



Repertorio Bibliografico Italiano di Medicina del Lavoro



a cura del Comitato Scientifico SIML

2023 - 3

Presentazione

La Presidenza SIMLI, considerato l'elevato gradimento avuto tra i soci della banca dati bibliografici messa a punto in occasione della pandemia COVID-19, ha chiesto al Comitato Scientifico di valutare la possibilità di predisporre una raccolta dei principali contributi scientifici che fossero comparsi sulle più importanti riviste internazionali in nel periodo più recente tecnicamente valutabile. Il Direttivo Nazionale della Società, riunitosi in data 17/3/23, ha approvato la proposta del Comitato Scientifico di avviare, per ora in forma sperimentale, in attesa di eventuali modifiche ed aggiustamenti futuri, di quello che si è deciso di chiamare "Repertorio bibliografico di Medicina del Lavoro".

La prima parte del numero 3 del Repertorio è composta dalle sintesi in italiano redatte dai singoli componenti del CS, dei lavori pubblicati fino al novembre 2023 connotati, a loro esclusivo giudizio e per l'area di competenza specifica nel CS, da rilievo, originalità, trattazione di temi attuali, proposta di tipo metodologico, e quindi meritevoli di essere segnalati ai soci attraverso un succinto commento critico.

Nella seconda parte viene riportata la raccolta dagli indici dei fascicoli 2023 (fino a ottobre novembre) delle riviste internazionali più importanti e rappresentative della nostra disciplina di cui alla tabella sotto riportata.

Riviste più rappresentative della Medicina del Lavoro, con Journal Impact Factor (JIF) 2022 e CiteScore (CS) del 2023 (tracking 5 Oct)

	Link to online issue	Country	JIF	CS	Owner/Publisher
American Journal of Industrial Medicine	Am J Ind Med	US	3.5	5.4	Wiley-Liss Inc.
Ergonomics	Ergonomics	UK	2.4	4.6	Taylor & Francis
International Archives of Environmental and Occupational Health	Int Arch Environ Occup Med	DE	3.0	5.0	Springer Verlag
International Journal of Occupational Medicine and Environmental Health	Int J Occup Med Environ Health	PL	2.0	3.4	Nofer Institute
Journal of Occupational Health	JOH	JA	3.0	4.9	Japan SOH
Journal of Occupational Medicine and Toxicology	J Occup Med Toxicol	UK	3.0	n.a.	BioMed Central Ltd.
Journal of Occupational and Environmental Medicine	JOEM	US	3.2	3.8	ACOEM
La Medicina del Lavoro	Med Lav	IT	2.7	4.2	SIML/Mattioli1885
Occupational and Environmental Medicine	OEM	UK	4.9	8.0	BMJ Publishing Group
Occupational Medicine	Occupational Medicine	UK	5.1	5.8	Oxford
Safety and Health at Work	SH@W	SK	3.5	6.0	Elsevier BV
Scandinavian Journal of Work, Environment and Health	SJWEH	FI	6.3	7.4	Finnish Institute of OH

Rispetto al precedente Repertorio sono stati inseriti l'istituzione e il paese di appartenenza del primo autore.

Il lettore attraverso la consultazione degli indici delle riviste, potrà avere una visione di insieme dei trend della ricerca nella nostra disciplina a livello mondiale, e se di interesse, cliccando sul link riportato nella seconda colonna della tabella o copiando e incollando in un browser l'URL ad esso associato, potrà accedere al sito della rivista ed aprire singoli fascicoli/articoli riportati in questa parte del repertorio, per scaricare gli articoli in extenso di personale interesse.

Si precisa che per gli articoli con più di tre autori è stata fatta la scelta, in analogia al metodo seguito da alcune delle riviste scrutinate, di riportare il primo secondo ed ultimo autore, rimandando all'articolo originale, per la lista completa.

Parte prima

ARTICOLI SELEZIONATI DAI SINGOLI COMPONENTI DEL COMITATO SCIENTIFICO SIML

Prof.ssa Valentina Bollati

Targeting the 'DNA methylation mark': Analysis of early epigenetic-alterations in children chronically exposed to arsenic

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Sci Total Environ. 2023 Dec 3:912:169049. doi: 10.1016/j.scitotenv.2023.169049.

Parole chiave: Tossicità dell'arsenico; Metilazione del DNA; Alterazioni epigenetiche; Numero di copie del DNA mitocondriale; DNA telomerico.

Contesto ed obiettivi

La contaminazione da arsenico attraverso l'acqua potabile a concentrazioni superiori ai limiti consentiti (cioè >10 µg/L, come stabilito dall'Organizzazione Mondiale della Sanità e dall'Agenzia per la Protezione dell'Ambiente degli Stati Uniti) provoca vari effetti avversi sulla salute sia negli adulti che nei bambini. Ridotta funzione intellettuale, neurotossicità, infezioni respiratorie acute, aumento della mortalità, ridotta immunità cellulo-mediata, immunosoppressione, infiammazione delle vie respiratorie sono soltanto alcuni dei problemi riscontrati negli esposti all'arsenico in vari paesi. L'arsenico può inoltre attraversare la barriera placentare e raggiungere il feto in via di sviluppo causando effetti nocivi.

L'arsenico inorganico viene facilmente biotrasformato nei suoi composti metilati che vengono eliminati dal corpo umano principalmente sotto forma di acido monometilarsonico (MMA) e acido dimetilarsinico (DMA). Un metabolismo inefficiente dell'arsenico causa l'accumulo di metaboliti metilati intermedi tossici (i.e. MMAIII e DMAIII) che danno luogo a danni ossidativi alle macromolecole cellulari mediante la formazione di radicali liberi, portando a un aumento della genotossicità e citotossicità. La difesa contro i danni ossidativi è mediata da diversi enzimi di riparazione del DNA che sostengono l'integrità cellulare attraverso la rimozione del danno. L'arsenico potrebbe agire sui meccanismi di cancerogenicità inducendo alterazioni epigenetiche in geni chiave per la riparazione del danno al DNA. Tra le principali vie di riparazione del DNA, il sistema di riparazione dei mismatch (MMR, "MisMatch Repair") è uno dei meccanismi biologici altamente conservati che mantengono l'integrità genomica durante la replicazione e la ricombinazione. L'epimutagenesi dei geni MMR è stata identificata come un significativo marcatore prognostico per varie malattie, compreso il cancro. Inoltre, in una popolazione di soggetti esposti ad arsenico nel Bengala Occidentale, è stata osservata una ipermetilazione del promotore con la conseguente inattivazione trascrizionale nei geni MLH1 e MSH2.

Oltre ai danni al DNA nucleare e all'inefficienza dei meccanismi di riparazione del DNA in risposta all'esposizione cronica all'arsenico, il genoma mitocondriale svolge un ruolo importante nell'instaurare e nel mantenere l'omeostasi cellulare. Le disfunzioni mitocondriali indotte dall'arsenico includono la generazione anomala di ROS, la perturbazione della catena di trasporto degli elettroni, l'alterazione del potenziale di membrana e l'inibizione della fosforilazione ossidativa. Studi hanno anche segnalato un'alterazione della metilazione del DNA mitocondriale in risposta alla tossicità da arsenico negli adulti. Il numero di copie del DNA mitocondriale (mtDNA) è considerato un indicatore della sua attività e biogenesi. Un numero maggiore

di copie del mtDNA è stato osservato in diverse malattie, compresi i tumori. L'aumento della biogenesi mitocondriale, inoltre, è stato documentato in relazione all'aumento della lunghezza dei telomeri. L'integrità del DNA telomerico è critica per l'omeostasi della lunghezza dei telomeri e la stabilità genomica.

Materiali e metodi

Nello studio di Sanyal et al. in esame, campioni biologici (sangue e urine) e campioni di acqua potabile sono stati raccolti da bambini di età compresa tra 5 e 16 anni provenienti da zone caratterizzate da alta esposizione ad arsenico (distretto di Murshidabad) e da zone caratterizzate da bassa esposizione (distretto di East Midnapur, Bengala Occidentale). Lo stato di metilazione subtelomerica e lo stato di metilazione del promotore di specifici geni target sono stati analizzati attraverso MSP (Methylation Specific PCR).

Risultati

Lo studio ha mostrato ipermetilazione del promotore dei geni MLH1 e MSH2 ($p < 0,05$ e $p < 0,001$) nei soggetti con esposizione levata ($75.34 \pm 23.58 \mu\text{g/L}$ di As nell'acqua potabile), suggestiva di un'inefficienza nella riparazione del danno al DNA. È stata osservata inoltre una ipometilazione nella regione D-loop mitocondriale ($p < 0,05$) e nella regione promotore del fattore di trascrizione mitocondriale TFAM ($p < 0,05$), insieme a un aumento del numero di copie del DNA mitocondriale nei bambini esposti. Si è riscontrato un significativo allungamento dei telomeri e ipermetilazione subtelomerica in regioni specifiche (XpYp, $p < 0,05$). L'analisi dei livelli di S-Adenosil Metionina (SAM) e 8-oxoDG hanno rivelato una significativa deplezione di SAM ($p < 0,001$) e un aumento del danno ossidativo al DNA ($p < 0,001$) in relazione alla esposizione ad arsenico.

Commento e possibili ricadute applicative

La diffusione della contaminazione da arsenico rappresenta una seria preoccupazione per la salute, con notevoli implicazioni sulla salute dei lavoratori esposti. Secondo i limiti stabiliti dall'Organizzazione Mondiale della Sanità e dall'Agenzia per la Protezione dell'Ambiente degli Stati Uniti, concentrazioni di arsenico superiori a $10 \mu\text{g/L}$ possono scatenare effetti avversi sia negli adulti che nei bambini.

Metabolismo dell'arsenico e impatto sulla salute dei lavoratori

Il metabolismo dell'arsenico e l'impatto sulla salute rivestono un ruolo di particolare rilevanza nel campo della medicina del lavoro, considerando la potenziale esposizione a questo metalloide in diverse ambienti di lavoro. L'arsenico, presente in suoli, acque sotterranee e persino in determinati settori industriali, può costituire una minaccia per la salute dei lavoratori, richiedendo un'attenta valutazione dei rischi e una gestione mirata. Nel contesto occupazionale, è cruciale comprendere come avvenga il metabolismo dell'arsenico nel corpo umano. Le vie di eliminazione, come la metilazione e la riduzione, assumono un ruolo di particolare importanza, poiché influenzano la tossicità dell'arsenico e la sua permanenza nell'organismo dei lavoratori esposti. I lavoratori che operano in settori a rischio di contaminazione da arsenico, come l'industria chimica o la lavorazione di materiali contenenti questo elemento, potrebbero essere esposti a livelli più elevati e più frequenti. Questo aumento dell'esposizione può essere correlato a gravi problemi di salute occupazionale, inclusi disturbi cardiovascolari, danni neurologici e rischi di sviluppare forme di cancro. La medicina del lavoro, pertanto, deve focalizzarsi sulla valutazione accurata delle fonti di esposizione all'arsenico nei luoghi di lavoro e sulla messa in atto di misure preventive. Ciò include l'implementazione di protocolli di monitoraggio ambientale e biologico, la formazione dei lavoratori sull'uso di dispositivi di protezione individuale e l'adozione di pratiche lavorative sicure. Le normative e le linee guida sulla presenza di arsenico negli ambienti di lavoro rivestono un ruolo fondamentale nella salvaguardia della salute occupazionale. La ricerca continua nel campo della medicina occupazionale è essenziale per sviluppare

approcci sempre più efficaci nella prevenzione e gestione di rischi correlati all'esposizione all'arsenico sul luogo di lavoro.

Riparazione del DNA e alterazioni epigenetiche

La riparazione del DNA e le alterazioni epigenetiche sono processi biologici di fondamentale importanza nel mantenimento dell'integrità genetica e nella regolazione dell'espressione genica. La riparazione del DNA è un intricato sistema di meccanismi cellulari che interviene per correggere danni al materiale genetico causati da fattori esterni o errori interni durante la replicazione cellulare. Questi meccanismi sono essenziali per prevenire mutazioni genetiche che potrebbero portare a gravi conseguenze, inclusi disturbi genetici e lo sviluppo di patologie come il cancro. D'altra parte, le alterazioni epigenetiche rappresentano modifiche chimiche che influenzano l'accessibilità e l'attività dei geni senza alterare la sequenza del DNA. Questi cambiamenti possono essere determinati da fattori ambientali e stili di vita, e hanno un impatto significativo sulle modalità con cui i geni vengono attivati o disattivati. In alcuni casi, alterazioni epigenetiche possono contribuire allo sviluppo di malattie croniche e condizioni patologiche.

La comprensione approfondita di come la riparazione del DNA e le alterazioni epigenetiche interagiscono tra loro è fondamentale, poiché può aprire nuove prospettive nella prevenzione e trattamento di malattie e condizioni legate all'epigenetica.

Ruolo di SAM e 8-oxo-dG nella tossicità da arsenico

Il ruolo della S-adenosilmetionina (SAM) e dell' 8-Oxo-2'-deossiguanosina (8-oxo-dG) riveste una particolare importanza nella tossicità da arsenico, poiché entrambi giocano un ruolo cruciale nei processi cellulari legati alla difesa e alla riparazione del DNA. La SAM, un importante donatore di gruppi metilici, è coinvolta nei processi di metilazione, compresa la metilazione dell'arsenico stesso. Questo meccanismo può influenzare la tossicità dell'arsenico, determinando se l'elemento sarà escreto dall'organismo o se si trasformerà in metaboliti più tossici.

D'altra parte, il 8-oxo-dG è un biomarcatore associato al danno del DNA causato dallo stress ossidativo, che può essere indotto anche dall'esposizione all'arsenico. Livelli elevati di 8-oxo-dG possono essere indicativi di una risposta cellulare allo stress causato dall'arsenico. La quantificazione di 8-oxo-dG può quindi fornire un'indicazione della gravità del danno al DNA causato dall'arsenico e della suscettibilità individuale. Comprendere il ruolo della SAM e del 8-oxo-dG nella tossicità da arsenico potrebbe essere fondamentale per sviluppare strategie compensative mirate. La regolazione della metilazione tramite la SAM potrebbe rappresentare un'area di intervento per mitigare gli effetti tossici dell'arsenico, mentre la valutazione dei livelli di 8-oxo-dG potrebbe fornire un importante strumento di monitoraggio per la salute cellulare e individuale.

Ruolo dei Mitocondri e Telomeri nella Risposta all'Arsenico

I mitocondri e i telomeri svolgono un ruolo centrale nella comprensione della risposta cellulare all'arsenico, contribuendo significativamente alla tossicità e alla stabilità genomica. I mitocondri, noti come le centrali energetiche delle cellule, sono particolarmente vulnerabili all'arsenico, poiché questo metalloide può interferire con la catena di trasporto degli elettroni e compromettere la produzione di energia. Tale compromissione mitocondriale può innescare processi di stress ossidativo, con conseguenze sulla salute cellulare e sulla risposta complessiva all'arsenico.

D'altra parte, i telomeri, le estremità protettive dei cromosomi, giocano un ruolo cruciale nella stabilità genomica. L'arsenico può influenzare la lunghezza dei telomeri, accelerandone il processo di accorciamento, che è correlato all'invecchiamento cellulare e alla suscettibilità alle malattie. La perdita di integrità dei

telomeri può contribuire all'instabilità genetica e aumentare il rischio di sviluppare patologie correlate all'arsenico, compresi un aumento del rischio cancerogeno.

La comprensione del ruolo dei mitocondri e dei telomeri nella risposta all'arsenico è essenziale per sviluppare strategie di prevenzione. Interventi mirati per proteggere la funzione mitocondriale e preservare l'integrità dei telomeri potrebbero rappresentare approcci cruciali per mitigare gli effetti nocivi dell'arsenico sulle cellule. La ricerca continua su questi fronti è fondamentale per delineare in modo più preciso i meccanismi coinvolti e per sviluppare strategie preventive che preservino la salute cellulare in contesti di esposizione all'arsenico.

Conclusione

In conclusione, la medicina del lavoro deve prestare attenzione agli effetti potenzialmente dannosi dell'esposizione all'arsenico sul luogo di lavoro, implementando misure preventive e monitoraggio attivo per proteggere la salute e la sicurezza dei lavoratori. La metilazione del DNA, i marcatori di danno ossidativo e la lunghezza telomerica potrebbero rappresentare strumenti utili per individuare gli effetti tossici precoci e caratterizzare la suscettibilità individuale.

Eventuale bibliografia di lavori pertinenti

S.S. Ameer, Y. Xu, K. Engström, H. Li, P. Tallving, B. Nermell, A. Boemo, L.A. Parada, L.G. Peñaloza, G. Concha, F. Harari Exposure to inorganic arsenic is associated with increased mitochondrial DNA copy number and longer telomere length in peripheral blood. *Frontiers in Cell and Developmental Biology* (2016), p. 87

M.A. Andrianova, G.A. Bazykin, S.I. Nikolaev, V.B. Seplyarskiy Human mismatch repair system balances mutation rates between strands by removing more mismatches from the lagging strand *Genome Res.*, 27 (8) (2017 Aug 1), pp. 1336-1343

P. Bhattacharjee, S. Paul Risk of occupational exposure to asbestos, silicon and arsenic on pulmonary disorders: understanding the genetic-epigenetic interplay and future prospects. *Environ. Res.*, 147 (2016 May 1), pp. 425-434

P. Bhattacharjee, T. Sanyal, S. Bhattacharjee Epigenetic alteration of mismatch repair genes in the population chronically exposed to arsenic in West Bengal, India. *Environmental Research*, 163 (2018 May 1), pp. 289-296

P. Bhattacharjee, A. Das, A.K. Giri Epigenetic regulations in alternative telomere lengthening: understanding the mechanistic insight in arsenic-induced skin cancer patients. *Sci. Total Environ.*, 704 (2020 Feb 20), Article 135388

Occupational Rhinitis: An Update

Jose Zamora-Sifuentes, Jill A. Poole

Current Allergy and Asthma Reports (2023) 23:579–587

Parole chiave: rinite, irritanti, apparato respiratorio, infiammazione

Contesto ed obiettivi

La rinite professionale è una malattia infiammatoria delle vie aeree superiori associata allo sviluppo di sintomi nasali, tra cui rinorrea, congestione nasale, starnuti e prurito direttamente collegati alle esposizioni lavorative e non associati con fattori che si verificano al di fuori del luogo di lavoro.

La prevalenza della rinite professionale non è ben definita a causa di diversi fattori, tra cui la mancanza di un algoritmo universale per diagnosticare la malattia.

La diagnosi precoce di rinite lavoro correlata è rilevante anche perché la malattia potrebbe predire il successivo e ben più grave sviluppo di asma bronchiale.

La rinite lavoro correlata comprende due sottogruppi di rinite: quello direttamente causato da esposizioni o condizioni del posto di lavoro e la rinite esacerbata dalle esposizioni sul posto di lavoro in un individuo con rinite preesistente. La prima forma, a sua volta, comprende una forma allergica ed una non allergica (o da irritanti). La rinite riacutizzata dal lavoro indica una forma preesistente di rinite che peggiora con esposizioni a particolari ambienti di lavoro, spesso in presenza di polveri, fumi o forti odori.

Così come per l'asma professionale, è possibile distinguere gli agenti eziologici della rinite occupazionale in base al peso molecolare delle sostanze (alto o basso peso molecolare): le sostanze ad alto peso molecolare (es. prodotti alimentari) inducono rinite allergica con periodo di latenza, con possibilità di sviluppare sensibilizzazione sia a seguito del contatto cutaneo che inalatorio. Le forme di rinite su base irritativa, descritte spesso negli addetti alle pulizie domestiche ed industriali, sono causate da un processo infiammatorio non allergico.

Per l'indagine della sensibilizzazione IgE-mediata a sostanze che si verificano sul posto di lavoro possono essere utilizzati anche test immunologici, come il prick test cutaneo o i test sierologici per la rilevazione degli anticorpi IgE allergene-specifici. Tuttavia, l'applicabilità dei test immunologici è attualmente limitata dalla scarsa disponibilità di sostanze di prova disponibili in commercio.

Anche se l'anamnesi dettagliata del paziente è particolarmente importante quando si tratta di diagnosticare la rinite professionale, il gold standard per confermare la diagnosi è il test di provocazione nasale; tuttavia, l'applicazione di questa procedura diagnostica è spesso difficile da praticare, anche a causa della scarsa presenza di protocolli standardizzati.

Il trattamento della rinite occupazionale ha due obiettivi: in primo luogo, la minimizzazione dei sintomi clinici della rinite e il suo impatto sulla qualità della vita del paziente, in secondo luogo, la prevenzione dello sviluppo

dell'asma occupazionale. Le opzioni terapeutiche comprendono l'evitamento dei fattori scatenanti, la riduzione dell'esposizione e la terapia farmacologica.

Malgrado la loro frequenza elevata nel quadro delle malattie respiratorie professionali, le rinite professionali rimangono il «parente povero» in letteratura di fronte all'asma professionale. Sono necessarie ulteriori ricerche per identificare meglio i predittori della malattia e per sviluppare strategie di gestione efficaci.

A volte falsamente considerata una malattia senza ricadute negative, la rinite incontrollata contribuisce negativamente sulla qualità della vita dei pazienti ed è fonte considerevole di morbilità; per esempio, rinite e rinosinusite sono spesso causare tosse cronica legata al lavoro, e la rinite può precedere lo sviluppo di asma.

La rinite correlata al lavoro è un tipo di rinite che può essere classificata come: 1) rinite professionale o 2) rinite esacerbata dal lavoro. A sua volta, la rinite professionale può essere avere eziologia allergica o irritativa (Figura 1).

La rinite viene diagnosticata dalla presenza di congestione nasale, rinorrea, starnuti o prurito, sintomi che tendono a migliorare quando il l'esposizione sul posto di lavoro non è più presente. Ad esempio, nella rinite professionale, in genere i sintomi si risolvono durante i fine settimana o durante le assenze dal posto di lavoro per periodi di tempo prolungati (fenomeno arresto-ripresa).

Per rinite aggravata dal lavoro ci si riferisce alla rinite che era presente prima dell'esposizione professionale e che peggiora a seguito della presenza di sostanze irritanti nel luogo di lavoro, come ad esempio fumi, odori forti o polveri.

In un'elevata percentuale di casi l'asma professionale è associata a rinite, e i sintomi nasali spesso precedono l'insorgenza di quelli bronchiali, rappresentando in molti casi un marker precoce utile nella sorveglianza sanitaria. Ciò sottolinea la stretta relazione tra le vie aeree superiori e inferiori, ipotizzando quindi un modello di patologia dell'intero tratto respiratorio. Ad esempio, nel lavoro di Ameille et al., in 555 casi di asma professionale, nel 60 % dei casi era presente anche rinite occupazionale; inoltre, la co-presenza di rinite ed asma professionale era maggiore in caso di esposizione ad agenti ad alto peso molecolare (HMW) rispetto a quelli a basso peso molecolare (LMW). Moscato et al. ha anche descritto un'associazione tra la gravità di rinite professionale e asma professionale, segnalando che la rinite professionale persistente da moderata a grave era un predittore di asma professionale persistente.

Casi di rinite professionale sono stati descritti a seguito dell'esposizione ad HMW e LMW: tra le esposizioni ad HMW, da ricordare i casi di rinite negli addetti alla manipolazione degli alimenti che possono sensibilizzarsi sia per via transcutanea diretta o attraverso l'inalazione di particelle aerosolizzate mentre si maneggia il cibo. Inoltre, in queste forme di esposizione, i lavoratori si possono sensibilizzare non solo al cibo che stanno maneggiando ma anche agli additivi utilizzati nell'ambiente di lavoro, come gli enzimi. Sono state descritti casi di rinite professionale con sensibilizzazione all'enzima fitasi, utilizzato come additivo di alcuni mangimi.

Sempre nelle esposizioni professionali in ambito alimentare, la revisione evidenzia come la rinite professionale e l'asma professionale siano particolarmente frequenti nei panificatori, in particolare nei fornai che maneggiavano farina di grano con additivi con additivi, così come quelli che trattano anche multicereali.

Inoltre, in un mercato in evoluzione che richiede prodotti biologici, senza glutine, e prodotti vegani, i fornai iniziano ad utilizzare anche nuove sostanze, con relativo rischio di sensibilizzazione. Per esempio, sono stati segnalati casi di rinite professionale a seguito ad esposizione alla farina di psillio, come sostituto del glutine e delle uova. La farina di grano saraceno, altra alternativa senza glutine, è stata anche collegato alla rinite professionale e all'asma l'industria alimentare, in particolare nei cuochi e nei panettieri.

Anche le nuove tendenze ad utilizzare prodotti biologici e vegani hanno portato ad un maggior impiego di coloranti a base vegetale, con incremento di casi di rinite professionale a seguito all'esposizione a tintura di indaco e hennè nei parrucchieri.

Tra le esposizioni a LMW, un recente studio di Paz et al. ha dimostrato che la presenza di sintomi suggestivi di rinite era più comune tra gli addetti alle pulizie rispetto agli impiegati indipendentemente dall'ambiente di lavoro. Una forte associazione tra rinite allergica ed esposizione a LMW è stata documentata nell'industria automobilistica, con esposizione a isocianati, e nei parrucchieri, con esposizione a persolfati, spesso con meccanismi non IgE mediati.

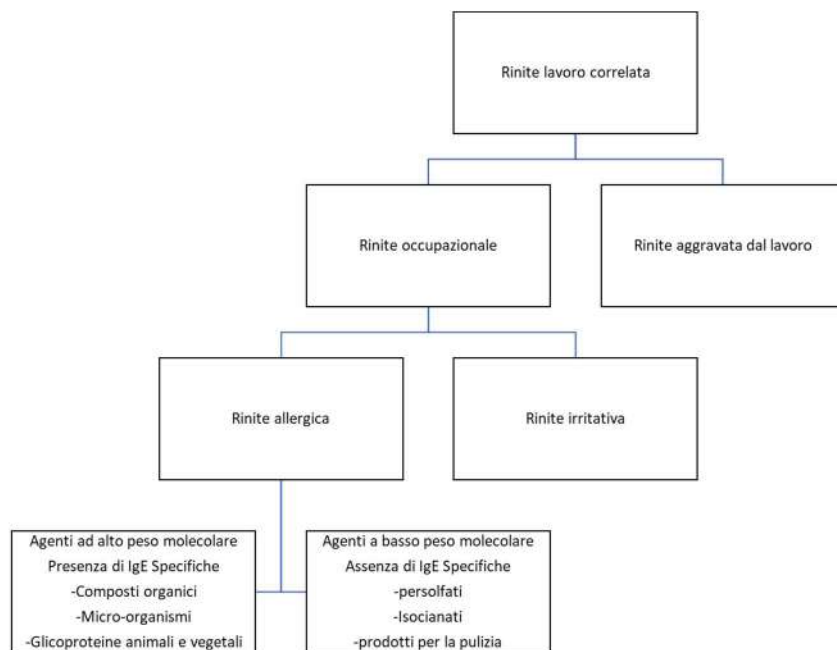


Figura 1. Schema generale della categorizzazione della rinite correlata al lavoro e dei meccanismi della malattia

Commento e conclusioni

La rinite professionale rappresenta una condizione eterogenea che può essere indotta da un ampio spettro di agenti sensibilizzanti ed irritanti. Con la continuo comparsa di nuovi prodotti nei settori alimentare e industriale, è probabile che continueremo a vedere nuovi agenti responsabili di rinite professionale.

La rinite professionale è una patologia comunemente sotto diagnosticata ma che dovrebbe essere considerata in qualsiasi paziente che presenta rinite cronica che si sviluppa o peggiora in età lavorativa. Il riconoscimento precoce della malattia con susseguente allontanamento dall'agente eziologico è importante per ottenere un risultato migliore come prognosi ed un miglioramento della qualità di vita. La diagnosi di rinite professionale, spesso, è per esclusione. È importante riconoscere la rinite occupazionale poiché spesso precede lo sviluppo di asma occupazionale.

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Scand J Work Environ Health. 2023 Nov 12:4132 (with additional material available belonging to this article on the Scandinavian Journal of Work, Environment & Health website)

Contesto ed obiettivi

Essere occupati permette di raggiungere uno stato di salute migliore del non esserlo, per tante ragioni, a cominciare dal poter avere un reddito. In alcune situazioni però il lavoro, quando non è sicuro e sano, può essere causa di un carico di malattia con diversa distribuzione nelle diverse aree del globo (GBD 2019).

Questo studio fornisce stime (globali, regionali e locali) della perdita di salute delle popolazioni a causa di malattie ed infortuni legati al lavoro. Per il 2019, a livello mondiale, gli autori valutano il carico di malattia riferibile al lavoro, fornendo dati sia di mortalità che di DALY (disability adjusted life years, in pratica gli anni di vita vissuta in buona salute che vengono persi a causa di questo o quel fattore di rischio).

Metodi

Gli autori utilizzano dati su occupazione, mortalità, malattie da lavoro, infortuni sul lavoro, frazione attribuibile (quella frazione di malattia che non sarebbe comparsa nella popolazione se questa non fosse stata esposta ad un determinato fattore). I dati utilizzati sono stati reperiti nella più recente letteratura o nei siti web di organizzazioni internazionali quali ILO (International Labour Organization), OMS, UE. Sono stati raccolti dati relativi a 120 coppie malattia-esposizione (incluse 5 malattie della sfera psichica) considerando come base quanto calcolato in Finlandia all'inizio del millennio (Nurminen e Karjalainen 2001). Alle coppie malattia-esposizione esaminate, è stata applicata una matrice mansione-esposizione per ottenere, per mansione, una stima della prevalenza di esposti a determinati fattori di rischio, considerando tipologia e livello di esposizione.

Per calcolare i DALY gli autori hanno calcolato (per ogni coppia malattia-esposizione) sia YLL (years of life lost, cioè gli anni di vita perduti per mortalità) che YLD (years lived with disability,

cioè gli anni di vita vissuta con disabilità) (si veda nota 1). Per il calcolo della frazione attribuibile (Population Attributable Fraction, PAF) gli autori hanno fatto riferimento a dati di letteratura scientifica, utilizzando metodiche già sperimentate.

Nota 1. Si consideri che i DALY sono la somma di YLL e YLD, cioè $DALY=YLL+YLD$. Si noti quindi che ai DALY contribuiscono sia gli anni di vita non vissuti (per decesso avvenuto prima del termine di speranza di vita), cioè YLL, che il grado di disabilità dovuto alla singola malattia od infortunio, sulla base del quale viene calcolata la proporzione di “anno vissuto in buona salute” che viene perduto, cioè YLD. Ad esempio, se un uomo che aveva vissuto in perfetto benessere muore a 70 anni (non raggiungendo gli 81,5 anni, massima speranza di vita raggiungibile nel paese - Giappone – in cui la speranza di vita è più alta al mondo, presa come riferimento dall’OMS) avrà perso 11,5 di vita vissuta in buona salute (YLL) ma avrà 0 di YLD e (ricordando la formula $DALY=YLL+YLD$) avrà $DALY=11,5+0=11,5$. Nel caso invece di un uomo che muore a 81,5 anni ma a 51,5 anni di vita si ammala di una patologia che determina una disabilità permanente e corrispondente alla perdita del 40% della “vita vissuta in buona salute” allora questi avrà perso $0,4 \times 30 = 12$ YLD, quindi avrà $DALY=0+12=12$. In un terzo caso, un uomo muore a 60 anni ma a 40 si è ammalato di una patologia che determina una disabilità del 50%. Il calcolo dei YLL porta a 21,5 anni di vita in buona salute non vissuti. Il calcolo dei YLD porta a $0,5 \times 20=10$, cioè 10 anni di vita vissuta in buona salute persi come somma dei 20 anni in cui è stato perso il 50% della vita vissuta in buona salute. I suoi DALY saranno uguali alla somma di YLL e YLD, quindi $DALY=21,5+10=31,5$. Questi esempi dimostrano che, quando si voglia tenere in considerazione sia la mortalità che la disabilità, è possibile fare la somma di queste, se sono entrambe espresse in anni, ottenendo come risultato i DALY e cioè il totale della perdita di anni di vita vissuta in buona salute. Questi calcoli possono essere eseguiti calcolando il carico di malattia (in DALY) che è associabile alle singole coppie esposizione-malattia.

Risultati

Nel 2019, nel mondo, gli autori calcolano 2,9 milioni di decessi in qualche modo correlati al lavoro, per infortunio o per malattia. Un terzo di questi (fig. 1) deriverebbero da neoplasie ed un terzo da malattie cardiovascolari (si veda Nota 2). Ogni giorno, nel mondo, nel 2019 si sarebbero avute quasi 8000 morti legate al lavoro, di cui 855 da infortunio e 7100 da malattia.

Rispetto ai dati calcolati con simili metodiche nel 2015 (Hamalainen 2017), si mette in evidenza un modesto aumento della mortalità da lavoro sostenuto dalle malattie, mentre la mortalità per

infortunio è in modesto calo. Tra le malattie correlate al lavoro risulta in calo (nel 2019, rispetto al 2015) solo la mortalità da agenti infettivi. Considerando le Regioni in cui l'OMS suddivide il mondo, per quel che riguarda la mortalità correlata al lavoro si può notare (Fig. 2) che: a) in Europa e nei paesi a più alto reddito pro-capite la mortalità da lavoro più alta si ha per neoplasie, mentre la mortalità per infortuni è più bassa che negli altri paesi; b) in Medio Oriente la mortalità più elevata risulta quella per malattie cardiovascolari; c) la mortalità più alta per infortuni si ha in Africa; d) la mortalità per "altre malattie" (quindi per malattie respiratorie, infettive, ecc.) è quella più rilevante sia in Africa che nel Sud-est asiatico.

Considerando non solo la mortalità, ma anche la disabilità, gli autori calcolano per il 2019 un carico di salute perduta per questioni legate al lavoro di 180 milioni di DALY. In questo caso, trattandosi anche di parziale perdita della salute e non di soli decessi, occupano un posto di primo piano anche i disturbi muscoloscheletrici, con il 9% di tutti i DALY (cioè, con circa 1,6 milioni di "anni di vita vissuta in buona salute perduti"). Gli autori (Fig. 3) mettono in luce differenze tra le aree del pianeta, per quel che riguarda i DALY correlati al lavoro: a) il tasso di DALY correlati al lavoro è più elevato (per 100.000 lavoratori) in Oriente (Sud-est asiatico e Pacifico occidentale, regione che tra gli altri comprende Cina, Giappone, Australia) ed in Africa, mentre in Europa e in America si registrano i tassi più bassi, benchè tra i paesi a più alto reddito i tassi di DALY siano relativamente più elevati; c) i DALY dovuti a malattie neoplastiche e a disturbi muscoloscheletrici hanno un'importanza relativa più elevata nei paesi ad alto reddito pro-capite; d) i DALY da disturbi della sfera psichica hanno un'importanza relativa maggiore in Oriente; e) in Africa invece i DALY derivano per più del 50% da "altre malattie" (respiratorie, infettive, dell'apparato digerente e di quello genito-urinario).

Considerando la spesa dovuta ai DALY correlati al lavoro (si veda Fig. S4 nel file Supplement), questa risulta, rispetto al prodotto interno lordo (GDP, Gross Domestic Product) elevata soprattutto per i paesi di Medioriente ed Africa e relativamente più bassa per Europa occidentale e Nord-America.

Nota 2. Va considerato, al riguardo di malattie cardiovascolari correlate al lavoro, che il nostro Legislatore, nella recente Tabelle delle malattie professionali (DM 10-10-2023) riporta solo le vasculopatie da solfuro di carbonio. Nell'allegato al DM 10-6-2014 (malattie di cui corre l'obbligo della notifica, se di origine professionale) sono presenti: ipertensione ed arteriosclerosi da solfuro di carbonio, turbe del ritmo cardiaco come esito di ossicarbonismo acuto, miocarditi negli esposti a fosforo, crisi anginose da nitroglicole e "malattie dell'apparato cardiocircolatorio" quale effetto

extrauditivo del rumore. Questa è l'unica coppia esposizione-malattia che questo DM ha in comune con le coppie esposizione-malattia cardiovascolare indagate dagli autori dell'articolo, che valutano anche: 1) lavoro su turni (anche notturni) e ischemia cardiaca; 2) gas di scarico o ossido di carbonio e ischemia cardiaca; 3) fumo passivo al lavoro e ischemia cardiaca; 4) lavoro su turni e malattie cerebrovascolari; 5) fumo passivo al lavoro e malattie cerebrovascolari; 6) Ore di lavoro settimanale >55 e ischemia miocardica. Va inoltre considerato che gli autori, nel calcolare DALY riferibili a malattie cardiovascolari correlate al lavoro utilizzano frazioni attribuibili (si vedano Tabella S1 e S2 del file Supplement) con valori (14,4% per gli uomini e 6,7% per le donne) più elevati di altre stime che gli stessi autori riportano in tabella S1. Va infine sottolineato che risulta estremamente difficoltoso nel caso delle malattie cardiovascolari individuare un'associazione causale con un fattore di rischio presente sul lavoro, considerando la notevole quantità di fattori e variabili genetici, metabolici, voluttuari e socio-economici che possono mascherare e confondere l'eventuale rilevanza di esposizioni professionali quali possibili determinanti di queste patologie.

Discussione -conclusioni

Data l'area di interesse della rivista, sicuramente una delle principali riviste del nostro ambito, lo studio ha il merito di portare all'attenzione del pubblico specializzato l'importante questione del carico di malattia che il lavoro (non sicuro e non sano) può determinare. È altresì importante che gli autori utilizzino metodi che permettano confronti con risultati ottenuti in precedenza, per valutare andamenti a livello mondiale e nelle diverse regioni del pianeta.

Questo consente a noi di comprendere la rilevanza dei diversi problemi di salute, in confronto tra loro, cosa che ci permette di indirizzare correttamente gli sforzi che portano alla prevenzione di infortuni e malattie correlate al lavoro. Da notarsi a questo riguardo che il calo della mortalità da infortunio riportato nell'articolo (e che potremmo presupporre sia dovuto ad un miglioramento "globale" delle condizioni di lavoro) fa il paio con un aumento della mortalità per neoplasie. Ciò non di certo per inefficienza nella prevenzione di queste patologie ma per l'effetto di pregresse esposizioni. La prevenzione della comparsa di neoplasie da lavoro farà sentire i suoi benefici più avanti nei decenni, mentre ancora oggi scontiamo gli effetti di esposizioni del passato.

Bene fanno gli autori a mettere in discussione i propri risultati con quelli ottenuti da altri gruppi di ricercatori. Innanzitutto, perché la discussione stessa in questo articolo è una fonte di utili indicazioni bibliografiche sul tema della valutazione del carico di malattia correlato al lavoro, e poi perché così permettono di comprendere quanto calcolare queste stime sia complesso. Le fonti stesse

delle informazioni possono fornire dati che, raccolti con modalità diverse e con finalità differenti, risultano poco confrontabili anche all'interno di uno stesso paese.

Uno studio come questo mette inoltre l'accento sulle necessità di ricerca, considerando quanto il lavoro sia importante per promuovere la salute delle persone e quanto invece possa danneggiarla, con modalità che ancora non ci sono del tutto note. Non abbiamo finito, cioè, di studiare.

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Supplementi dell'articolo di utile consultazione

Supplementary Annex . Additional Tables and Figures and Updated population attributable fraction and related references. Pages 1 - 21.

Supplementary Data Table covering consolidated global, regional and country data on work-related diseases, injuries and calculation methods. Excel formatted data converted to delimited pdf-file. Pages 22 - 119

Global Estimates on Biological Risks at Work

Takala J, Descatha A, Oppliger A, Hamzaoui H, Bråkenhielm C, Neupane S.

Safety and Health at Work. 2023 Dec; 14(4):390-397. doi: 10.1016/j.shaw.2023.10.005

Contesto ed Obiettivi

I rischi biologici sono un problema globale di primaria importanza sul luogo di lavoro. La recente pandemia COVID-19 ha evidenziato la necessità di una comprensione più completa dei rischi biologici sul lavoro. Questo studio presenta dati relativi sia ad agenti biologici infettivi trasmissibili sia a fattori non trasmissibili che hanno causato morte e disabilità nell'anno 2021.

Metodi

Abbiamo seguito la metodologia stabilita dall'Organizzazione Internazionale del Lavoro (ILO) nelle sue precedenti stime globali sugli infortuni sul lavoro e sulle malattie correlate al lavoro. Abbiamo utilizzato le stime dell'ILO relative alle sostanze pericolose e le relative frazioni attribuibili di popolazione ricavate dalla letteratura, che sono state poi applicate ai dati di mortalità dell'Organizzazione Mondiale della Sanità. Le malattie trasmissibili incluse nelle stime sono state la tubercolosi, le malattie da pneumococco, la malaria, le malattie diarroiche, altre malattie infettive, le malattie tropicali neglette, le malattie respiratorie associate all'influenza e COVID-19. Le malattie e gli infortuni non trasmissibili presi in considerazione sono stati le malattie ostruttive croniche (BPCO) dovute alle polveri organiche, l'asma, le reazioni allergiche e i rischi legati al contatto con gli animali. Abbiamo stimato la mortalità attribuibile al rischio biologico sul lavoro e la disabilità in termini di anni di vita aggiustati per disabilità (DALY).

Risultati

Abbiamo stimato che nel 2022, 550.819 decessi sono stati causati da fattori di rischio biologici, con 476.000 decessi attribuiti a malattie infettive trasmissibili e 74.000 decessi causati da fattori non trasmissibili. Tra questi, 223.650 decessi sono stati attribuiti a COVID-19 sul lavoro. Abbiamo calcolato un tasso di 584 DALY per 100.000 lavoratori, che rappresenta un aumento dell'11% rispetto alla precedente stima del carico globale delle disabilità lavoro-correlate misurato in DALY.

Conclusioni: Questo è il primo aggiornamento dalle precedenti stime dell'ILO del 2007, che risultano alla valutazione attuale aumentate del 74%, coprendo la maggior parte dei fattori di rischio biologico. Tuttavia, è importante notare che potrebbero mancare nei dati analizzati altre malattie e decessi, che dovranno essere inclusi quando nuove informazioni saranno rese disponibili. Vale la pena ricordare che, mentre i decessi causati dalle principali malattie trasmissibili, tra cui COVID-19, sono relativamente rari tra la popolazione lavorativa, le assenze dal lavoro dovute a queste malattie sono probabilmente molto comuni tra la forza lavoro attiva.

Discussione

Nello studio viene evidenziata l'attuale rilevanza degli agenti biologici come ambito di rischio occupazionale, di maggiore importanza rispetto a quanto ritenuto in precedenza. L'identificazione dei pericoli comprende un ampio elenco di agenti biologici, sostanze e processi che potrebbero essere presenti nei luoghi di lavoro [1]. Questi agenti biologici, compresi gli agenti infettivi, possono influire negativamente sulla salute dei lavoratori. Quantificare il livello dei vari rischi biologici è fondamentale per prevenire le morti e le disabilità associate al lavoro in questo ambito. L'Organizzazione Internazionale del Lavoro (ILO) ha precedentemente sviluppato una metodologia per quantificare il livello dei vari rischi derivanti da sostanze e prodotti chimici pericolosi sul lavoro [2]. Anche se la valutazione dell'entità di tutti i possibili rischi potrebbe non essere realizzabile, la comprensione della gravità e della frequenza dei rischi causati da agenti biologici è importante per comprenderne il carico di malattia e mortalità associate, dato ampiamente ignorato ad oggi.

A tal proposito, risulta essenziale considerare gli agenti, le sostanze e le circostanze associate ai rischi biologici occupazionali. Esistono due gruppi principali di agenti biologici considerati tra i rischi professionali: agenti allergenici e/o tossici che formano *bioaerosol* e agenti che causano malattie infettive.

Come sempre, occorre tenere conto delle specificità del lavoro e delle circostanze, soprattutto tra i gruppi vulnerabili, come i giovani lavoratori, gli anziani, le lavoratrici in gravidanza e i lavoratori immunodepressi.

Al fine di affrontare questi rischi, in particolare in considerazione dei nuovi agenti emergenti e pandemici, è necessario indagare i fattori causali per anticipare e identificare i rischi per la salute, implementando sistemi di allerta nazionale e globale. Ciò significa che devono essere presi in considerazione sia gli agenti infettivi e trasmissibili sia i fattori non trasmissibili che possono causare morte, disabilità e malattie.

Una precedente stima delle malattie trasmissibili letali associate al lavoro, effettuata nel 2007, era di 320.000 decessi [3]: lo scopo del presente studio è stato di aggiornare questa stima, anche alla luce della recente pandemia COVID-19.

In sintesi, sono stati raccolti i dati su malattie, decessi e disabilità da varie fonti, tra cui l'Organizzazione Mondiale della Sanità (OMS), l'ILO, gli studi sul carico globale delle malattie (GBD) e la letteratura scientifica.

Per stimare la correlazione al lavoro di questi dati, sono state utilizzate le frazioni attribuibili di popolazione (PAF), seguendo la prassi adottata per le precedenti stime a cura di ILO, OMS e GBD [2].

Sono stati raccolti e presentati il numero di malattie, disturbi, lesioni e decessi, nonché le stime dei costi economici per i gruppi di malattie più importanti. Nello specifico, sono stati stimati i decessi, le disabilità e le lesioni derivanti da malattie trasmissibili sul lavoro, tra cui la tubercolosi, le malattie da pneumococco, la malaria e alcune malattie tropicali, come la febbre dengue e le infezioni da Ebola. Queste malattie sono causate da vari agenti e fattori, tra cui batteri, virus, funghi e animali, comprendendo anche il settore dell'agricoltura. La stima dell'entità dei rischi ha compreso tutte le possibili vie di esposizione, come l'ingestione (compresa la scarsa qualità dell'acqua, i servizi igienici e i sistemi fognari), l'inalazione, il contatto con la cute o le mucose.

Il numero totale stimato di decessi dovuti a fattori di rischio biologico in ambito lavorativo nel 2021 è risultato di circa 550.000 soggetti. Tuttavia, è importante notare che, a causa dell'insufficienza di dati per un numero di malattie, disturbi e lesioni, è probabile che il valore totale dei decessi registrati risulti sottostimato.

Eliminando i possibili doppi conteggi, 313.521 decessi non risultano ricompresi nelle stime precedenti, che includono tutte le malattie e gli infortuni correlati al lavoro. Di conseguenza, i fattori di rischio biologici risultano in causa nel 9,8% di tutti i decessi correlati al lavoro precedentemente stimati, con un aumento del 10,8% rispetto alla stima precedente di 2,9 milioni di decessi.

La figura sottostante (Fig.1) mostra l'entità degli esiti attribuibili ai rischi biologici rispetto ad altri rischi correlati al lavoro riportati da altre fonti di dati [4,5]. Poiché i dati relativi ai rischi biologici non erano disponibili al momento della stima di tutti i decessi lavoro-correlati nell'anno 2019, i numeri totali a livello globale (2,9 milioni di decessi) non risultano del tutto accurati, ma forniscono una quota approssimativa associata ai fattori di rischio biologico. I decessi per malattie trasmissibili correlate al lavoro sono inclusi nei settori infortuni e malattie respiratorie del grafico a torta riportato di seguito, mentre sono correttamente visualizzati separatamente nel riquadro dedicato ai rischi biologici.

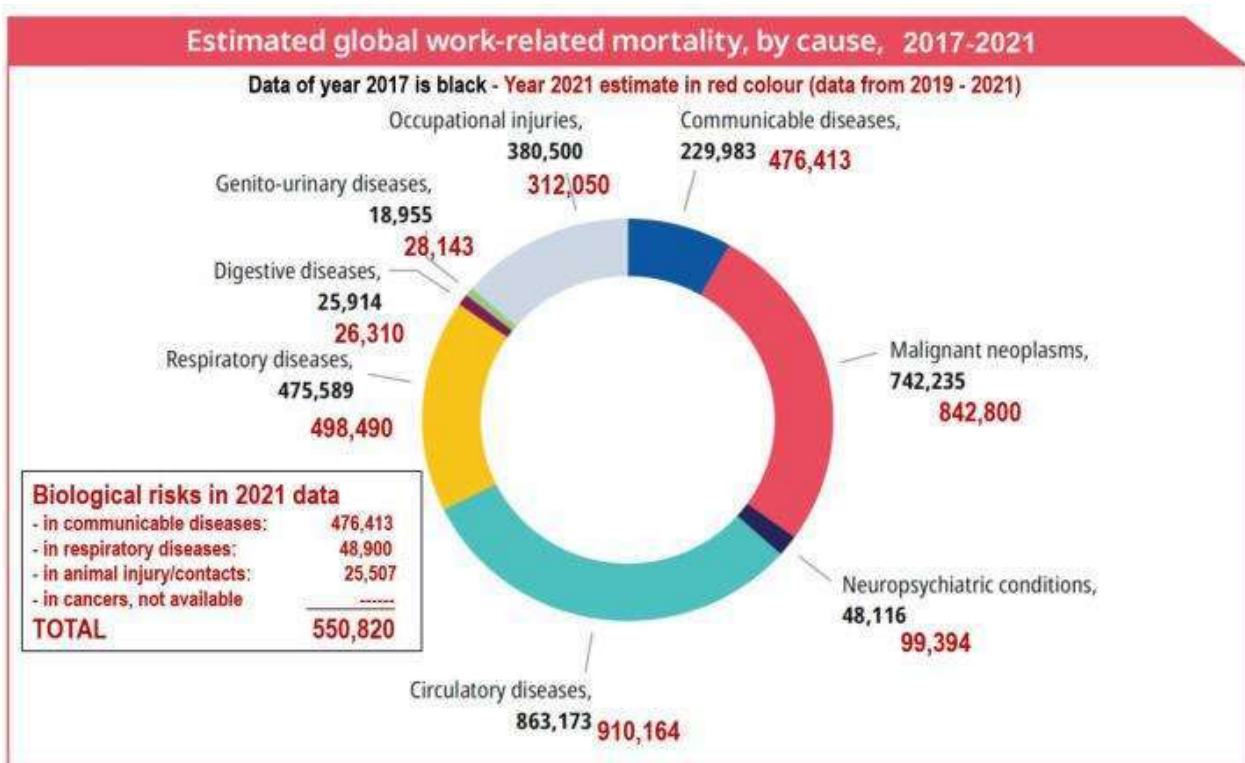


Figura 1. Stima globale di mortalità correlata al lavoro, per causa, 2017-2021.

Il costo economico annuale globale causato dalla scarsa prevenzione delle malattie e degli infortuni biologici è stimato essere pari allo 0,58% del PIL globale, pari a 548 miliardi di dollari.

I calcoli dettagliati dei DALY correlati all'esposizione a rischi biologici sul lavoro non sono stati calcolati per gruppi di malattie, ma una stima complessiva indica che il numero di DALY aumenta all'incirca della stessa percentuale del numero di decessi, circa il 10,8%. Di conseguenza, la stima globale dei DALY è risultata essere di 5.390 DALY/100.000 lavoratori.

Per l'anno 2021, la componente maggiore è stata attribuita al COVID-19, che ha aumentato in modo significativo il numero dei decessi associati al lavoro, raggiungendo 223.000 casi mortali. Tuttavia, la frazione attribuibile di popolazione per i casi mortali di COVID-19 è stata relativamente bassa, pari al 3%, mentre la frazione di popolazione in età lavorativa infetta è stata molto più alta, pari al 30%. Ciò indica un impatto significativo sulla disabilità temporanea e a lungo termine dovuto al COVID-19, che riguarda circa il 19,4% dei casi correlati al lavoro [6].

Conclusioni ed indicazioni

I rischi biologici rappresentano un importante problema globale nei luoghi di lavoro e la pandemia COVID-19 ha ulteriormente evidenziato la necessità di una loro più completa comprensione in ambito occupazionale. Riconoscendo l'importanza di questi rischi, anche l'ILO ha posto come obiettivo la rivalutazione degli esiti negativi a essi associati, in particolare alla luce dell'impatto globale della pandemia COVID-19 sui lavoratori.

Il presente studio evidenzia come le pandemie siano il fattore più significativo che contribuisce all'aumento degli esiti negativi per la salute dei lavoratori, soprattutto nei Paesi meno sviluppati. Il COVID-19, considerato come singola causa, ha raddoppiato gli esiti negativi sulla salute occupazionale rispetto alle precedenti stime relative alle malattie trasmissibili. Tuttavia, ad oggi, non esistono evidenze certe dell'effettivo impatto dell'esposizione professionale sulla mortalità e sulla morbosità correlate al COVID-19.

Nel 2022, oltre 550.000 decessi sono stati causati da fattori di rischio biologico, con 476.000 decessi risultati attribuibili a malattie infettive trasmissibili e 74.000 causati da agenti non trasmissibili.

In base alle analisi effettuate, i fattori di rischio biologici contribuirebbero al 9,8% del totale di 3,2 milioni (2,9 milioni più 0,314 milioni) di decessi associati al lavoro. Ciò rappresenta un aumento del 10,8% rispetto alla precedente stima, pari a 2,9 milioni di decessi correlati al lavoro. Pertanto, gli Autori hanno dimostrato come i rischi biologici contribuiscano in modo significativo alla mortalità, alla disabilità e alle perdite economiche associate al lavoro a livello globale. Ulteriori misure normative, l'ampliamento della copertura dei rischi professionali nei sistemi d'indennizzo, nonché il rafforzamento delle conoscenze sulle misure di prevenzione e protezione, risultano fondamentali per migliorare il controllo delle infezioni in ambito occupazionale, tramite la preparazione e la resilienza nei confronti dei fattori di rischio biologico, particolarmente in previsione di possibili emergenze di nuovi agenti biologici con potenziale pandemico.

In conclusione, sono necessarie ulteriori azioni per valutare e gestire efficacemente i fattori di rischio biologico, sia dal punto di vista di tutela della salute occupazionale sia dell'impatto economico. A tal fine, sistemi di gestione della salute e sicurezza occupazionale efficaci possono fornire un contributo essenziale nell'ambito della tutela della salute dei lavoratori, con importanti risvolti anche in termini di Sanità Pubblica.

Con l'obiettivo di permettere l'implementazione di nuovi sistemi di sorveglianza epidemiologica delle malattie-infortunio causate dagli agenti biologici negli ambienti di lavoro nel nostro Paese, tramite lo sviluppo di un sistema di monitoraggio e di valutazione dei fattori di rischio associati, è in atto un progetto di ricerca BRIC 2022, progetto PRATI (Progetto di Ricerca Attiva delle Tecnopatie Infettive), che vede coinvolti, in un *network* collaborativo, diversi Centri di ricerca universitari di Medicina del Lavoro, Ospedali di riferimento regionale e Servizi di prevenzione e la sicurezza negli ambienti di lavoro.

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* Alma Mater Studiorum University of Bologna, Italy

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*The First Affiliated Hospital of Chongqing Medical University, China



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*Duke University, USA

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* University of Massachusetts Lowell, USA

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*University of Maryland, USA

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* University of New South Wales, Australia (R.A.B.).

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* Hubei University of Medicine, Shiyan, China

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* University of Iowa College of Public Health, USA

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*American University of Beirut Medical Center, Beirut

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*VA Boston Healthcare System, USA

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*West Virginia University, USA

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* University of California San Diego Health, USA

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*Johns Hopkins Bloomberg School of Public Health, USA

Epidemiology of Work-Related Traumatic Spinal Cord Injury: An Analysis of Workers' Compensation Claims in Korea, 2011–2019

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*Seoul National University Hospital, Republic of Korea

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*University of Occupational and Environmental Health, Japan

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*Groupement Interprofessionnel Médico-Social (GIMS), France

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*University of British Columbia, Canada

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*Kyoto University School of Public Health, Japan

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*University of the Western Cape, South Africa

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*University of Occupational and Environmental Health, Japan

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*American College of Occupational and Environmental Medicine

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* Norton Neuroscience Institute, USA

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* NIOSH Division of Safety Research

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*Emory University, USA

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*University of Zürich, Switzerland

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* Ankara Atatürk Sanatorium Training and Research Hospital, Turkey.

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*The Ohio State University, USA

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*University of California, USA

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*University of Utah, USA

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*Federal University of Ceará, Medical School, Brazil

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*Augusta University, USA

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*University, Philadelphia, USA

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*Johns Hopkins School of Medicine, USA

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*University of Miami, USA

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*University of the Witwatersrand, South Africa

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*Université Paris-Saclay, France

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* Fuwai Hospital Chinese Academy of Medical Sciences, China

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* Örebro University, Sweden

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*Chung-Ang University, Seoul, Republic of Korea

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*Luleå University of Technology, Luleå, Sweden

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*University of Occupational and Environmental Health, Japan

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* Inje University College of Medicine, Republic of Korea

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* SUNY Downstate Health Sciences University, USA

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* Ascensus Health, St Petersburg, Florida, USA

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* National Center for Chronic Disease Prevention and Health Promotion, USA

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*National Safety Council, USA

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*Federal University of Ouro Preto, Brazil

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*Gumilyov Eurasian National University, Kazakhstan

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* University of Tokyo, Japan

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*Universidade Federal de Mato Grosso, Brazil

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*International University of Health and Welfare, Tokyo, Japan

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* University of Minnesota, USA

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* Health Promotion and Chronic Disease Prevention Section, USA

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* Oregon Health & Science University, USA

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* Utrecht University, Utrecht, the Netherlands

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* University of Toronto, Toronto, Canada

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* Soonchunhyang University Hospital, Seoul, South Korea

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* Université du Québec en Abitibi-Témiscamingue, Canada

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* Toyo University, Japan

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* Boston University Medical Center, USA

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* University of Washington School of Public Health, Seattle, USA

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* University of North Carolina Greensboro, USA

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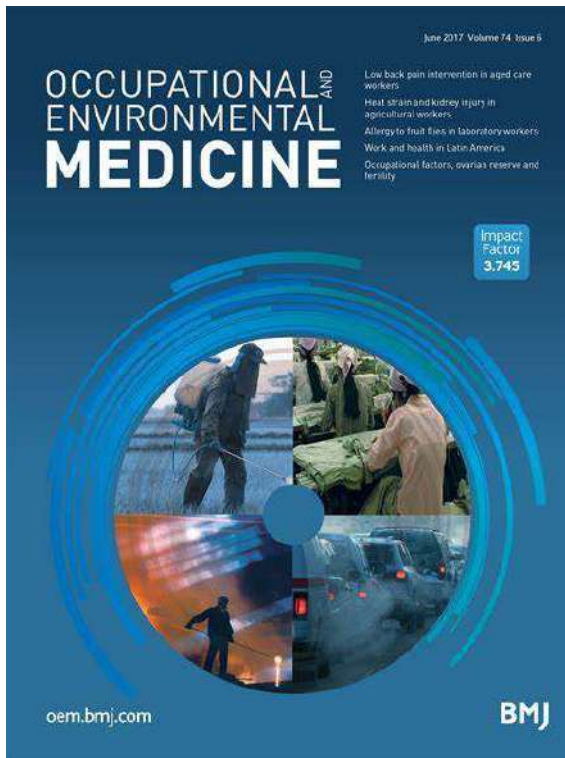
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* University of Alberta, Canada

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* Fire Department of the City of New York, USA

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Yuko Ochiai*, Masaya Takahashi & Yasumasa Otsuka

* National Institute of Occupational Safety and Health, Japan

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* University of Glasgow, UK

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*Health and Safety Executive Bootle Headquarters, UK

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*Univ Rennes, France

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*Japan Organization of Occupational Health and Safety, Japan

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* International Business Machines Corporation, Research Triangle Park, North Carolina, USA

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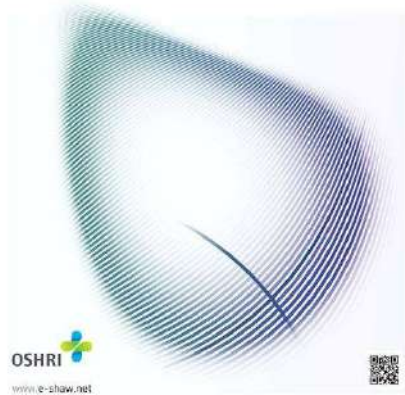
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* University of North Dakota, USA

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* King's College London, UK



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* International Agency for Research on Cancer, France

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* Asia University, Taiwan

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* University of Melbourne, Australia

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Ohwi Kwon*, Ji-Hun Song & Joonho Ahn

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Aust B*, Møller JL & Jaspers SØ

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Dobson KG*, Mustard CA & Smith PM

* Institute for Work & Health, Canada

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Nielsen SB*, Schøning M, Laurent L & Meeuwssen JM

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