Examine.com

Research Digest

Exclusive Sneak Peek

Issue 6 • April 2015

Click here to purchase ERD

Kick the can: how BPA in canned drinks impacts blood pressure

Exposure to bisphenol A from drinking canned beverages increases blood pressure: randomized crossover trial

Introduction

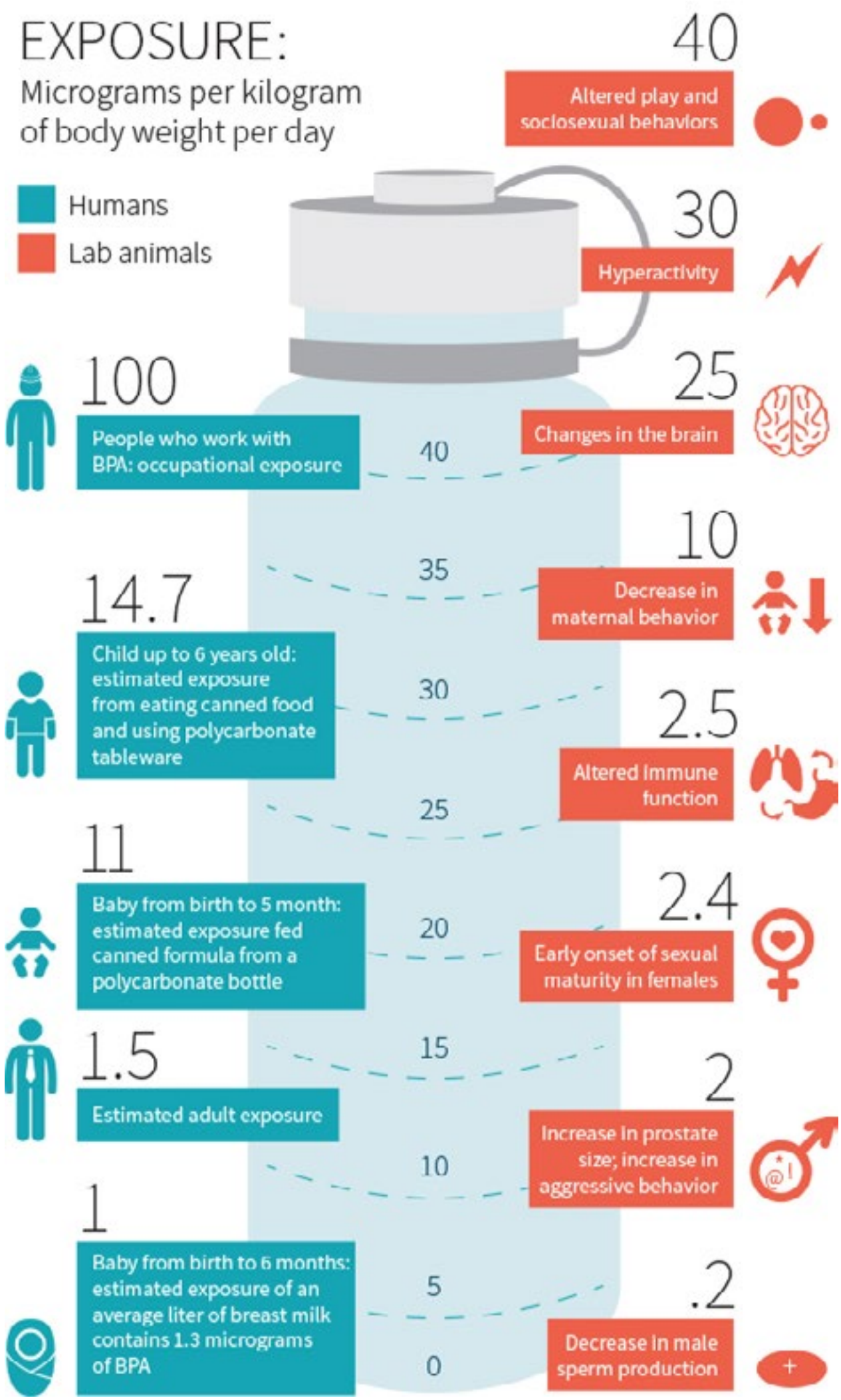
Modern consumers are constantly flooded with warnings of harmful chemicals in everyday products. It's so common for these warnings to be falsified or overblown that finding danger in harmless chemicals has almost become cliche. Unfortunately, these warnings distract from reports on chemicals that could actually cause harm. One of these ubiquitous harmful chemicals is bisphenol A (BPA).

BPA is a critical component of plastic and epoxy manufacturing, which means it's in a variety of products, even those that you wouldn't expect to find any plastic in, like dental fillings and aluminum cans. These cans are lined with a variety of materials, including plastics and epoxies, that prevent the liquid contents from degrading or oxidizing the aluminum of the can.

The BPA in can linings is an estrogen analogue, which means it can interfere with hormonal signaling. Most people normally think of estrogen as a hormone related to secondary sex characteristics and fertility, but it is also involved in many other processes, such as liver function and insulin response. Consequently, researchers have begun to study the effects of BPA on various health parameters. As might be expected, the primary focus of initial research was on the effects of BPA on fertility, especially in light of the fact that environmental BPA contamination generally impairs animal reproduction and development.

As the field matures, however, researchers are starting to assess a variety of other health parameters that could be affected by BPA (as seen in Figure 1), including blood pressure. Some previous studies have shown a correlation between canned beverage consumption or BPA exposure and hypertension, but there are very few studies to assess whether BPA exposure directly causes changes in blood pressure. This study

Figure 1 - BPA in humans, compared to animal trials



Sources: Vandenburg et al., Rev Environ Health. 2013
vom Saal & Hughes, Environ Health Perspect. 2005

was a follow-up on previous work conducted by the authors. It specifically sought to determine whether the BPA exposure from drinking canned beverages could affect blood pressure.

BPA, a component of plastic and epoxy manufacturing, is found in the lining of beverage cans and many other products. It is an estrogen analogue and may cause a variety of health problems. The authors of this study examined whether BPA can affect blood pressure.

Who and what was studied?

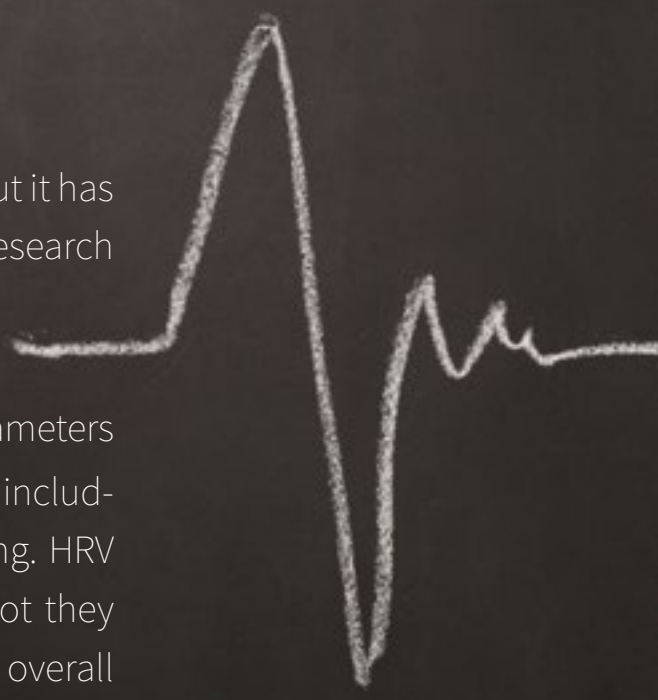
The participants in this study were 60 elderly, but otherwise relatively healthy, people. Almost all of the participants were women. About half of them reported medical histories of hypertension or diabetes, and most of the participants that reported these conditions were receiving treatment for them at the time of the study. The researchers specifically selected elderly participants because they are more likely to be affected by environmental chemical exposure than young and middle-aged adults. The participants drank two servings of soy milk from either glass bottles or aluminum cans. The soy milk was sourced from the same manufacturer that offers two different packaging options: a BPA-free glass bottle or a BPA-containing aluminum can.

Participants fasted for eight hours, arrived at the study site, drank two servings of soy milk from a randomly chosen container, and were analyzed two hours later. Because both servings were randomized, the participants either received two bottled servings, two canned servings, or one canned and one bottled serving. Analyses consisted of highly sensitive urine testing for BPA concentration, duplicate resting blood pressure assessments taken about 10 minutes apart, and heart rate variability monitoring.

The researchers performed the same procedure three separate times with a week in between each visit. In each visit, the researchers randomized the participants to another group, so every participant eventually consumed soy milk from all three possible packaging combinations. This crossover design ensured that any demographic differences between the groups canceled each other out because every participant had a data point in every experimental group, which means it takes fewer overall participants to notice any effects. This is a key feature of crossover studies and one of the reasons they are regarded as very reliable.

The researchers also used very stringent statistical analyses to ensure that blood pressure measurements were standardized for all environmental factors, including climate and

Is there evidence for heart rate variability?



Heart rate variability (HRV) has recently gained more attention in popular media, but it has shown associations with health outcomes for many years. Most of the original research on HRV was done in the context of heart attack risk and mortality.

More recent studies have focused on the interaction between HRV and other parameters beyond cardiac functions. Associations between HRV and a variety of processes, including factors like concentration, have been noted, and the field is rapidly expanding. HRV monitoring has also become a popular tool for athletes to assess whether or not they are over-reaching, because it is believed that HRV can be used as a barometer for overall bodily stress. But so far, the scientific evidence behind this claim isn't strong.

nonexperimental BPA exposure.

The experiment consisted of giving healthy, elderly participants soy milk to drink either from two bottles, two cans, or one bottle and one can in a crossover design, where each participant participated in each condition. Researchers measured the blood pressure and urinary BPA concentration of each participant.

What were the findings?

Urinary BPA concentration increased significantly only in participants who consumed soy milk from aluminum cans. After accounting for environmental factors, blood pressure increased linearly with urinary BPA. Participants who consumed two servings from the cans showed roughly a five mmHg increase in systolic blood pressure compared to those who consumed two servings from bottles. The change in systolic blood pressure was significant between groups both with and without extensive statistical adjustment, whereas there was no significant change in diastolic blood pressure.

Despite the significant changes in blood pressure, heart rate variability did not change. This is in contrast to the researchers' previous study, which found that heart rate variability significantly decreased (and blood pressure increased) in a much larger cohort of patients. Decreased heart rate variability is associated with a variety of negative health outcomes, including mortality after heart attacks.

BPA was associated with an increase in systolic blood pressure, but not with changes in heart rate variability.

What does the study really tell us?

BPA exposure acutely increases blood pressure in elderly women. One canned drink serving is sufficient to significantly increase BPA concentrations in the body, while two canned drink servings causes a transient, measurable blood pressure effect.

It can be implied that a substantial amount of BPA leached from the can liners and into the canned beverages. This suggests that the consumption of canned beverages (depending on the BPA content of the packaging) will not only increase the BPA concentration in the body, but also have measurable, negative effects on blood pressure. Drinking the same beverage from a BPA-free glass bottle does not result in this response.

The researchers used soy milk rather than water. They note that soy milk hasn't been found to increase blood pressure and is widely commercially available, and is hence an ideal study beverage. While they cited longitudinal and trial evidence of soy milk actually decreasing blood pressure, that evidence doesn't really apply to the current study because it doesn't look at acute blood pressure changes, occurring right after beverage consumption.

Given that soy phytoestrogens have some estrogenic activity and that soy milk contains fat (which could theoretically increase the extraction and solubility of fat-soluble compounds such as BPA from the liner), soy might not actually be the ideal study beverage. Interestingly, even the soy milk in the glass bottles had a bit of BPA in it (with levels at 0.31 and 8.2 μg/L, in bottles and cans respectively.) As shown in Figure 2, heat exposure and age of packaging can affect BPA levels, so there are other factors to consider outside of simply the beverage and type of packaging material. It would be worth replicating this trial with water, soda, and other common beverages, to see if the results are similar.

The big picture

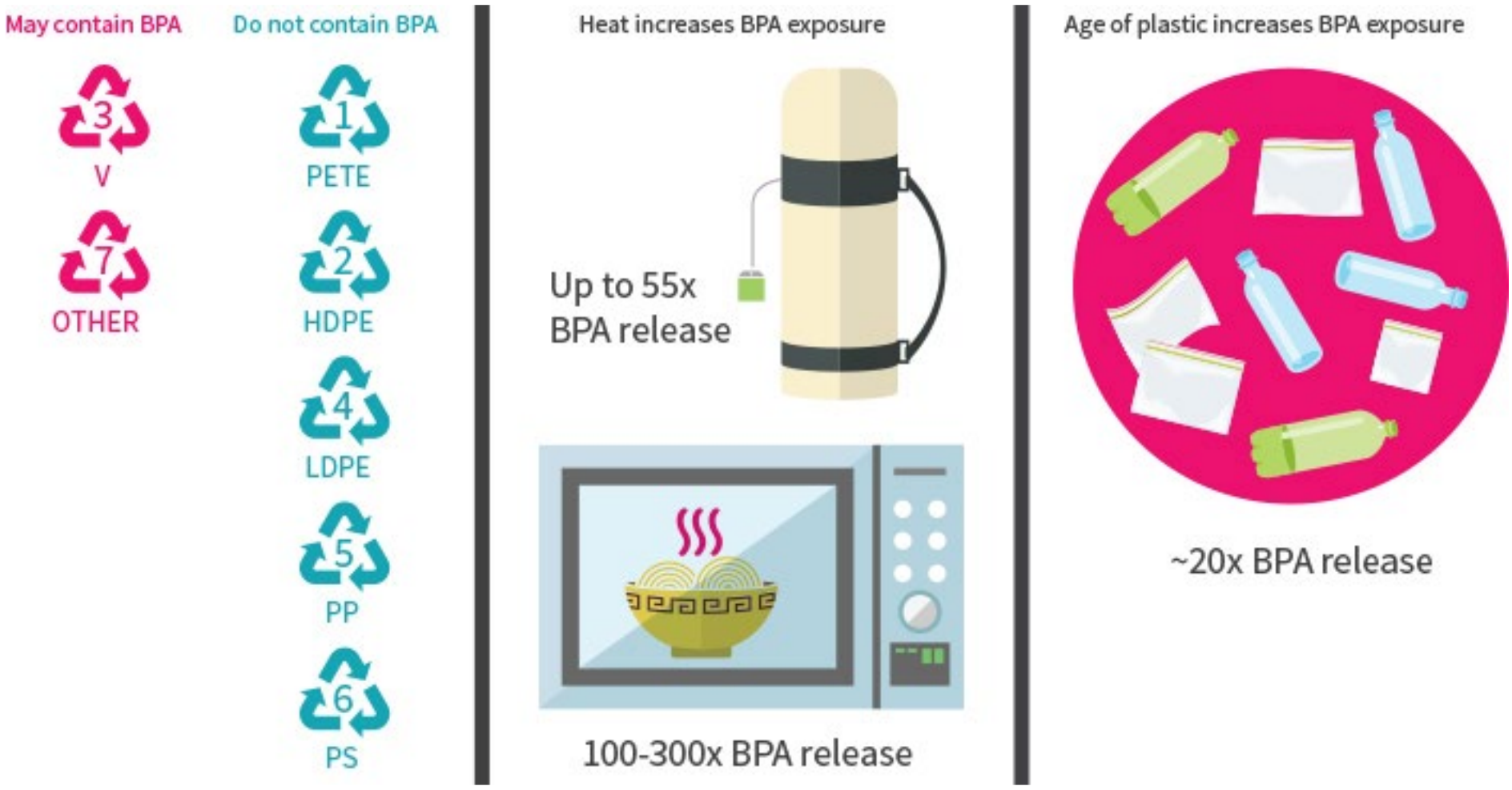
This study is in line with previous studies that found

significant biological changes in response to acute BPA exposure. Some of these previous studies were conducted by the same group that conducted this study. This study is still important, however, because it confirmed many previous correlative findings from a variety of groups. More importantly, it also suggests a direct causative role for BPA increasing systolic blood pressure: participants experienced a small, but significant, increase in blood pressure after consuming a canned beverage, and this blood pressure increase appeared to correlate with an increase in urinary BPA.

Despite the fact that this study showed that BPA exposure can cause acute blood pressure changes, it is still not clear how chronic BPA consumption affects health outcomes. It is important to avoid extrapolating biological changes to disease states. This is one of the most common errors in science journalism. Practically speaking, this means that a small transient increase in blood pressure may not necessarily cause hypertension or other chronic diseases in the long run. BPA exposure might have a clinically relevant effect on blood pressure in some cases (for example, increasing the blood pressure of a prehypertensive person into the hypertensive range for a few hours), but it is not clear how long the response to BPA lasts. Much more work needs to be done before can-based exposure to BPA can definitively be linked to a disease state like hypertension or cardiovascular disease. If this link is eventually found, it would be a major finding, but it would also make it difficult to conduct further studies on BPA because ethical review boards are unlikely to approve studies that involve exposing participants to chemicals with known harmful effects.

Another factor to keep in mind is that many of the participants in this study were already being treated for hypertension. There is always a risk for confounding factors when a large subset of a study population is known to have aberrations in a measured variable. Consequently, a similar study in a different population could have different results. The findings of this study are likely real, but they may be population-specific. For example, younger participants with normal blood pressure values could respond very differently to BPA, and BPA may interact with anti-hypertensive med-

Figure 2: BPA in everyday life



Sources:Tan & Mustafa, Asia Pac J Public Health. 2003 Munguia-Lopez & Soto-Valdez, J Agric Food Chem. 2001

ication in some unknown way. Therefore, other studies to specifically assess the mechanisms linking BPA and blood pressure are needed to conclusively say how BPA causes these effects.

Even in this study, the researchers were uncertain as to how exactly BPA increased blood pressure. The effect may have been due to estrogen receptors (which can play a role in blood vessel repair, although that may more of a role in longer term blood pressure impacts), thyroid hormone effects, or mechanisms that haven't yet been well-elucidated.

Frequently Asked Questions

If BPA is ubiquitous, what's the point in avoiding it?

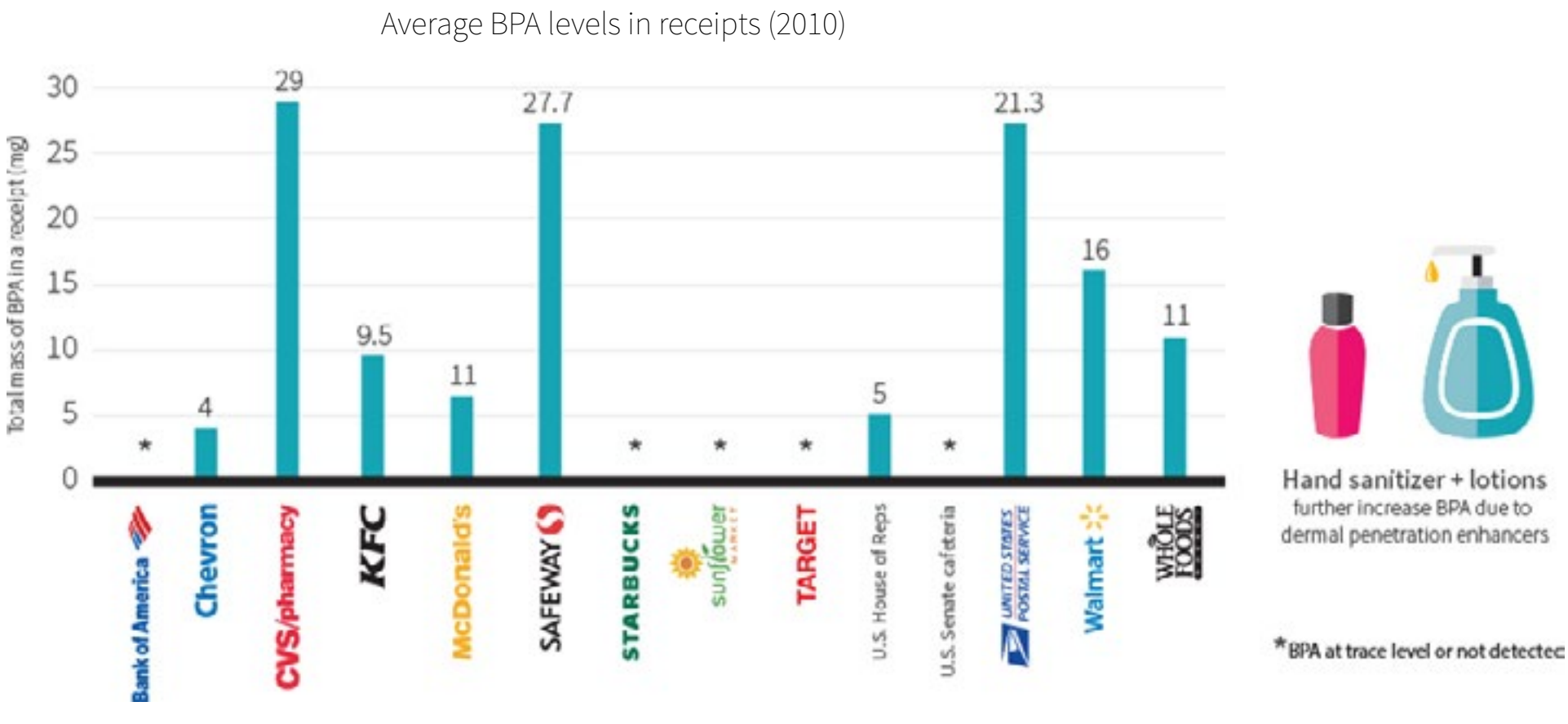
Because BPA seems to have dose-dependent effects, it's still likely useful to minimize BPA exposure whenever possible. Many correlative studies, some of which used extremely large data sets, have found associations between BPA exposure and a variety of cardiovascular disease states, including heart attacks.

However, there isn't much evidence for direct interactions between BPA exposure and health risks in humans. There is, however, a large body of evidence studying the effects of BPA exposure in a variety of animals, and which typically show harm. At this point, minimizing BPA exposure is a good idea, since a policy-level intervention like banning BPA from all food products isn't so likely, at least in the US (in contrast, France has much stricter policies, with regulations starting in 2015). This may be due to huge economic ramifications and lack of feasible alternatives for all of BPA's many uses.

Why don't manufacturers move away from BPA if there's so much data suggesting against its use?

It would be very expensive to convert machinery and processes from standard procedures to BPA-free alternatives. More importantly though, such a conversion likely wouldn't increase sales enough to offset the expense. Because there's no government regulation and no definitive proof that BPA causes medically relevant harm, it's far easier and more economical for large companies to maintain their current manufacturing and packaging processes. One example is store receipts. As seen in Figure 3, many receipts contain fair-

Figure 3 - BPA exposure from receipts



Source: Environmental Working Group, 2010

ly large amounts of BPA. This may be a concern for those who repeatedly handle store receipts (such as clerks or shopaholics), and the effect is amplified when hand sanitizer or certain lotions are worn. Despite the public outcry in 2010, when the data was released, few stores have turned to alternatives.

However, many niche and small manufacturers, especially those in the health and wellness community, have moved to BPA-free processes. Therefore, these BPA-free products may be good alternatives as the growing body of research on BPA's negative effects pushes consumers toward BPA-free products

Why is there so much research on BPA?

BPA is an estrogen analogue, which means it can bind to estrogen receptors in the body. Estrogen is a nearly ubiquitous signaling hormone in the animal kingdom, and it is responsible for many things beyond the secondary sexual characteristics it is normally associated with. Estrogen receptors are found on nearly every major tissue type in the human body, and they are key regulators of processes including bowel motility, fluid balance, blood coagulation, and metabolic health.

It is also similarly important in most animals, some of which are far more sensitive to endocrine disruption than humans. Fish and other aquatic species are especially susceptible to BPA exposure, and because it causes a variety of birth defects in these species, it is believed (with a growing body of supporting evidence) that it may also affect human cellular and metabolic signaling.

What should I know?

BPA is nearly ubiquitous, but it should still be avoided when possible, which means avoiding canned beverages and trying to find containers that are BPA-free.

The findings in this study are mostly applicable to elderly women, but the entire body of research on BPA exposure seems to indicate that BPA offers no known health benefits while being associated with a variety of potential health risks. Unfortunately, BPA is everywhere, which makes avoiding it very difficult. However, it is also important to realize that although there are many correlations between BPA and disease states, as well as some direct evidence that BPA causes acute biological and metabolic changes, there still isn't enough evidence to say whether or not BPA actually directly contributes to disease. If it does, it's nearly impossible to quantify the exact contribution to disease, as it's one single part of a multifactorial disease process. Since the evidence for health impacts will never be ideal, it's a personal decision as to how much you want to focus on BPA-reduction in everyday life. ◆

How much BPA is in your kitchen? Does your keyboard have BPA in it? Don't fret, you can head over to the Facebook ERD forum, which is both BPA-free and a great place to talk about the evidence on this important issue.