1	
	moderate		16.7		56.7 ± 30.1		45.7 ± 23.9	
Worsening during work	Severe persistent							
	No		0.3	<u>0.04</u>	12.4 ± 11.6	<u><0.001</u>	13.2 ± 18.8	<u><0.001</u>
	Yes		5.6		41.4 ± 24.1		36.6 ± 20.1	

(Continued)

Variables		Absenteeism	P	Presenteeism	P	Productivity Loss	P
Improvement during leave	No	0.3	0.06	15.2 ± 12.09	<0.001	16.56 ± 20.03	<0.001
	Yes	5.5		39.6 ± 25.18		34.94 ± 21.09	
Occupational Disease Claim	No	3.6	<0.001	30.9 ± 25.2	0.01	28.5 ± 21.7	0.03
	Yes	9.1		50.9 ± 26.2		28.5 ± 21.7	
Benefit from reclassification	No	3.4	<0.001	31.7 ± 25.5	0.01	29.4 ± 22.3	0.08
	Yes	19.3		60 ± 21.1		47.3 ± 11.6	
Number of absences		r = 0.3	<0.001	r = 0.4	<0.001	r = 0.3	<0.001
Number of hospitalizations		r = 0.16	0.1	r = 0.1	0.2	r = 0.005	0.9
Adherence	No	2.3	0.5	32.3 ± 24.5	0.65	31.1 ± 21.5	0.6
	Yes	8.04		34.8 ± 29.3		29.09 ± 24.02	

P= Pearson coefficient, r = Pearson correlation coefficient, FEV1: forced expiratory volume in second.

Table 5. Multivariate analysis of productivity determinants.

Model	Coefficients		
	B	CI [low. bound, up. bound]	p
Number of exacerbations per year	0.3	[0.1, 0.5]	<0.001
Aggravation of symptoms during work	0.4	[0.5, 0.8]	<0.001
Number of absences	0.3	[0.00, 0.03]	<0.001

B: odds ratio, CI: confidence interval, low: lower, up: upper.

Working hours and spirometry parameters were not associated with productivity.

The average number of acute exacerbations per year and absences in the previous year were significantly associated with lower productivity in the study population (Table 4).

3.3.2. Multivariate Study

The variable introduced in the multivariate productivity analysis was “decline in productivity”. In the final model, this multivariate regression retained the following statistically correlated determinants of productivity decline: the number of exacerbations, worsening of the disease during work, and the number of absences (Table 5).

4. DISCUSSION

This study aimed to investigate the impact of asthma on work productivity in adults receiving asthma therapy. Productivity, activity impairment, and fatigue were assessed using the SMAQ, WPAI, and Pichot questionnaires, respectively. Various studies have shown that patients suffering from asthma, whether occupational or not, generally experience unfavorable outcomes, including a very high frequency of absenteeism [25, 26], work disability [27, 28], and shorter working life [29]. Our study showed that asthma had a moderate impact on productivity at work: the number of work hours missed due to asthma was 2.5/10, the effect of general health status on productivity was 3.3 ± 2.5/10, and on activities of daily living was 2.9 ± 2.4/10. Absenteeism was 4.25%, and presenteeism was 33.3% ± 25.9. The drop in productivity was estimated at 30.4 ± 22.2%. At the end of the univariate and multivariate study, productivity was determined by sociodemographic factors: it was essentially associated with female gender (p = 0.02) and alcohol consumption (p < 0.001).

Regarding the association of female gender with the productivity of asthma patients, similar results were obtained from a survey of 11068 patients in France, conducted by Dress and Dares, which indicated that asthma was linked to a higher frequency of unemployment periods in women compared

to men, resulting in a shorter duration of professional activity that reflects a certain instability [30]. Data from the European Community Respiratory Health Survey (ECRHS) concluded that the risk of leaving a job due to respiratory problems during the follow-up of asthma patients was greater in women than in men [31]. Several hypotheses can be proposed to explain gender differences in asthma severity, including the role of hormones [32, 33]. Thus, the negative impact of asthma on productivity, especially in women, could be attributed to the presence of pathophysiological differences between the two genders. Indeed, asthma incidence is higher in boys than in girls before puberty, although it is more prevalent in women during adulthood [34, 35].

Differences in occupational exposure may play a role, as women do not hold the same jobs and, therefore, do not experience the same exposures. For instance, it has been noted that women are generally more exposed to cleaning agents in the workplace [36–38]. Moreover, several studies indicate that in adulthood, women experience more severe and less controlled asthma than men [39–41]. Conversely, comorbidities were associated with lower work productivity in this study (32.6 ± 20.5 vs. 28.07 ± 23.4), although no statistically significant difference was found between the two groups ($p = 0.32$). However, absenteeism was significantly higher among patients with comorbidities ($p = 0.01$). A study by Solmaz Ehteshami-Afshar et al, which involved 284 active asthma patients assessing the impact of comorbidities on productivity, demonstrated that comorbidities significantly reduced the productivity of working asthma patients [38]. This discrepancy between the two studies may be attributed to the small number of patients with comorbidities included in our study.

Another Canadian study of 300 asthmatic patients showed that over a third of asthmatic subjects suffered from psychological disorders and comorbidities (depression, osteoporosis, obesity...), and this affected absenteeism and presenteeism [43, 44]. As a matter of fact, asthma treatments can also cause or contribute to comorbidity. Oral corticosteroids are well known to produce significant adverse effects, but even inhaled corticosteroids may

predispose to osteoporosis, increased fracture risk and pneumonia [45, 46].

In addition, poorly controlled asthma correlated significantly with psychological distress, thus loss of productivity was higher in these patients than in those with controlled asthma and no associated psychological pathology [47]. Despite the documented burden of comorbidities in asthma, their effect on productivity was overlooked in the past, as asthma patients represent a relatively young population and were thus assumed to be free of comorbidities [48].

In addition to socio-demographic characteristics, the results of the present study showed that the productivity of asthma sufferers was strongly dependent on asthma disease characteristics such as the occupational etiology of asthma ($p = 0.01$), disease control ($p < 0.001$), increase in the number of acute exacerbations and absences in the previous year ($p < 0.001$ and $p < 0.001$ respectively). Similarly, the worsening of the disease in the workplace ($p < 0.001$) and the declaration of asthma as an occupational disease ($p < 0.001$) were associated with lower productivity.

Several studies have demonstrated that poorly managed asthma is linked to lower work output and productivity compared to well-managed asthma [12, 49]. In each phase of this survey, asthma served as a marker for work disability and the utilization of healthcare facilities [50]. The researchers discovered that individuals with poorly controlled or uncontrolled asthma experienced higher absenteeism rates than those without asthma.

In a European study, 24–59% of asthmatic patients reported at least one day of absence from work in the past year [12]. Similarly, in an American study, workers with poorly controlled asthma experienced greater work disability than those with well-controlled asthma [51, 52]. Work-related asthma, whether occupational or a pre-existing condition worsened by exposure to respiratory irritants in the workplace, significantly impacted work productivity. Indeed, a study conducted in California involving asthmatic patients indicated that total or partial work incapacity was linked not only to the severity of asthma but also to work conditions, particularly exposure to sensitizing factors in the workplace [53].

In France, a follow-up study of patients with occupational asthma found that, one year after diagnosis, 30% of patients were still exposed to occupational hazards, 16% had found new employment, and a significant number had stopped working permanently [54]. Additionally, the likelihood of leaving the initial workplace was greater for workers who sought recognition of their asthma as an occupational disease, and it was inversely related to the employee's education level and the size of the company.

A cohort study in Finland involving 48,296 hospital and local authority employees revealed that asthmatic patients averaged 24 days off work per year, compared to 14 days for non-asthmatic employees. Predictors of work absence due to respiratory issues included the type of occupation (metal workers and welders faced a higher risk than office workers), low FVC, and occupational exposure to vapors, gases, dust, fumes, and cleaning products [55]. This study highlights that "symptomatic" asthma can negatively impact occupational activity. Therefore, first, actions must be taken to manage the disease and its associated comorbidities. Second, ongoing medical monitoring and proper education for workers exposed to sensitizing agents are crucial for effective prevention of acute exacerbations and management of productivity. Adequate support for asthmatic employees, involving clinicians and occupational physicians, is also necessary to sustain employment and encourage their return to work.

Strengths and Weaknesses of the Study

This mono-center study involved 101 subjects, which is a significant number. However, larger multi-center studies would have been preferable for generalizing the results. Nonetheless, this study has several strengths. First, data collection was based on a survey form previously developed and administered by a single investigating physician, minimizing discrepancies in the information collected. Secondly, several authors have agreed on the validity of the questionnaires used in the studies under certain precautions. Each question must be formulated clearly (with a choice of answers limited to a metric with a progressive meaning). This work only provided an

introductory framework for more extensive longitudinal studies to enhance the professional fulfillment of individuals with asthma patients.

5. CONCLUSION

Asthma is considered one of the most common chronic diseases causing high morbidity and mortality, mainly in developing countries.

An extension of this work could involve continuing the study over a more extended period to enhance the sample size and statistical power. Additionally, managing asthma-related comorbidities, improving disease control, and providing therapeutic education could enable the pulmonologist to enhance these patients' productivity. Clinicians must inquire about the occupational impact of their patient's asthma. Workplaces could consider offering training and strategies to assist patients in managing their physical and mental fatigue, thereby reducing productivity. Establishing close collaboration between the pulmonologist and the occupational physician at the time of hiring is essential to achieve this aim.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE: No names or other participant identifiers were used. Participation in the study was voluntary, and oral informed consent was obtained from all participants. The study was approved by Taher Sfar Hospital Ethical Committee (Reference: CEM-2025-04-08).

CONFLICT OF INTEREST DECLARATION: There is no conflict of interest to declare.

INFORMED CONSENT STATEMENT: Informed consent was obtained from all subjects involved in the study. Written informed consent has also been obtained to publish this paper.

AVAILABILITY OF DATA AND MATERIALS: Data and materials are available if needed.

COMPETING INTERESTS: The authors declare no conflict of interest.

AUTHORS CONTRIBUTION: L.B., J.K., T.K. and N.B. contributed to the design and implementation of the research. A.O., I.T., R.R. and Y.B. contributed to the analysis of the

results. A.O., L.K. and I.T. contributed to the writing of the manuscript.

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