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SPECIAL THEME

Indoor Toxicants

NEDERLANDSE VERENIGING VOOR TOXICOLOGIE

Colofon

Toxicologische Communicatie, Data en Documentatie (TCDD)

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Indien u ervoor kiest zelf uw contributie over te maken, dan worden € 5,- administratiekosten in rekening gebracht.

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TCDD
TOXICOLOGIE

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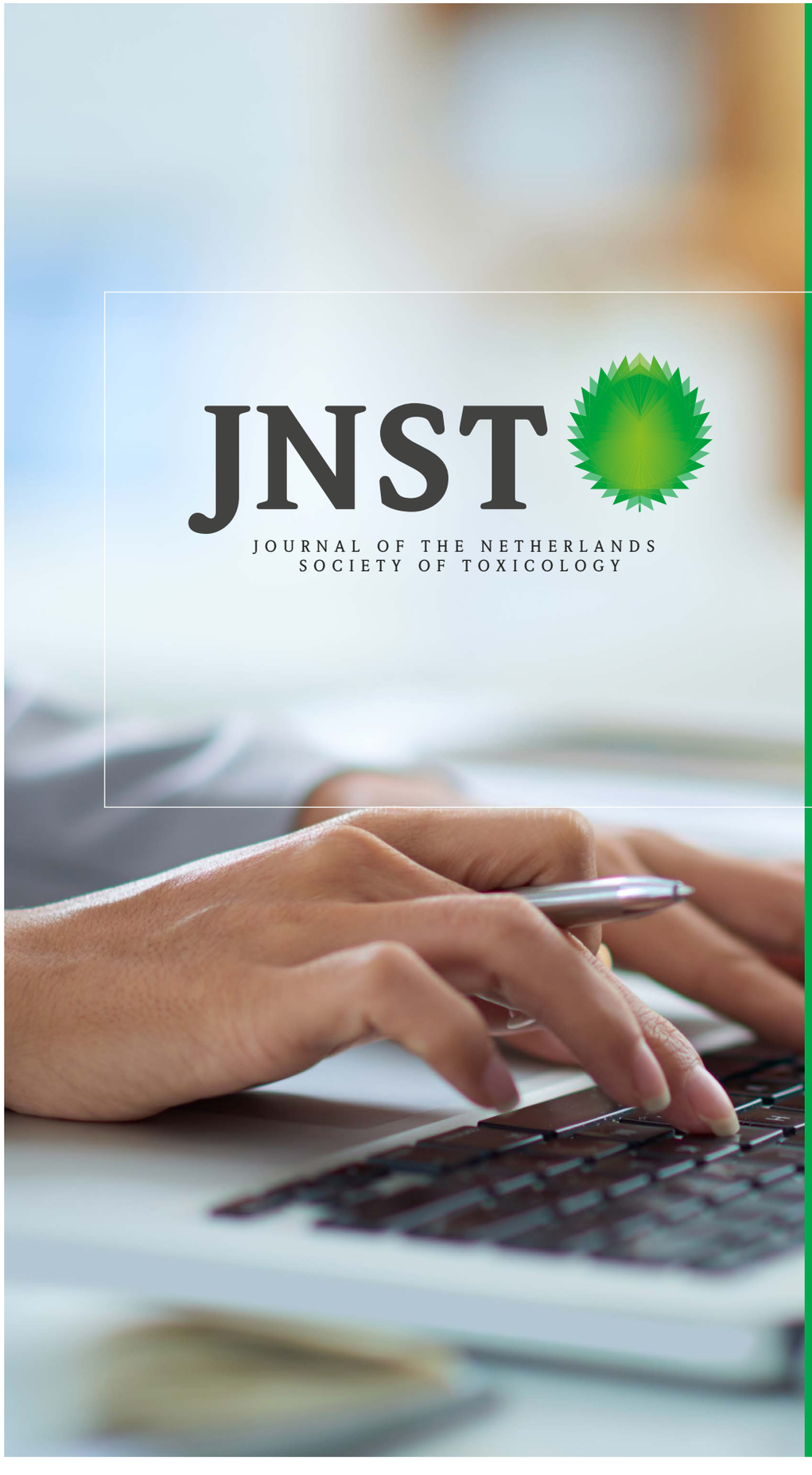

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TERUG NAAR INHOUD

Editorial

The holidays are a time for celebration, and there's nothing like being cozy at home with loved ones, enjoying the glow of festive lights, delicious food, and the warmth of the season. But amidst all the merriment, we often forget that our indoor environments can become breeding grounds for hidden hazards. As we decorate, cook, and gather, the air we breathe and the products we use can unknowingly expose us to indoor toxins. The winter months, in particular, keep us indoors, where poor ventilation and the use of holiday decorations, candles, and cleaning products can contribute to harmful air quality and chemical exposure.

Damien visited Em. Prof. Jan H. Koeman, founder of the NVT to talk about the past, future and his vision on toxicology, we highlight the risks of water filters and the things we sleep with. This issue also features a piece from prof. Dr. Flemming Cassee on the use of gas stoves with regards to cardiovascular health. Of course, no December issue of the TCDD can be complete without the holiday puzzle.

On behalf of the editorial team, I wish you warm and happy holidays!

Sincerely,

Jelmer Faber

Photo by Jess Bailey on Unsplash

News from the board

By *Frederik-Jan van Schooten*

Welcome to the fourth and final edition of TCDD for 2024. I am honored to step into the role of NVT president, succeeding Paul Jennissen. Paul, I would like to thank you for your leadership and invaluable contributions as president, and I am pleased that you will continue your work as vice president.

The NVT's 45th anniversary jubilee meeting 18-19 June at the Reehorst in Ede was a great success, and I was privileged to chair this milestone event. I would like to express my sincere thanks to the organizing team, especially the junior members, whose dedication and energy were truly outstanding. It was a fantastic experience, and I encourage all junior members to consider volunteering for the 46th Annual Meeting in 2025 (still one junior member needed!). It's a great opportunity to get involved and make lasting memories!

Updates from the NVT Board

Our 'Future-Proofing' working group, consisting of board members and section representatives, is actively engaging in discussions about the professionalization of our society, the future of our sections, and improving communication, including an update of the NVT website. If you are interested in contributing to these important discussions, please don't hesitate to reach out to us. Your input is highly valued.

We are also in the early stages of exploring a collaboration with the German Society of Toxicology. We hope to learn from their experiences and explore opportunities for joint meetings as well as trainings or courses in the future.

Regarding academia, the standard of theses defended in 2024 has been exceptionally high. I encourage all supervisors to keep an eye on the call for nominations for the Joep van Bercken Prize for the Best Toxicology Thesis, which will come out early next year. This is an excellent opportunity to recognize outstanding research and researchers in the entire toxicology field.

It has been a good tradition for years that the NVT has money for travel grants for young researchers who want to visit an international conference. In recent years, the board has also received requests for financial support for study/group trips. That is why, from January 2025, it will be possible for a university to apply for a group budget once every five years (with a maximum of €2500), at the discretion of the board and availability of the budget for trips. For more information see https://toxicologie.nl/en/travel-scholarships/.

Celebrating Dutch Toxicologists

We are proud that two prominent Dutch toxicologists have received prestigious awards at the 2024 EUROTOX Congress in Copenhagen:

- **Prof. dr. Ivonne Rietjens** was honored with the **EUROTOX Merit Award 2024**.
- **Prof. dr. Juliette Legler** received the **EUROTOX Lecture Award 2024**.

It is a remarkable achievement that both esteemed experts were nominated by NVT and went on to win an award at EUROTOX. As far as I know, it is the first time in EUROTOX history that both award recipients are from the same country. Congratulations, Juliette and Ivonne - your accomplishments are a source of immense pride and inspiration for the Dutch toxicology society.

Prof. dr. Ivonne Rietjens was honored with the EUROTOX Merit Award 2024.

EUROTOX 2024
COPENHAGEN | DENMARK
8-11 SEPTEMBER 2024

Prof. dr. Juliette Legler received the EUROTOX Lecture Award 2024.

Additionally, our board member **Hans Bouwmeester** has been appointed as a professor at Wageningen University, and he recently gave his inaugural lecture. A heartfelt congratulations to Hans on this well-deserved achievement!

Looking Ahead and Challenges

As we are closing 2024 soon, it's hard not to be concerned about the current political and societal landscape. The rise of right-wing politics in several regions, coupled with the potential downsizing of critical issues like sustainability, energy transition, climate change and loss of biodiversity is deeply worrying. These are areas of great significance for everyone and is impacting our work as toxicologists, as we are at the forefront of ensuring a healthy and safe environment for all species, including ourselves.

Furthermore, cuts to national research funding continue to pose challenges for scientific progress. Now, more than ever, it is crucial that we unite as a community to advocate for the importance of toxicology and research in safeguarding public health and the environment.

As we enter the year-end period, a time for joy, reflection and rest, let us also take a moment to recognize that in other areas of the world people are facing hardship - whether due to conflict, like the ongoing war in Ukraine or the tragic events in Gaza, or other global challenges. While we may be fortunate to enjoy time with our loved ones, we must not forget those for whom this will not be possible. Let's continue to do our best and support efforts to create a better world for us all.

Wishing you all a relaxing and joyful holiday season.

Warm regards, also on behalf of the board,

Frederik-Jan van Schooten

TERUG NAAR INHOUD

SECTIE
ARBEIDSTOXICOLOGIE

Een batterij aan nieuwe risico's?

Gevaren van lithium-ion batterijen op de werkvloer.

De sectie Arbeidstoxicologie organiseert in samenwerking met de Contactgroep Gezondheid en Chemie een hybride bijeenkomst op **20 maart 2025** in het Aristo Meeting Center in **Eindhoven** van 13.00-17.00 uur. De voorlopige titel voor deze bijeenkomst is "Een batterij aan nieuwe risico's? Gevaren van lithium-ion batterijen op de werkvloer."

Meer informatie volgt in januari.

calling all PhD candidates!

We are excited to highlight your PhD defense journey in our section, 'Proefschriftpromopraatje'. This is your chance to share your hard work, insights, and experiences with our community.

Submit your content and let us celebrate your achievements together! Include a summary of your research, a reflection on your defense and advice for future candidates, we want to hear from you.

Please refer to the 'colofon' for the submissions deadline.

Send your submissions to: redactie@toxicologie.nl

Let's inspire and support each other on this incredible academic journey. We can't wait to read your stories!

Best regards,

TCDD Editorial Team

TERUG NAAR INHOUD

Interview met

Em. Prof. Jan H. Koeman

Door *Damiën van Berlo*

Ik loop richting een huis in het groene Wageningen-Hoog, waar de oprichter van onze NVT woonachtig is. Zijn vrouw Nicole, een charmante en erudiete dame, verwelkomt ons op de oprit. Em. Prof. Jan Hein Koeman zit in één van zijn favoriete stoelen in de woonkamer. Inmiddels heeft hij de leeftijd van 88 jaar bereikt, maar dat zou je niet zeggen: zijn ogen zijn helder, hij is nog altijd welbespraakt en zijn geheugen is scherp, hij rakelt in vlot tempo namen op van collega's, vrienden, vakgenoten. Hoewel zij er niet allemaal meer zijn, is de waardering en het respect voor hen niet afgenomen. Mijn eerste indruk is dat ik het ieder NVT-lid toewens om zo oud (kwantitatief; het aantal levensjaren), en zó oud (kwalitatief; de manier waarop) te mogen worden.

Jan blijkt een enthousiast verteller en heeft een ontzettend rijk palet aan ervaringen om uit te putten; we hebben onder meer gesproken over zijn liefde voor de natuur, zijn reizen en zijn bibliotheek. En ook over zijn visie op de toxicologie en een stukje geschiedenis van onze NVT; in dit TCDD artikel zal het met name daarover gaan.

We starten met een definitie-vraag; wat zijn volgens u de hoekstenen van het vakgebied toxicologie? Wat is cruciaal en definiërend?

De toxicoloog en chemicus Matthieu Orfila (1787-1853) benoemde de essentie van het onderzoeken van de toxiciteit van een stof als het identificeren van de organen waar deze stof op aangrijpt en het bestuderen van de veranderingen in die organen. Waar in de vroege toxicologie de nadruk lag op acute, snel optredende toxiciteit, beschreef de Nederlandse toxicoloog Alexander van Hasselt de werking van zogenoemde "langzame vergiften", stoffen die leiden tot chronische toxiciteit. Een voorbeeld hiervan is asbest, met zijn latentietijd van meerdere decennia, waarvan door Jan Stumphius, bedrijfsarts bij scheepswerf De Schelde in de jaren 50, 60 en 70, is aangetoond dat ingeademd asbest vele jaren later leidt tot mesothelioom en sterfte. In een RIVM rapport uit 2017 wordt geschat dat er tot 2050 nog 15.800 personen gediagnosticeerd zullen worden met asbest-gerelateerde ziekte (en hieraan zullen sterven); de wijze waarop de regering is omgegaan met asbest, vind ik schandalig. Een ander centraal concept in de toxicologie is de kinetiek, het gedrag van stoffen in het lichaam. Een laatste kenmerk van de toxicologie is het optreden van inter-species verschillen: zo is het zo dat bij vogelsoorten die in de winter naar Afrika trekken, zoals sterns, zij hun reserves verbruiken en de stoffen die daarin aanwezig zijn mobiliseren. Bij de eidereend werden vooral de vrouwtjes getroffen door de effecten van "drins" (zie kader): zij dronken zoet water op het wad en verloren

ongeveer 30% van hun gewicht tijdens de broedtijd. Ook door specifiek gedrag kan de ene soort anders reageren op de aanwezigheid van een specifieke stof in hun milieu.

Hoe zou u de bijdrage van Nederland inschatten in de internationale toxicologische gemeenschap? Waar zijn "wij" goed in?

Nederland heeft een grote invloed in de internationale toxicologie. Hier liggen een aantal factoren aan ten grondslag:
1) De ligging: Nederland is een delta, dus veel rivieren passeren ons, met daarin de door grote bedrijven (vooral in het buitenland) geloosde schadelijke stoffen. Nederland heeft dus een belang bij het onderzoeken van de risico's.
2) Nederland is een sterk geïnstitutionaliseerd land: je vindt nergens in de Europese Unie zo veel instituten per eenheid van oppervlakte. Hier speelt onder meer het RIVM een belangrijke rol, als een poortwachter op het gebied van toxicologie. Ook het Nationale Vergiftingen Centrum, dat is ingebed in het UMC Utrecht, heeft een bepalende rol met goede klinische toxicologen, er komen elk jaar duizenden informatieverzoeken (NVIC website: 43.000/jr) binnen. Andere belangrijke instituten zijn onder meer TNO, het Nederlands Forensisch Instituut (NFI) en het Rijks- Kwaliteitsinstituut voor Land- en Tuinbouwproducten (RIKILT, inmiddels Wageningen Food Safety Research). Nederlandse toxicologen hebben relatief veel invloed gehad in organisaties als de WHO en de OECD. Ook heeft Nederland bedrijven gehad die actief betrokken waren in de toxicologie, zoals Shell.

Kunt u een algemeen beeld schetsen van de ontwikkeling van de toxicologie in met name Nederland, in een aantal fasen? Hoe is de focus verschoven over de tijd, wat is er zoal veranderd en wat is hetzelfde gebleven? Deze vraag heeft een aantal (mogelijke) aspecten, bijvoorbeeld 1) de maatschappelijke aandacht; 2) de methodieken, 3) de academische toxicologie en 4) het toxicologisch onderwijs;

Een overzicht van 40 jaar toxicologie, van 1949 t/m 1999, heb ik geschetst in mijn afscheidscollege: het Venijn zit in de Staart (*Koeman, 2000; link in de referentielijst*). Sommige belangrijke werken zijn pas laat vertaald; zo is *De Re Metallica* ("On the Nature of Metals") van Georgius Agricola, een standaard werk over de mijnbouw, pas in 1915 vertaald. De vertaler was overigens niemand minder dan Herbert Hoover, later president van de VS. Wat we hebben gezien in de 20e eeuw, is dat de ontwikkeling van de toxicologie is gestuurd door een aantal rampzalige gebeurtenissen. Zo werd in 1956 de ziekte van Minamata ontdekt, een ernstige neurologische aandoening die werd veroorzaakt door lozing van methylkwik door een chemische fabriek. Deze fabriek bleef van 1936 tot 1968 kwik lozen, ook de regering deed weinig om de ernstige gezondheidsschade te voorkomen. In dezelfde periode werd Thalidomide/Softenon op de markt gebracht (1957), om er in 1961 te worden verboden wegens ernstige geboortedefecten; dit heeft geleid tot een hervorming van de regulering en monitoring van medicijnen. In Nederland is er ophef geweest vanwege de enorme vervuiling met chemisch afval van de Vogelmeerpolder bij Amsterdam, in de jaren 60; pas in 1980 werd dit bekend vanwege een klokkenluider. Ook in dit geval werd er gedoogd door de overheid; het gebied is nog steeds de grootste vervuilde locatie van Nederland. Tijdens de Vietnam-oorlog (vanaf 1961) is het ontbladeringsmiddel Agent Orange op grote schaal ingezet, dat vaak het bijprodukt dioxine bevatte, dat bij veel inwoners tot ernstige aandoeningen heeft geleid. En in 1962 kwam het boek Silent Spring uit van de Amerikaanse Rachel Carson, waarin de toxische effecten van pesticiden op het milieu werden beschreven. In Nederland bleken de effecten ook heel ernstig te zijn.

Em. Prof. Jan H. Koeman in vogelvlucht; heeft belangrijk toxicologisch onderzoek gedaan naar de effecten van bestrijdingsmiddelen op met name vogels, maar ook bijvoorbeeld mosselen, zeehonden en vissen. Zijn onderzoek naar de "drins" (o.a. dieldrin, aldrin, telodrin) in de Waddenzee en hun schadelijke werking op de populaties van grote stern en eidereend heeft er toe geleid dat Shell besloot de produktie van telodrin stil te leggen. Als hoogleraar/opleider te Wageningen heeft hij bekende toxicologen als Prof. dr. ir. Ivonne Rietjens en Prof. dr. ir. Juliette Legler onder zijn hoede gehad tijdens hun promotietraject. Jan heeft zijn toxicologische kennis van pesticiden praktisch ingezet als voorzitter van het College voor de Toelating van Bestrijdingsmiddelen (het huidige Ctgb). Hij is de belangrijkste initiator geweest voor het oprichten van de NVT, die sedert 18 januari 1979 bestaat volgens de aanmelding bij de Kamer van Koophandel, en was tussen 1979 en 1982 de eerste voorzitter.

U bent de oprichter van de NVT: wat waren de redenen hiervoor en als u terugkijkt, zijn de doelen die u voor ogen had behaald?

Het begin was als volgt: Eef Ariëns, als hoogleraar werkzaam aan het Radboudumc te Nijmegen, zei me dat het tijd was voor een Nederlandse vereniging voor toxicologie. Hij kwam dus als eerste met het idee voor de NVT. Tijdens een vergadering is vervolgens besloten om de NVT op te richten en is deze vastgelegd bij de Kamer van Koophandel (*Jan laat de KvK-inschrijving zien, waarop te lezen is dat de exacte datum van oprichting 18 januari 1979 was*). Ik werd benoemd als eerste voorzitter voor een termijn van drie jaar; Klaas Jager, toxicoloog bij Shell, was de eerste secretaris en Frans van der Kreek de eerste secretaris-penningmeester. Interessant detail is die laatste de doornappel, een in Nederland vrij algemeen voorkomende maar uitermate giftige plant, heeft bedacht als symbool van de NVT. In 1982 werd ik als voorzitter opgevolgd door mijn vriend en studiegenoot Vic Feron (inhalatietoxicoloog, TNO). Er is al vroeg bedacht dat de NVT in verschillende secties zou moeten worden uitgesplitst voor de verschillende toxicologie sub-disciplines/expertises. Het nadeel hiervan is wel dat er weinig allround toxicologen zijn met het volledige overzicht van het vakgebied.

In een recent interview dat is afgenomen door Em. Prof. Mart van Lieburg (zie de referenties voor de link), geeft u aan dat er in de academische toxicologie veel onderzoek plaatsvindt dat weinig relevantie heeft voor daadwerkelijke maatschappelijke toxicologische problematiek. Hoe kunnen we de academische toxicologie beter koppelen aan de praktijk van bijvoorbeeld de regulatoire toxicologie? Waarom gaat dit of lijkt dit zo moeizaam?

Het probleem komt grotendeels door de structuur van de universiteiten: hoe meer promovendi, hoe hoger een groep wordt aangeslagen en hoe meer geld er beschikbaar is voor onderzoek. Promovendi leveren geld op, het financieringssysteem van de wetenschap is laakbaar. De NVT kan hier een belangrijke rol spelen door de samenhang te bewaren en door samenwerking te stimuleren en faciliteren; onderzoekers leren zich vooral als individu te profileren.

U bent kritisch op de tijdsduur die nodig is om een stof te verbieden nadat is aangetoond dat die een onacceptabel risico vormt voor volksgezondheid en/of milieu. Dat is begrijpelijk, inderdaad duren dergelijke processen vaak vele jaren. Hoe zou dit versneld kunnen worden, welke partij zou daarin welke rol moeten nemen?

Regelgeving is steeds complexer geworden, in ieder geval voor bestrijdingsmiddelen; besluitvorming wordt daardoor sterk vertraagd. Vóór 2007 stond in Art.3 van Bestrijdingsmiddelenwet heel helder geformuleerd wat het doel is. Ook zou de industrie zelf het besluit moeten nemen om een stof niet meer te produceren zodra bekend is dat deze risico's met zich meeneemt; bedrijven zouden zelf meer verantwoordelijkheid moeten nemen. Neem het eerdere voorbeeld van Shell (*zie kader*): het bedrijf nam zelf de beslissing om een stof niet meer te produceren, toen bleek dat deze toxisch was voor vogels. Ditzelfde zouden de producenten van PFAS (Poly- en perfluoralkylstoffen) in het heden moeten doen, nu we weten dat die stoffen erg schadelijk zijn. Zoals eerder aangegeven, moet het vaak eerst heel erg fout gaan, voor er iets verandert…

Hoe denkt u over de transitie naar proefdiervrije methoden; er wordt al heel lang over gesproken maar er is qua proefdiergebruik weinig vooruitgang geboekt. Wat zijn de belangrijkste flessenhalzen, ziet u oplossingsrichtingen? Is het überhaupt mogelijk om regulatoire toxicologie te bedrijven zonder proefdiertests?

In menig opzicht is de transitie al gelukt; er zijn al veel voorbeelden van. Voor het vaststellen van aanvaardbare risico's zijn veiligheidsfactoren van belang; 100% veiligheid bestaat niet. Er zijn bovendien veelbelovende ontwikkelingen gaande, in Japan is bijvoorbeeld een methode ontwikkeld gebaseerd op stamcellen, in combinatie met analyse met behulp van kunstmatige intelligentie (*Yamane et al., 2022*). Ik ben van mening dat dergelijke methoden proefdieren kunnen gaan vervangen.

Hoe ziet u de toekomst: wat heeft de toxicologie nodig om mens en milieu in de toekomst beter te kunnen beschermen? Wat zouden we meer moeten gaan doen en wat juist minder?

De toxicologie is *over the hill*. Veel toxicologische problemen zijn opgelost, als het gaat om voedsel, werkplek en milieu. Misstanden liggen voornamelijk aan het onvermogen van de samenleving om kennis die er is, in de praktijk te brengen. De pesticiden problematiek bij bloembollen bijvoorbeeld: er zijn al heel goede biologische bestrijdingsmethoden die de pesticiden cocktail kunnen vervangen, een bedrijf als Koppert (Rotterdam) is hier al heel ver mee en biedt veel aan. Qua voeding, is het probleem dat de mens niet wil betalen voor kwaliteit, maar alles goedkoop moet zijn. Supermarkten zijn ingericht op efficiëntie en financieel gewin, niet op het bevorderen van gezondheid van mens en milieu. Er mist een stuk bewustwording bij de consument, men zou zich bewust moeten zijn van de eigen verantwoordelijkheid. In 2023 heeft de KNAW een indrukwekkend rapport uitgedracht met als titel "*Planetary health, an emerging field to be developed* (2023)". Dit gaat over de prioriteiten voor de toekomst. Vervuiling is belangrijker dan vergiftiging; toxicologie maakt plaats voor meer intensieve ecologie, onze biosfeer loopt gevaar. De afstand tussen landbouw en natuur is de afgelopen halve eeuw kleiner geworden. Neem bijvoorbeeld de bedreigde status van de kemphaan in Nederland, een weidevogel die vrijwel is uitgeroeid door de intensivering van de

landbouw. De toxicologie is internationaal aan herziening toe. Het is tijd om los te komen van de ramp als drijvende kracht; het zou goed zijn als er orde op zaken wordt gesteld qua agentschappen, vergaderingen etc. De organisatie internationaal is een chaos.

Wat zou u ambitieuze jonge toxicologen, die net hun registratie hebben behaald, nog willen meegeven?

Het moment is gekomen voor de NVT om het probleem van de mondiale ontwikkelingen in de toxicologie qua organisatie en regelgeving in kaart te brengen, om het te saneren. Welke niet-gouvernementele organisaties kunnen worden opgeheven, hoe maken we het systeem efficiënter? Er wordt heel veel geld verspild aan duplicaties en reizen. Dan Kampelmacher (microbioloog, voormalig plaatsvervangend Directeur-Generaal van het RIVM) zei eens: er zijn twee soorten wetenschappers, de bakkers en de venters. De bakkers zijn goede onderzoekers die nieuwe data genereren; de venters reizen de wereld af, van congres naar congres. Er wordt meer geld besteed aan het reizen dan aan de wetenschap; dit is uiteraard geen goede verhouding. Om het systeem te verbeteren zou een commissie moeten worden ingesteld, wellicht kan de OECD daar een belangrijke rol in spelen. Verder zou ik mee willen geven dat de relatie tussen farmacologie en toxicologie bijzonder waardevol is; ik heb heel veel baat gehad bij de kruisbestuiving, bijvoorbeeld door mijn gesprekken en samenwerking met Eef Ariëns. De klinische kant van de toxicologie zal mijns inziens actueel blijven, waar de milieukant beter kan worden vertegenwoordigd door andere disciplines, zoals de klimatologie.

Erkenning/dank van de auteur: dank aan collega-toxicoloog Bert Haenen voor de interview-tip. Ook ben ik Jan en Nicole zeer erkentelijk voor de hartelijke ontvangst en het fijne gesprek; namens de hele redactie wens ik jullie alle goeds voor de toekomst.

Referenties

- Jan. H. Koeman. Het venijn zit in de staart. Kanttekeningen bij de ontwikkeling van de toxicologie over de laatste 40 jaar, de verworvenheden en toekomstige uitdagingen. https://edepot.wur.nl/234508
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Blootstelling aan aerosolen afkomstig van koken op gasfornuizen binnenshuis en de resulterende reacties van het cardiovasculaire systeem

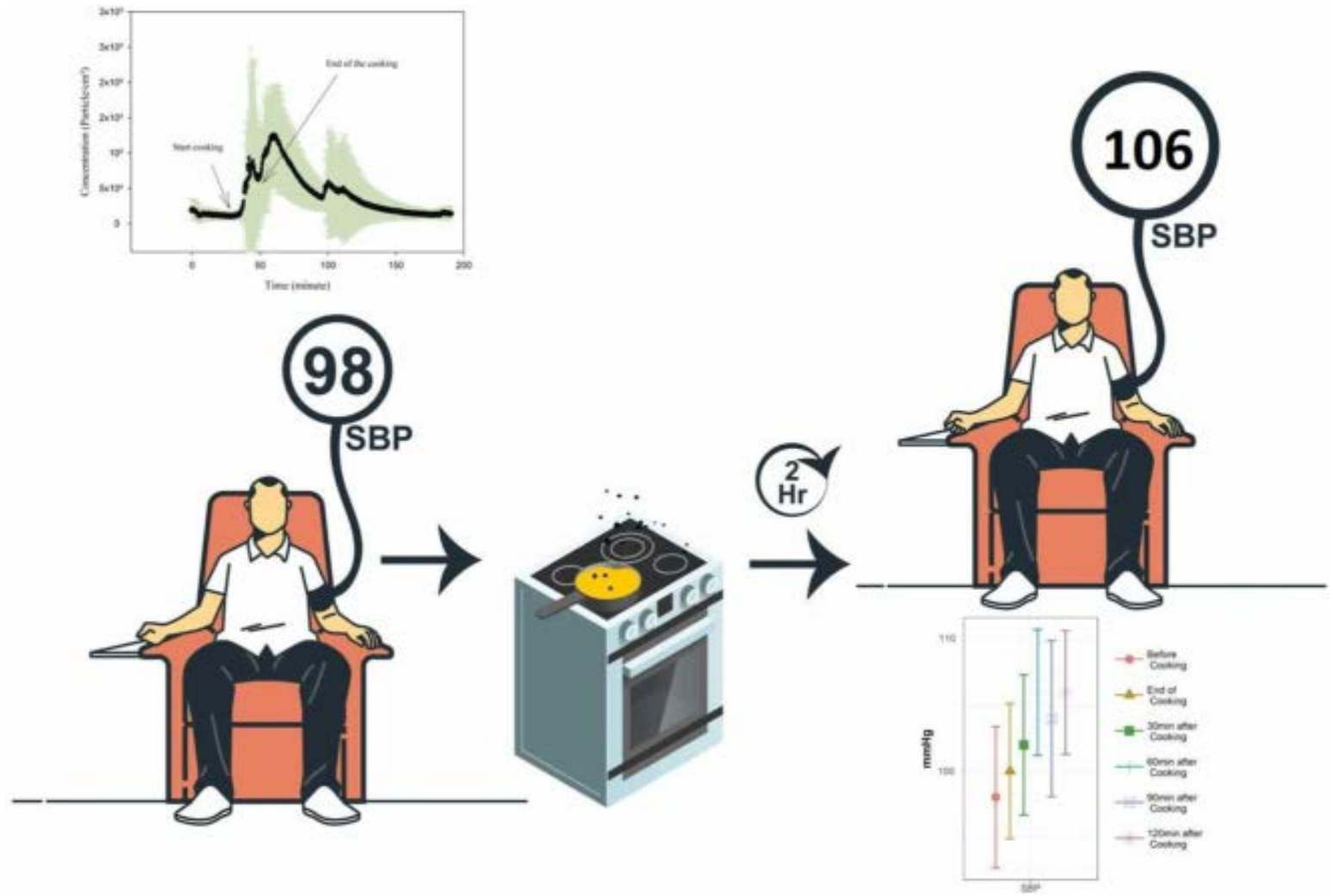
Door *Flemming R. Cassee (RIVM en IRAS- Universiteit van Utrecht)*

In oktober van dit jaar heeft de Europese Raad formeel een richtlijn aangenomen met bijgewerkte luchtkwaliteitsnormen voor de hele EU. De nieuwe regels zullen bijdragen tot de EU-doelstelling van ‘zero-pollution’ in 2050 en zullen vroegtijdige sterfgevallen als gevolg van luchtvervuiling helpen voorkomen. EU-burgers zullen een vergoeding kunnen eisen voor schade aan hun gezondheid wanneer de EU-regels inzake luchtkwaliteit niet worden nageleefd. In de herziene richtlijn wordt prioriteit gegeven aan de gezondheid van EU-burgers: er worden nieuwe luchtkwaliteitsnormen vastgesteld voor verontreinigende stoffen die tegen 2030 moeten worden bereikt en die nauwer aansluiten bij de richtlijnen voor luchtkwaliteit van de WHO. Deze verontreinigende stoffen omvatten onder andere PM10- en PM2,5-deeltjes, stikstofdioxide en zwaveldioxide, waarvan bekend is dat ze ademhalingsproblemen veroorzaken.

Toch wordt er vanuit de wetenschap met enige regelmaat informatie gegenereerd die wellicht helpen bij het vormen van beleid. Een voorbeeld is een studie naar het effect op mensen van aerosolen die bij het bereiden van voedsel vrij komen. Daarbij werd onderzocht wat daarvan de invloed is op het functioneren van op het menselijk hart. Hartslag en bloeddruk van 33 gezonde volwassenen werden gemeten voor, precies na en twee uur na blootstelling (30 minuten, 60 minuten, 90 minuten en 120 minuten na het koken). Honderdtwintig gram gemalen rundvlees werd gedurende twintig minuten gebakken in zonnebloemolie op een gasfornuis zonder ventilatie. Ultrafijne deeltjes, binnentemperatuur, relatieve vochtigheid, kooldioxide, olie- en vleestemperaturen werden gemonitord tijdens het experiment. De gemiddelde deeltjesemissiesnelheid (S) en de gemiddelde vervalsnelheid (a+k) voor het bakken van vlees waren respectievelijk $2{,}1\times10^{13}$ deeltjes/min, en 0,06 particles/min. Er werden geen statistisch

significante veranderingen in diastolische bloeddruk (DBP) en hartslag (HR) waargenomen. De gemiddelde systolische bloeddruk (SBP) steeg statistisch significant van 98 mmHg (vóór de blootstelling) naar 106 mmHg 60 minuten na de blootstelling. De resultaten suggereerden dat de frituuremissie een statistisch significante invloed had op de bloeddruk. Voor gezonde personen is dat geen probleem maar voor mensen met een zwak hart kan dit wel worden gezien als een extra risico.

In het kader van de energietransitie zien we een toenemende aandacht voor de invloed hiervan op de kwaliteit van de lucht in ons binnenmilieu. Het RIVM is een pilot gestart waarin we onderzoeken of de kwaliteit van de lucht in huis verandert door verduurzaming. Met dit onderzoek draagt het RIVM eraan bij dat een duurzamere woning niet alleen goed is voor het milieu, maar ook voor onze gezondheid.



Sleep Tight? The surprising truth about what you sleep with

By *Héloïse Proquin*

During our entire life, we sleep around one third of the time. For a lot of people, the bedroom is an important room in the house. But is it as safe as we think? We usually discuss what types of compounds are present in the living area but less of what we are sleeping with.

The Belgium association for ecological living and gardening has performed a study (1) where they tested the presence of some pesticides as well as their concentration in 112 bedrooms in Belgium and the Netherlands. These participants had to fit certain criteria:

- 48 participants were with at least one agricultural field and/or orchard within 250 metres along one or more sides of the dwelling and with at least one pet (cat or dog).
- 54 participants were with at least one agricultural field and/or orchard less than 250 metres along one or more sides of the house sides of the dwelling and without a cat or dog as a pet
- 5 participants, as a control group living in an urbanised area, with physical barriers (houses, trees) to the nearest located field and/or orchard that is (much) further than 250 metres from the dwelling and having at least one cat or dog as a pet
- 5 participants, as a control group living in an urbanised area, with physical barriers (houses, trees) to the nearest located field and/or orchard that is (much) further than 250 metres from the home and without a cat or dog as a pet.

Additionally, these 112 participants must have had no use of pesticides in the garden by 2024, no use of pesticides against indoor pests (mosquitoes, ants, flies, ...) by 2024, and no purchased indoor plants in the bedroom.

Each participant was asked not to vacuum the bedroom for 2 weeks before sampling. All participants took their own dust sample from the bedroom with their own vacuum cleaner where a headpiece with a filter was attached to the rod, with or without an adapter, to suck up the dust vacuuming and sample 1 gram of dust was collected.

Results showed that a total of 137 different pesticides were detected in the 112 bedrooms. The detected substances belong to 13 different categories including fungicide (52 bedrooms), insecticide (38 bedrooms), herbicide (28 bedrooms), acaricide/insecticide (8 bedrooms). The average number found per bedroom was 21 pesticides with a lowest number of 6 and a highest number of 52.

The 5 most common pesticides found were mostly insecticides and fungicide and one synergist as shown on the table below and described afterwards.

Name of substance	Type of pesticides	Number of bedrooms	Highest concentration (g/kg)
Permethrin	Insecticide	100	67,6
DEET	Insecticide	96	7,1
Propiconazol	Fungicide	92	26,1
Piperonylbutoxide	Synergist	85	76.8
Propamocard	Fungicide	85	2.7

Permethrin is a ‘multiple source’ pesticide. It is used as protection of textiles (clothing, bedding), as building materials, as an agent against pests (mosquitoes, ants, flies, ...) or as protection of wood against woodworms. It is also found in pipettes and bands against fleas and ticks in cats and dogs. Until 2018, permethrin was also authorised in shampoos against head lice in humans. It was banned in the EU for farmers since 2001. This substance is classified in the hazard classification & labelling from ECHA (CLP) as very toxic to aquatic life (with long lasting effects), is harmful if swallowed, is harmful if inhaled and may cause an allergic skin reaction.

DEET is used against mosquitoes and other insects, via sprays rollers or ointments. Some products against pests also contain DEET. DEET has never had any recognition for use in agriculture. This substance is classified (CLP) as harmful if swallowed, causes serious eye irritation and causes skin irritation.

Propiconazole was used as a fungicide in arable farming (cereals, sugar beet, fodder beet) until 2020.

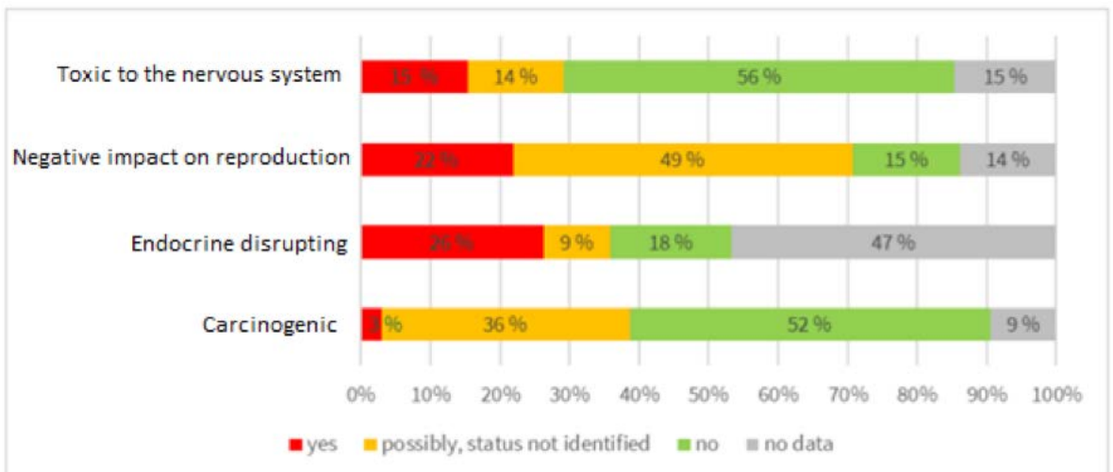
Since then, this use has been banned by farmers in the EU. It is also used in building materials and as a wood preservative. This substance is classified (CLP) as may damage the unborn child, is very toxic to aquatic life (with long lasting effects), is harmful if swallowed and may cause an allergic skin reaction. It is further identified in the REACH registration as may damage fertility or the unborn child.

Piperonyl butoxide enhances the action of other active insecticides. It is added to natural pyrethrins and synthetic pyrethroids. It is also a ‘multiple source’ pesticide. Farmers may use it on vegetables, potatoes and cereals (post-harvest). It is also available for individuals: for in the vegetable garden, for indoor use against pests, for flea and tick control in cats and dogs. This substance is classified (CLP) as very toxic to aquatic life (with long lasting effects), causes serious eye irritation and may cause respiratory irritation.

Propamocarb is a fungicide authorised for farmers in vegetable and ornamental crops. There are no products for pets or for indoor use with this substance. This substance is classified (CLP) as a skin allergen and a skin irritant.

Flutolanil is a fungicide authorised for farmers in the preservation of potato seedlings. There are no products for pets or for indoor use with this substance. This substance is classified (CLP) as very toxic to aquatic life (with long lasting effects).

All 137 different pesticides were checked for the effects and some effects were summarized in the below figure.



Credit: Vereniging voor Ecologisch Leven en Tuinieren

In summary, pesticides enter the bedroom dust in different ways. Three broad categories were distinguished: through use by a neighbouring farmer, through the treatment of pets against parasites (fleas, ticks) and through all kinds of indoors uses (mosquito plugs, ant baits) and applications (preservative in clothing, bedding and other objects). Based on current and past authorisations, it appears that 70% (96 out of 137) of pesticides recovered are attributable to use by a nearby farmer. At the same time, 24% of the substances recovered are ‘multiple source' pesticides.

Next time you are going to your bedroom, take a deep breath and sleep tight (maybe after vacuuming).

Reference:
Eindrapport_SOS-Slaapkamer-1.pdf

When ‘Clean’ Water Isn’t Clean

By *Jelmer Faber*

Water filtration systems are popular household devices marketed as affordable effective tools for improving the quality, purity and taste of tap water. However, these popular filters are not as effective -or safe- as claimed or believed by the wider public.

How do these filters work?

Most commercial water filters, rely on activated carbon to absorb impurities. This method is particularly effective for reducing chlorine, some organic compounds, and certain heavy metals like lead. However, their performance heavily depends on factors like the size of the filter pores, the flow rate of water, and, crucially, the lifespan of the filter.

Ironically, the Dutch water boards and other municipal systems already use activated carbon filtration on a broad scale to treat drinking water. This means the need for additional filtering at home is often overstated, as tap water in many regions is already of high quality.

Can Water Be Too Clean?

It might seem counterintuitive, but water can indeed become “too clean.” Drinking water naturally contains essential minerals like sodium, calcium, and potassium, which are vital for health. Over-filtration by commercial systems can strip these beneficial minerals, leaving water that is so purified it can disrupt the body’s mineral balance. Research suggests that when these elements are removed, the body compensates by excreting its own stores of minerals through diffusion, potentially leading to deficiencies over time (1).

Hidden Hazards

Improper maintenance of filtration systems poses serious health risks. Failing to replace the filter on time can turn it into a breeding ground for bacteria. Studies have shown that while unfiltered tap water contains about 1 colony-forming unit (CFU) per milliliter, and bottled spring water has around 4 CFU/ml, filtered water can have as many as 1,504 CFU/ml—a staggering number that makes it unsuitable for drinking (2,3)

Another overlooked issue with these systems is microplastic contamination. In a 2020 ConsumerLab test, many filters were found to provide only modest reductions in microplastics, while some even worsened the problem. One system increased the microplastic content of water by over 1,000%, raising significant concerns about long-term health risks like inflammation and cellular damage (4,5).

A Cosmetic Solution?

While these filters are effective at improving taste and odor, their deeper claims of improving health are often overstated. Improper or uninformed use can introduce additional risks, such as bacterial contamination or the release of microplastics. In essence, many commercial water filtration systems are little more than cosmetic tools,

offering surface-level improvements without addressing the full scope of water quality concerns. For households with access to safe municipal water supplies, a commercial filtration system may not be necessary—and in some cases, it might even do more harm than good. It's crucial to research and understand the limitations of these devices before relying on them as a solution for clean drinking water.

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EPA Finalizes Rules on TCE and PCE to Protect Public Health

Based on EPA announcement

The U.S. Environmental Protection Agency (EPA) has issued final risk management rules under the Toxic Substances Control Act (TSCA) to address the health risks associated with trichloroethylene (TCE) and perchloroethylene (PCE).

TCE: Full Ban with Limited Transitional Use
TCE is linked to severe health impacts, including cancer, reproductive toxicity, and damage to the central nervous system, liver, kidneys, and immune system, even at low concentrations. The rule bans all uses of TCE, with most prohibitions taking effect within one year. Certain industrial uses, such as cleaning aircraft parts and manufacturing refrigerants, are granted longer phaseout periods to allow for alternatives or due to national security and infrastructure needs. These uses require robust worker protections, including stringent inhalation exposure limits. Laboratory uses for TCE contamination cleanup will continue for 50 years with worker safety measures in place.

PCE: Ban on Consumer and Most Commercial Uses with Worker Protections for Limited Applications
PCE exposure is associated with cancers, neurotoxicity, and organ damage. The rule prohibits manufacturing, processing, and distribution of PCE for all consumer uses and most commercial uses within three years. Dry-cleaning operations face a 10-year phaseout, with older equipment phased out sooner and new equipment banned within six months.

For industrial applications deemed essential, such as chemical production and tanker cleaning, the EPA requires Workplace Chemical Protection Programs with stringent safety measures. These continuing uses support critical industries, including national security and climate initiatives, such as the phaseout of hydrofluorocarbons.

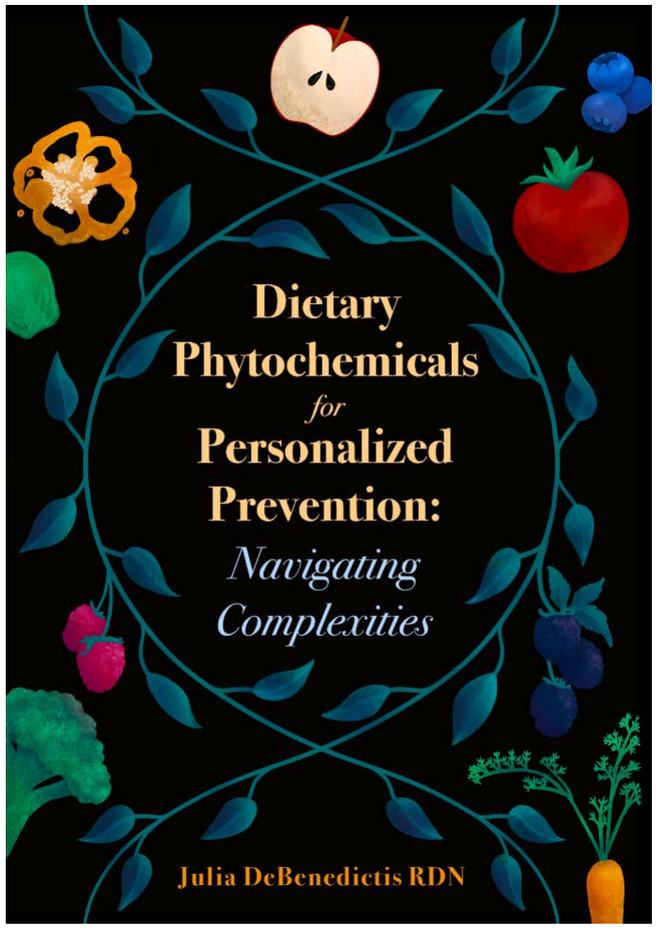
Key Distinctions Between TCE and PCE Rules
While all TCE uses will be phased out, some analogous uses of PCE will continue indefinitely under strict workplace controls. Examples include use as an electrical cleaner and for vapor degreasing. PCE's rule incorporates longer compliance timeframes for workplace protections and broader allowances for critical infrastructure applications.

Time for an alternative: Dry-cleaning operations face a 10-year phaseout of PCE (image credit: Simon Law)

My Journey from Dietetics to Phytochemical Research

On October 3, 2024, I successfully defended my thesis, titled “Dietary Phytochemicals for Personalized Prevention: Navigating Complexities,” marking the culmination of a long academic journey and laying the foundation for my professional career as a scientist. This work contributes to the fields of nutrigenetics and nutrigenomics.

By *Julia DeBenedictis*



My academic journey began in Houston, TX, USA, where I completed my master’s degree in Human Nutrition & Metabolism. During this time, I also completed over 1,200 hours of supervised practice as a dietitian, working in various clinical settings, including the neonatal intensive care unit and with adults recovering from traumatic brain injuries. My rotations extended to large food service systems, community work, and research, where I had my first experience with nutrition-related laboratory research. Initially, I was drawn to the field of neuroscience, fascinated by the potential to leverage existing knowledge and explore new interactions to explain phenomena that were not yet fully understood.

Although I enjoyed the work as a dietitian, directly improving patients’ lives and comfort, I felt that the field of nutrition science had much more to offer, and I wanted to contribute to its advancement. After receiving my board certification as a Registered Dietitian Nutritionist in Texas, I moved to snowy Norway to investigate mechanisms of weight recidivism through human studies. There, I conducted a research study and won a grant for my lab’s continued research. However, my curiosity for personalized nutrition and my desire to gain new skills led me to the Netherlands, where I completed my PhD project in the Toxicogenomics department at Maastricht University. This project provided me with the opportunity to learn bioinformatic techniques and contribute to the burgeoning field of nutrigenomics, which studies how nutrients impact gene expression and lead to nutrient-specific physiological changes.

My primary goal was to understand how the bioactive compounds in fruits and vegetables (phytochemicals) contribute to chronic disease reduction and influence gene expression. This began with an investigation of the effects of processing and storage techniques on the preservation of bioactive compounds in fruits and vegetables. I then coordinated and led the MiBlend Study, whose results demonstrated that various combinations of fruits and vegetables, along with increased overall consumption, can enhance our resistance to oxidative stress in tissues and DNA, as well as improve vascular health. Moreover, the gene expression changes in our participants mirrored these physiological changes. I also explored the influence of genetic variability on the responses to these nutrients. This

part of the research aimed to uncover why some people benefit more from certain dietary components than others.

As my expertise grew, I applied more advanced techniques to previously conducted studies in the department. I explored how specific genetic profiles and combinations of genes might make some individuals more susceptible to the harmful effects of processed red meats. Conversely, I also identified who might gain the most protection from the addition of plant extracts when consuming these foods. In the final phase of my research, we used bioinformatic techniques to analyze gene expression changes from colon tissue. This approach addresses the challenge of detecting significant gene expression changes in complex tissues, providing a more detailed understanding of how diet influences health at the cellular level.

Overall, my research contributes to a broader understanding of how we can optimize our diets for better health through whole foods using appropriate processing techniques, how certain genes might impact how beneficial a specific diet is for long-term health, and how to improve what is possible to capture from nutrigenomics studies.

Conducting human research poses numerous challenges due to the countless variables affecting outcomes and the uniqueness of each participant. I found that connecting with participants to build trust and open communication was essential to optimize compliance and find solutions to individual challenges. Additionally, managing large projects with limited funding taught me the value of perseverance and resourcefulness, as I supervised a team of student interns to achieve our research goals.

Currently, I am a nutrition scientist on the Global Nutrition Team at Danone, where I leverage my academic background and scientific literature to provide advice on nutrients, ingredients, and nutritional needs, supporting decision-making on products that impact many lives.

This journey has been incredibly rewarding, thanks to the help of many mentors and colleagues along the way. I am excited about the future possibilities in the realm of personalized nutrition and its impact on global health.

REGISTRATIE CIE

Inschrijving register

Voorletters	Achternaam	Datum inschrijving	Datum uitschrijving
M.	Busch	02-12-2024	02-12-2029
T.C.A. van	Tongeren	02-12-2024	02-12-2029
W.	Bil	02-12-2024	02-12-2029

Inschrijving TiO

Voorletters	Achternaam	Opleider	Datum inschrijving
C.	Xing	Prof.dr. R. Masereeuw	Datum inschrijving

AIO toxafette - Michele Davigo

In the toxafette, PhD-students working in the toxicology field get the chance to open up about their experiences in performing research. Every issue a new candidate answers a series of questions, and then pass the baton to a fellow PhD-student. This time Michele Davigo, from Maastricht University tells us about his project.

Can you introduce yourself? My name is Michele Davigo, I am a 28-year old Italian PhD candidate, working at Maastricht University (department of Pharmacology and Toxicology) and affiliated with the National Institute for Public Health and the Environment (Centre for Health Protection) and the Centre for Health Protection (Office of Risk Assessment).

How would you explain the subject of your research to a layperson? My research aims at evaluating the toxicity of newly developed tobacco products, such as Heated Tobacco Products (HTPs), which are claimed to represent a less harmful alternative to regular cigarettes. We tackled this general aim by characterizing the mainstream emissions from the most widely used HTP worldwide (named IQOS), by performing various *in vitro* toxicological assessments on relevant lung *in vitro* models and with an observational human exposure study on cigarette smokers and IQOS users, which aimed at comparing short-term cardiovascular toxicity of regular cigarettes and IQOS.

How is your research related to the field of toxicology, and why did you choose this subject? My research is related to toxicology as we carried out various *in vitro* toxicological assessments on the mainstream emissions generated from IQOS, in comparison with regular cigarette smoke. For instance, similar dysregulation of mitochondrial metabolism was detected in human alveolar epithelial cells acutely exposed to cigarette and IQOS emissions. Moreover, both cigarette and IQOS emissions were found to contain reactive oxygen species, carbon/nitrogen-centered radicals and caused DNA damage in human bronchial epithelial cells. I chose this subject due to its high societal importance and impact, as HTPs are more and more diffused worldwide but literature describing their toxicity is very limited. Furthermore, this specific research topic is also connected to personal interest and reasons (several of my friends started to use IQOS in the last years as they considered it safer than smoking regular cigarettes, albeit this has not been proven by scientific evidence).

What was your motivation for starting a PhD program? After completing my MSc in Cellular and Molecular Biotechnology at Wageningen University, I was highly intrigued by the idea of pursuing an academic career, as I started to like fundamental research and felt the importance of improving my research skills. I moreover wanted to specifically carry out my PhD in the Netherlands as here I had (and still have) the opportunity to carry out my own research line and to present my results in various national and international conferences and symposia.

How do you see the future of your research topic (follow-up research / social impact)? What do you hope for? More industry-free research assessing the toxicity of HTPs is needed, specifically on the long-term harmfulness of these products, as they are becoming more and more popular but limited data on their toxicity is currently available. In this regard, I believe that more and more industry-independent institutions will acquire funds to carry out such research. Moreover, I expect that more human exposure studies will be performed, as there are more and more HTP users in the world, but the toxicity of these products still remains to be accurately described. I

hope that such research will provide key findings for the correct evaluation of the toxicity of HTPs, in comparison with regular cigarette, electronic cigarette but also with smoking abstinence.

Can you explain how different subjects or areas relate to your research, and why this connection matters? My PhD project represents a rare example of multi-disciplinary research project, in which at least three different scientific areas were explored. As previously mentioned, analytical chemical approaches were used to characterize the mainstream emissions of IQOS and regular cigarettes. Moreover, this study was carried out at the Centre for Health Protection of the National Institute for Public Health and the Environment, and this allowed me to be part of this research group and to learn analytical chemical techniques and how to operate various machines (High Performance Liquid Chromatography, Gas Chromatography, Liquid Chromatography–Mass Spectrometry). We next collaborated with various departments within the Faculty of Health, Medicine and Life Sciences of Maastricht University to perform our *in vitro* exposure experiments. For instance, we collaborated with the department of Human Biology, Toxicogenomics and Orthopedics to carry out various toxicological tests. Finally, as previously described, we endured an international collaboration with the Mario Negri Institute to carry out the observational human exposure study.

How do you plan to share your research findings with both experts and non-experts? As I am in the final year of PhD, my PhD dissertation is currently in preparation, and I believe this, in combination with our scientific publications, can substantially contribute to disseminate our results. Moreover, my friends and I aim to share the key messages of my results (which have high and sensitive societal impact) using other kinds of communication strategies, such as podcasts, posts on social media and interviews on local newspapers. This is key as we describe the health effects associated with the use of HTPs, whose diffusion is steadily growing as these products are perceived as less harmful than regular cigarettes. However, our *in vitro* assessments and the results of our human study do not point in this direction, and we are therefore engaged in properly informing current and potential future HTPs users about the potential health effects associated with their use.

Have you traveled to other countries for research purposes? If so, how has this impacted your perspective on toxicology. As previously mentioned, we carried out an observational human exposure study in Italy, in collaboration with the Maio Negri Institute of medical research. This experience highly contributed to boosting my perspective in toxicology, as this was the first time that I was coordinating and carrying out a human study. This experience, and the precious advice and directives of the collaborators, helped me to understand the key requirements to carry our human exposure studies, as well as the complex originative work and experimental design that is needed to carry out such studies.

How do you expect society will benefit from your PhD research? As we describe the health effects associated with the use of HTPs, we will provide society with industry-free data on the toxicological effects of these products. Such results can help both current and potential future users to take conscious decisions about the use of tobacco products but can also provide regulators with evidence to ban and/or limit the diffusion and the aggressive marketing of these products. Finally, our results point out the need to reformulate the industry claims regarding HTPs, which are marketed as less harmful than regular cigarettes without sufficient toxicological data describing it.

What goals do you have regarding your career after finalization of your PhD? Would this be inside or outside academia, and why? Would you consider going abroad? As I highly enjoyed my PhD trajectory and obtained valuable scientifically samples from our observational human exposure study, my supervision team and I are in the process of acquiring additional funds to perform follow-up postdoctoral research on the same topic and in the same research facilities. The human exposure study was carried out in Milan, Italy, where we established a scientific collaboration with researchers of the Mario Negri Institute. It would therefore be of high interest to further explore this collaboration and process the human study samples (buccal DNA and saliva) together, or to involve a different institute to perform our assessment. I am usually highly motivated by new experiences and by joining new research lines/groups, and I would therefore like to perform (part of) my future research abroad.

What do you like most about doing your PhD-research? As previously mentioned, I highly appreciated the independence and freedom during my PhD trajectory, both in terms of research line and in terms of work-life balance. I had the opportunity to take sensitive decisions about my research, although with careful supervision and key advice from my promotion team. Moreover, my project allowed me to explore various research disciplines (analytical chemistry, *in vitro* exposure studies, human exposure studies) and to substantially expand both my theoretical knowledge and my laboratory skills. Finally, I am incredibly happy and proud to have had the opportunity to present our research in various international conferences (Society of Toxicology, European Mutagenesis and Genomic Society meeting) and to have met and connected with fellow researchers.

3rs student grants 2025: call for submissions

The European Partnership for Alternative Approaches to Animal Testing (EPAA) supports students and young scientists with outstanding work in the field of alternative approaches for attending a high-profile scientific event.

Every year, a number of high-profile international meetings bring together world-class scientists working on the development and acceptance of 3R alternatives to animal testing (Replacement, Reduction or Refinement). Costs linked to participation may prevent students with promising work or young scientists at the beginning of their career from attending these events. The EPAA partners are therefore happy to sponsor the **3Rs Student grants** to facilitate the participation of students and young scientists in such events.

A jury will assess the applications and propose a list of selected candidates to the EPAA Steering Committee. The jury will be composed of 4 members (two from the Industry and two from the European Commission) who will judge.

In 2025, a two full grants of 1000€ for MPS World Summit 2025, SETAC 2025 and EUROTOX 2025 are available.

- All grants cover the reimbursement of the event registration fees for the student/young scientist as well as travel and accommodation fees, on the basis of the expense receipts. Payment will be made after the event.

Eligibility
Eligibility criteria for both students and events are defined as follows. Applications falling out of this scope will not be accepted.

Students
Applicants have to be based (i.e. studying) in one of the 27 EU Member States or the UK. Citizenship may be from any country (i.e. also outside of the EU).

1) Applicants must be graduated (BSc / First cycle completed with at least 180 ECTS credits) when applying and should not have a doctoral degree.

2) Applicants must still be considered as full-time students or young scientists (≤ 35 years old) when applying.

3) Young scientists employed by industry are not eligible

4) No funding or reimbursement by another entity for the same student and event is allowed.

Application and selection process
The application process is as follows:

1. Applications must be sent to EPAA functional mailbox (grow-epaa@ec.europa.eu) by midnight of the day indicated above
2. The Award will be granted provided an abstract is accepted for an oral presentation. At the sole discretion of the Jury, in exceptional cases work presented in a poster format will be eligible, too. EPAA visibility must be guaranteed by including a clear acknowledgment of EPAA's support in the presentation/poster.

Selection will be made by the jury on the basis of the following documents to be provided by the applicant:

- Abstract submitted for one of the selected events
- Detailed CV of the applicant with list of publications (if any)
- Cover letter describing why the work described in the abstract is important for the 3Rs and why it should be supported by the EPAA grant
- Recommendation letter from a professor/supervisor also confirming the applicant is a full-time student
- Proof of acceptance to the event (i.e. invitation to the event or confirmation mail). It can be submitted after the deadline

All documents should be sent in a single pdf file.
Enquiries should be directed to grow-epaa@ec.europa.eu

Events
Selected high-profile scientific meetings are eligible for the EPAA 3Rs Student grants. For 2025, the following events are open for application:

EVENT	DEADLINE FOR THE APPLICATION
MPS World Summit 2025 in Brussels, Belgium (9-13 June 2025)	14/02/2025
SETAC 2025 in Vienna, Austria (11-15 May 2025)	14/02/2025
EUROTOX 2025 in Athens, Greece (14-17 September 2025)	15/05/2025

EPAA recognition
The winner of the grant accepts to give recognition to EPAA in their presentation/poster. The winner is required to provide a proof which clearly shows him or her giving recognition to EPAA (a photo or a video with oral statement).

The winner of the grant also accepts that the EPAA may publish the abstracts of the presentation / the poster on its website (after the event), in order to promote and disseminate the research. A short summary report of the event and how the student benefitted from the participation needs to be provided.

The European Partnership for Alternative Approaches to Animal Testing

European Commission

ABOUT EPAA
EPAA is a Public-Private Partnership across seven industry sectors and between European Commission and Industry stakeholders. Launched in 2005, it gathers 38 companies, 9 European trade federations and 5 Directorates-General of the European Commission.

Further information is available on:

https://single-market-economy.ec.europa.eu/sectors/chemicals/european-partnership-alternative-approaches-animal-testing_en

EPAA Annual report 2024:

https://ec.europa.eu/docsroom/documents/62494/attachments/1/translations/en/renditions/native

TERUG NAAR INHOUD

Goodbye

After seven remarkable years of dedication and contributions as part of the TCDD editorial team, Carolien Schophuizen is stepping down from her role. At the recent editorial team meeting, Carolien was presented with a recognition plaque as a token of our gratitude for her commitment, insight, and the lasting impact she has made on our work.

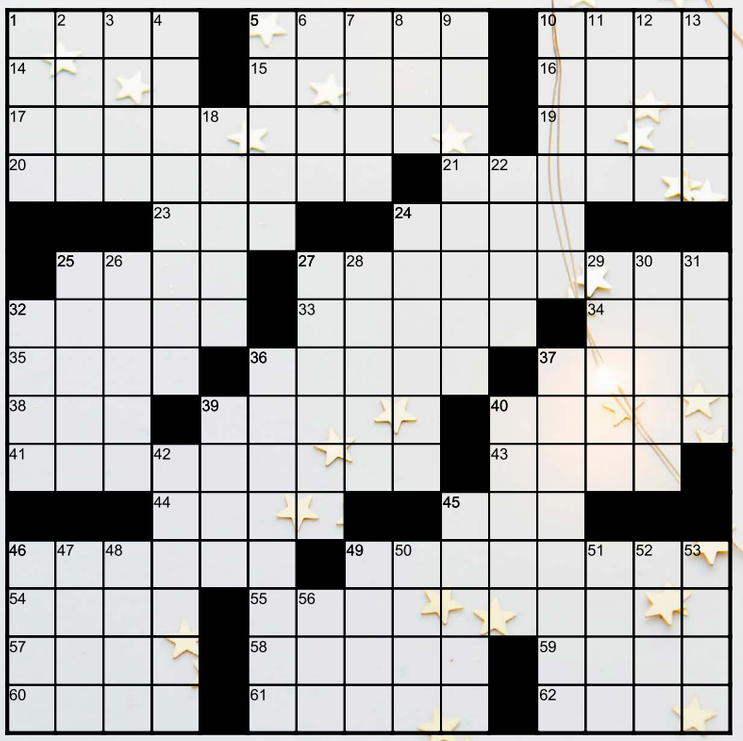
We wish Carolien all the best in her future endeavors and thank her for her years of service to TCDD.

From left to right: Jelmer Faber, Barae Jomaa, Carolien Schophuizen, Damiën van Berlo and Héloïse Proquin

Christmas Puzzle & Riddle

ACROSS
1. Ear part
5. Barracouta
10. First man
14. Mountain goat
15. Wigwam
16. Govern
17. Solitarily
19. Japanese wooden clog
20. Quadrangle
21. English photographer
23. Bawl
24. Young horse
25. Hip bones
27. Family members
32. Gash
33. Woodmen
34. French, water
35. Tennis star, - Natase
36. Played the part of
37. Poker stake
38. The (German)
39. Concerned with a specific subject
40. Veered
41. Former
43. Charge over property
44. Angers
45. - kwon do (Korean martial art)
46. Puts at rest
49. Asymmetry
54. Travel
55. Not allowing passage
57. Prefix, eight
58. Crypt
59. New Guinea currency unit
60. Pastry items
61. Sea eagles
62. Finishes

DOWN
1. Rhythmic swing
2. Hautboy
3. Crooked
4. Bodily exertion
5. Inexpensive cigar
6. Verne's submariner
7. Candid
8. Conger
9. Portable organ-like instrument
10. Wild sheep of Asia
11. Performance by two
12. Singer
13. Intend
18. Mother of Isaac
22. Food
24. Wool
25. Sicker
26. Dens
27. Stem
28. Laud
29. Meeting place
30. Consumed
31. Took legal action against
32. Team
36. Tending to adhere
37. Estrange
39. Askew
40. Cabbage salads
42. Coronets
45. Examines
46. At the apex
47. Positions
48. Stringed instrument
49. Reeled
50. Cabbagelike plant
51. Black
52. Toboggan
53. Oceans
56. Spoil



Submit your answers for a chance to win a prize!

Send your solution to the editors of the TCDD via redactie@toxicologie.nl, stating 'result Christmas puzzle 2024'.

Riddle

I'm a liquid that's heavy yet clear,
A solvent well-known, so don't come near.
I clean your clothes, but not for long,
For health and safety, I've been called wrong.
With "P" in my name and a chlorine trace,
Guess me quickly, don't lose the race!

What am I? _____

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MINI-REVIEW

Barae Jomaa, Damiën van Berlo, Héloïse Proquin

Gas Stove Pollutants: Consequences on Indoor Air Quality and Health

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Mini-Review

Gas Stove Pollutants: Consequences on Indoor Air Quality and Health

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Abstract
Gas stoves are prevalent in residences worldwide as they are both reliable and economical. However, there is a growing body of evidence that indicates that they emit significant levels of indoor air pollutants, including nitrogen dioxide (NO_2), carbon monoxide (CO), volatile organic compounds (VOCs) such as formaldehyde, and particulate matter (PM), which pose serious health risks. Studies demonstrate that hourly average NO_2 concentrations in kitchens can exceed 200 µg/m³, surpassing the World Health Organization (WHO) indoor air quality guidelines. Similarly, CO levels can reach above 34 mg/ m³, potentially exceeding the WHO guidelines for indoor air quality of 35 mg/m³ over 1 hour. VOCs and PM add to the pollution burden, with indoor formaldehyde concentrations ranging from 0.18 mg/m³ to 0.45 mg/m³ and PM levels reaching over 86 µg/m³ during gas oven use. These emissions may exacerbate respiratory diseases, such as asthma, cardiovascular and neurological health issues. This review consolidates scientific literature on the health impacts of these gas stove pollutants and discusses mitigation strategies that can effectively reduce exposure.

Keywords
Indoor Air Pollution, Gas Stove Emissions, Nitrogen Dioxide (NO_2), Particulate Matter (PM2.5), Volatile Organic Compounds (VOCs), Health Impacts of Cooking Appliances

Introduction

According to a 2019 estimate by the WHO, household air pollution accounts for approximately 3.2 million deaths annually: the main source of pollution is still smoking, but cooking is the second largest contributor (1). In developing countries, many people cook on open fire fuelled by kerosene or biomass such as animal dung and crop waste, but the modern gas stove is a source of air pollution as well. Gas stoves are common in households worldwide due to their long track record of reliability and cost-effectiveness. In recent years, these advantages have been faced with increasing concerns in relation to indoor air pollution and the corresponding health risks. Notably, in a recent study it was estimated that 12.7% of childhood asthma cases in the US might be attributed to gas stove use (2). Another study has shown that benzene is emitted by gas stoves at levels similar to what one would be exposed to when in the presence of a cigarette smoker (3). The impact on mortality is significant: gas stove-emitted nitrogen dioxide has been estimated to cause around 40,000 premature deaths per year in the EU and UK combined (4); this is higher than the number of people estimated to perish from second-hand smoke exposure in the EU each year, which is around 24,000 (5), and the number of yearly deaths from car crashes in the EU (20,400 in 2023) (6). It should be noted that the mentioned statistics only reflect mortality due to nitrogen dioxide emission, which is only one of the harmful substances emitted by gas stoves. This review explores the toxicological effects of gas stove pollutants, including nitrogen dioxide (NO_2), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter (PM). The health impacts of these emissions can be substantial. Both NO_2 and PM are correlated with respiratory issues, such as the occurrence of asthma symptom episodes and decreased lung function (7,8). CO exposure can impair oxygen transport due to its ability to react with hemoglobin to form carboxyhemoglobin (COHb), thereby affecting cardiovascular and neurological health over the long term (9). Formaldehyde contributes to diseases of the respiratory tract as well as cancer, further amplifying public health concerns arising from the continued use of gas stoves (10).
Despite clear health concerns, regulatory standards for gas stove emissions are often insufficient globally. This is aggravated by the nature of the indoor environment: air dilution is minimal compared to the outside, and especially in older houses ventilation may hardly occur in the colder seasons.
This review consolidates scientific literature on gas stove emissions and their health impacts then evaluates mitigation strategies to reduce associated risks.

Nitrogen Dioxide (NO_2)

Chemical Properties and Sources: NO_2 is a reddish-brown gas with a sharp odour at high concentrations yet clear and odourless at lower concentrations. The high heat that is generated during the combustion of fuel causes the nitrogen and oxygen in the air to react and form NO_2.
Exposure: Gas stoves are a notable source of nitrogen dioxide (NO_2). Studies have indicated that hourly average NO_2 levels in kitchens can exceed 200 µg/m³ (11), which is the 1-hour limit value set by the World Health Organization's (WHO) for indoor air quality (12) (table 1).
Mechanism of Toxicity: NO_2 irritates the respiratory tract and

exacerbates conditions such as asthma, particularly in children, through oxidative stress and inflammatory responses (13).
Epidemiology: A meta-analysis found a 24% increased risk of developing current asthma and 42% increased risk of developing lifetime asthma in children living in homes with gas cooking. Even more, the analysis revealed a 15% increase in current wheeze for the children per 15ppb of NO_2 (13). NO□ exposure from gas cooking appliances is estimated to be responsible for approximately 41,000 pediatric asthma cases in the EU and UK (4). As an oxidant, NO□ may impair endothelial function by reducing nitric oxide bioavailability, potentially leading to arterial stiffness and inflammation of the vascular endothelium. This process increases the risk of hypertension.

Pollutant	Guideline Value	Averaging Time	Comments
$PM_{2.5}$	5 µg/m³	Annual average	-
	15 µg/m³	24 hours	99th percentile (i.e. 3-4 exceedance days per year)
Benzene	No safe level	Not applicable	Lifetime cancer risk at 1 µg/m³ is 2.2–7.8 in a million. Airborne concentrations with risks: 17 (1/10,000), 1.7 (1/100,000), 0.17 µg/m³ (1/1,000,000). Unit risk of leukemia per 1 µg/m³ is 6×10^{-6}.
Carbon monoxide	100 mg/m³	15 minutes	Not to occur more than once per day (light exercise).
	35 mg/m³	1 hour	Not to occur more than once per day (light exercise).
	10 mg/m³	8 hours	Arithmetic mean (light to moderate exercise).
	7 mg/m³	24 hours	Arithmetic mean (awake and alert, not exercising).
Formaldehyde	0.1 mg/m³	30 minutes	Arithmetic mean.
Nitrogen dioxide	200 µg/m³	1 hour	Arithmetic mean.
	40 µg/m³	Annual average	-

Table 1: OECD air quality guidelines for $PM_{2.5}$ (14) and indoor air quality guidelines for benzene, carbon monoxide, formaldehyde and nitrogen dioxide (12)

Carbon Monoxide (CO)

Chemical Properties and Sources: CO is a colourless and odourless gas produced by incomplete combustion. Inefficient burners contribute to higher CO emissions (15).
Exposure: Another substance of concern is carbon monoxide (CO) that is produced by incomplete combustion and can reach levels of ≥ 30 ppm (ca. ≥ 34 mg/ m³) indoors (16), potentially surpassing World Health Organization's (WHO) indoor air quality guideline of 35 mg/m³ over 1 hour (12).
Mechanism of Toxicity: CO competes with oxygen by reacting with hemoglobin to form carboxyhemoglobin, thereby impairing oxygen transport. This can exacerbate respiratory conditions like COPD and diminish immune responses (17).
Epidemiology: A number of epidemiology studies have focussed on respiratory outcomes including pulmonary function, hospital admissions related to respiratory disease, and asthma and exacerbation of asthma symptoms (18). As it relates to pulmonary function, ATDSR concluded that the results are mixed and conflicting and it is difficult to sort the effects of CO from the urban air pollutants. The confounding effect of other air pollutant is also present in the outcome of hospital admission related to respiratory diseases. Nonetheless, studies do provide evidence of an association between CO and an increasing risk of respiratory symptoms that require medical assistance. Furthermore, the association between CO exposure and asthma symptoms is clearer as results show that the odds ratio for asthma diagnosis increase with an increase CO concentration. Schildcrout et al. examined 990 children in North America and showed that a 1 ppm increase in CO concentration was associated with an odds ratio of 1.08 for asthma symptoms (19).

Volatile Organic Compounds (VOCs)

Chemical Properties and Sources: VOCs include hazardous compounds, such as formaldehyde and benzene, that are emitted from the combustion of gas during cooking.
Exposure: Formaldehyde was found to be present at concentrations ranging from 0.18 mg/m³ to 0.45 mg/m³ during cooking (20). The WHO guideline limit for formaldehyde in indoor air is 0.1 mg/m³ over 30 minutes whereas benzene has no safe level (12). Gas stoves have been found to emit 2.8 to 6.5 µg/min benzene (3). Furthermore, VOC concentrations were evaluated in 69 residential houses in Boston and benzene was found to be present in 95% of the samples at mean concentrations of 164 ppbv (parts per billion by volume) (CI:134-196). In comparison, the Environmental Protection Agency (EPA) measured benzene in Boston urban air between 2020 and 2023 and found a median concentration of 0.14 ppbv (21).
Mechanism of Toxicity: VOCs exposure may lead to respiratory issues with some VOCs, including formaldehyde and benzene, causing cancer. Benzene is widely distributed throughout the body after inhalation, and its metabolism produces highly reactive metabolites that contribute to its toxic effects. The primary and most sensitive targets of benzene toxicity are the hematopoietic systems and the immune system (21). Formaldehyde, on the other hand, primarily affects the respiratory system and is a potent irritant, with prolonged exposure linked to nasopharyngeal cancer and leukemia (10).
Epidemiology: Exposure to VOC indoors in various, a study in 69 residential houses in Boston found not only methane and ethane but also 296 unique non-methane VOCs of which 21 were designated as hazardous air pollutants like benzene (22). In the Agency for Toxic Substances and Disease Registry (ATDSR) evaluation, the minimal risk levels (MRL) of benzene were evaluated and showed that after inhalation these risks are dependent on the exposure duration (Table 2) (21).

Exposure duration	MRL (provisional)	Critical effect
Acute	0.009 ppm (0.03 mg/m³)	Reduction in peripheral lymphocyte count and impaired function of bone marrow lymphocytes
Intermediate	0.007 ppm (0.02 mg/m³)	Delayed immune response of splenic lymphocytes to foreign antigens
Chronic	0.002 ppm ($6x10^{-3}$ mg/m³)	Decreased peripheral lymphocyte count

Table 2: Minimal Risk Levels (MRLs) for benzene inhalation: Adapted from the ATDSR toxicological profile for benzene (21)

Particulate Matter (PM)

Chemical Properties and Sources: PM2.5 (PM < 2.5µm in size) can be formed from fuel combustion and are prevalent during high-temperature cooking. Moreover, combustion processes can readily generate ultrafine particulate matter (UFPM), with a diameter of <0.1µm. The presence of extremely small nanoparticles with a particle size in the range of 1-3 nm, referred to as atmospheric nanocluster aerosol, has been associated with cooking episodes (23). However, it should be noted that frying meat or vegetables generates indoor particulate matter regardless of whether a gas or electric cooker is used.
Exposure: Gas oven usage contributes significantly to PM2.5 emissions, with concentrations exceeding 86 µg/m³ over one hour (24). The World Health Organization's (WHO) air quality guideline is set at 15 µg/m³ for a 24-hour average (14) and while a 1-hour limit is not set, high short-term peaks can meaningfully elevate daily exposure levels (14). When considering even smaller particles (ultrafines/nanoparticles), it has been

shown that as much as 90% of total exposure to ultrafine particles occurs in the indoor environment (25). Extremely small (1-3 nm) nanoparticle numbers of 10^5 to $10^7/cm^3$ have been measured in the indoor air during propane gas cooking episodes (23). The highest levels of particle emission were produced during the self-cleaning cycle of stoves.

Mechanism of Toxicity: PM2.5, consisting of small particles, penetrates lung tissue and can cause inflammation and can exacerbate cardiovascular conditions. This can be made worse by hazardous substances that adsorb onto the surface of PM. The smallest particles, in the nano range, can cross the blood-lung barrier, migrate into the systemic circulation and thereby reach organs distal to the lung (26).
Epidemiology: In a great number of epidemiological studies, associations between particulate matter air pollution and a broad range of adverse health effects have been found (27–29). The adverse impact on human health included cardiovascular (e.g., cardiac arrhythmia, increased chance of stroke and cardiac arrest) and respiratory (e.g., decreased lung function, exacerbation of asthma, airway irritation) health effects as well as overall mortality. The WHO estimates that PM air pollution contributes to 800,000 premature deaths each year, which means it is the 13th leading cause of mortality (worldwide). Associations between exposure and adverse health effects were stronger for smaller particle fractions, i.e., PM2.5 and PM0.1 (UFP) (30).

Outlook and Conclusion

Addressing the health risks of gas stove emissions requires an integrated approach combining a transition towards electric stoves, improved ventilation for gas powered stoves, and comprehensive regulations. Public awareness and financial incentives may prove to be essential for creating healthier indoor environments and reducing the global burden of disease associated with indoor air pollution.

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TERUG NAAR INHOUD

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