Public Health 244 (2025) 105738

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Original Research

Enhancing occupational health literacy in the context of SDGs: Evidence from Sicilian workers

Ginevra Malta [a,*], Veronica Traversini [b], Omer Kocak [c], Yuksel Goktas [d], Sevda Kucuk [e], Emanuele Cannizzaro [f]

[a] Department of Health Promotion, Mother and Childcare, Internal Medicine and Medical Specialties (PROMISE), Section of Forensic Medicine, University of Palermo, Italy
[b] Department of Experimental and Clinical Medicine, University of Florence, Italy
[c] Department of Information & Document Management, Department of Educational Technology, Ataturk University, Erzurum, 25240, Turkey
[d] Department of Software Engineering, Ataturk University, Erzurum, Turkey
[e] Department of Instructional Technology, Kazım Karabekir Education Faculty, Ataturk University, Erzurum, Turkey
[f] Department of Health Promotion, Mother and Childcare, Internal Medicine and Medical Specialties (PROMISE), Section of Occupational Medicine, University of Palermo, Italy

ARTICLE INFO

Keywords:
Occupational health literacy (OHL)
Sustainable development goals (SDG)
Workplace health promotion
Occupational safety and health (OSH)
Health literacy assessment

ABSTRACT

Objectives: This study aims to investigate the levels of Occupational Health Literacy (OHL) among workers in Sicilian companies and identify key predictors of elevated OHL. The research also seeks to highlight the role of OHL in promoting workplace health, reducing inequalities, and contributing to the Sustainable Development Goals (SDGs), particularly SDG 3 (Health and well-being) and SDG 4 (Quality education).
Study design: A cross-sectional study was conducted over a three-month period, from September to December 2024, involving a sample of 796 workers from various Sicilian companies.
Methods: Participants completed three validated questionnaires: the Occupational Health Literacy Scale (OHLS), the Work Productivity and Activity Impairment Questionnaire (WPAI-GH), and the EQ-5D for assessing quality of life. Logistic regression models were employed to analyze the data and identify predictors associated with elevated OHL levels.
Results: Among the participants, 28.8 % demonstrated high levels of OHL, whereas 71.1 % exhibited insufficient levels. Key determinants of elevated OHL included age, gender, and education. Higher education was significantly associated with high OHL levels ($p < 0.001$).
Conclusions: The study underscores the importance of targeted educational interventions to enhance OHL, thereby fostering workplace health and supporting the achievement of SDGs. These findings call for further research to address regional disparities and promote sustainable occupational health and safety practices.

1. Introduction

Health literacy (HL), a key determinant of health status,[1,2,3] aligns with the United Nations Sustainable Development Goals (SDGs), particularly Goal 3 (Health and well-being) and Goal 4 (Quality education). HL encompasses the knowledge, motivation, and skills to access, understand, evaluate, and apply health information for decisions on health care, disease prevention, and promotion. Its goals include improving quality of life, reducing inequalities, and fostering inclusive growth[2–4]

Low HL results in inefficient use of health care resources, creating a gap between patients' cognitive abilities and system demands.[5]

In health literacy, mental health refers to the ability to make informed decisions in daily life.[6] High mental health enables clear expression of concerns, informed judgments, and revising beliefs when necessary.[7]

In Italy, the OECD Survey of Adult Skills found 35 % of adults (OECD average 26 %) scored at or below literacy level 1, classifying them as functional illiterates. These individuals can read and write but struggle to understand or use information. At level 1 (25 % in Italy), they can

* Corresponding author.
E-mail addresses: ginevra.malta@unipa.it (G. Malta), veronica.traversini@unifi.it (V. Traversini), kocakomer@atauni.edu.tr (O. Kocak), yukselgoktas@atauni.edu.tr (Y. Goktas), sevdakucuk@atauni.edu.tr (S. Kucuk), emanuele.cannizzaro@unipa.it (E. Cannizzaro).

https://doi.org/10.1016/j.puhe.2025.105738
Received 22 January 2025; Received in revised form 17 April 2025; Accepted 24 April 2025
Available online 15 May 2025
0033-3506/© 2025 The Authors. Published by Elsevier Ltd on behalf of The Royal Society for Public Health. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

interpret short texts with clear information, while below level 1 (10 %), they can only comprehend simple sentences. Only 5 % (vs. 12 % OECD average) reached levels 4–5, demonstrating the ability to process complex texts and tasks. This poses challenges for everyday life, work, and preventive health.[8]

In occupational health literacy, limited levels pose challenges for safety training and hinder optimal use of human resources.[9]

In the occupational field, health status is assessed by the competent physician, often with a multidisciplinary approach.[10] Health surveillance visits, as a first contact point, identify mental and physical issues and ensure task compatibility with existing conditions.[11]

Health management encompasses health care, disease prevention, and health promotion. In the occupational context, it also involves preventing accidents, occupational diseases, and fostering appreciation for one's work.[12]

In recent years, health literacy has received particular attention in public health research and health service reform initiatives, as it has been recognized as a major determinant of individual health status and effective use of health care.[13–16]

In the Italian context, assessing literacy levels is particularly important to support the long-term sustainability of the health care system.[16,17]

As a result, occupational physicians also become essential in promoting occupational health literacy (OHL).[18] Similarly, employers should consider among their information and training obligations the promotion of occupational health literacy.[19]

The present study, the basis of a broader collaboration aimed at expanding HL empowerment programs to vulnerable populations in several European countries - including Italy and Turkey, aims, as a first step, to assess levels of occupational health literacy in workers operating in Sicilian Companies, using the Occupational Health Literacy Scale (OHLS) questionnaire, recently adapted and validated in Italian, a practical tool to assess the degree of occupational health literacy among Italian workers.[20]

2. Methods

This study used a cross-sectional design, with data collection conducted between September 2024 and December 2024.

The group of workers was recruited from different Companies, operating in the Sicilian territory, encompassing a range of activities from predominantly physical to administrative jobs, to ensure maximum heterogeneity among job tasks, and by reflection, also in the different degree of schooling.

Ethical approval for this study was not required because the data were obtained totally anonymously (according to WHO Guidelines), in paper format, in a sealed envelope and without identifying elements.[21–23]

2.1. Study sample

The study population included workers with permanent, or fixed term but renewed employment contracts for at least two years with the same company.

Inclusion criteria required participants to be at least 20 years old and no older than 65, and fluent in Italian. The age-range selected to reflect the active working population in Italy.

Exclusion criteria included, reflexively, a length of employment of less than 2 years (including any apprenticeship period), a level of education below 5th grade (class 1 according to ISCED - International Standard Classification of Education).[24]

The research design was explained in advance to employers so that companies could be made aware of the type of survey, and employees could have prior insight in order to make participation entirely voluntary.

The sample size for this study was calculated for a minimum of 600 participants, taking into account the number of employees in the selected companies, and the assumption of an expected prevalence of 50 % for the primary outcome (low or high OHLS levels), with a precision of ±5 % and a 95 % confidence interval.

2.2. Tools

Three questionnaires were used to obtain a comprehensive assessment of Occupational Health Literacy:

2.2.1. OHLS questionnaire

The Occupational Health Literacy Scale (OHLS), validated in Italy with a Cronbach's alpha of 0.943,[20] comprises 12 items across two domains. The first domain (Q1–Q8) assesses the ability to locate, evaluate, and use occupational safety and health (OSH) information, including understanding OSH guidelines, addressing workplace stress, modifying conditions, evaluating health promotion services, and seeking OSH information. The second domain (Q9–Q12) evaluates responsibility for OSH, emphasizing awareness of regulations, personal accountability, sharing information, and proactive participation in health promotion.

According to the validated OHLS scoring system we considered OHL as inadequate OHL for total score 0–16, problematic for total score 17–32 and adequate for total score 33–48.

For logistic regression analyses, scores were dichotomized into High OHL as Adequate (total score 33–48) and Low OHL as Inadequate and Problematic (total score 0–32).[20]

2.2.2. WPAI-GH questionnaire

The Work Productivity and Activity Impairment Questionnaire: General Health (WPAI-GH) assesses health-related impacts on work productivity and daily activities.[25,26] It measures absenteeism (work absences), presenteeism (reduced productivity at work), overall work productivity loss (absenteeism and presenteeism combined), and limitations in non-work activities. These domains provide quantitative data for epidemiological studies, health intervention effectiveness, and economic analyses, making WPAI-GH versatile for various diseases and occupational health research.

2.2.3. EQ-5D questionnaire

The EQ-5D, developed by the EuroQol Group, assesses health-related quality of life (HRQoL)[27] across five domains: mobility, personal care, usual activities, pain/illness, and anxiety/depression. Each domain is rated on three- or five-level scales (EQ-5D-3L or EQ-5D-5L). A visual analog scale (EQ-VAS) allows self-assessment of general health (0–100). This tool provides a quantitative index for population comparisons, economic evaluations, and clinical studies.

2.3. Statistical analysis

The OHLS questionnaire stratified responses into two categories: easy ("easy" and "very easy") and difficult ("difficult" and "very difficult"). The OHL score, summing responses, was classified into three levels: inadequate (0−16), problematic (17–32), and adequate (33–48). For analysis, these were grouped into adequate (high) and inadequate (low-to-medium, including inadequate and problematic), following previous studies.[28–30]

2.3.1. Statistical analysis of sociodemographic variables

Workers' age, recorded in years, was categorized into two groups (20–45 and 46–65) to analyze differences in occupational health literacy (OHLS). Education level, based on the International Standard Classification of Education (ISCED 2011), was simplified into two categories: ISCED 0–2 (lower education: primary and lower secondary) and ISCED 3–8 (higher education: upper secondary, undergraduate, and postgraduate).[24,31,32]

A univariate analysis assessed sociodemographic determinants of

occupational health literacy (OHLS) among Sicilian workers. Results included odds ratios (ORs), 95 % confidence intervals (CIs), and p-values, with significance at $p \leq 0.05$. Variables with $p \leq 0.25$ were included in a multivariate logistic regression to identify independent associations with OHLS.

2.3.2. Statistical analysis of correlations

Pearson's correlation coefficients were calculated for continuous variables to examine the relationship between occupational health literacy levels (OHLS), the influence of health on work activity (measured through the WPAI) and perceived health status (assessed through the EQ-5D).

All statistical analyses were performed using Prism Graphpad v.10 software, to ensure the robustness and reliability of the results.

3. Results

The binary classification of OHLS into high (adequate) and low (inadequate and problematic) identified participants with differing health literacy levels. OHLS high included scores above the median, indicating strong abilities to understand, evaluate, and apply work-related health information. OHLS low comprised scores at or below the median, highlighting challenges in effectively using occupational health and safety (OSH) information. This dichotomy served as the dependent variable in logistic regression to analyze sociodemographic determinants, identify predictors, and highlight disparities. Similarly, stratifying education (ISCED 0–2 vs. 3–8) enabled a detailed assessment of education and age impacts on OHLS among Sicilian workers.

A total of 796 workers from Sicilian companies completed the questionnaire, while 55 (6.9 %) declined participation. The sample included 596 males (74.9 %) and 200 females (25.1 %), with a mean age of 42.6 years (range: 20–65). Occupations comprised 238 blue-collar workers (29.9 %), 204 drivers (25.6 %), 196 office workers (24.6 %), and 158 food service workers (19.8 %). Education levels varied: 138 participants held ISCED 6 (high school, bachelor's), 414 ISCED 3 (high school), and 244 ISCED 2 (lower middle school).

OHLS levels showed 28.8 % (230 participants) with high OHLS and 71.1 % (566) with low OHLS. Sociodemographic analysis revealed no significant gender differences but showed younger and more educated participants had higher OHLS levels.

Univariate analysis identified significant associations between gender, age, and education with OHLS and occupational well-being. Females had higher odds of elevated OHLS (OR = 2.97; 95 % CI: 2.13–4.13; $p < 0.001$) compared to males (lower OHLS: OR = 2.44; 95 % CI: 1.74–3.42; $p < 0.001$). Reduced work productivity (WPR) was significantly associated with females (OR = 1.39; 95 % CI: 1.01–1.92; $p < 0.05$), while health-related quality of life (EQ-5D) showed an inverse association with female gender (OR = 0.41; 95 % CI: 0.29–0.59; $p < 0.001$) (Table 1, Fig. 1).

Age was a protective factor for higher OHLS levels, with an OR = 0.72 (95 % CI: 0.54–0.94; $p < 0.05$) in workers aged 20–45 and OR = 0.78 (95 % CI: 0.59–1.04; $p < 0.05$) in those aged 46–65, indicating a trend toward elevated health literacy. Conversely, age increased the risk of lower OHLS levels, with OR = 1.4 (95 % CI: 1.05–1.85; $p < 0.05$) in younger and OR = 1.54 (95 % CI: 1.16–2.04; $p < 0.05$) in older workers.

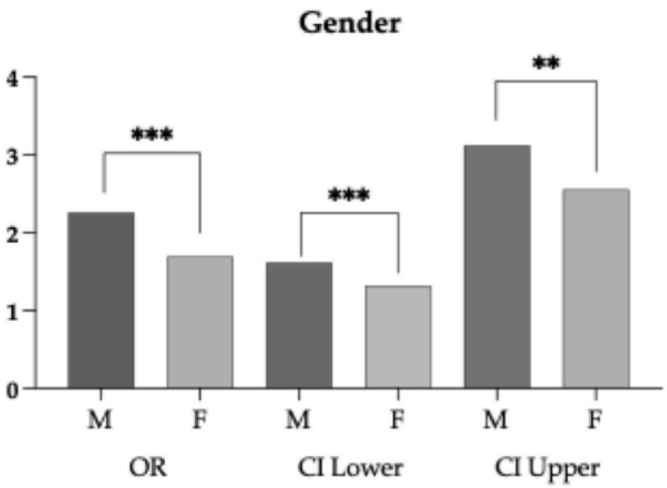

Fig. 1. Univariate analysis in relation to gender as a predictor.

For reduced work productivity (WPR), no significant age associations were found, with OR = 1.26 (95 % CI: 0.95–1.67) in younger and OR = 1.38 (95 % CI: 1.05–1.84) in older workers.

Regarding quality of life (EQ-5D), older workers showed better outcomes, with OR = 3.72 (95 % CI: 2.76–5.01; $p < 0.001$) in the 20–45 group and OR = 4.09 (95 % CI: 3.04–5.50; $p < 0.001$) in the 46–65 group (Table 2, Fig. 2).

In analyzing education level (ISCED) and OHLS, workers with higher education (ISCED 3–8) were significantly more likely to achieve high health literacy scores than those with lower education (ISCED 0–2). The OR for ISCED 0–2 was 4.85 (95 % CI: 2.1–11.2; $p < 0.001$), compared to 5.4 (95 % CI: 2.3–12.6; $p < 0.001$) for ISCED 3–8. Conversely, at lower OHLS levels, ISCED 0–2 was associated with a significantly reduced likelihood of high scores (OR = 0.01; 95 % CI: 0.02–0.02; $p < 0.001$), while ISCED 3–8 showed an increased risk (OR = 12; 95 % CI: 4–28; $p < 0.001$).

Education level showed no significant association with reduced work productivity (WPR) for ISCED 0–2 (OR = 1.20; 95 % CI: 0.88–1.62) or ISCED 3–8 (OR = 1.44; 95 % CI: 1.06–1.95).

Health-related quality of life (EQ-5D) was significantly linked to education. Workers with lower education (ISCED 0–2) had an OR = 0.22 (95 % CI: 1.61–0.31; $p < 0.001$), indicating worse health perception, compared to ISCED 3–8 (OR = 0.27; 95 % CI: 0.18–0.37; $p < 0.001$) (Table 3, Fig. 3).

The OHLS score was correlated with both the WPAI and the EQ-5D. Pearson's coefficients are summarized in Table 4.

4. Discussion

This study assessed occupational health literacy (OHLS) in 796 workers from Sicilian companies, achieving a high response rate (92.3 %) and completion rate, likely due to prior project presentations to the companies.

Of the participants, 502 (63.1 %) had high OHLS, while 294 (36.9 %)

Table 1
Univariate analysis in relation to gender as a predictive factor.

Question	Predictor: Gender							
	OR		CI Lower		CI Upper		P-value	
	F	M	F	M	F	M	F	M
OHLS high	2.97	2.44	2.12	1.74	4.13	3.39	<0.001	<0.001
OHLS low	2.98	2.14	2.12	1.73	4.13	3.38	<0.001	<0.001
WPR	1.53	1.24	1.10	0.90	2.10	1.72	<0.05	<0.05
EQ-5D	0.45	0.37	0.32	0.26	0.64	0.52	<0.001	<0.001

Table 2
Univariate analysis in relation to age as a predictive factor.

Question	Predictor: Age							
	OR		CI Lower		CI Upper		P-value	
	20–45	46–65	20–45	46–65	20–45	46–65	20–45	46–65
OHLS high	0.72	0.78	0.54	0.59	0.94	1.04	<0.05	<0.05
OHLS low	1.4	1.54	1.05	1.16	1.85	2.04	<0.05	<0.05
WPR	1.26	1.38	0.95	1.05	1.67	1.84	n.s.	n.s.
EQ-5D	3.72	4.09	2.76	3.04	5.01	5.50	<0.001	<0.001

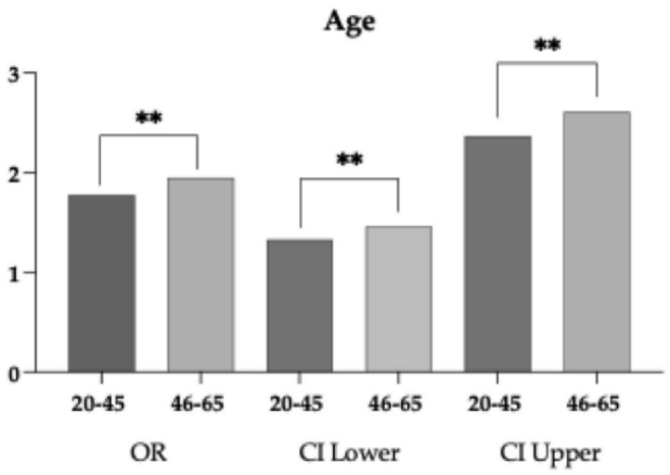

Fig. 2. Univariate analysis in relation to age as a predictive factor.

had lower levels. Compared to previous Italian studies using tools like EQ-5D, the results highlight variability in health literacy estimates, influenced by measurement methods, sample differences, and regional disparities.

Sociodemographic analysis indicated a potential gender disparity, with women being more vulnerable in maintaining productivity but reporting better subjective health perceptions. Age was inversely related to OHLS, with younger workers showing higher levels, possibly due to training gaps or update challenges in older workers. However, age showed no significant link to reduced productivity, suggesting other factors, such as work environment or health status, may play a greater role. Older workers reported a more positive perception of health, potentially reflecting better management of stress and chronic conditions.[33]

Analysis of educational attainment (ISCED) revealed significant associations with occupational health literacy (OHLS) and health-related quality of life (EQ-5D), but no significant correlation with reduced work productivity (WPR). This highlights the role of formal education in enhancing health skills and improving the use of occupational health information.[34] However, even highly educated individuals may face health literacy gaps,[35] potentially linked to errors in repetitive, overlooked processes. These findings suggest that labor productivity may depend more on factors like organizational context, working conditions, or individual health than education alone.[36,37]

Analyses of health status emphasize education's role in shaping health skills and subjective perceptions of health and well-being. A significant association was found between higher occupational health literacy and better perceived health status, suggesting a positive link between literacy, health perception, and work productivity.[38–41]

Correlation analyses revealed significant associations: OHLS and WPAI (r = 0.53) linked higher health literacy with better work productivity; OHLS and EQ-5D (r = 0.27) indicated better health perceptions; and WPAI and EQ-5D (r = 0.28) suggested improved quality of life aligns with higher productivity. Using OHLS, WPAI, and EQ-5D, the study examined links between health literacy, productivity, and quality of life. Educational level and perceived health emerged as key determinants, emphasizing the need for educational and health promotion strategies to enhance well-being and efficiency.[42–44]

A summary of results are reported in flowchart (Fig. 4).

The limited studies on occupational health literacy (OHLS) hinder comparisons among workers across Italian regions, despite significant socioeconomic and health disparities. Sicily, representing much of

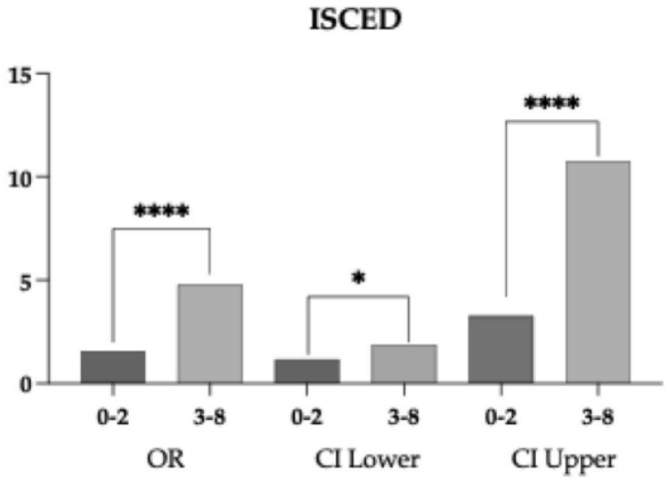

Fig. 3. Univariate analysis in relation to ISCED as a predictor factor.

Table 4
Correlation analysis.

Correlation	Coefficient
OHLS e WPAI	0.53
OHLS e EQ-5D	0.27
WPAI e EQ-5D	0.28

Table 3
Univariate analysis in relation to ISCED as a predictor factor.

Question	Predictor: ISCED							
	OR		CI Lower		CI Upper		P-value	
	0–2	3–8	0–2	3–8	0–2	3–8	0–2	3–8
OHLS high	4.85	5.4	2.1	2.3	11.2	12.6	<0.001	<0.001
OHLS low	0.01	12	0.02	4	0.02	28	<0.001	<0.001
WPR	1.20	1.44	0.88	1.06	1.62	1.95	n.s.	n.s.
EQ-5D	0.22	0.27	1.61	0.18	0.31	0.37	<0.001	<0.001

southern Italy, has a predominance of small and medium enterprises, lower average education and income, and less uniform access to corporate health services.[45,46] In contrast, northern Italy, with higher industrialization and structured corporate health systems,[47] may promote higher OHLS levels among workers.

Recent studies reveal disparities in occupational health literacy (OHL) across Europe. Heijmans et al. (2021)[48] found high OHL levels in the Netherlands, supported by structured company programs and integrated health and labor policies. In contrast, studies by Petrova et al. (2023)[49] in Bulgaria and Tuzun (2023)[50] in Turkey reported lower OHL levels, linked to limited job training and unfavorable socioeconomic conditions, highlighting the potential of health promotion programs to improve OHL and HL.

In Italy, this study confirms internal disparities consistent with those observed across Europe. These findings highlight the need for targeted interventions addressing regional specificities and workers' needs to improve health literacy and ensure equitable access to information, training, and occupational health resources.[51,52]

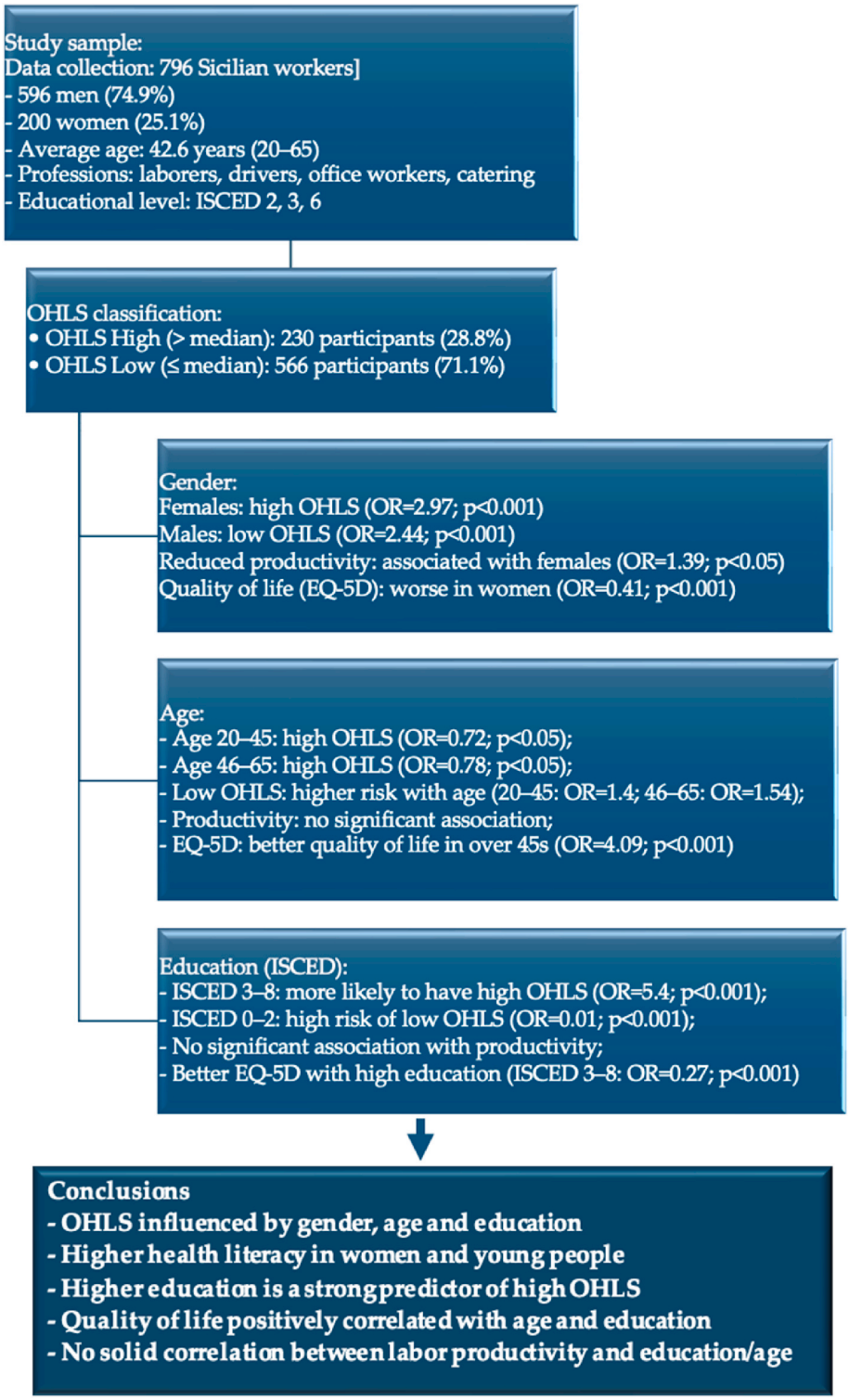

Fig. 4. Summary of OHLS study.

Recent studies link low occupational health literacy (OHLS) to negative health outcomes and reduced work productivity,[52] including poorer health self-assessments, limited prevention program use, higher absenteeism, and lower efficiency.[53,54] Low OHLS is more prevalent among older, less-educated workers and in resource-limited settings.[55] These findings highlight the need for targeted strategies to improve health literacy among Sicilian workers, considering regional and company-specific training disparities.

This study analyzed three sociodemographic factors—education level, age, and perceived health status—and three instruments: OHLS, WPAI, and EQ-5D. Multivariate analysis identified education as the only sociodemographic factor significantly associated with OHLS, consistent with studies linking higher education to better health information management and work skills.[56–58] The WHO also identifies individuals with low education as a vulnerable group with limited health literacy.[59,60]

As Work-related health behaviors (WPAI) and perceived health status (EQ-5D) positively correlated with OHLS,[25,61] confirming that higher OHLS improves occupational health management, workplace safety, and general well-being.[62–64] These findings underscore the need for targeted educational interventions, particularly in resource-limited corporate settings like Sicilian companies, and are consistent with recent findings by Carrouel et al. (2024), who reported similar patterns in workplace-related health literacy among civil servants, highlighting the need for targeted workplace HL programs to reduce disparities and promote health equity in occupational settings.[18]

4.1. Limitations

This study has limitations that may impact validity. The sample, drawn from Sicilian companies, is not representative of the broader working population, so observed OHLS levels may not reflect those in other regions or socioeconomic contexts. These factors could introduce biases affecting result generalizability and the accuracy of associations.

It is also possible that individuals with lower levels of OHL were less likely to participate, possibly due to limited confidence or comprehension skills, thereby introducing a non-response bias and leading to an underestimation of low OHL prevalence.

Despite this, the study offers valuable insights into OHLS levels and associated factors in Sicilian firms, a largely unexplored research area.

4.2. Conclusions

This study is among the first to investigate occupational health literacy (OHLS) in Sicilian companies. Results indicate generally low OHLS levels, influenced by regional labor and socioeconomic factors. However, the non-representative sample limits generalization to the broader Sicilian workforce.

Further representative studies across diverse sectors and job types are needed to better understand OHLS in Sicily and Italy. Such research is essential for designing evidence-based interventions to enhance OHLS, worker health, and productivity.

Programs to improve health literacy—via education, information campaigns, and digital tools—are critical to reducing health information inequalities and strengthening decision-making. These interventions support disease prevention, safer working conditions, and sustainable growth, aligning with the UN 2030 Agenda and SDGs.

Author statements

Ethical approval

The study was condicted by the WHO guidelines (2022) which clearly indicate that observational studies that are not clinical, diagnostic, or therapeutic in nature, do not involve any funding, and are conducted in total anonymity as part of ordinary activities, do not require ethical approval in accordance with the World Health Organization's standards for scientific research, and therefore do not require approval by local ethics committees. Furthermore, prior to participation, it was specified in the data processing authorization forms and informed consent forms that the data would be collected anonymously for scientific purposes, so as to leave the subjects free to choose whether to participate.

Funding

This research received no external funding.

Competing interests

The authors declare no conflicts of interest.

Informed consent

Informed consent was obtained from all subjects involved in the study.

Institutional review board

Not applicable.

Author contributions

Conceptualization: (GM) and (EC); methodology: (GM) and (EC); validation: (GM), (EC) and (VT); formal analysis: (GM) and (EC); investigation: (GM), (EC) and (VT); resources: (GM), (OK), (YG), (SK) and (EC); data curation: (GM), and (EC); writing-original draft preparation: (GM) and (EC); writing-review and editing: (GM), (EC); visualization: (VT); supervision: (EC). All authors have read and agreed to the published version of the manuscript.

Data availability

The data are not available due to [ethical/legal/commercial] restrictions, and in addition the participants in this study signed a written consent where they were guaranteed to anonymize their data to be shared publicly, so due to the sensitive nature of the research the supporting data are not available.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2025.105738.

References

1. Liu H, et al. Assessment tools for health literacy among the general population: a systematic review. *Int J Environ Res Publ Health*. Aug. 2018;15(8):1711. https://doi.org/10.3390/ijerph15081711.
2. Kickbusch IS. Health literacy: addressing the health and education divide. *Health Promot Int*. Sep. 2001;16(3):289–297. https://doi.org/10.1093/heapro/16.3.289.
3. Çalışkan C, Üner S. Disaster literacy and public health: a systematic review and integration of definitions and models. *Disaster Med Public Health Prep*. Aug. 2021;15(4):518–527. https://doi.org/10.1017/dmp.2020.100.
4. McCaskill A, Gasch-Gallen A, Montero-Marco J. Measuring general health literacy using the HLS19-Q12 in specialty consultations in Spain. *BMC Public Health*. Nov. 2024;24(1):3247. https://doi.org/10.1186/s12889-024-20710-7.
5. Choudhry FR, et al. Health literacy studies conducted in Australia: a scoping review. *Int J Environ Res Publ Health*. Mar. 2019;16(7):1112. https://doi.org/10.3390/ijerph16071112.
6. Rowlands G, Khazaezadeh N, Oteng-Ntim E, Seed P, Barr S, Weiss BD. Development and validation of a measure of health literacy in the UK: the newest vital sign. *BMC Public Health*. Dec. 2013;13(1):116. https://doi.org/10.1186/1471-2458-13-116.
7. Schulz PJ, Nakamoto K. Health literacy and patient empowerment in health communication: the importance of separating conjoined twins. *Patient Educ Counsel*. Jan. 2013;90(1):4–11. https://doi.org/10.1016/j.pec.2012.09.006.
8. *Survey of Adult Skills 2023*. OECD; 2024. https://doi.org/10.1787/3639d1e2-en.

9. Güner MD, Ekmekci PE. Health literacy level of casting factory workers and its relationship with occupational health and safety training. *Workplace Health Saf*. Sep. 2019;67(9):452–460. https://doi.org/10.1177/2165079919843306.
10. Persechino B, et al. Collaboration of occupational physicians with national health system and general practitioners in Italy. *Ind Health*. 2017;55(2):180–191. https://doi.org/10.2486/indhealth.2016-0101.
11. Franco G. The role of the occupational physician in the enlarged European Union: challenges and opportunities. *Occup Med*. May 2006;56(3):152–154. https://doi.org/10.1093/occmed/kqj017.
12. Caron RM, Noel K, Reed RN, Sibel J, Smith HJ. Health promotion, health protection, and disease prevention: challenges and opportunities in a dynamic landscape. *AJ Focus*. Feb. 2024;3(1), 100167. https://doi.org/10.1016/j.focus.2023.100167.
13. Poureslami I, Nimmon L, Rootman I, Fitzgerald MJ. Health literacy and chronic disease management: drawing from expert knowledge to set an agenda. *Health Promot Int*. Feb. 2016:daw003. https://doi.org/10.1093/heapro/daw003.
14. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med*. Jul. 2011;155(2):97. https://doi.org/10.7326/0003-4819-155-2-201107190-00005.
15. Tamayo-Fonseca N, Pereyra-Zamora P, Barona C, Mas R, Irles MÁ, Nolasco A. Health literacy: association with socioeconomic determinants and the use of health services in Spain. *Front Public Health*. 2023;11(Oct). https://doi.org/10.3389/fpubh.2023.1226420.
16. Palumbo R, Annarumma C, Adinolfi P, Musella M, Piscopo G. The Italian Health Literacy Project: insights from the assessment of health literacy skills in Italy. *Health Policy*. Sep. 2016;120(9):1087–1094. https://doi.org/10.1016/j.healthpol.2016.08.007.
17. Khoury G, Ward JK, Mancini J, Gagneux-Brunon A, Luong Nguyen LB. Health literacy and health care system confidence as determinants of attitudes to vaccines in France: representative cross-sectional study. *JMIR Public Health Surveill*. May 2024;10, e45837. https://doi.org/10.2196/45837.
18. Carrouel F, et al. Promoting health literacy in the workplace among civil servants: cross-sectional study. *JMIR Public Health Surveill*. Aug. 2024;10, e58942. https://doi.org/10.2196/58942.
19. Pescud M, et al. Employers' views on the promotion of workplace health and wellbeing: a qualitative study. *BMC Public Health*. Dec. 2015;15(1):642. https://doi.org/10.1186/s12889-015-2029-2.
20. Cannizzaro E, Malta G. Occupational Health Literacy Scale development and validation in Italy: a pilot study. *Public Health*. 2024;236. https://doi.org/10.1016/j.puhe.2024.07.017.
21. Borovecki A, Mlinaric A, Horvat M, Supak Smolcic V. Informed consent and ethics committee approval in laboratory medicine. *Biochem Med*. Oct. 2018;28(3). https://doi.org/10.11613/BM.2018.030201.
22. Kıraç FS. Is ethics approval necessary for all trials? A clear but not certain process. *Malecular Imaging and Radionuclide Therapy*. Dec. 2013;22(3):73–75. https://doi.org/10.4274/Mirt.80664.
23. World Health Organization. *WHO Guidance on Research Methods for Health Emergency and Disaster Risk Management*. 2022.
24. Schneider SL. *The International Standard Classification of Education 2011*. 2013:365–379. https://doi.org/10.1108/S0195-6310(2013)0000030017.
25. Zhang W, Bansback N, Boonen A, Young A, Singh A, Anis AH. Validity of the work productivity and activity impairment questionnaire - general health version in patients with rheumatoid arthritis. *Arthritis Res Ther*. Sep. 2010;12(5), R177. https://doi.org/10.1186/ar3141.
26. Frändemark Å, et al. Work productivity and activity impairment in disorders of gut-brain interaction: data from the Rome Foundation Global Epidemiology Study. *United European Gastroenterol J*. Jul. 2023;11(6):503–513. https://doi.org/10.1002/ueg2.12425.
27. Bhadhuri A, et al. Measurement properties of EQ-5D-3L and EQ-5D-5L in recording self-reported health status in older patients with substantial multimorbidity and polypharmacy. *Health Qual Life Outcome*. Dec. 2020;18(1):317. https://doi.org/10.1186/s12955-020-01564-0.
28. Gustafsdottir SS, Sigurdardottir AK, Arnadottir SA, Heimisson GT, Mårtensson L. Translation and cross-cultural adaptation of the European health literacy survey questionnaire, HLS-EU-Q16: the Icelandic version. *BMC Public Health*. Dec. 2020;20(1):61. https://doi.org/10.1186/s12889-020-8162-6.
29. Storms H, Claes N, Aertgeerts B, Van den Broucke S. Measuring health literacy among low literate people: an exploratory feasibility study with the HLS-EU questionnaire. *BMC Public Health*. Dec. 2017;17(1):475. https://doi.org/10.1186/s12889-017-4391-8.
30. Dijkman EM, ter Brake WWM, Drossaert CHC, Doggen CJM. Assessment tools for measuring health literacy and digital health literacy in a hospital setting: a scoping review. *Healthcare*. Dec. 2023;12(1):11. https://doi.org/10.3390/healthcare12010011.
31. Pedersen SE, Aaby A, Friis K, Maindal HT. Multimorbidity and health literacy: a population-based survey among 28,627 Danish adults. *Scand J Publ Health*. Mar. 2023;51(2):165–172. https://doi.org/10.1177/14034948211045921.
32. Altová A, et al. Educational inequalities in cervical cancer screening participation in 24 European countries. *Public Health*. Aug. 2024;233:1–7. https://doi.org/10.1016/j.puhe.2024.04.036.
33. Hsu H-C. Age differences in work stress, exhaustion, well-being, and related factors from an ecological perspective. *Int J Environ Res Publ Health*. Dec. 2018;16(1):50. https://doi.org/10.3390/ijerph16010050.
34. Hahn RA, Truman BI. Education improves public health and promotes health equity. *Int J Health Serv*. Oct. 2015;45(4):657–678. https://doi.org/10.1177/0020731415585986.
35. Karl JI, McDaniel JC. Health literacy deficits found among educated, insured university employees. *Workplace Health Saf*. Sep. 2018;66(9):419–427. https://doi.org/10.1177/2165079918758773.
36. Radło M-J, Tomeczek AF. Factors influencing labor productivity in modern economies: a review and qualitative text analysis. *WSEAS Trans Environ Dev*. Feb. 2022;18:291–314. https://doi.org/10.37394/232015.2022.18.30.
37. Cannizzaro E, et al. The influence of the COVID-19 pandemic emergency on alcohol use: a focus on a cohort of Sicilian workers. *Int J Environ Res Publ Health*. Mar. 2023;20(5):4613. https://doi.org/10.3390/ijerph20054613.
38. Lari M. A longitudinal study on the impact of occupational health and safety practices on employee productivity. *Saf Sci*. Feb. 2024;170, 106374. https://doi.org/10.1016/j.ssci.2023.106374.
39. Chen L, et al. Perceived workplace health support is associated with employee productivity. *Am J Health Promot*. Jan. 2015;29(3):139–146. https://doi.org/10.4278/ajhp.131216-QUAN-645.
40. Jiang L, Zhang J, Wong YD. Digital technology in occupational health of manufacturing industries: a systematic literature review. *Discov Appl Sci*. Nov. 2024;6(12):631. https://doi.org/10.1007/s42452-024-06349-4.
41. Singh B, Malviya R, Kaunert C. *Elevating Workplace Sustainability for Employees Lensing Mental Health Advancements*. 2024:285–310. https://doi.org/10.4018/979-8-3693-3470-6.ch014.
42. Shiri R, Nikunlaakso R, Laitinen J. Effectiveness of workplace interventions to improve health and well-being of health and social service workers: a narrative review of randomised controlled trials. *Healthcare*. Jun. 2023;11(12):1792. https://doi.org/10.3390/healthcare11121792.
43. van Oostrom SH, et al. Workplace interventions for preventing work disability. In: Anema JR, ed. *Cochrane Database of Systematic Reviews*. Chichester, UK: John Wiley & Sons, Ltd; 2009. https://doi.org/10.1002/14651858.CD006955.pub2.
44. Luisa Cantonnet M, Carlos Aldasoro J, Rodriguez Oyarbide I. Well-Being through workplace health promotion interventions by European enterprises. *Saf Sci*. Jul. 2022;151, 105736. https://doi.org/10.1016/j.ssci.2022.105736.
45. Orazi F, Sofritti F. Innovation 4.0 policies in Italy: strengths and weaknesses of the innovation ecosystem of the 'transition 4.0' plan from an international perspective. *Societies*. Mar. 2024;14(3):42. https://doi.org/10.3390/soc14030042.
46. Cernigliaro A, et al. A regional equity profile to assess the impact of social inequalities on determinants and health outcomes in the population residing in Sicily Region (Southern Italy). *Epidemiol Prev*. 2020;44(5-6 Suppl 1):54–63. https://doi.org/10.19191/EP20.5-6.S1.P054.074.
47. Vola F, Benedetto V, Vainieri M, Nuti S. The Italian interregional performance evaluation system. *Research in Health Services & Regions*. Sep. 2022;1(1):10. https://doi.org/10.1007/s43999-022-00010-6.
48. Hernández B, et al. Comparisons of disease cluster patterns, prevalence and health factors in the USA, Canada, England and Ireland. *BMC Public Health*. Dec. 2021;21(1):1674. https://doi.org/10.1186/s12889-021-11706-8.
49. Danailova Petrova-Geretto E, Yanakieva A, Vodenicharova A. Health literacy: a call for action for a just and egalitarian society. *Sci Int J*. Mar. 2023;2(1):37–40. https://doi.org/10.35120/sciencej020137d.
50. Tüzün H, et al. How health literacy associates with healthcare utilization and health promotion behaviours in Turkey?: contributions to discussions concerning the Anderson model and ecological models. *Int J Health Plann Manag*. Jul. 2023;38(4):986–998. https://doi.org/10.1002/hpm.3640.
51. Matranga D, Maniscalco L. Inequality in healthcare utilization in Italy: how important are barriers to access? *Int J Environ Res Publ Health*. Feb. 2022;19(3):1697. https://doi.org/10.3390/ijerph19031697.
52. Wang J, et al. Association of length of service and job category with occupational health literacy of port employees in Shenzhen, China. *BMC Public Health*. Jun. 2023;23(1):1223. https://doi.org/10.1186/s12889-023-15769-7.
53. Friedrich J, Rupp M, Feng Y-S, Sudeck G. Occupational health literacy and work ability: a moderation analysis including interpersonal and organizational factors in healthy organizations. *Front Public Health*. Feb. 2024;12. https://doi.org/10.3389/fpubh.2024.1243138.
54. Rauscher KJ, Myers DJ. Occupational health literacy and work-related injury among US adolescents. *Int J Inj Control Saf Promot*. Mar. 2014;21(1):81–89. https://doi.org/10.1080/17457300.2013.792288.
55. Asiamah N, et al. Discrimination of older peers is associated with workplace age discrimination: moderation by occupational health literacy. *BMC Psychol*. Nov. 2024;12(1):662. https://doi.org/10.1186/s40359-024-02163-0.
56. Mannevaara P, et al. Discovering the importance of health informatics education competencies in healthcare practice. A focus group interview. *Int J Med Inf*. Jul. 2024;187, 105463. https://doi.org/10.1016/j.ijmedinf.2024.105463.
57. Raghupathi V, Raghupathi W. The influence of education on health: an empirical assessment of OECD countries for the period 1995–2015. *Arch Public Health*. Dec. 2020;78(1):20. https://doi.org/10.1186/s13690-020-00402-5.

58. Lee KH, et al. Impact of health informatics analyst education on job role, career transition, and skill development: survey study. *JMIR Med Educ*. Sep. 2024;10, e54427. https://doi.org/10.2196/54427.
59. Smith C, Goss HR, Issartel J, Belton S. Health literacy in schools? A systematic review of health-related interventions aimed at disadvantaged adolescents. *Children*. Feb. 2021;8(3):176. https://doi.org/10.3390/children8030176.
60. Das S, Mia MN, Hanifi SMA, Hoque S, Bhuiya A. Health literacy in a community with low levels of education: findings from Chakaria, a rural area of Bangladesh. *BMC Public Health*. Dec. 2017;17(1):203. https://doi.org/10.1186/s12889-017-4097-y.
61. Jones C, Payne K, Thompson A, Verstappen SMM. Predicting presenteeism using measures of health status. *Qual Life Res*. Feb. 2022;31(2):425–435. https://doi.org/10.1007/s11136-021-02936-9.
62. Torun SD. Occupational health literacy level and related factors in casting factory workers. *Bakirkoy Tip Dergisi/Med J Bakirkoy*. Jun. 2023;19(2):229–235. https://doi.org/10.4274/BMJ.galenos.2023.2023.4-6.
63. Ehmann AT, Ög E, Rieger MA, Siegel A. Work-related health literacy: a scoping review to clarify the concept. *Int J Environ Res Publ Health*. Sep. 2021;18(19):9945. https://doi.org/10.3390/ijerph18199945.
64. Jørgensen MB, Larsen AK. Occupational health literacy: healthy decisions at work. In: *International Handbook of Health Literacy*. Policy Press; 2019:347–358. https://doi.org/10.56687/9781447344520-026.