Bulletin de veille
Polyexpositions hétérogènes
N°4 – septembre 2025

Objectif : ce bulletin présente un état de littérature scientifique sur le thème des polyexpositions hétérogènes, avec trois situations de coexpositions pouvant être rencontrées en situations de travail : associations substances chimiques et agents biologiques, associations substances chimiques et charge physique de travail, associations substances chimiques et travail de nuit.

Ce bulletin périodique a pour but de prendre connaissance des différents travaux internationaux des chercheurs dans ce domaine, d'explorer les données publiées, afin de préciser les effets sur la santé des travailleurs de ces différentes combinaisons et leurs conséquences en milieu professionnel.

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS. Les éléments issus de cette veille sont fournis sans garantie d'exhaustivité.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

Actualités web

- Exposome Moonshot Forum. May 12-15, 2025. https://exposomemoonshot.org

Une coalition mondiale se réunit pour jeter les bases de l'Exposome humain, un complément au Projet du génome humain. 16 mai 2025. IARC participates in the inaugural Exposome Moonshot Forum

- Inserm Communiqué de Presse 1er avril 2025. Grand Paris : les déplacements jouent un rôle majeur dans l'exposition au bruit, surtout à cause du temps passé en voiture et dans le métro.

Lien vers l'article dans la revue Journal of Exposure Science & Environmental Epidemiology

- 17 juin 2025. Rapport de la Dares sur le travail de nuit en France en 2024. Le travail de nuit | DARES

- 7 juillet 2025. L'ASNR participe à la caractérisation de l'exposome radiologique de la population française : contribution de l'accident de Tchernobyl.
  https://www.irsn.fr/savoir-comprendre/environnement/lasnr-participe-caracterisation-lexposome-radiologique-population. Lire le rapport de l'ASNR

- 21 août 2025. L'Agence européenne pour la sécurité et la santé au travail (EU-OSHA) gère une base de données contenant des ressources sur **la gestion des risques liés aux agents chimiques sur les lieux de travail.** Cette base permet de rechercher des informations sur les risques chimiques, elle contient plus de 900 ressources différentes (sites web, outils, bdd…) :
  https://perosh.eu/news/the-practical-tools-and-guidance-database-on-hazardous-substances/

- 22 août 2025. L'Organisation mondiale de la santé (OMS) et l'Organisation météorologique mondiale (OMM) publient un **rapport conjoint sur les effets sur la santé de la chaleur extrême chez les travailleuses et travailleurs**, et établissent des orientations de prévention vers les pouvoirs publics, les employeurs et les autorités sanitaires.
  https://www.who.int/news/item/22-08-2025-who-wmo-issue-new-report-and-guidance-to-protect-workers-from-increasing-heat-stress

Polyexpositions :

Substances chimiques et agents biologiques

M. Dias, B. Gomes, P. Pena, R. Cervantes, M. Rodriguez, B. Riesenberger, et al.
Boosting knowledge on occupational exposure to microbial contamination in Portuguese carpentries.
Front. Public Health, Vol. **13**, June 2025

Introduction: Wood industry workers face health risks due to exposure to microorganisms and their metabolites. This study aimed to characterize seasonal microbial contamination, antifungal resistance, mycotoxins, cytotoxicity, and particulate matter in Portuguese carpentries, to reduce exposure and promote safe working conditions.
Methods: Conducted in six carpentries in Lisbon, Portugal, the sampling strategy encompassed active and passive sampling methods to assess microbial contamination. A Handheld Particle Counter HH3016-IAQ was used to monitor particulate matter size, temperature, and humidity.
Results: The highest fungal load was in the cold season, with Aspergillus sp. being the predominant species, and the highest bacterial load in the warm season. Reduced susceptibility to azoles was observed in both seasons, with greater species diversity in the cold season. In the warm season, Nidulantes and Fumigati sections of Aspergillus were detected by RT-PCR, with Fumigati being the most prevalent; in the cold season, only Nidulantes was detected. Mycotoxins, mainly fumonisins, were more prevalent in the warm season; in the cold season, griseofulvin was the most prevalent mycotoxin. Cytotoxicity was more prevalent in A549 cells than in SK cells. Settled dust caused greater cytotoxicity in SK cells, and filters from the vacuumed dust in A549 cells. Higher particulate matter concentrations in the indoor sampled areas suggest a significant contribution of indoor activities to workers' exposure.
Discussion: The study highlights concern about seasonal variations in microbial contamination, emphasizing the potential for respiratory diseases, invasive infections by azole-resistant fungi, mycotoxin exposure, and cytotoxicity in lung cells due to co-exposure to fungi, particulate matter, and mycotoxins influenced by environmental conditions.
https://doi.org/10.3389/fpubh.2025.1574881

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Chateau, L.
Occupational hazards in the operating room.
(Risques professionnels dans la salle d'opération)
Revue de l'Infirmière, Vol. **74** (312), (2025), 28-29 p.

In the operating theatre, many factors linked to working conditions have an impact on the health of teams : light, noise, emergencies, stress, pressure, and so on. Occupational risks are numerous: musculoskeletal disorders, accidents involving exposure to blood, inhalation of gas or surgical fumes. The consequences of these hazards for caregivers' occupational health need to be taken seriously, as they have an impact on their personal lives.
https://doi.org/10.1016/j.revinf.2025.06.008

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Mourouvin-Chevolot, E., Laurent, L., Claude, F., Westeel, V., Calame, P., Delabrousse, E.*, et al.*
Distinctive computed tomography features of chronic obstructive pulmonary disease among dairy farmers and smokers.
Respiratory Medicine, Vol. **248**, November 2025, 108319.

Purpose: To assess whether Chronic Obstructive Pulmonary Disease (COPD) associated with dairy farming presents distinct chest computed tomography (CT) features compared to smoking-related COPD and mixed-exposure COPD.
Materials and methods: We analyzed data from a prospective monocentric cohort of COPD patients categorized into three groups: non-smoking dairy farmers (F-COPD), smoking dairy farmers (M-COPD), and individuals with smoking related COPD without occupational exposure (S-COPD). All participants underwent chest CT at inclusion. Two radiologists, blinded to exposure status, independently assessed imaging features using standardized criteria.
Results: A total of 85 patients were included, with a mean age of 67 f 9 years; 72 (85 %) were men. Emphysema was significantly less frequent in F-COPD (54.2 %) than in M-COPD (80.8 %) and S-COPD (80.0 %) ($p = 0.05$). Paraseptal emphysema was nearly absent in F-COPD (7 %) but prevalent in M-COPD (57 %) and S-COPD (75 %) ($p < 0.001$). Mucus plug score was highest in F-COPD than S-COPD (1.17 f 1.16), followed by by M-COPD (0.80 f 1.05) and S-COPD (0.37 f 0.77) ($p = 0.04$). Smoking-related features such as airway enlargement with fibrosis and pulmonary nodules were significantly less common in F-COPD. Tobacco exposure was lower in M-COPD than in S-COPD ($p = 0.02$).
Conclusion: F-COPD exhibits a distinct, airway-dominant CT-phenotype with prominent mucus plugging and limited emphysema, suggesting a different pathophysiological mechanism driven by chronic exposure to organic dusts and bioaerosols in dairy farming. These findings support the use of chest CT for exposure-specific phenotyping and highlight the need for tailored therapeutic approaches in occupational COPD.
https://doi.org/10.1016/j.rmed.2025.108319

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Paba, E., Mediati, F., Montesanti, I. E. R., Chiominto, A., Marcelloni, A. M., Samele, P.*, et al.*
Occurrence of toxigenic fungi and mycotoxins in pig feeds : potential implications for workers' exposure.
Mycotoxin Research, Vol. PrePrint, (2025).
Prépublication ; has not been peer reviewed by a journal.

The objective of the study was to assess the potential exposure of pig farmers to toxigenic fungi and mycotoxins by investigating their presence in feeds to understand whether these matrices may represent a source of release into the environment and pose an occupational health risk. Feed samples were collected from several intensive farms located in Southern Italy and analyzed through a multi-methodological approach. A total of 35 molds were isolated and A. flavus turned out to be the most frequently species, representing nearly 46% (16/35), followed by A. niger and A. candidus, each at 11.43%. Among the 16 A. flavus strains, 8 possessed all 5 key genes of the aflatoxin biosynthetic pathway but only 4 showed the true aflatoxigenic capacity as confirmed by HPLC/MS-MS analysis (AFB1 range: 0.52–1030 µg/L). The most frequent mycotoxin was Ochratoxin A (OTA), occurring in 100% of the samples at mean concentration of 33.6 µg kg − 1 while Fumonisin B1 (FB1) occurred in 97% of the feed samples at mean concentration of 247.1 µg kg − 1. Only one sample was contaminated by Aflatoxin B1

(5.84 µg kg − 1), classified as carcinogenic to humans.
Our results confirm that feedstuffs can contribute to contamination of the work environment, and tasks involving their handling may represent critical procedures that expose personnel to airborne toxigenic fungi and mycotoxins.
https://doi.org/10.21203/rs.3.rs-7323823/v1

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Dou, M., Wang, X. M., Li, Y., Song, J. X., Gong, A. J.
Occupational hazard exposures among archivists.
Frontiers in Public Health, Vol. **13**, (2025), p.

Background Archival work environments, often characterized by inadequate ventilation and a high concentration of materials, are prone to the accumulation of diverse harmful substances. Continuous exposure to such an environment may result in an array of health problems.
Objective This study strives to investigate and synthesize existing research on the occupational hazards encountered by archivists, classify these hazards, detail their associated health impacts, and proffer strategies to preserve and enhance the health of archivists.
Methods This study followed the PRISMA guidelines to conduct a systematic search of multiple electronic databases, including Web of Science and PubMed, for articles on occupational hazards among archivists. Specific inclusion and exclusion criteria were applied to select relevant studies published between 2000 and 2025. The information organization followed a systematic approach conducted in four stages: question-posing, literature search, literature selection, data extraction and synthesis.
Result Our review reveals that archivists face multiple occupational hazards. Chemical hazards, including formaldehyde and toluene volatile organic compounds (VOCs), can cause respiratory problems, neurological damage. Biological hazards, such as mold and dust mites, can lead to allergic reactions and respiratory diseases. Physical hazards encompass inadequate temperature and humidity control, insufficient lighting, and ergonomic stress, resulting in eye strain and musculoskeletal injuries. Moreover, overwork and improper postures can cause chronic physical ailments.
Conclusion This review identifies that archivists are exposed to significant occupational hazards spanning chemical, biological, physical, and ergonomic dimensions, which contribute to a range of health issues. The findings underscore the necessity for in-depth research into archivists' occupational health and the urgent development of targeted protective strategies to address these hazards. Systematic review registration Identifier, CRD420251050852.
https://doi.org/10.3389/fpubh.2025.1631626

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KHAN M.W. ; VALLBONA-VISTOS M. ; TURNER M.C.
Occupational cancer risk factors in Europe. Findings of the workers' exposure survey for health and social care workers.
(Facteurs de risque de cancer d’origine professionnelle en Europe. Constatations de l’enquête sur l’exposition des travailleurs des secteurs de la santé et de l’aide sociale).
Report. TE-01-25-003-EN-N, European Agency for Safety and Health at Work (EU-OSHA), Bilbao (Espagne), 2025, 39 p., ill., bibliogr. (En anglais)

Ce rapport de l'EU-OSHA porte sur les résultats de l'enquête sur l'exposition des travailleurs aux facteurs de risque de cancer en Europe dans le secteur de la santé et de l'aide sociale. Il montre que 29,5 % des travailleurs du secteur de la santé et de l'aide sociale ont été exposés, au cours de leur dernière semaine de travail, à au moins un des 24 facteurs de risque de cancer évalués dans le cadre de l'enquête sur l'exposition des travailleurs, et il fournit des informations inédites sur l'utilisation des mesures de contrôle et de prévention au travail. Les conclusions peuvent servir de base à une prévention ciblée dans le secteur, contribuer à sensibiliser les acteurs aux agents cancérigènes au travail et soutenir des initiatives stratégiques au niveau de l'UE.
Référence INRS-Biblio : 744699

https://osha.europa.eu/fr/publications/occupational-cancer-risk-factors-europe-findings-workers-exposure-survey-health-and-social-care-workers
Site de l'éditeur : https://osha.europa.eu/

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Niang M. ; Reponen T. ; Talaska G. ; Yin J. ; Et Coll.

Preliminary human health risk assessment of antibiotic exposures in human waste handling occupations.

Journal of Occupational and Environmental Hygiene 2024 ; 21 (10) : 721-741

Ce travail débute par une revue approfondie de la littérature scientifique afin d'identifier et d'analyser les études existantes sur les risques professionnels liés à la manipulation de biosolides, qui sont des boues résiduaires traitées issues du traitement des eaux usées utilisées comme fertilisants ou amendements organiques. L'analyse porte sur les travailleurs exposés dans divers métiers : opérateurs de stations d'épuration, agents de traitement des eaux usées, travailleurs du compostage, agriculteurs, paysagistes, travailleurs impliqués dans l'épandage agricole, conducteurs de camions de transport de biosolides, travailleurs de l'entretien des fosses septiques, plombiers et ouvriers de la construction. L'objectif est d'évaluer le risque sanitaire lié à l'inhalation de deux antibiotiques fréquemment retrouvés dans ces biosolides, la ciprofloxacine et l'azithromycine. Les concentrations estimées dans l'air des postes de travail sont très inférieures aux valeurs limites d'exposition professionnelle, indiquant un risque toxique direct très faible pour les travailleurs. Toutefois, la revue souligne l'importance de poursuivre la surveillance, notamment face aux risques de bactéries résistantes aux antibiotiques, et recommande de maintenir des mesures de prévention adaptées pour protéger la santé des professionnels exposés.
https://doi.org/10.1080/15459624.2024.2405405

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Substances chimiques et charge physique de travail

De Luca, H. P., Borgatta, M., Wild, P., Lozano, N. C., Plateel, G., Hopf, N. B.
Impact of physical activity on ethoxy- and propoxypropanol human toxicokinetics in vivo.
Archives of Toxicology, Vol., (2025), p.

Organic solvents such as propylene glycol ethers (PGEs) represents more than 20 different substances and are incorporated in thousands of commercial and professional products. Two PGEs commonly used in Europe and found mainly in cleaning and water-based paint products are propylene glycol ethyl ether (PGEE) and propylene glycol propyl ether (PGPE). Given their volatile properties, inhalation is the most common route of exposure.
The aim of this study was to characterize human toxicokinetics following PGEE and PGPE inhalation exposure. The participants were exposed (4 h) at rest to a single PGE (between 15 and 35 ppm) under controlled conditions and blood, urine, and exhaled breath were collected. Our study shows that both PGEs were rapidly detected in blood (absorption rate: 0.01 mu g/mL/h*ppm) and elimination was more important through urine (half-life: 1 h) than exhaled breath (half-life: 2 min). We also evaluated the impact of a moderate physical activity (30 min, 100 W) during exposure. A significant increase of blood absorption (absorption rate: 0.03 mu g/mL/h*ppm) and internal dose (increase of 48%) was observed.
Our results confirm that both PGEs are easily absorbed at rest and even faster with a moderate physical activity. The biomonitoring approach we have developed here allow the measurement of the "real" internal dose in workers handling these solvents. The existing occupational exposure limits do not consider workload, which may lead to their underestimation. Therefore, we recommend the use of biomonitoring for future studies and the consideration of physical workload for future exposure limits settings as an important parameter for risk assessment.
https://doi.org/10.1007/s00204-025-04094-0

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Descatha, A., Dousseau, H., Pitet, S., Magnolini, F., Mcmillan, N., Mangelsdorf, N.*, et al.*
Work Exposome and Related Disorders of Firefighters: An Overview of Systematized Reviews.
Safety and Health at Work, Vol. **16** (2), (2025), 145-155

Introduction : Firefighters experience many exposures associated with negative health outcomes. Because of this, there are many studies on the subject. Our objective here was to conduct an umbrella review of systematized reviews to identify firefighting activities and related exposures associated with negative health outcomes.
Methods : A comprehensive search of the PubMed, Web of Science, and Scopus (Health) was conducted using all firefighter systematized reviews. We extracted the country and date of the review, type of firefighter, types of exposure, and related health outcomes. Risk of bias was based on AMSTAR-2 checklist.
Results : In 1130 studies, 47 systematized reviews were included, mostly in the last 5 years and from North America and Australia. The topics were diverse, ranging from general aspects to specific exposures, such as polycyclic aromatic hydrocarbons, wildland fires, organizational, traumatic, or psychological stress exposure, and from prevention or surveillance to specific health effects (e.g., cancer, mental health, musculoskeletal disorders, cardiovascular, and pulmonary health, etc.). The risk

of bias assessment using the selection grid shows a significant heterogeneity, though some studies were of very high quality.
Discussion: This umbrella review provides a comprehensive description of systematized reviews describing populations of firefighters, including information on exposure, health outcomes, and illness/injury prevention.

https://doi.org/10.1016/j.shaw.2025.04.003

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Grahn, K., Lissaker, C., Andersson, T., Gustavsson, P., Tinnerberg, H., Wiebert, P.*, et al.*
Occupational exposure to chemicals and particles and incidence of myocardial infarction-a nationwide cohort study in Sweden.
Environmental research, Vol., (2025), 122783

Cardiovascular disease (CVD) is the leading cause of death in Europe, with myocardial infarction (MI) being one of its most severe manifestations. While many risk factors for CVD are well known, occupational exposures remain relatively understudied-especially in analyses that adjust for co-occurring workplace exposures. This study aimed to examine the association between occupational exposure to chemicals and particles and the risk of first-time MI.
The cohort included all Swedish residents born between 1930 and 1990 who were employed between 1985 and 2013 and had no prior MI. Participants were followed from 1986 to 2017, and their occupational histories were linked to the Swedish Job Exposure Matrix (SweJEM) to estimate exposure to 31 chemicals and particles. MI cases were identified through national hospital discharge and cause of death registers. Using discrete time proportional hazards regression, we estimated gender-specific hazard ratios, adjusting for age, decision authority, physical workload, noise, other chemicals/particles, and within a subset smoking and body mass index (BMI).
Among 225,366 incident MI cases, the strongest increased risk was associated with both cumulative, ever, and recent exposure to diesel exhaust, polycyclic aromatic hydrocarbons, sulfur dioxide, carbon dioxide, cadmium, chromium, iron, and lead. These associations remained after adjusting for smoking, BMI, and education. Hazard ratios were generally higher among women. The attributable proportion among exposed individuals was 9%, corresponding to over 20,000 cases during the follow-up period. Our findings highlight the importance of reducing occupational exposure to harmful substances to prevent future cases of MI.
https://doi.org/10.1016/j.envres.2025.122783

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Lothrop, N., Gutenkunst, S., Fimbres, J., Quijada, C., Chaires, M., Cortez, I.*, et al.*
Characterizing full-shift worker exposures to VOCs in small-sized auto repair shops in the Tucson, Arizona, USA metropolitan area.
Sci Rep, Vol. **15** (1), (2025), 20382

Auto repair shops employ 1% of the US labor force. These workers are constantly exposed to volatile organic compounds (VOCs), which have known and often irreversible health effects, yet exposure studies are sparse.
Our goal was to assess what exposure factors were related to total personal and shop-level specific VOC exposures for entire shifts in marginalized, predominantly Spanish-speaking workers in auto repair shops. Full-shift, real-time worker exposure factors like activities and ventilation conditions were recorded, along with personal total VOCs and shop-level specific VOC samples. The relationship of total VOCs with activity and ventilation, along with shift and shop, was analyzed using linear mixed effects modeling. Specific VOC concentrations were combined into hazard scores for potential health risks based on EPA inhalation reference or reference dose. Personal exposures were characterized by episodic peaks, with the highest peaks during spraying brake cleaner and painting activities in 22/35 shifts. Shift within shop and shop accounted for about half the variation in total VOC exposures to workers (35% and 15%, respectively), while activity and ventilation explained almost none. Acetone and toluene were detected in all samples.
While worker exposure patterns were characterized by infrequent but very high peak exposures to total VOCs related to aerosolization activities, activities were only slightly predictive of VOC exposure overall. Instead, shift within shop and shop explained just half the variability. While additional study on exposure factors is needed, this should be done with a focus on interventions tailored to worker and shop.
https://doi.org/10.1038/s41598-025-08546-6

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Wagoner, R. S., Lopez-Galvez, N. I., Casarez, I. J., Canales, R. A., Beamer, P. I., Farland, L. V.*, et al.*
Longitudinal associations and interactions of heat and metal(loid) exposure with kidney outcomes in Mexican agricultural workers.
Environ Res, Vol. **285** (Pt 3), (2025), 122533

BACKGROUND : Agricultural workers perform physically demanding labor in extreme heat, increasing their risk for kidney injury. Agricultural workers are also exposed to nephrotoxic metal(loid)s, yet little research examines the combined effects of heat and metal(loid) exposure on kidney health.
OBJECTIVE : This study assessed how simultaneous exposure to metal(loid)s and heat impacts acute kidney injury (AKI) and kidney function over time.
METHODS : As part of a longitudinal study, we followed a cohort of male grape farmworkers near the Arizona-Sonora border (n = 77), collecting biological samples and questionnaires at two timepoints: at the beginning (i.e., baseline) and again at the end of the work season (i.e., follow-up). Physiological strain index (PSI) was estimated using inner ear temperature and heart rate. Urine samples were analyzed for metal(loid)s, specific gravity, and neutrophil gelatinase-associated lipocalin (uNGAL), while blood serum was used to calculate estimated glomerular filtration rate (eGFR). Linear mixed effect and linear regression models evaluated the impact of metal(loid)s and PSI on kidney health, incorporating interaction terms for chronic (seasonal) and acute (PSI) heat exposure.
RESULTS : Participants averaged 29 years old, with 35 % primarily speaking an Indigenous language.

Urinary arsenic (beta = 0.35, 95 %CI: 0.15, 0.55), cadmium (beta = 0.27, 95 %CI: 0.14, 0.40), and chromium (beta = 0.54, 95 %CI: 0.20, 0.88) were associated with increased uNGAL, while increased uranium was associated with reduced eGFR (beta = -2.45, 95 %CI: 4.81, -0.08). Effects were attenuated in stratified models. Interactions showed chronic heat exposure exacerbated arsenic and cadmium's effects (arsenic-uNGAL, p < 0.01; cadmium-uNGAL, p = 0.02). No significant interactions were observed for acute heat stress.
DISCUSSION: Heat may modify the impact of toxic metal(loid)s on kidney health, emphasizing the need for workplace policies that mitigate heat stress among agricultural workers.
https://doi.org/10.1016/j.envres.2025.122533

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Zheng, Y., Xu, R. J., Chen, Y. L., Li, Y. X., Bi, Y. X., Jia, X. H.*, et al.*
Opposite Interactive Effects of Heat Wave and Cold Spell with Fine Particulate Matter on Pneumonia Mortality.
Toxics, Vol. **13** (8), (2025)

Exposure to extreme temperature events (ETEs) and ambient fine particulate matter (PM2.5) has been linked to an increased risk of pneumonia mortality, but their interactive effects remain largely unknown. We investigated 50,196 pneumonia deaths from 2015 to 2022 in Jiangsu province, China, with a time-stratified case-crossover design. An individual-level exposure to heat wave, cold spell, and PM2.5 was assessed at each subject's residential address using validated grid datasets. Conditional logistic regression models integrated with a distributed lag nonlinear model were used to quantitatively estimate both independent and interactive effects. With different ETE definitions, the cumulative odds ratio (OR) of pneumonia mortality associated with heat wave and cold spell ranged from 1.22 (95% confidence interval [CI]: 1.14, 1.31) to 1.60 (1.40, 1.81), and from 1.08 (1.002, 1.17) to 1.18 (1.01, 1.38), respectively, while the OR for PM2.5 ranged from 1.013 (1.006, 1.021) to 1.016 (1.009, 1.024).
We observed a synergistic effect (relative excess risk due to interaction [RERI] ranging from 0.40 [0.06, 0.76] to 1.16 [0.41, 2.09]) of co-exposure to heat wave and PM2.5, as well as an antagonistic effect (RERI ranging from -0.20 [-0.40, -0.03] to -1.02 [-1.78, -0.38]) of co-exposure to cold spell and PM2.5 on pneumonia mortality. It was estimated that up to 6.49% of pneumonia deaths were attributable to heat wave and PM2.5 exposures. We found that heat wave and cold spell interacted oppositely with PM2.5 to increase the odds of pneumonia mortality, highlighting the needs to reduce co-exposures to heat wave and PM2.5.
https://doi.org/10.3390/toxics13080702

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WEST M. ; BROWN S. ; NOTH E. ; DOMITROVICH J. ; ET COLL.
A review of occupational exposures to carcinogens among wildland firefighters.
(Revue des expositions professionnelles à des agents cancérogènes chez des pompiers de forêts).
Journal of Occupational and Environmental Hygiene, vol. 21, n° 10, 2024, pp. 741-764, ill., bibliogr. (En anglais)
Cette revue de la littérature analyse les expositions professionnelles à des agents cancérogènes chez les pompiers de forêts, un secteur où les personnels sont exposés à de nombreux contaminants lors d'incendies de végétation ou d'opérations de brûlage dirigé.

L'étude a identifié 31 substances cancérogènes, dont les particules fines, les hydrocarbures aromatiques polycycliques, les composés organiques volatils, la silice cristalline, le noir de carbone, l'amiante, des radionucléides et certains métaux. Les risques abordés concernent principalement l'inhalation de fumées, de poussières et de cendres, mais aussi le contact cutané avec certains polluants.
L'objectif principal est de synthétiser les connaissances sur les niveaux d'exposition et d'identifier les substances préoccupantes pour la santé des travailleurs, en particulier le risque de cancer. Les résultats montrent que, même si peu de mesures dépassent les valeurs limites d'exposition professionnelle, la multiplicité des agents présents, la durée des missions et la pénibilité du métier peuvent entraîner un risque cumulatif non négligeable.
L'article recommande de renforcer les stratégies de prévention, d'améliorer la surveillance des expositions et de promouvoir des mesures collectives et individuelles pour limiter les risques cancérogènes dans ce secteur.
Référence INRS-Biblio : 743963
Lien vers l'article : https://doi.org/10.1080/15459624.2024.2388532

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Substances chimiques et travail de nuit

Van Der Grinten, T., Van De Langenberg, D., Van Kerkhof, L., Harding, B. N., Garde, A. H., Laurell, C*., et al.*
Detailed assessment of night shift work aspects and potential mediators of its health effects: the contribution of field studies.
Frontiers in public health, Vol. **13**, May 2025, 1578128

Night shift work has been associated with adverse health outcomes, but inconsistencies in epidemiological findings reveal gaps in understanding the mechanisms involved. Beyond shift schedules (e.g., duration and intensity) and nighttime light exposure, we propose assessing ten key aspects to enhance understanding of shift work's nature and health implications.
These include: (1) exposure-related factors ("meal timing and composition during the night shift," "physical activity during the night shift"); (2) potential mediators ("supplements and medication use," "social disruption," "sunlight exposure," "meal timing and dietary patterns outside shifts," "physical activity," "sleep quality," and "substance use"); and (3) effect modifiers ("occupational co-exposures"). Recent advances in technology, such as mobile apps, wearable sensors, and biomarkers, enable real-time, multidimensional assessments of these factors in field studies. Incorporating these tools into high-quality data collection can provide critical insights into the pathways linking night shift work and health. Such approaches will generate new hypotheses and inform the design of next-generation cohort and case-control studies, fostering a deeper understanding of this complex exposure and its health implications.
https://doi.org/10.3389/fpubh.2025.1578128

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Yu, L., Zhang, C. H., Wu, B., Guo, J. S., Fan, D. X., Wang, G.*, et al.*
Combined exposure of sleep deprivation and environmental particulate matter drives aging in multiple systems.
Journal of Hazardous Materials, Vol. **491**, (2025)

Sleep disturbance accelerates aging, with accompanying exposure to air pollution. However, most studies ignore the combined exposure. This study aimed to investigate the combined effects of sleep deprivation and PM2.5 exposure on multi-system aging and to explore the damage mechanisms. The sleep deprivation instrument and the Shanghai Meteorological and Environmental Animal Exposure System (Shanghai-METAS) were used to construct a combined exposure model for one month.
Our study used multiple behavioral, imaging, and molecular biological examinations to describe the aging characteristics in the cardiovascular system, metabolism, and central nervous system. Besides, the mechanisms in Sirt1, Wnt10 beta pathways were explored and correlation of damage among tissues was clarified. Based on sleep disruption, PM2.5 exposure was able to induce elevated serum T-CHO levels, impaired conditioned learning ability, abnormal brain tissue metabolic levels, and aberrant expression of multiple molecular markers related to cellular senescence, whereas PM2.5 exposure alone did not induce changes in the above indices. In addition, the Sirt1, Wnt10 beta pathway mediated cardiac and hepatic aging induced by combined exposure.
Moreover, there was a significant correlation between heart and liver aging damage, which suggesting heart-liver axis may be involved in the aging process. Sleep deprivation and PM2.5 exposure trigger senescence in multiple tissues. In particular, on the basis of sleep deprivation, PM2.5 accelerates of the aging process in several tissues and organs. The problem of air pollution on top of sleep disturbance should be taken seriously, as it has a greater potential to accelerate aging than air pollution.
https://doi.org/10.1016/j.jhazmat.2025.137914

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Zhang, H., Zheng, Z., Wang, N., Li, Z., Zhang, S., Su, Y.*, et al.*
Correlation between occupational hazard exposure and abnormal bone mineral density in steelworkers.
BMC public health, Vol. **25** (1), (2025), 1431

OBJECTIVES: To investigate the relationships between abnormal bone mineral density (BMD) and exposure to single or combined occupational hazards in steelworkers by analyzing the correlations between various occupational hazards (night-shift work, high temperature, dust and noise) and abnormal BMD with both a single-risk score model (SRSM) and a hybrid-risk score model (HRSM). METHODS: Participants were selected from a cross-sectional study called "Cohort Study on the Health Effects of the Occupational Population in the Beijing-Tianjin-Hebei Region". A total of 6816 participants were recruited for this study. Night-shift work and high temperature, dust and noise exposure were considered occupational hazards and were analyzed separately and in combination (coexposure). The health risk factor score and partial regression coefficient were used to establish an SRSM and an HRSM. RESULTS: The rate of abnormal BMD in steelworkers was 27.6% (28.0% in males and 23.3% in females). Logistic regression revealed that, compared with that of individuals with 0 cumulative days of night-shift work, the risk of abnormal BMD for individuals with various amounts of night-shift work was as follows: ~927.20 days (OR=1.40, 95% CI: 1.15~1.72), ~1772.02 days (OR=1.45, 95% CI: 1.19~1.77), and ≥2573.50 days (OR=1.55, 95% CI: 1.27~1.89). Compared with that of the cumulative exposure to high

temperatures in the 0°C·y group, the risk of abnormal BMD in the other groups was as follows: 667.49~°C·y (OR=1.34, 95% CI: 1.06~1.71) and ≥790.30°C·y (OR=1.32, 95% CI: 1.03~1.69). Compared with that of the cumulative amount of dust exposure in the 0 mg/m3·y group, the risk of abnormal BMD for the other groups was as follows: 30.42~mg/m·y (OR=1.23, 95% CI: 1.02~1.49) and ≥40.17mg/m·y (OR=1.37, 95% CI: 1.14~1.65). Compared with that of the cumulative amount of noise exposure in the 0 dB(A)·y group, the risk of abnormal BMD for the other groups was as follows: ≥1707.47 dB(A)·y (OR=1.17, 95% CI: 1.00~1.40). When an SRSM was used, compared with that in the control group (score<0.42), the risk of abnormal BMD in the other groups was as follows: ~0.42 (OR=1.24, 95% CI: 1.03~1.19), ~0.72 (OR=1.51, 95% CI: 1.24~1.83), and ≥0.97 (OR=2.11, 95% CI: 1.71~2.60). When an HRSM was used, compared with that of the reference group (score<0.360), the risk of abnormal BMD for the other groups was as follows: ~0.360 (OR=1.26, 95% CI: 1.05~1.52), ~0.576 (OR=1.43, 95% CI: 1.18~1.74), and ≥0.779 (OR=2.08, 95% CI: 1.70~2.55).
CONCLUSIONS: (1) Night-shift work and high temperature and dust exposure may contribute to abnormal BMD in steelworkers. (2) The higher the corresponding risk score of occupational hazard coexposure is, the greater the risk of abnormal BMD in steelworkers. When workers are exposed to multiple occupational hazards at the same time, coexposure models could reveal the relationships between occupational hazard exposure and abnormal BMD in steelworkers more accurately.
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Expositions aux facteurs environnementaux, exposome – (sélection)

Wang, B., Lan, C., Zhang, G., Ren, M., Wu, T., Gao, N.*, et al.*
ExposomeX: Development of an Integrative Exposomic Platform to Expedite Discovery of the "Exposure-Biology-Disease" Nexus.
Environ Sci Technol, Vol., (2025), https://doi.org/10.1021/acs.est.5c05956

We proposed presenting a novel integrated platform, ExposomeX, that was created to expedite discovery of the "exposure-biology-disease" nexus. This platform has six major functions, i.e., exposome database (E-DB), biological link (E-BIO), statistical analysis (E-STAT), mass spectrometry data processing (E-MS), meta-analysis (E-META), and data visualization (E-VIZ). Twenty-three supporting databases were curated for this platform, encompassing the exposome and diseases together with their related biological pathways and molecules, to build their interaction network. The network nodes included up to 119,247,057 unique exposures, 17,186 diseases, 153,780 proteins, 19,122 metabolites, and 572,278 annotated pathways, while the network links included 10 interaction modes, e.g., exposure and protein (3,971,005 pairs), exposure and GO (28,632 pairs), protein and disease (10,153 pairs), gene and disease (108,298,474 pairs), GO and disease (3,085,406 pairs), and associations between exposures and diseases for meta-analysis and review summary (1244 pairs). ExposomeX allows effective analysis of multidimensional exposomic data as well as investigations of the "exposure-biology-disease" nexus through explorations of the association strengths, which was well-validated by reanalyzing three typical multiomics data sets. All the aforementioned functions were implemented using R programming and integrated into a web-based server to enhance user interaction through an online interactive platform (http://www.exposomex.cn).
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Pignon, B., Schürhoff, F.
Exposome physique et maladies psychiatriques : les objectifs du PEPR PROPSY.
Med Sci (Paris), Vol. **41** (5), (2025), 508-515

L'exposition à certains facteurs environnementaux, comme les infections ou la pollution atmosphérique, augmente significativement le risque de développer des troubles psychiatriques. Les infections sont associées à un risque accru de troubles du spectre de l'autisme, de schizophrénie, et de troubles de l'humeur. L'exposition chronique à des niveaux élevés de pollution de l'air, en particulier de micro-particules et de dioxyde d'azote, est liée à un risque accru de troubles psychotiques, anxieux et dépressifs. Le programme PEPR PROPSY a pour objectif d'améliorer les connaissances sur les liens entre expositions environnementales et troubles psychiatriques, notamment sur le rôle de la pollution de l'air. Ce programme s'appuie sur des mesures phénotypiques multimodales réalisées auprès d'une cohorte de 2 500 patients et 500 témoins, ainsi que sur des estimations précises de leurs expositions environnementales tout au long de leur vie.
https://doi.org/10.1051/medsci/2025069

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De Hoogh, K., Hoek, G., Fluckiger, B., Bussalleu, A., Vienneau, D., Jeong, A.*, et al.*
A Europe-wide characterization of the external exposome : A spatio-temporal analysis.
Environ Int, Vol. **200**, (2025), 109542

BACKGROUND : Harmonised data on external environmental exposures are essential for multi-cohort exposome studies. This paper describes the development of fine-spatial resolution models and resulting exposure maps for 33 major exposome factors -including physical-chemical, built, social, and food environments-across Europe from 2000 to 2020, and examines their spatial and temporal interrelations.
METHODS : New fine spatial resolution Europe-wide models were developed for annual/monthly average air pollution, daily temperature, and annual-average road-traffic noise, combined with post-processing of existing data on green, blue, and grey spaces (imperviousness), walkability, light-at-night, and urbanicity. Exposure metrics relevant for epidemiological studies were developed for all exposome factors, with correlations calculated at European and country levels. Stability and trends over time were assessed for 18 factors.
RESULTS : At the European level, most environmental factors showed weak correlations ($R < 0.4$), except NO(2), which showed moderate to strong correlations with built environment factors. Country-level correlations varied. Annual average exposure surfaces were stable over time, with strong correlations between early and late time points for all factors except O(3) ($R = 0.66$). Trends indicated decreases in air pollution and increases in temperature, green space, and imperviousness, while trends in light-at-night and O(3) were mixed across Europe.
CONCLUSIONS : This comprehensive analysis of the temporal and spatial relationships between external exposome factors across a large geographical area show low to moderate correlations between exposome factors. Annual average exposure surfaces were also stable over time across Europe. These findings support both the utility of multi-exposure epidemiological analyses, and that any modest temporal misalignment between exposure assessment and follow-up period of health studies is not critical. The data described in his paper are openly available to researchers.
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