A landmark study, published in *Environmental Health Perspectives* in May 2015, suggests that exposure to traffic-related air pollution (TrAP) in a baby's first year of life may lead to the development of allergies to foods, mould, pets, and pests. It is the first study to identify such an early link.

Bad Air, Good Dirt

Traffic pollution. Nobody likes it. We know that breathing in traffic exhaust is bad for us, yet most of us simply put up with it. But what if you found out that these fumes could make your toddler more prone to becoming allergic to cats or dogs? Or to household mould? Or even to milk or peanuts?

New Canadian research by Dr. Michael Brauer, an AllerGen investigator and a professor in the School of Population and Public Health at The University of British Columbia (UBC), is pointing in that direction. Together with Dr. Hind Sbihi, an AllerGen trainee and postdoctoral fellow in his laboratory, Dr. Brauer published a landmark study in *Environmental Health Perspectives* in May 2015, that suggests that exposure to traffic-related air pollution (TrAP) in a baby's first year of life may lead to the development of allergies to foods, mould, pets, and pests. It is the first study to identify such an early link.

Dr. Michael Brauer, Professor
The University of British Columbia

Dr. Hind Sbihi, Postdoctoral Fellow
The University of British Columbia

Dr. Brauer, a Harvard-educated air pollution specialist, previously investigated whether genes influence the effect of air pollution on asthma risk, discovering that children with specific genetic profiles had a significantly greater risk of developing asthma in high-TrAP environments.

Studies by other researchers had shown that pollution exposure increases allergic flare-ups in older children and adults. However, given the importance of the early years of life in shaping the immune system, Dr. Brauer wondered whether TrAP might set the very youngest among us—babies in *utero* and infants—on a course toward allergy. "Most studies to date have looked at older children," says Dr. Brauer. "Our focus on pregnancy and the first year of life is what makes this research unique."

2,500 kids—2,500 environments

To gather information for his study, Drs Brauer and Sbihi used data from the Canadian Healthy Infant Longitudinal Development (CHILD) Study, an AllerGen legacy project. Launched in 2008 and led by a consortium of over 40 internationally renowned Canadian researchers and physicians, this massive project is following over 3,500 children in four cities (Toronto, Vancouver, Winnipeg, and Edmonton) from pre-birth until they turn five years old. Data is collected from questionnaires, home inspections, and various biological samples including blood and stool. Most pertinent to Dr. Brauer's investigation: at age one, the children underwent allergy tests for sensitivity to 10 common allergens, ranging from cat hair and fungus to peanut and egg.

Dr. Brauer's analysis focused on about 2,500 of the CHILD Study subjects, using estimates of nitrogen dioxide (NO_2), a common pollutant, in the children's environment to assess their exposure to TrAP in the first year of life. "We didn't just rely on air pollution levels at a child's home address—we examined the child's schedule of activities to unearth other possible TrAP sources," he says. For instance, a child might live on a quiet street near a park, but attend daycare near a freeway, or spend time at parent and baby programs in a community centre downwind from a bus depot. The model also considered the microenvironment of each home. Were the windows mostly open or mostly shut? Did the ventilation system move fresh air through the house or recirculate stale air? Did the heating and air conditioning work as they should? All of this data rolled up into the final estimate of total TrAP exposure.

As expected, children living in the two larger cities, Toronto and Vancouver, had more TrAP exposure than those living in Winnipeg and Edmonton, though within each city, TrAP exposure varied significantly from child to child. Depending on where they lived and how they spent their days, "some children had five or even 10 times more pollution exposure than others," says Dr. Brauer.

Dr. Sbihi did most of the number crunching. "She collected all the information about where these thousands of children

lived, whether they relocated, and where they moved throughout the day, and fed this data into our TrAP-estimation model," says Dr. Brauer. "It was painstaking work and Hind did it expertly."

Car fumes and allergies

Next, the researchers crossed TrAP estimates with results from each child's allergy tests. The findings left no doubt: TrAP exposure in the first year of life did increase the risk of allergy. Specifically, every 10% increase in NO_2 exposure raised the risk of allergy by 16%. "That may not sound like a lot, but when you consider that some infants had 10 times more TrAP exposure than others, the difference in allergy risk can be substantial," says Dr. Brauer. On the other hand, increased TrAP exposure during pregnancy did not affect the children's allergy risk after birth. Allergy rates also differed across the four study cities: the proportion of allergic children was highest in Vancouver (23.5%), followed by Toronto and Edmonton (both 17%), and lowest in Winnipeg (9%).

So how might breathing in car fumes in infancy trigger an allergy later on? While the precise mechanisms are not yet known, Dr. Brauer says researchers have at least three theories to investigate: that the exhaust modifies the expression of newborns' genes, leading to allergic sensitivity; that the fumes react chemically with the allergens; and that the pollutants alter the connections between cells, making it easier for allergens to get through.

Germs welcome!

The study also teased out some protective factors that the researchers had not expected. Daycare, for one. "Children who attended daycare were less vulnerable to the effects of TrAP on

allergy risk," Dr. Brauer explains. "We're not sure why, but we suspect that the increased exposure to everyday germs in day-care settings directs the immune system to develop normally to combat pathogens, rather than veering towards an allergic response." The researchers also found that babies with older siblings, cats or dogs in the house were less likely to show allergy at age one. Here again, increased germ exposure may help to explain the difference—"or it could be that only the parents who were less likely to have allergies themselves owned pets, and that they transmitted their protective genes to their kids."

Taken together, these findings support the "hygiene hypothesis" of allergy development, which says that shielding infants from dirt and bacteria may derail the normal development of the immune system during the critical first few months of life. According to the hygiene hypothesis, squeaky-clean environments don't provide enough exposure to germs to "educate" the immune system to defend itself against microbes or other invaders. "It seems that there is such a thing as too clean," says Dr. Brauer. Not that continuous exposure to germs would solve the problem, though. "As with many things in life, balance is key."

The study also lent support to the notion that the immune system has a "window of opportunity" vital to its development. According to Dr. Brauer, this window—likely open during the first few months of life—"may steer the immune system toward an allergic path or a non-allergic path."

More to learn

News of Dr. Brauer's study reverberated rapidly through the mass media, leading to interviews with the *CBC*, the *UK Telegraph*, and *Global News*, among others. Dr. Brauer attributes this media buzz to an abiding interest in allergy. "Allergies affect everyone," he says. "Chances are, you either have an allergy yourself or you have an affected family member."

The media latched onto the idea that "pollution causes allergy," which Dr. Brauer views as a vast oversimplification. "We never claimed it's a cause," he says. "At best it's one of many contributing factors." Journalists were also curious to know why the Vancouver children had such high allergy rates. Was the city too polluted? Should city planners be doing something differently? Dr. Brauer says there are many possible reasons related to the environment and differences in the populations

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between cities: "Among other possible factors, Vancouver has a relatively affluent population, and we know that wealthier urban populations tend to have higher allergy rates."

It's also far from clear whether or not the link between early exposure to TrAP and allergic susceptibility persists over time. "It is possible that the children will lose the added vulnerability as they get older," says Dr. Brauer, who plans to follow the same group of children up to school age to find out. He will also revisit the genetic link uncovered in his previous research to determine whether early TrAP exposure increases the risk of allergy in everyone or just in people with a particular genetic profile.

Also on the drawing board: "We'll look at which of these kids develop asthma and find out if it corresponds to early TrAP exposure." Finally, Dr. Brauer plans to find out whether allergy-prone children have a different assortment of gut bacteria from non-allergic children, to further probe the hygiene hypothesis.

In the meantime, how might this particular study help new parents to protect their children from developing allergies? In this regard, Dr. Brauer cautiously recommends "taking reasonable steps to avoid polluted areas." When choosing where to live, for example, "even a block away from a major roadway may be better than right on it." What parents don't need to worry about: everyday germs, dust and dirt. "Don't try to protect kids too much," he advises. "Let them play in the sandbox and get dirty—it's good for the immune system!"