Exposure to traffic-generated VOCs: Total exposure in urban environments and the specific contribution of exposure while in traffic

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Introduction

Traffic emissions include a wide array of VOCs that pose potential threats to human health, not only individually, but also as a mixture. Urban populations have heavier exposures due to the high density of both population and traffic. This study separates out the contribution to personal exposure due to traffic emissions in Athens, Basel and Helsinki.

Methodology

Personal, ambient, and indoor (home and workplace) exposure concentrations from the EXPOLIS database were used to perform a microenvironmental apportionment of 8 traffic-related VOCs, as well as Black Smoke. Individuals with exposure to Environmental Tobacco Smoke (ETS) were excluded from the analysis. This first step yielded the indoor- and outdoor-generated fractions, as well as the fraction attributable to other locations (mainly commuting).

The latter two fractions were subjected to Maximum-Likelihood principal factors analysis to determine the traffic contributions. Traffic emissions were separated by other fuel emissions (evaporative) by including Black Smoke in the analysis. The communalities of the traffic factors were used to quantify the traffic contributions.

The sampling design did not allow a complete separation of workplace contributions, which may therefore include a quota of outdoor contributions, including some from traffic.

The full separation of traffic sources was possible only for the city of Helsinki, due to a larger sample size. Less specific information could be obtained for Athens and Basel.

Results

Tailpipe VOC emissions appear to be the largest contributor to personal exposure for 6 of the VOCs analyzed, including benzene, as shown in the figure.

In all cases, the majority (≥ 2/3) of exposure to traffic VOCs takes place indoors.

Other outdoor sources are generally of minor importance. with the notable exception of benzene.

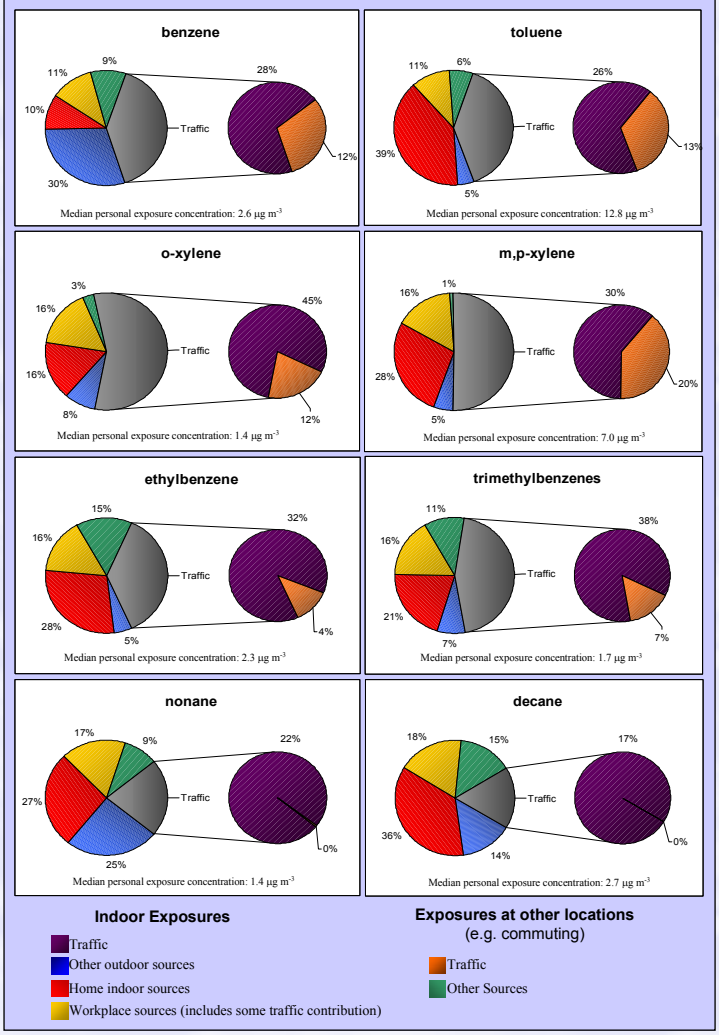
Indoor sources - presumably from evaporative emissions and consumer products - on the other hand, contribute a very large fraction of personal exposure.

The make-up of indoor/outdoor and traffic/non-traffic source contributions is quite specific to each urban environment considered (Table 1).

Table 1. Comparisons of contributions to benzene exposure across cities.

Benzene	Median personal exposure concentration ($\mu g\ m^{-3}$)	Indoor generated	Indoor exposure to traffic	Indoor exposure to other outdoor sources	Exposure in other locations
Athens	10.3	10% ± 5%	65% ± 11%	10% ± 2%	17% ± 9%
Basel	2.6	53% ± 17%	26% ± 5%	24% ± 5%	20% ± 7%
Helsinki	2.5	22% ± 4%	29% ± 1%	31% ± 1%	23% ± 3%

Contributions to total personal exposure in Helsinki (non ETS exposed population)



Implications

- The observation that the majority of exposure to traffic byproducts takes place indoors at home, presents a major challenge in terms of exposure reduction strategy. While office and commercial buildings equipped with HVAC systems might implement some air treatment, the situation for individual homes is hardly viable to a treatment option.
- Thus, the available approaches must necessarily aim to reduce ambient levels of these compounds and/or to reduce the proximity of heavily populated residential areas to major traffic routes.
- Controlling exposure in commercial areas or while commuting would apparently have a less important, though by no means negligible, impact.
- The generally important contributions from indoor sources, however, point to a careful evaluation of the most cost-effective strategy. Unfortunately, whether limited resources should be allocated to reducing exposure from traffic or from consumer products, building materials, etc. can only be determined for each city individually.

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