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PRESCRIPTION

Latest news and updates from the Faculty of Pharmacy, Universiti Teknologi MARA

BEFORE BIRTH, ALREADY EXPOSED:
What We are Missing About Everyday Chemicals

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"We have become very good at controlling what threatens us externally but far less precise in understanding what quietly shapes us from within."

We have become increasingly effective at controlling mosquitoes, but far less precise in understanding what we are regulating within ourselves.

In Malaysia, insecticides such as pyrethroids are part of daily life. Household sprays, mosquito repellents, treated fabrics, and community fogging all rely on compounds like permethrin and deltamethrin. Their effectiveness is not in dispute here. But effectiveness should not be mistaken for uniform safety. A quieter question remains: what happens when exposure begins before birth?

IN THIS ISSUE :

EXPOSURE STARTS EARLIER THAN WE THINK

Exposure does not begin when we are aware of it. It can begin in utero. Chemicals encountered during pregnancy may cross the placenta, reaching a developing system that is still establishing its biological capacity. The first 1,000 days of life is not only a period of growth, but also a period of programming, where early exposures may shape long-term health trajectories. At the same time, detoxification systems are still maturing.

In adults, pyrethroids are metabolised through cytochrome P450 (CYP450) enzymes, followed by phase II conjugation such as glucuronidation via UDP-glucuronosyltransferases (UGT), enabling elimination [1]. In early life, these pathways are not yet fully developed. Even in adults, however, this system is not uniform.

ONE EXPOSURE, MANY METABOLISMS

We often describe exposure as if it were fixed. It is not. Malaysia's population is genetically diverse, and this extends to xenobiotic-metabolising enzymes. Variants in CYP450 and UGT pathways influence how efficiently chemicals are processed and cleared [2]. Two individuals with similar exposure to permethrin may carry very different internal burdens. One clears it efficiently; another does not. In pregnancy, this variability is layered onto an already immature fetal system. At that point, the idea of a single "safe exposure level" becomes less certain than we might prefer.

FROM ENVIRONMENT TO BIOLOGY

This is where measurement becomes critical and where our work sits within the national birth cohort. The Children's Environmental Health Birth Cohort in Kuala Lumpur and Selangor (2025–2030), led by the National Institutes of Health (NIH), Ministry of Health Malaysia, provides a platform to move beyond assumptions into measurable reality.

My contribution here focuses on analytical toxicology, detecting and quantifying xenobiotic compounds in biological samples, and interpreting these measurements within a biological context. We are not simply asking what is present in the environment.

We are asking what has entered the body and in what amount. Using targeted analytical approaches, we measure metabolites such as 3-phenoxybenzoic acid (3-PBA), a biomarker of exposure to pyrethroids including permethrin and deltamethrin [3]. This shifts the question from presence to biological experience.

WHAT EXISTING DATA ALREADY SUGGEST

While Malaysian data remain limited, international studies offer important signals.

Higher prenatal or early-life exposure to pyrethroids, often assessed via urinary metabolites such as 3-PBA, has been associated with:

- differences in cognitive and behavioural development
- altered attention and executive function
- changes in early motor development

These findings do not establish causation. However, they consistently indicate that early-life exposure is biologically relevant and cannot be assumed negligible [4–6]. Whether these patterns manifest similarly in a Malaysian population, given differences in exposure patterns and pharmacogenomic variability, remains an open question.

EXPOSURE IS RARELY SINGULAR

Risk assessment often evaluates chemicals in isolation. Real-world exposure does not.

Individuals are exposed to mixtures of xenobiotics from insecticides and household chemicals to dietary and environmental contaminants. These compounds may share metabolic pathways, particularly CYP450 systems, leading to competition or altered metabolism.

In a biologically diverse population, this introduces further variability. The outcome is not linear; it is dynamic.

A MALAYSIAN GAP

Malaysia's exposure landscape is continuous rather than occasional. Regular use of pyrethroids, both domestically and through public health programmes, creates sustained exposure potential.

Yet, biomonitoring data in pregnant women and early-life populations remain limited. At the same time, pharmacogenomic variability, well recognised in drug metabolism, has not been meaningfully integrated into environmental exposure research.

This gap matters.

Without local data that account for both internal exposure and biological variability, our understanding remains incomplete and policy inevitably reflects that limitation.

BEYOND MEASUREMENT

Measurement is necessary, but not sufficient. The shift forward is towards precision environmental health, recognising that exposure, metabolism, and outcome are not uniform.

By integrating:

- what is present in the body
- how it is processed
- what it leads to over time

we move closer to biological reality.

WHAT WE ARE PREPARED TO SEE

Pyrethroids will remain part of public health strategy. That is not in question. What may need reconsideration is how we understand exposure. For too long, it has been treated as external, uniform, and predictable. It is none of these things. Because ultimately, the issue is not whether exposure exists. It is whether we are prepared to measure it, interpret it with sufficient nuance, and accept that in a biologically diverse population, one exposure does not translate into one outcome, and one assumption is rarely enough.

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ABOUT AUTHOR

Dr. Normala's research focuses on xenobiotic metabolism, analytical toxicology, and environmental exposure science, with particular interest in how chemical exposures interact with biological systems and population-specific variability. She is currently involved in the NIH Malaysia birth cohort study investigating early-life environmental exposures and their long-term health implications.

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