et al., 2023), BPA and phthalate metabolites were reported as being the most targeted chemicals, possibly reflecting heightened media scrutiny. Dietary interventions, particularly those focused on BPA, were generally successful either alone or combined with PCP-related measures. Unexpected outcomes, including even increased metabolite concentrations in certain PCP studies, underscore the complexity of exposure reduction. Overall, the studies emphasise the need for interventions to consider participant compliance and motivation, and the ease with which the changes proposed can be adopted to enhance effectiveness.

The challenges of identifying "safer" replacement products were evident, with unintentional contamination from these replacements sometimes posing a risk. Participants, moreover, expressed difficulties in adhering to long-term changes, emphasising the need to promote sustainable interventions. Although varied participant demographics and the lack of long-term follow-up limit the generalisability of some of the interventions reported, successful instances showcase the potential for the widespread impact of policy measures that target exposure sources, transcending individual behavioural changes.

Urban exposome interventions

Mònica Ubalde López

Traditional urban structures have been designed primarily to promote mobility in private vehicles and not to meet the needs of the more vulnerable, i.e. children, youth, the elderly, and those with chronic conditions. However, motorised vehicular traffic is a major contributor to poor air quality in most urban areas which, if they also fail to comply with international air quality directives and WHO recommendations, suffer the weighty burden of premature mortality and increased morbidity. This traditional urban planning model, moreover, typically ignores the possibilities of creating more naturalised and inclusive open spaces that can satisfy the diverse needs of daily life, and contribute to reducing other harmful urban exposures: for example, high noise levels, the heat island effect, and the lack of green/blue spaces and areas for physical activity and social interaction. However, in recent decades, cities have responded by developing traffic calming measures aimed at reducing motorised vehicle traffic. Urban re-designs that limit vehicular parking, reduce speed limits or eliminate traffic entirely can improve air quality, safety, and encourage active modes of transportation.

It is evident that effective preventive actions are urgently required to reduce the health and economic burden of the harmful urban exposome. These actions need to recognise the "complex systems" affecting population exposure, including "upstream" (e.g. economic, political, and global forces, as well as the natural

and built environment) and "downstream" (e.g. individual and organisational behaviour) influences on the effectiveness of exposome-reduction interventions (Rutter et al., 2017). The rapid translation of evidence into practice requires engaging communities, stakeholders, and decision-makers in the development and evaluation of interventions (Eldredge et al., 2016). In this sense, it is critical to develop, implement, and evaluate co-produced effective, scalable interventions to reduce personal exposure to the harmful effects of the urban exposome. New technologies (e.g. wearable air pollution sensors, smartphone apps) have the potential to provide a richer understanding of outdoor and indoor personal exposures (Larkin & Hystad, 2017). In this way, real-time information can help individuals make informed decisions to reduce exposome exposure (e.g. by choosing less polluted routes for active travel).

Interventions in the public space – synonymous, we might claim, with public health interventions – need to be developed in close partnership with communities and key stakeholders to ensure that the co-produced actions are both acceptable and feasible, and can thus guarantee their rapid translation into practice. Indeed, a number of tools designed to guide urban planning specifically incorporate this critical dimension of citizen participation, whereby greater participation provides a democratic mandate and serves to leverage political will. One example of such a tool is provided by the EU's Sustainable Urban Mobility Plans (SUMPs), a strategic policy that is tellingly built upon people's needs and which mobilises specific self-assessment toolkits (Rupprecht et al., 2019). However, to date, little attention has been paid to the barriers to and facilitators of governance when designing interventions in the public space. It is apparent that participation should not only be possible, but that it needs to be significant as well. Yet, the value of public participation only becomes evident when a plan's results are clearly and systematically integrated in a sustainable urban mobility project. Future projects need to address these challenges of governance head-on. Interventions to reduce multiple exposures can be co-produced, but meaningful reductions require structural changes as well as changes to individual behaviour.

Urban interventions aimed at re-naturalising the built environment, eliminating traffic and fostering active mobility and public transport are critical in improving the urban exposome. Traffic restriction measures, such as the low traffic neighbourhoods (LTNs) implemented in London, help create healthier, safer places for the community not only because of a potential reduction in air pollution (without the problem being displaced to neighbouring streets) (Yang et al., 2022), but also because of their impact on noise levels and their ability to win back urban sites for people and naturalised infrastructures. The benefits of increasing street greenery, boosting biodiversity and introducing new ecosystem services and climate-resilience have been estimated for mental health in adults and the

FIGURE 13. Community participation, co-production, and action aimed at enhancing the urban exposome.
SOURCE: Created by Mònica Ubalde.

related burden in public health services (Yañez et al., 2023), as well as for behavioural and cognitive development in children (Opbroek et al., 2024).

In some urban settings, schools are often urban exposome "hotspots", located in areas with extreme levels of pollution and noise, compounded by high levels of car use during the school run. Indeed, home-to-school commuting is reported as being responsible for 20% of a child's daily dose of air pollutants. Clearly, if we

envisage health from a public health perspective and adopt a life-course approach (Kalache & Kickbusch, 1997), there is a more than pressing need to begin to design healthy, safe urban environments for and with children and young people (Bishop & Corkery, 2017), since health outcomes in later life are strongly influenced by an individual's early habits and behaviours, which in turn are strongly conditioned by the urban environment.

Urban school environments should therefore be seen as priority spaces for the health and well-being of children and their families. Yet, as schools are distributed across all neighbourhoods, their urban environments should be understood as a strategic point of entry for achieving a healthier, safer city. Implementing interventions in school environments and prioritising the health of the most vulnerable (i.e. taking an equity perspective) can ultimately benefit all by reducing their urban exposome. School streets' programmes seek to improve the quality of these public spaces through street re-designs, traffic-calming measures, the elimination of car parking zones, and the addition of street furniture and greenery; however, to date, few urban planning programmes have actually been subject to rigorous impact assessments. The few that have specifically been conducted in school environments report that street-calming measures do improve the urban exposome by reducing traffic flow and related pollutants (i.e. NO_2), increasing available public space for citizens, promoting play areas for children in the street, and providing spaces for physical activity and social interaction (Ferrer-Fons et al., 2023; Ubalde-López et al., 2023).

The transformative potential of school environments is, of course, indisputable, the goal being to ensure schools continue to be a great educational resource that can safeguard childhood growth as well as foster the well-being and health of the entire city. Yet, despite the key role of urban school settings, interventions to modify outdoor stressors in the built and natural environment that act as urban exposures target primarily individual behavioural change (e.g. increasing time spent in green spaces and active travel) rather than seeking to implement structural changes that can promote healthy behaviour and reduce urban exposure at the population level (Fernandes et al., 2023). Ultimately, built environment changes (e.g. infrastructure and support for bikes and walking) are required to support sustainable behavioural changes and an impact evaluation strategy needs to be integrated from the early design phase of the intervention. In common with all public policy design and practices, it is essential to identify what works and for whom, taking steps to identify barriers and enablers for implementation and evaluation.