TOPLOTNI TALASI I ZDRAVSTVENA ZAŠTITA: POVEZIVANJE PODATAKA I PRAKSE

RAD PO POZIVU

INVITED PAPER

HEATWAVES AND HEALTHCARE: BRIDGING DATA AND FRONTLINE PRACTICE

Margo Tonnelier[1]

[1] Université catholique de Louvain, Institute of Health and Society (IRSS), Brisel, Belgija

[1] *Université catholique de Louvain, Institute of Health and Society (IRSS), Brussels, Belgium*

SAŽETAK

Toplotni talasi i srodni ekološki događaji otkrivaju ključne ranjivosti preopterećenih zdravstvenih sistema i ukazuju na potrebu integrisanja kliničkih i ekoloških podataka radi podrške blagovremenim javnozdravstvenim intervencijama. Međutim, učešće zdravstvenih radnika u prikupljanju podataka često je ograničeno velikim obimom posla i fragmentiranom, restriktivnom strukturom zdravstvenih informacionih sistema. Ovaj rad razmatra strategije za jačanje veze između produkcije javnozdravstvenih podataka i kliničkog odgovora u cilju smanjenja zdravstvenih rizika povezanih sa toplotnim talasima. Programi direktnog uključivanja epidemiologa u rad na terenu unapređuju razumevanje operativnih ograničenja i podstiču osmišljavanje pragmatičnih intervencija. Međutim, nedostatak standardizovanih zdravstvenih mera i široko prihvaćenog konceptualnog okvira ograničava delotvornost epidemiologije toplotnih talasa. Smatramo da takvi pristupi mogu sistematski poboljšati validnost, primenljivost i pravičnost javnozdravstvenih istraživanja i prakse, te predlažemo okvir za standardizovano zdravstveno praćenje tokom toplotnih talasa.

Ključne reči: toplotni talasi, epidemiologija, javno zdravlje, zdravstveni rizici

ABSTRACT

Heatwaves and related environmental events expose critical vulnerabilities in overburdened health systems and underscore the need to integrate clinical and environmental data to support timely public health interventions. However, healthcare professionals' participation in data collection is often limited by high workloads and fragmented, restrictive health information system architectures. This article explores strategies to strengthen the link between public health data production and clinical response to mitigate the health risks associated with heatwave events. Field immersion programs for epidemiologists enhance understanding of operational constraints and promote the design of pragmatic interventions. However, the lack of standardized health measures and a widely accepted conceptual framework limits the effectiveness of heatwave epidemiology. We argue that such approaches can systematically improve the validity, applicability, and equity of public health research and practice, and propose a framework for standardized health monitoring during heatwaves.

Keywords: heatwaves, epidemiology, public health, health risks

RESUME

Les vagues de chaleur et les événements environnementaux associés révèlent les vulnérabilités des systèmes de santé surchargés et soulignent la nécessité d›intégrer les données cliniques et environnementales afin de soutenir la mise en place d'actions rapides de santé publique. Cependant, la participation des professionnels de santé à la collecte de données reste limitée en raison de charges de travail élevées et d'une architecture des systèmes d'information sanitaire souvent fragmentée et restrictive. Dans cet article, nous examinons les moyens de renforcer le lien entre la production de données de santé publique et la réponse clinique afin de mieux atténuer les risques sanitaires liés aux vagues de chaleur. Les programmes d'immersion sur le terrain pour les épidémiologistes permettent de mieux comprendre les contraintes opérationnelles et de concevoir des interventions plus pragmatiques. Toutefois, l'absence de mesures sanitaires standardisées et d'un cadre conceptuel largement accepté continue de limiter l'efficacité de l'épidémiologie des vagues de chaleur.

Mots cles: Chaleur extrême, Epidémiologie, Santé Publique, Evaluation de l'impact sur la santé

Autor za korespondenciju:
Margo Tonnelier
Université catholique de Louvain, Institute of Health and Society (IRSS)
Clos Chapelle-aux-champs 30, Woluwe St Lambert, 1200, Brisel, Belgija
Elektronska adresa: margo.tonnelier@uclouvain.be

Corresponding author:
Margo Tonnelier
Université catholique de Louvain, Institute of Health and Society (IRSS)
Clos Chapelle-aux-champs 30, Woluwe St Lambert, 1200, Brussels, Belgium
E-mail: margo.tonnelier@uclouvain.be

Primljeno • *Received*: September 5, 2025; **Revidirano • *Revised*:** November 13, 2025; **Prihvaćeno • *Accepted*:** November 13, 2025; ***Online first*:** December 25, 2025

DOI: 10.5937/smclk6-61317

KONTEKST KOJI SE BRZO MENJA

Zdravstveni sistemi širom sveta suočavaju se sa sve ozbiljnijim izazovima. Klimatske promene, vidljive kroz sve učestalije i intenzivnije toplotne talase [1], dodatno se pogoršavaju ponovnom pojavom epidemija [2], starenjem stanovništva [3] i strukturnim ekonomskim pritiscima [4]. Zajedno, ovi faktori opterećuju zdravstvene ustanove, produbljuju postojeće nejednakosti u domenu zdravstvene zaštite, te povećavaju zahteve u odnosu na zdravstvene radnike u pogledu njihovog kapaciteta da adekvatno odgovore na potrebe [5].

Toplotni talasi postaju sve veći prioritet u domenu javnog zdravlja [6,7]. Oni su direktno povezani sa pojavom toplotnih udara i poremećajima sna, a indirektno sa lošijim mentalnim zdravljem, porastom međuljudskog nasilja i pogoršanjima postojećih kardiovaskularnih i respiratornih bolesti [8–11]. Iako je svest o toplotnim talasima kao javnozdravstvenom problemu porasla, njihovi posredni zdravstveni efekti i dalje su nedovoljno istraženi. Šumski i periurbani požari, koji su sve češći tokom ekstremnih vrućina, ne samo da izazivaju povrede i raseljavanje stanovništva [12], već i povećavaju izloženost finim česticama, čime doprinose respiratornom morbiditetu, uz fiziološke posledice toplotnog stresa [12]. Ove krize prožimaju više disciplina i zahtevaju trajnu integraciju ekoloških i zdravstvenih podataka – uključujući temperaturu, kvalitet vazduha, zdravstvene pokazatelje pacijenata i parametre primarne zdravstvene zaštite – kako bi se omogućili efikasni odgovori. Zdravstveni radnici su zaduženi za sprovođenje preventivnih i edukativnih mera radi umanjenja zdravstvenih posledica, uz istovremeno pružanje zdravstvene nege pogođenim pacijentima. Istovremeno, ovi rizici zahtevaju ozbiljne populacione analize i sisteme ranog upozoravanja u cilju praćenja trendova, informisanja javnosti i zdravstvenih radnika, kao i usmeravanja javne politike i raspodele resursa. Ovaj rad ima za cilj da razmotri strategije za jačanje veze između produkcije javnozdravstvenih podataka i kliničkog odgovora na potrebe, kako bi se smanjili zdravstveni rizici povezani sa pojavom toplotnih talasa.

ZAJEDNIČKI SISTEM PRAĆENJA ZA EPIDEMIOLOGE I ZDRAVSTVENE RADNIKE

Zdravstveni radnici predstavljaju prvu liniju nadzora nad funkcionisanjem zdravstvenog sistema. Oni uočavaju, u *realnom vremenu*, porast broja pacijenata primljenih zbog toplotnog udara, dehidratacije, kardio-respiratornih komplikacija ili akutnih psihijatrijskih stanja. Požari povezani sa toplotnim talasima dodatno otežavaju situaciju, dovodeći do opekotina, trauma tokom evakuacije i pogoršanja respiratornih oboljenja usled izloženosti finim česticama.

A RAPIDLY CHANGING CONTEXT

Healthcare systems worldwide face increasing challenges. Climate changes, reflected in the rising frequency and severity of heatwaves [1], is further compounded by the resurgence of epidemics [2], population ageing [3], and structural economic pressures [4]. Together, these factors strain healthcare organizations, exacerbate health inequalities, and heighten demands on professionals' capacity to respond [5].

Heatwaves are gradually becoming a public health priority [6,7]. They are directly linked to heatstroke and disrupted sleep patterns and indirectly associated with poorer mental health, increased interpersonal violence, and exacerbations of underlying cardiovascular and respiratory diseases [8–11]. Although awareness of heatwaves as a public health issue has grown, their indirect health consequences remain insufficiently explored. Forest and peri-urban fires, which occur more frequently during periods of extreme heat, not only cause injuries and population displacement [12] but also increase exposure to fine particulate matter, contributing to respiratory morbidity, in addition to the physiological effects of heat stress [12]. These crises span multiple disciplines and require sustained integration of environmental and health data – including temperature, air quality, patient health indicators, and frontline care metrics – to inform effective responses. Healthcare professionals are responsible for implementing preventive and educational measures to reduce health impacts while also providing care to affected patients. At the same time, these hazards demand robust population-level analyses and early warning systems to monitor trends, alert the public and healthcare workers, and guide public policy and resource allocation. This article aims to explore strategies to strengthen the connection between public health data production and clinical response in order to mitigate the health risks associated with heatwave events.

A SHARED MONITORING SYSTEM BETWEEN EPIDEMIOLOGISTS AND HEALTHCARE PROFESSIONALS

Healthcare professionals act as the frontline monitors of their health systems. They observe, in *real time*, increases in admissions for heatstroke, dehydration, cardiorespiratory complications, or psychiatric crises. Heatwave-associated fires further exacerbate the situation, causing burns, trauma from evacuations, and respiratory exacerbations from fine particulate exposure.

Epidemiologists operate both retrospectively and in near-real time: they analyze historical data to better understand determinants of population health and

Epidemiolozi deluju i retrospektivno i u približno realnom vremenu: analiziraju istorijske podatke kako bi bolje razumeli determinante zdravlja populacije, te koriste najnovije i prognozirane podatke za izdavanje upozorenja – iako se u slučaju toplotnih talasa ta upozorenja najčešće izdaju prvenstveno putem meteoroloških službi i službi civilne zaštite. Oni funkcionišu kao svojevrsni „zdravstveni radar", prikupljajući, analizirajući i distribuirajući informacije koje potom usmeravaju dalje delovanje. Identifikovanjem najugroženijih grupa – stara lica, deca, ljudi sa višestrukim komorbiditetima, radnici na otvorenom i socijalno ugrožene populacije – epidemiolozi omogućavaju adekvatnu prevenciju i ciljano delovanje [13].

Leto 2003. godine jasna je ilustracija ranjivosti Zapadne Evrope kada su u pitanju toplotni talasi i njihov uticaj na zdravlje stanovništva. U Francuskoj su Emon i Žugla procenili višak smrtnosti upoređujući zabeležene smrti tokom prvih 20 dana avgusta 2003. godine sa prosečnim brojem smrti u istom periodu između 2000. i 2002. godine [14]. U Portugalu je između prvog i 31. avgusta 2003. godine zabeleženo 2.099 smrtnih slučajeva više nego što se očekivalo prema referentnom periodu 1997-2001 [15]. Potonji toplotni talasi nastavili su da izazivaju značajan višak mortaliteta širom regiona. Na primer, toplotni talas u Češkoj, 2015. godine, izazvao je veći porast viška smrtnosti nego takav događaj iz 1994. godine (265% naspram 240% iznad osnovne vrednosti) [16]. U Belgiji je Sciensano zabeležio 4,3% viška smrtnosti u svim starosnim grupama tokom leta 2020. godine, kada je Kraljevski meteorološki institut Belgije registrovao dva toplotna talasa (23-26. jun i 2-17. avgust 2020). Drugi toplotni talas poklopio se sa najvećim brojem dnevnih smrtnih slučajeva tokom letnjeg perioda u Belgiji, sa 492 smrti zabeležene 13. avgusta 2020. godine [17].

Kada se sistematski organizuju i distribuiraju, gore navedena zapažanja služe kao pokazatelji za unapređivanje epidemioloških modela i identifikovanje ranih znakova upozorenja. Primer Belgije, gde se podaci o smrtnosti u realnom vremenu integrišu sa klimatskim indikatorima, ilustruje dodatnu vrednost ovakve međusektorske saradnje. Ipak, u mnogim evropskim zemljama ovakvo praćenje i dalje nije prisutno.

RAZLIKE U STEPENU RAZVIJENOSTI RAZLIČITIH EPIDEMIOLOŠKIH DISCIPLINA

Epidemiologija infektivnih bolesti oslanja se na dobro uspostavljene sisteme nadzora sa rutinskim protokolima koji omogućavaju brzo izdavanje upozorenja o izbijanju epidemija [18]. Nasuprot tome, ekološka epidemiologija – koja se bavi toplotnim talasima, šumskim požarima i zagađenjem vazduha – i dalje je manje sistematizovana i često je ograničena fragmentisanim podacima i sporijim izveštavanjem [19]. Iako inovacije kao

use recent and forecast data to raise alerts – although for heatwaves, such alerts are often issued primarily by meteorological services and civil protection agencies. They act as a health radar, collecting, analyzing, and disseminating information that guides responses. By identifying the most vulnerable groups – the elderly, children, people with multiple morbidities, outdoor workers, and socially disadvantaged populations – they enable tailored prevention and targeted action [13].

The summer of 2003 remains emblematic of Western Europe's vulnerability to heatwaves and their impact on population health. In France, Hémon and Jougla estimated excess mortality by comparing observed deaths during the first 20 days of August 2003 with the 2000-2002 average number of deaths for the same period [14]. In Portugal, between August 1 and August 31, 2003, there were 2,099 excess deaths relative to the expected baseline for the 1997–2001 period [15]. Subsequent heatwaves continued to cause substantial mortality across the region. For example, the 2015 heatwave in the Czech Republic caused a larger increase in excess mortality than the 1994 event (265% versus 240% above the baseline) [16]. In Belgium, Sciensano recorded a 4.3% excess mortality rate across all ages during the summer of 2020, when the Royal Meteorological Institute of Belgium reported two heatwaves (23-26 June and 2-17 August, 2020). The second heatwave coincided with the highest number of daily deaths for the summer period in Belgium, with 492 deaths on 13 August 2020 [17].

When systematically structured and shared, the above-described observations serve as indicators for refining epidemiological models and identifying early warning signs. Belgium's integration of real-time mortality data with climate indicators demonstrates the added value of such cross-sector collaboration. However, such monitoring remains absent in many European countries.

DIFFERENT LEVELS OF DEVELOPMENT ACROSS EPIDEMIOLOGICAL DISCIPLINES

Infectious disease epidemiology relies on well-established surveillance systems, with routine protocols that enable rapid outbreak alerts [18]. By contrast, environmental epidemiology – focused on heatwaves, wildfires, and air pollution – remains less systematized and is often constrained by fragmented data and slower reporting [19]. Although advances such as high-resolution sensors and exposome approaches are expanding the capacities of environmental epidemiologists, the field continues to face challenges in translating environmental data into timely public health alerts [19,20]. Ethical frameworks are only re-

što su senzori visoke rezolucije i pristupi zasnovani na ekspozomu, proširuju kapacitete ekološke epidemiologije, ova oblast je i dalje suočena sa izazovima prilikom pretvaranja ekoloških podataka u blagovremena javnozdravstvena upozorenja [19,20]. Etički okviri se tek poslednjih godina konsoliduju kako bi se obezbedila temeljitost studija koje ispituju zdravstvene efekte višestrukih, interagujućih ili vremenski promenljivih izlaganja datim elementima [21]. Zbog toga je od ključnog značaja jačanje saradnje sa meteorološkim službama i hitnim službama u bolnicama, jer upozorenja na toplotne talase i šumske požare često potiču od službi izvan zdravstvenog sektora i moraju biti integrisana kako bi efikasno usmeravala javnozdravstvene intervencije.

SPREMNOST ZDRAVSTVENIH RADNIKA DA UČESTVUJU U PRIKUPLJANJU EPIDEMIOLOŠKIH PODATAKA

Glavna prepreka učešću zdravstvenih radnika u prikupljanju epidemioloških podataka jeste obim njihovog posla, naročito tokom vanrednih situacija. Oni već rade pod hroničnim pritiskom – nedostatak osoblja, starenje populacije pacijenata i rast broja prijema [22,23]. Ekstremni vremenski događaji povezani sa klimatskim promenama dodatno povećavaju ovaj teret [5]. Na primer, poklapanje toplotnih talasa sa pandemijom KOVID-19 oboljenja 2020. godine, jasno je pokazalo koliko je veliko opterećenje i iscrpljenost zdravstvenih radnika [24,25]. Takvo preopterećenje ne samo da ograničava učešće u inicijativama nadzora i razmene podataka, već služi i kao upozorenje: potrebno je preispitati raspodelu kompetencija i organizaciju zdravstvene zaštite [26].

Još jedna prepreka leži u fragmentiranoj i često restriktivnoj strukturi zdravstvenih informacionih sistema. Preterana ograničenja pristupu podacima i slaba interoperabilnost mogu značajno da ometaju epidemiološka istraživanja [27]. Kada su skupovi podataka nepotpuni ili ograničeni na određene dijagnostičke kategorije, mnoge potencijalne studije postaju neizvodljive. Nedostatak standardizacije podataka, logističke poteškoće u prikupljanju i upravljanju podacima, kao i izostanak sistematskih lokalnih etičkih odbora dodatno otežavaju sprovođenje studija koje bi bile uporedive i ponovljive [28].

Upotreba standardizovane sestrinske terminologije i dosledno vođenje dokumentacije pokazalo se kao način da se poboljša kvalitet nege, obezbedi kontinuitet i poveća upotrebljivost prikupljenih podataka [29]. Ipak, ovi alati se i dalje nedovoljno koriste, često zbog preopterećenosti poslom i ograničene digitalne pismenosti. Uključivanje ovih veština u početnu obuku zdravstvenih radnika moglo bi da pomogne u prevazilaženju jaza između kliničke dokumentacije, istraživanja i praćenja na nivou populacije.

cently being consolidated to ensure rigor in studies examining the health effects of multiple, interacting, or time-varying exposures [21]. Strengthening collaboration with meteorological services and hospital emergency units is therefore essential, as alerts for heatwaves and wildfires often originate outside the health sector and must be integrated before they can effectively inform public health action.

HEALTHCARE PROFESSIONALS' READINESS TO PARTICIPATE IN EPIDEMIOLOGICAL DATA COLLECTION

The main barrier to healthcare professionals' participation in epidemiological data collection is their workload, particularly during emergency events. Professionals already operate under chronic pressure – staff shortages, ageing patient populations, rising admissions [22,23]. Climate-related extreme events further intensify this strain [5]. For instance, the convergence of heatwaves with the COVID-19 pandemic in 2020 highlighted the strain being placed on healthcare workers' resilience [24,25]. Such an overload not only restricts participation in surveillance and data-sharing initiatives but also serves as a warning: the distribution of skills and the organization of care need to be reexamined [26].

Another obstacle lies in the fragmented and often restrictive architecture of health information systems. Excessive data restrictions and limited interoperability can significantly hinder epidemiological research [27]. When data sets are incomplete or confined to specific diagnostic categories, many potential studies become unfeasible. The lack of data standardization, logistical challenges in data collection and management, and the absence of systematic local ethics committees further complicate the implementation of comparable and reproducible studies [28].

The use of standardized nursing terminologies and consistent documentation practices has been shown to improve care quality, ensure continuity, and increase the utility of collected data [29]. However, these tools remain underused, often due to workload constraints and limited digital literacy. Incorporating these skills into the initial training of professionals could help bridge the gap between clinical documentation, research, and population-level monitoring.

Finally, another barrier to healthcare professionals' participation in epidemiological data collection is the level of their motivation to engage in research. A recent systematic review has highlighted that limited time for research, organizational constraints, lack of funding, and insufficient institutional support all reduce healthcare professionals' willingness to invest their efforts in research [30]. Without addressing

Konačno, još jedna prepreka učešću zdravstvenih radnika u prikupljanju epidemioloških podataka jeste njihov nivo motivacije za uključivanje u istraživanja. Nedavna sistematska analiza pokazala je da ograničeno vreme za istraživanje, organizaciona ograničenja, nedostatak finansiranja i nedovoljna institucionalna podrška umanjuju spremnost zdravstvenih radnika da ulože trud u učešće u naučnim studijama [30]. Ako se po pitanju ovih faktora ne nađu adekvatna rešenja, manja je verovatnoća da će zdravstveni radnici integrisati epidemiološko rezonovanje u svoju praksu.

PREISPITIVANJE OBRAZOVANJA I OBUKE ZDRAVSTVENIH RADNIKA

Ograničena zastupljenost epidemiologije i statistike u ranim fazama obrazovanja lekara i medicinskih sestara može imati za posledicu da zdravstveni radnici budu slabije upoznati sa načinima svakodnevne primene zdravstvenih podataka u praksi. Nasuprot tome, dobro osmišljeni obrazovni programi koji povezuju istraživanje i praksu u javnom zdravlju – poput onih koji se primenjuju u Kvebeku, Kanadi – podstiču aktivno uključivanje u rad sa populacionim zdravstvenim podacima, sistemima nadzora i primenjenim istraživačkim projektima. Time se unapređuju sposobnosti zdravstvenih radnika da tumače podatke, procenjuju zdravstvene rizike i uvode preventivne mere u svoju praksu [31,32]. Ovakva iskustva pokazuju da je od ključnog značaja da se kultura javnog zdravlja i pripremljenost na ekstremne događaje povezane sa klimatskim promenama integrišu u prvi nivo obuke odnosno obrazovanja zdravstvenih kadrova [33,34]. Štaviše, ovakva reforma mogla bi da doprinese rešavanju aktuelne krize dobrobiti zdravstvenih radnika i valorizacije njihovog rada. Dokazi ukazuju da sveže obučeni kadrovi često ulaze u radno okruženje nedovoljno pripremljeni za psihološke i organizacione zahteve koje to okruženje nosi, što značajno utiče na njihovo mentalno zdravlje i ostanak u profesiji [35].

Sistem zdravstvene zaštite kao takav prolazi kroz značajnu transformaciju. Upis na programe master studija javnog zdravlja (engl. *Master of Public Health, MPH*) i visoke studije sestrinstva (engl. *Advanced Practice Nursing, APN*) je u porastu, što odražava kako rastuću potrebu za interdisciplinarnim i analitičkim veštinama, tako i hitnu potrebu za rešavanjem globalnog nedostatka medicinskih sestara [36,37]. Uloge koje na sebe preuzimaju zdravstveni radnici *APN* obrazovnog profila redefinišu tradicionalne hijerarhije u zdravstvenoj zaštiti proširivanjem kliničke autonomije, podsticanjem međusektorske saradnje i jačanjem veza između brige o pacijentima i istraživačke delatnosti [38]. Na isti način, sve veća prisutnost stručnjaka sa master diplomom u oblasti javnog zdravlja u bolnicama i drugim in-

these factors, healthcare professionals are less likely to integrate epidemiological reasoning into their practice.

REEXAMINING HEALTHCARE TRAINING

The limited role of epidemiology and statistics in the early stages of medical and nursing education may contribute to healthcare professionals' limited familiarity with and use of health data in practice. Conversely, structured training programs that integrate public health research and practice – such as those implemented in Quebec, Canada – strengthen direct engagement with population health data, surveillance systems, and applied research projects, thereby enhancing healthcare workers' ability to interpret data, anticipate health risks, and adopt preventive measures in their practice [31,32]. Building on such approaches, integrating a culture of public health and preparedness for climate-related extreme events in initial training has become essential [33,34]. Importantly, such reform could also help address the current crisis of wellbeing and recognition among healthcare professionals. Evidence shows that new graduates often enter the workforce underprepared for its psychological and organizational demands, which has a considerable impact on their mental health and retention [35].

The healthcare landscape is undergoing a significant transformation. Enrolment in Master of Public Health (MPH) and Advanced Practice Nursing (APN) programs has increased, reflecting both the growing demand for interdisciplinary and analytical skills and the urgent need to address the global nursing shortage [36,37]. APN roles are redefining traditional care hierarchies by expanding clinical autonomy, promoting cross-sector collaboration, and strengthening links between patient care and research [38]. Similarly, the increasing presence of MPH graduates within hospital and community settings signals a convergence between clinical expertise and population health competencies [39] – a positive development for bridging the persistent gap between frontline practice and epidemiological insight.

This paradigm shift reflects the dedication of healthcare professionals to participating in an educational reform that is both integrative and forward-thinking. Training in health surveillance, modelling, risk communication, and the responsible use of digital technologies enables professionals to interpret complex data ecosystems, understand the structural determinants of health, and actively contribute to public health intelligence [38,39]. By rethinking education to better align with day-to-day practical experience

stitucijama ukazuje na približavanje kliničkog stručnog znanja i kompetencija iz oblasti populacionog zdravlja [39] – što predstavlja pozitivan pomak ka premošćavanju dugotrajnog jaza između prakse na prvoj liniji zdravstvene zaštite i epidemioloških saznanja.

Ova promena paradigme odražava posvećenost zdravstvenih radnika učešću u obrazovnoj reformi koja je istovremeno integrativna i usmerena ka budućnosti. Obuka iz oblasti zdravstvenog nadzora, modelovanja, komunikacije rizika i odgovorne upotrebe digitalnih tehnologija omogućava stručnjacima da tumače složene ekosisteme podataka, razumeju strukturne determinante zdravlja i aktivno doprinose javnozdravstvenoj inteligenciji [38,39]. Preispitivanjem obrazovanja kako bi se ono bolje uskladilo sa svakodnevnim praktičnim iskustvom i novonastalim potrebama javnog zdravlja, Evropa ima priliku ne samo da unapredi otpornost, već i cenjenost, privlačnost i održivost profesija koje su pod sve većim opterećenjem.

PONOVNO POVEZIVANJE EPIDEMIOLOGA SA KONTEKSTOM PODATAKA

Epidemiolozi bi imali značajnu korist od povremenog boravka u kliničkim okruženjima, gde bi mogli neposredno da sagledaju praktična ograničenja, kao što su opterećenje poslom, raznolikost pacijenata i istovremeno prisustvo, često suprotstavljenih prioriteta. Skorašnja studija, čiji je cilj bio izrada vodiča za osmišljavanje nastavnih programa iz epidemiologije, pokazala je delotvornost pristupa učenju zasnovanog na praktičnom radu i promišljanju [40]. U tom smislu, programi poput *Epidemic Intelligence Service* (*EIS*) pri Centru za kontrolu i prevenciju bolesti (engl. *Centers for Disease Control and Prevention – CDC*) predstavljaju dobar primer ovakvog praktičnog pristupa: polaznici stiču neposredno terensko iskustvo uz blisko mentorstvo, učeći kako da epidemiološke podatke pretoče u konkretna javnozdravstvena rešenja i kako da obezbede da sistemi nadzora i preduzete mere ostanu čvrsto utemeljeni u realnom, svakodnevnom kontekstu prve linije zdravstvene zaštite [41]. Takvo iskustvo iz prve ruke pomaže da se razjasni zašto je pojedine podatke teško prikupiti ili zašto se smernice ne mogu uvek dosledno i delotvorno primeniti u praksi, a istovremeno podstiče realističnije i pragmatičnije osmišljavanje intervencija [41].

Ovaj pristup dodatno je potkrepljen dokazima dobijenim kroz druge programe obuke iz terenske epidemiologije. Programi obuke iz terenske epidemiologije (engl. *Field Epidemiology Training Programs, FETP*) jesu dvogodišnje inicijative zasnovane na principu „učenja kroz rad", osmišljene da ojačaju kako kadrovske kapacitete, tako i sisteme javnozdravstvenog nadzora. Slično tome, Evropski program za obuku iz interventne epide-

and emerging public health needs, Europe has the opportunity not only to strengthen resilience but also to enhance recognition, attractiveness, and sustainability of the professions that are under strain.

RECONNECTING EPIDEMIOLOGISTS WITH THE CONTEXT BEHIND THE DATA

Epidemiologists would benefit from periodic immersion in clinical environments to directly observe practical constraints such as workload pressures, patient diversity, and competing priorities. A recent study aimed at developing a guide for designing epidemiology courses demonstrates the effectiveness of an immersive and reflective learning environment [40]. In concrete terms, programs such as the Centers for Disease Control and Prevention's Epidemic Intelligence Service (EIS) illustrate this practical approach: officers gain real-world field experience under close mentorship, learning to translate data into practical public health solutions and ensuring that surveillance systems and response efforts remain grounded in the frontline context of healthcare [41]. Such first-hand exposure clarifies why certain data remain difficult to capture or why guidelines may not always translate effectively into practice, while fostering more grounded, pragmatic modelling and intervention design [41].

This approach is also supported by evidence from other field epidemiology training programs. Field Epidemiology Training Programs (FETPs) are two-year, 'learning by doing' initiatives designed to strengthen both the workforce and the public health surveillance systems. Similarly, the European Programme for Intervention Epidemiology Training (EPIET) trains field epidemiologists – often in collaboration with national programs – highlighting the importance of structured mentoring, field assignment rotation, and iterative reflection on operational challenges in strengthening epidemiological capacity and data literacy [42].

Treadwell et al. [43] call for a reform of data collection practices to include more disaggregated information, enabling a clearer understanding of – and response to – health inequalities. They argue that this requires a fundamental transformation of data collection methods and structures.

Collectively, these perspectives suggest that combining field immersion, well-designed collaborative networks, and targeted training can help reconnect epidemiologists with the operational context underpinning the data, thereby enhancing the validity, applicability, and equity of public health research and practice.

miologije (engl. *European Programme for Intervention Epidemiology Training – EPIET*) obučava terenske epidemiologe – često u saradnji sa nacionalnim programima – ističući značaj strukturisanog mentorstva, rotacije terenskih zadataka i iterativnog promišljanja o operativnim izazovima u jačanju epidemioloških kapaciteta i pismenosti u radu sa podacima [42].

Tredvel i saradnici [43] pozivaju na reformu praksi prikupljanja podataka kako bi se obuhvatili detaljnije razloženi podaci, što bi omogućilo jasnije razumevanje zdravstvenih nejednakosti i adekvatnije reagovanje na njih. Oni ističu da ovo zahteva temeljni preobražaj metoda i struktura prikupljanja podataka.

U celini, ovi stavovi ukazuju na to da kombinovanje terenskog rada, dobro osmišljenih mreža saradnje i ciljane obuke može doprineti ponovnom povezivanju epidemiologa sa operativnim kontekstom koji stoji u osnovi podataka, čime se unapređuju validnost, primenljivost i pravičnost javnozdravstvenih istraživanja i prakse.

IZGRADNJA ZAJEDNIČKOG OKVIRA ZA ZDRAVSTVENI NADZOR TOPLOTNIH TALASA

Primer toplotnih talasa posebno jasno ilustruje jaz između epidemiologa i zdravstvenih radnika u tumačenju i korišćenju podataka, budući da trenutno ne postoji široko prihvaćen konceptualni okvir niti standardizovan skup zdravstvenih pokazatelja za merenje njihovog uticaja. Iako brojne studije kvantifikuju višak smrtnosti [44,45] ili višak hospitalizacija [46], ti napori se često zasnivaju na različitim metodologijama, što otežava poređenje rezultata i uspostavljanje zajedničkog stručnog jezika među disciplinama.

U akutnim kliničkim uslovima, pokazatelji kao što su višak smrtnosti, popunjenost bolničkih kapaciteta i prijem u jedinice intenzivne nege (JIN) obezbeđuju primenljive signale u realnom vremenu, kako kliničarima tako i javnozdravstvenim instuticijama. Pored ovih neposrednih mera, pokazatelji populacionog zdravlja – uključujući prevalenciju, incidenciju, prevremenu smrtnost, morbiditet i invaliditet, kakvi se koriste u Studiji globalnog opterećenja bolešću (engl. *Global Burden of Disease – GBD*) [47] – nude standardizovan metod za kvantifikovanje i mortaliteta i morbiditeta u populacijama, kao i za poređenje relativnog uticaja različitih uzroka bolesti i povreda. Zbirne mere, kao što su godine života prilagođene invaliditetu (engl. *disability-adjusted life years – DALYs*), razvijene u okviru *GBD* studije, objedinuju ove pokazatelje u jedinstvenu meru ukupnog opterećenja bolešću, dok godine života prilagođene kvalitetu (engl. *quality-adjusted life years – QALYs*) obuhvataju uticaj zdravstvenih stanja na kvalitet života pacijenata, povezujući kliničke ishode sa proživljenim iskustvom.

BUILDING A COMMON FRAMEWORK FOR HEATWAVE HEALTH MONITORING

The example of heatwaves is particularly illustrative of the gap between epidemiologists and healthcare professionals in interpreting and using data, as no widely accepted conceptual framework or standardized set of health metrics currently exists to measure their impact. While numerous studies quantify excess mortality [44,45] or excess hospitalizations [46], these efforts often rely on different methodologies, making it difficult to compare results or establish a shared language across disciplines.

In acute clinical settings, indicators such as excess mortality, hospital bed occupancy, and intensive care unit (ICU) admissions provide actionable, real-time signals for both clinicians and public health authorities. Beyond these immediate measures, population health indicators – including prevalence, incidence, premature mortality, morbidity, and disability, as used in the Global Burden of Disease (GBD) Study [47] – offer a standardized method for quantifying both mortality and morbidity across populations and comparing the relative impact of different causes of disease and injury. Summary measures such as disability-adjusted life years (DALYs), developed as part of the GBD Study, integrate these indicators into a single metric of overall disease burden, while quality-adjusted life years (QALYs) capture the impact of health conditions on patients' quality of life, linking clinical outcomes to lived experience.

Establishing a common set of such indicators at the European level could facilitate clearer communication between epidemiologists, healthcare professionals, and policymakers by providing a shared reference for measuring health impact, setting public health targets, and prioritizing interventions. These measures are particularly valuable for anticipating health risks, planning preventive strategies, evaluating progress over time, and comparing burden across different causes of disease, rather than serving solely as tools for immediate crisis response [48,49].

CONCLUSION

In a world where heatwaves, fires, epidemics, and socio-economic crises are intensifying, it is essential to raise awareness among both epidemiologists and healthcare professionals about the benefits of closer collaboration. Reconciling these two complementary and interdependent fields requires the development of a clear conceptual framework and a shared language. Rethinking training programs in both domains could represent a long-term strategy to strengthen the resilience of health systems.

Uspostavljanje zajedničkog skupa ovakvih pokazatelja na evropskom nivou moglo bi da olakša jasniju komunikaciju između epidemiologa, zdravstvenih radnika i donosilaca odluka, pružajući zajedničku referentnu osnovu za merenje zdravstvenog uticaja, postavljanje javnozdravstvenih ciljeva i određivanje prioriteta intervencija. Ove mere su naročito dragocene za predviđanje zdravstvenih rizika, planiranje preventivnih strategija, praćenje napretka tokom vremena i poređenje opterećenja među različitim uzrocima bolesti, a ne samo kao alati za neposredan odgovor na krizne situacije [48,49].

ZAKLJUČAK

U svetu u kojem se toplotni talasi, požari, epidemije i socioekonomske krize sve više intenziviraju, od ključnog je značaja da se unapredi svest, kako među epidemiolozima tako i među zdravstvenim radnicima, o koristima bliskije saradnje. Usklađivanje ove dve komplementarne i međusobno zavisne oblasti zahteva uspostavljanje jasnog konceptualnog okvira i zajedničkog stručnog jezika. Preispitivanje i unapređivanje programa obrazovanja/obuke u oba domena moglo bi predstavljati dugoročnu strategiju za jačanje zdravstvenih sistema.

SPISAK SKRAĆENICA

APN – Advanced Practice Nursing; visoke studije sestrinstva
DALYs – disability-adjusted life years; godine života prilagođene invaliditetu
EIS – Epidemic Intelligence Service; Epidemiološka obaveštajna služba
EPIET – European Programme for Intervention Epidemiology Training; Evropski program za obuku iz interventne epidemiologije
FETPs – Field Epidemiology Training Programs; programi obuke iz terenske epidemiologije
GBD Study – The Global Burden of Disease Study; Studija globalnog opterećenja bolešću
JIN – jedinica intenzivne nege
MPH – Master of Public Health; master studije javnog zdravlja
QALYs – quality-adjusted life years, godine života prilagođene kvalitetu

Sukob interesa: Nije prijavljen.

LIST OF ACRONYMS

APN – Advanced Practice Nursing
DALYs – disability-adjusted life years
EIS – Epidemic Intelligence Service
EPIET – European Programme for Intervention Epidemiology Training
FETPs – Field Epidemiology Training Programs
GBD Study – The Global Burden of Disease Study
ICU – intensive care unit
MPH – Master of Public Health
QALYs – quality-adjusted life years

Conflict of interest: None declared.

LITERATURA / *REFERENCES*

1. Russo E, Domeisen DIV. Increasing intensity of extreme heatwaves: the crucial role of metrics. Geophys Res Lett. 2023;50(14):e2023GL103540. doi: 10.1029/2023GL103540.
2. Van de Vuurst P, Escobar LE. Climate change and infectious disease: a review of evidence and research trends. Infect Dis Poverty. 2023 May 16;12(1):51. doi: 10.1186/s40249-023-01102-2.
3. Khan HTA, Addo KM, Findlay H. Public health challenges and responses to the growing ageing populations. Public Health Challenges. 2024;3(3):e213. doi: 10.1002/puh2.213.
4. Reeves A, McKee M, Basu S, Stuckler D. The political economy of austerity and healthcare: cross-national analysis of expenditure changes in 27 European nations 1995–2011. Health Policy. 2014 Mar;115(1):1-8. doi: 10.1016/j.healthpol.2013.11.008.
5. Barten DG, Paganini M, Khorram-Manesh A, Leledakis G, Ciottone G. Hospital vulnerabilities to a changing climate: extreme heat, droughts, and wildfires. Eur J Emerg Med. 2024 Dec;31(6):383-4. doi: 10.1097/MEJ.0000000000001168.
6. Ebi KL, Vanos J, Baldwin JW, Bell JE, Hondula DM, Errett NA, et al. Extreme weather and climate change: population health and health system implications. Annu Rev Public Health. 2021 Apr 1;42:293-315. doi: 10.1146/annurev-publhealth-012420-105026.
7. Romanello M, Di Napoli C, Drummond P, Green C, Kennard H, Lampard P, et al. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. Lancet. 2022 Nov 5;400(10363):1619-54. doi: 10.1016/S0140-6736(22)01540-9.
8. van Daalen KR, Kallesøe SS, Davey F, Dada S, Jung L, Singh L, et al. Extreme events and gender-based violence: a mixed-methods systematic review. Lancet Planet Health. 2022 Jun;6(6):e504-23. doi: 10.1016/S2542-5196(22)00088-2.
9. Ebi KL, Capon A, Berry P, Broderick C, de Dear R, Havenith G, et al. Hot weather and heat extremes: health risks. Lancet. 2021 Aug 21;398(10301):698-708. doi: 10.1016/S0140-6736(21)01208-3.
10. Minor K, Bjerre-Nielsen A, Jonasdottir SS, Lehmann S, Obradovich N. Rising temperatures erode human sleep globally. One Earth. 2022 May 20;5(5):534-49. doi: 10.1016/j.oneear.2022.04.008.
11. Liu J, Varghese BM, Hansen A, Xiang J, Zhang Y, Dear K, et al. Is there an association between hot weather and poor mental health outcomes? A systematic review and meta-analysis. Environ Int. 2021 Aug;153:106533. doi: 10.1016/j.envint.2021.106533.
12. Bansal A, Cherbuin N, Davis DL, Peek MJ, Wingett A, Christensen BK, et al. Heatwaves and wildfires suffocate our healthy start to life: time to assess impact and take action. Lancet Planet Health. 2023 Aug;7(8):e718-25. doi: 10.1016/S2542-5196(23)00134-1.
13. Banks E, Haynes A, Lovett R, Yadav UN, Agostino J. Output-orientated policy engagement: a model for advancing the use of epidemiological evidence in health policy. Health Res Policy Syst. 2023 Jan 16;21(1):6. doi: 10.1186/s12961-022-00955-7.
14. Hémon D, Jougla E. Surmortalité liée à la vague de chaleur d'août 2003: suivi de la mortalité post-canicule, causes médicales de décès observées au cours de la vague de chaleur. Paris: INSERM; 2004 Oct. p. 76.
15. Calado R, Nogueira PJ, Catarino J, Paixão EDJ, Botelho J, Carreira M, et al. A onda de calor de Agosto de 2003 e os seus efeitos sobre a mortalidade da população portuguesa. Rev Port Saúde Pública. 2004;22(2).
16. Urban A, Hanzlíková H, Kyselý J, Plavcová E. Impacts of the 2015 Heat Waves on Mortality in the Czech Republic-A Comparison with Previous Heat Waves. Int J Environ Res Public Health. 2017 Dec 13;14(12):1562. doi: 10.3390/ijerph14121562.
17. Bustos Sierra N, Braeye T, Nganda S, Vernemmen C, Jurcevic J, Ekelson R, et al. Surveillance de la mortalité toutes causes confondues en Belgique, Flandre, Wallonie et Bruxelles durant l'été 2020 [Internet]. Bruxelles: Sciensano; 2020 [cited 2024 Jan 25]. Report No.: D/2023.14.440/20. Available from: https://epistat.sciensano.be/docs/momo/Be-MOMO-summer-2020-report-FR.pdf
18. Murray J, Cohen AL. Infectious disease surveillance. In: Atkinson P, editor. International Encyclopedia of Public Health. 2nd ed. Amsterdam: Elsevier; 2017. p. 222-9.
19. Tonne C, Basagaña X, Chaix B, Huynen M, Hystad P, Nawrot TS, et al. New frontiers for environmental epidemiology in a changing world. Environ Int. 2017 Jul;104:155-62. doi: 10.1016/j.envint.2017.04.003.
20. Gudžiūnaitė S, Shabani Z, Weitensfelder L, Moshammer H. Time series analysis in environmental epidemiology: challenges and considerations. Int J Occup Med Environ Health. 2023 Dec 15;36(6):704-16. doi: 10.13075/ijomeh.1896.02237.
21. Etzel RA, Abbas NH, Anastario MP, Mustapha A, Osuolale O, Sarkar A, et al. Ethics guidelines for environmental epidemiologists: 2023 revision. Environ Epidemiol. 2024 Apr;8(2):E299. doi: 10.1097/EE9.0000000000000299.
22. Catania G, Zanini M, Cremona MA, Landa P, Musio ME, Watson R, et al. Nurses' intention to leave, nurse workload and in-hospital patient mortality in Italy: a descriptive and regression study. Health Policy. 2024 May;143:105032. doi: 10.1016/j.healthpol.2024.105032.
23. Bahlman-van Ooijen W, Malfait S, Huisman-de Waal G, Hafsteinsdóttir TB. Nurses' motivations to leave the nursing profession: A qualitative meta-aggregation. J Adv Nurs. 2023 Dec;79(12):4455-71. doi: 10.1111/jan.15696.
24. Riedel B, Horen SR, Reynolds A, Hamidian Jahromi A. Mental health disorders in nurses during the COVID-19 pandemic: implications and coping strategies. Front Public Health. 2021;9:707358. doi: 10.3389/fpubh.2021.707358.
25. Gómez-Salgado J, Domínguez-Salas S, Romero-Martín M, Romero A, Coronado-Vázquez V, Ruiz-Frutos C. Work engagement and psychological distress of health professionals during the COVID-19 pandemic. J Nurs Manag. 2021;29(5):1016-25. doi: 10.1111/jonm.13239.
26. Tonnelier M. Construction d'un outil de mesure de la charge en compétences d'un service de soins de santé en milieu hospitalier: le Skills On Time In Full [Internet] [Master's thesis]. Woluwe-Saint-Lambert: UCLouvain; 2022 [cited 2025 Aug 21]. Available from: https://hdl.handle.net/2078.2/42519
27. Strongman H, Williams R, Meeraus W, Murray-Thomas T, Campbell J, Carty L, et al. Limitations for health research with restricted data collection from UK primary care. Pharmacoepidemiol Drug Saf. 2019 Jun;28(6):777-87. doi: 10.1002/pds.4765.
28. Levine AC, Barry MA, Agrawal P, Duber HC, Chang MP, Mackey JM, et al. Global health and emergency care: overcoming clinical research barriers. Acad Emerg Med. 2017 Apr;24(4):484-93. doi: 10.1111/acem.13142.
29. Saranto K, Kinnunen UM, Kivekäs E, Lappalainen AM, Liljamo P, Rajalahti E, et al. Impacts of structuring nursing records: a systematic review. Scand J Caring Sci. 2014 Dec;28(4):629-47. doi: 10.1111/scs.12094.
30. D'Arrietta LM, Vangaveti VN, Crowe MJ, Malau-Aduli BS. Rethinking health professionals' motivation to do research: a systematic review. J Multidiscip Healthc. 2022 Jan 26;15:185-216. doi: 10.2147/JMDH.S337172.
31. Paradis G, Hamelin AM, Malowany M, Levy J, Rossignol M, Bergeron P, et al. The university-public health partnership for public health research training in Quebec, Canada. Am J Public Health. 2017 Jan;107(1):100-4. doi: 10.2105/AJPH.2016.303529.

32. Iyamu I, Ramachandran S, Chang HJ, Kushniruk A, Ibáñez-Carrasco F, Worthington C, et al. Considerations for adapting digital competencies and training approaches to the public health workforce: an interpretive description of practitioners' perspectives in Canada. BMC Public Health. 2025 Jan 10;25(1):122. doi: 10.1186/s12889-024-21089-1.
33. Ghimire A, Ghimire P. Building climate resilience: A qualitative exploration of disaster preparedness in nursing education. Nurse Educ Today. 2025 Oct;153:106791. doi: 10.1016/j.nedt.2025.106791.
34. Tiitta I, Cubelo F, McDermott-Levy R, Jaakkola JJK, Kuosmanen L. Climate change integration in nursing education: a scoping review. Nurse Educ Today. 2024 Aug;139:106210. doi: 10.1016/j.nedt.2024.106210.
35. Jarden RJ, Jarden A, Weiland TJ, Taylor G, Bujalka H, Brockenshire N, et al. New graduate nurse wellbeing, work wellbeing and mental health: a quantitative systematic review. Int J Nurs Stud. 2021 Sep 1;121:103997. doi: 10.1016/j.ijnurstu.2021.103997.
36. Wheeler KJ, Miller M, Pulcini J, Gray D, Ladd E, Rayens MK. Advanced practice nursing roles, regulation, education, and practice: a global study. Ann Glob Health. 2022;88(1):42. doi: 10.5334/aogh.3698.
37. Zwanikken PAC, Dieleman M, Samaranayake D, Akwataghibe N, Scherpbier A. A systematic review of outcome and impact of master's in health and health care. BMC Med Educ. 2013 Feb 7;13:18. doi: 10.1186/1472-6920-13-18.
38. Horvath S, Visekruna S, Kilpatrick K, McCallum M, Carter N. Models of care with advanced practice nurses in the emergency department: a scoping review. Int J Nurs Stud. 2023 Dec;148:104608. doi: 10.1016/j.ijnurstu.2023.104608.
39. Kasper J, Bigum Sundar TK, Valla L, Lilleengen AM, Rydtun Haug AG, Engen Marsdal K, et al. How the master's level is implemented in internships within master's programmes - exploring the views of students, clinicians, and educators in midwifery and public health nursing. BMC Med Educ. 2024 Dec 19;24(1):1496. doi: 10.1186/s12909-024-06461-4.
40. Gille F, Frei A, Kaufmann M, Lehmann A, Muñoz Laguna J, Papadopoulos K, et al. A guide for a student-led doctoral-level qualitative methods short course in epidemiology: faculty and student perspectives. Int J Epidemiol. 2024 Feb 14;53(2):dyae029. doi: 10.1093/ije/dyae029.
41. Centers for Disease Control and Prevention (CDC). About the Epidemic Intelligence Service [Internet]. 2025 [cited 2025 Aug 25]. Available from: https://www.cdc.gov/eis/php/about/index.html/.
42. Walke H, Simone P. Building capacity in field epidemiology: lessons learned from the experience in Europe. Euro Surveill. 2009 Oct 29;14(43):19376. doi: 10.2807/ese.14.43.19376-en.
43. Treadwell HM, Ro M, Sallad L, McCray E, Franklin C. Discerning disparities: the data gap. Am J Mens Health. 2019;13(1):1557988318807098. doi: 10.1177/1557988318807098.
44. Zhao Q, Li S, Ye T, Wu Y, Gasparrini A, Tong S, et al. Global, regional, and national burden of heatwave-related mortality from 1990 to 2019: a three-stage modelling study. PLoS Med. 2024 May;21(5):e1004364. doi: 10.1371/journal.pmed.1004364.
45. Guo Y, Gasparrini A, Li S, Sera F, Vicedo-Cabrera AM, de Sousa Zanotti Stagliorio Coelho M, et al. Quantifying excess deaths related to heatwaves under climate change scenarios: a multicountry time series modelling study. PLoS Med. 2018 Jul;15(7):e1002629. doi: 10.1371/journal.pmed.1002629.
46. van Loenhout JAF, Delbiso TD, Kiriliouk A, Rodriguez-Llanes JM, Segers J, Guha-Sapir D. Heat and emergency room admissions in the Netherlands. BMC Public Health. 2018 Jan 5;18(1):108. doi: 10.1186/s12889-017-5021-1.
47. Devleesschauwer B, Charalampous P, Gorasso V, Assunção R, Hilderink H, Idavain J, et al. Standardised reporting of burden of disease studies: the STROBOD statement. Popul Health Metrics. 2024 Oct 7;22(1):28. doi: 10.1186/s12963-024-00347-9.
48. Marron L, Gilroy J, Williams M, Parlour R, Boland M. A narrative literature review to inform the development of a health threats preparedness framework in Ireland. Front Public Health [Internet]. 2025 Feb 6 [cited 2025 Aug 22];13. doi: 10.3389/fpubh.2025.1490850.
49. Khan Y, Brown AD, Gagliardi AR, O'Sullivan T, Lacarte S, Henry B, et al. Are we prepared? The development of performance indicators for public health emergency preparedness using a modified Delphi approach. PLoS One. 2019 Dec 23;14(12):e0226489. doi: 10.1371/journal.pone.0226489

CURRICULUM VITAE

Margo Tonnelier

Margo Tonnelier is a nurse by training and holds a Master's degree in Public Health Sciences. She is currently a PhD candidate at the Centre for Research on the Epidemiology of Disasters (CRED). Her research focuses on hospital workload, health statistics, and the health impacts of disasters, with particular attention to heatwaves. She is responsible for epidemic-related activities within the International Disaster Database EM-DAT and serves as a teaching assistant at the Faculty of Public Health, UCLouvain (Belgium), where she teaches health statistics and epidemiology..