

HEALTH EFFECTS AND DIETARY EXPOSURE

When discussing BTEX – benzene, toluene, ethylbenzene and xylenes – three questions must be distinguished: what effects can a substance cause in the body, by which route does it enter, and what dose is a person actually exposed to? A hazardous substance does not necessarily pose the same risk in every circumstance. Equally, a low concentration measured in one food is insufficient to describe a person's total exposure.

HAZARD, EXPOSURE AND RISK ARE NOT SYNONYMS

Hazard is the inherent capacity of a substance to cause harm. Exposure concerns the amount with which the body comes into contact, the frequency and duration of contact, and the route of entry. Risk depends on the interaction of these factors, taking account of the substance's toxicological properties and uncertainties in the available evidence.

For a food contaminant, assessment requires at least its concentration in food, the quantities actually consumed and possible contributions from other foods and water. Air must also be considered for BTEX: these volatile substances have often been studied chiefly in workplaces or near emission sources. Findings from high occupational exposures cannot be applied directly to someone ingesting traces through food.



DIFFERENT ROUTES OF EXPOSURE

Inhalation is an important route for BTEX because they may occur in air following emissions from fuels, solvents and industrial activities. Ingestion can involve contaminated water or food; skin contact occurs particularly in certain workplaces. Once absorbed, these compounds are distributed and metabolised differently, and some may be eliminated in exhaled air or urine.

Volatility also makes sample preparation and storage important: loss of a substance before analysis can underestimate the original concentration. This matters in food testing, but does not mean that simple evaporation during domestic cooking is a reliable way to make contaminated food safe.

BENZENE: BLOOD EFFECTS AND CARCINOGENICITY

Benzene is the BTEX compound with the strongest evidence of carcinogenicity in humans. The International Agency for Research on Cancer (IARC) classifies it in Group 1, carcinogenic to humans. The most firmly established associations concern cancers of the blood-forming system, particularly acute myeloid leukaemia. Benzene and certain metabolites can damage bone marrow and disrupt blood-cell production.

Much of the epidemiological evidence derives from inhalation exposure, especially at work. Animal toxicology studies also document carcinogenic effects after oral administration, so ingestion should not be regarded as harmless. Equally, however, a hazard classification cannot quantify the numerical risk from every detectable trace in food. That requires data on actual dietary exposure and suitable models.

For a genotoxic carcinogen such as benzene, a generic 'safe threshold' applicable to any exposure is inappropriate. Assessments take precautionary approaches and, where possible, use dose-related risk estimates. Drinking-water guideline values apply to that matrix and are not automatically legal limits for other foods and beverages.

TOLUENE: NEUROLOGICAL EFFECTS PREDOMINATE

The best-documented effects of sufficiently high toluene exposure involve the central nervous system: dizziness, drowsiness, and impaired attention and coordination may occur. Occupational studies and animal experiments have improved understanding of repeated exposures. The severity and likelihood of effects depend on dose and circumstances.

Toluene can also be absorbed through the gastrointestinal tract and is metabolised mainly in the liver. Nevertheless, the available evidence does not justify assuming that

concentrations measured in a particular food cause the same effects observed in solvent misuse or workplace exposure. These scenarios differ substantially in doses and routes of contact.

ETHYLBENZENE AND XYLENES: WHAT STUDIES SHOW

Ethylbenzene has mainly been studied by inhalation. At high exposure levels, neurological and other systemic effects have been described in experimental animals. IARC classified it in Group 2B ('possibly carcinogenic to humans'): this category describes the strength of carcinogenicity evidence, not the risk arising from a particular food concentration. Its evidence profile is not equivalent to benzene's.

Xylenes include three isomers – ortho-, meta- and para-xylene – and often occur in technical mixtures. High exposures can cause central nervous system effects and irritation; depending on dose and administration route, experimental studies have also observed effects on the liver and kidneys. Evidence specifically concerning chronic dietary exposure at low concentrations is much more limited than evidence on inhalation.

COMBINED EXPOSURE: WHAT CAN AND CANNOT BE CONCLUDED

Substances do not always occur in isolation. BTEX and other organic compounds may coexist in contaminated environments or matrices. ATSDR has published an assessment of possible toxicological interactions within BTEX mixtures, recognising that individual constituents can influence one another's absorption or metabolism.

Simultaneous occurrence does not, however, demonstrate synergy. Evaluating additivity, antagonism or interaction requires appropriate experimental data, dose information and clearly identified health outcomes. Simply adding concentrations of benzene, toluene, ethylbenzene and xylenes as if they had equal toxic potency can be misleading.

LIMITATIONS OF THE DIETARY EVIDENCE

A central difficulty is that much toxicological information on BTEX comes from environmental, occupational or experimental exposure. For many substance–food combinations, extensive, comparable and representative measurement datasets are lacking. Concentrations found in a local sample or after an accident do not automatically describe levels in ordinary marketed products.

Estimated intake also depends on actual dietary consumption, frequency and other exposure sources. Analytical detection, estimated exposure and risk characterisation

must therefore remain distinct. 'Not quantifiable' means only that the compound was not measured above the method's quantification limit under the conditions used; it does not prove complete absence.

INTERPRETING RESULTS RESPONSIBLY

A scientifically robust interpretation should report the identity of the BTEX compounds tested, food matrix, measurement units, analytical method and its limitations, together with any applicable regulatory reference. Health implications can then be discussed where appropriate exposure and dose–response information exists.

The conclusion has two parts: benzene deserves particular attention because its carcinogenicity is established, while other BTEX have different, non-interchangeable toxicological profiles. At the same time, serious assessment cannot end with 'substance detected': protecting health requires understanding how much is taken in, by which routes and for how long.

SCIENTIFIC REFERENCES

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3. WHO. Exposure to benzene: a major public health concern. [Source](#)
4. ATSDR (2004). Interaction Profile for Benzene, Toluene, Ethylbenzene, and Xylenes. [Source](#)
5. ATSDR. Toxicological Profile for Toluene – Health Effects. [Source](#)
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