Part 2: Body Burden

This section describes the measurement of environmental chemicals or their metabolites in children. The measurement of chemicals in the body is called biomonitoring. Biomonitoring can be done on urine, blood, hair, nails, saliva, fat tissue, and other tissues and it is conducted to determine the "body burden" of environmental contaminants.

Biomonitoring can be useful to confirm that exposures have occurred, even if the source or dose is typically not known. In a population, biomonitoring can be used to determine reference ranges for "normal" body burdens, and to help define the body burden associated with disease (a "dose-response"). This is a complicated task because many factors other than environment influence the development of disease. Some chemicals also have a relatively rapid turnover in the body and are thus more difficult to monitor. Thus, a body burden of a certain chemical does not necessarily mean that an individual will develop a disease. However, it is generally assumed that the higher the body burden (dose), the higher the risk of developing an associated disease. This may be true for groups of children with similar exposures, but may not necessarily hold for individuals because of other unknown influences.

Interpretation of biomonitoring data should ideally be based on comparison to baseline or reference values for a comparable unexposed population. The most straightforward way to do this is with a comparison group sampled at the same time. Reference values from a general population may also be used, but these should be recent because levels of chemicals may change in the environment and in the population over time (Wilhelm et al., 2003).

There are several chemicals of concern in Maryland that lend themselves to biomonitoring; however, there is limited availability of body burden measures in children. At the national level, the CDC has incorporated body burden measures, including lead, mercury, and an increasing number of other chemicals (e.g., pesticides) into annual national surveys. Blood lead is the only measure that has been widely and regularly assessed in children and thus is the only body burden indicator that is presented in this section.

2.1 Lead in Children

Lead is a metal that has toxic effects on multiple organ systems, and is capable of causing severe health problems up to and including death. Even at low levels, childhood exposure to lead contributes to reduced intelligence and cognitive development. Studies also have found that childhood exposure to lead contributes to attention-deficit/hyperactivity disorder and hyperactivity and distractibility; an increased risk of having a reading disability, lower vocabulary and lower class standing in high school; and an increased risk for dropping out of high school, antisocial, and delinquent behavior (Bellinger, 2004; Lanphear et al., 2000; Needleman and Gatsonis, 1990). Although a blood lead level of 10 micrograms per deciliter (µg/dL) or greater may be referred to as "elevated blood lead level," there is no safe level of lead in blood. For example, declines in reading and arithmetic have been observed at blood lead levels below 5 µg/dL (Needleman and Gatsonis, 1990). Studies suggest that every 10 µg/dL increase in blood lead is associated with a 1-point to 5-point decline in IQ (Koller et al., 2004; Canfield et al., 2003). In children between the ages of one and five, lead is particularly harmful to the developing brain and nervous system (Koller et al., 2004).

In the past, outdoor air concentrations of lead from leaded gasoline were a major contributor to blood lead levels in children. In 1978, there were about three to four million children with blood lead levels greater than 10 µg/dL in the United States. By 2002,

with the banning of leaded gasoline and lead-based paint, that number dropped to just over 300,000 children (EPA, 2005). Today's elevated blood lead levels are due mostly to ingestion of contaminated dust, paint, and soil. Lead is not biodegradable, therefore the gradual deterioration or renovation of properties with lead-based paint can produce contaminated dust, soil, and paint chips. Past emissions of leaded gasoline that subsequently were deposited in the soil can also end up in and around the house.

Blood lead levels are highest for younger children, who play and crawl on the ground and frequently put their hands in their mouths. Within the larger population, blood lead concentrations differ by race and family income and are useful in identifying communities that are at greatest risk. Maryland and the CDC have adopted a goal to reduce the number of new cases of elevated blood lead to zero by 2010.

B1: Percentage of Children 0 – 72 Months of Age Tested for Lead and Percentage With Blood Lead Levels ≥ 10 Micrograms Per Deciliter

Blood lead testing is mandatory practice for pediatricians serving in communities with older housing. Maryland has many such areas and requires all children who live or have lived in at-risk areas to be tested during their routine doctor visits at twelve and twenty-four months of age. Testing is also mandatory for children who are receiving Medicaid assistance. Screening questionnaires or blood lead tests are required for children entering day care.

- Testing for young children increased statewide from 13.2 percent in 1996 (59,700 children) to 22.2 percent in 2006 (103,000 children).

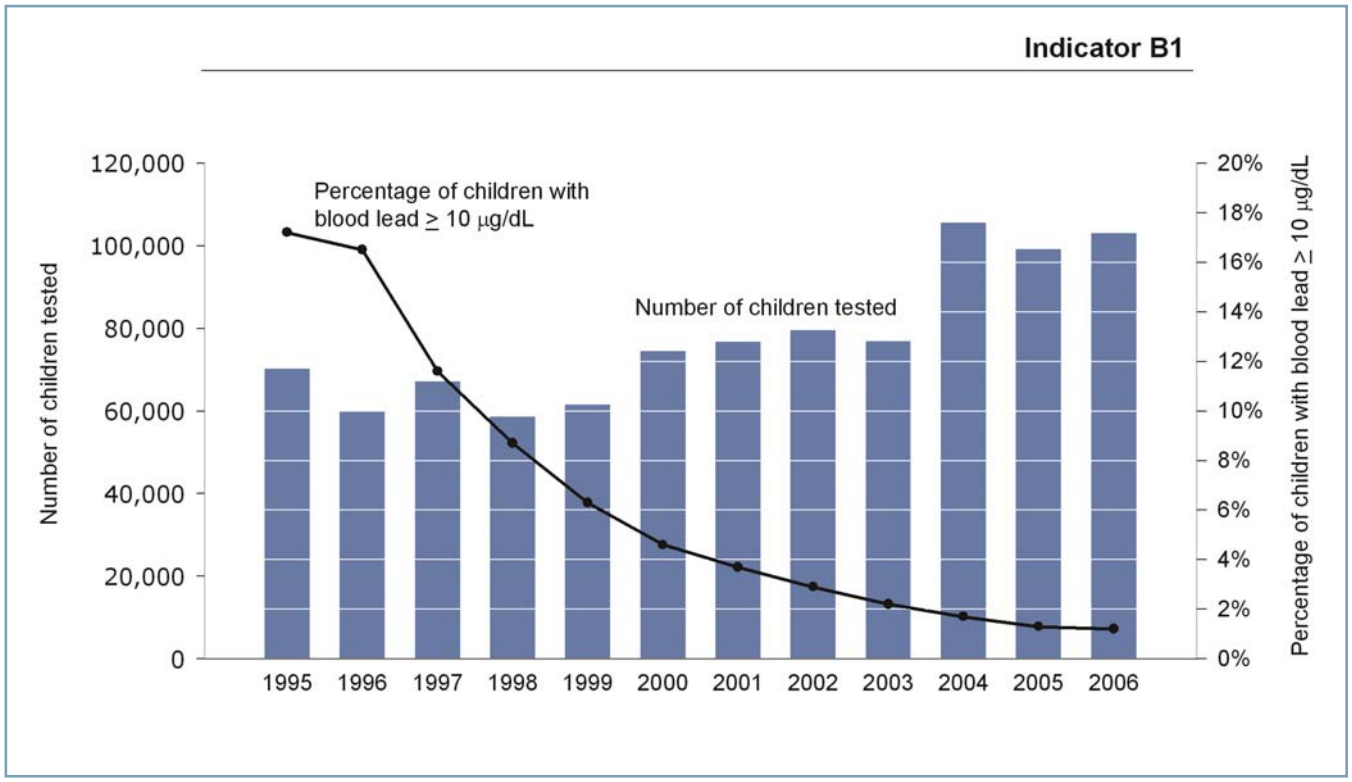

Figure 18. Trends in Blood Lead Testing and Elevated Blood Lead Levels in Maryland Children 0 – 72 months of Age, 1995 – 2006
Source: Maryland Childhood Lead Registry

- The number of children statewide with blood lead levels greater than 10 µg/dL has declined steadily from 17.2 percent in 1995 to 1.2 percent in 2006 (see Figure 18).

Healthy People 2010: Objective 8-25 of Healthy People 2010 focuses on reducing exposure of the population to pesticides, heavy metals, and other toxic chemicals, as measured by blood and urine concentrations of the substances or their metabolites (8-25c—Lead). Objective 8-27 of Healthy People 2010 focuses on increasing or maintaining the number of territories, tribes, and states and the District of Columbia that monitor diseases or conditions that can be caused by exposure to environmental hazards (8-27a—Lead Poisoning). Maryland Health Improvement Plan 2000 – 2010: Child and Adolescent Health—Focus Area 2 focuses on Preventing Childhood Lead Poisoning.

B2: Distribution of Concentrations of Lead in the Blood of Children 0 – 72 Months

The CDC's recommended action level, the trigger for initiating case management and individual care of children, dropped from 60 µg/dL in the 1970s to 10 µg/dL in 1991 as more information came to light concerning the adverse effects of lead. The case management of children uses a multi-layered approach, which varies slightly between jurisdictions. Typically, at 10 µg/dL, steps are taken to educate the parents, notify the property owner, and confirm the blood lead results. At 15 µg/dL, an environmental sanitarian conducts an investigation and landlords are required to fix the property, if warranted. At 20 µg/dL, a complete medical evaluation is added, including a developmental and psychological evaluation. Special medical treatment to reduce blood lead levels is considered at this stage.

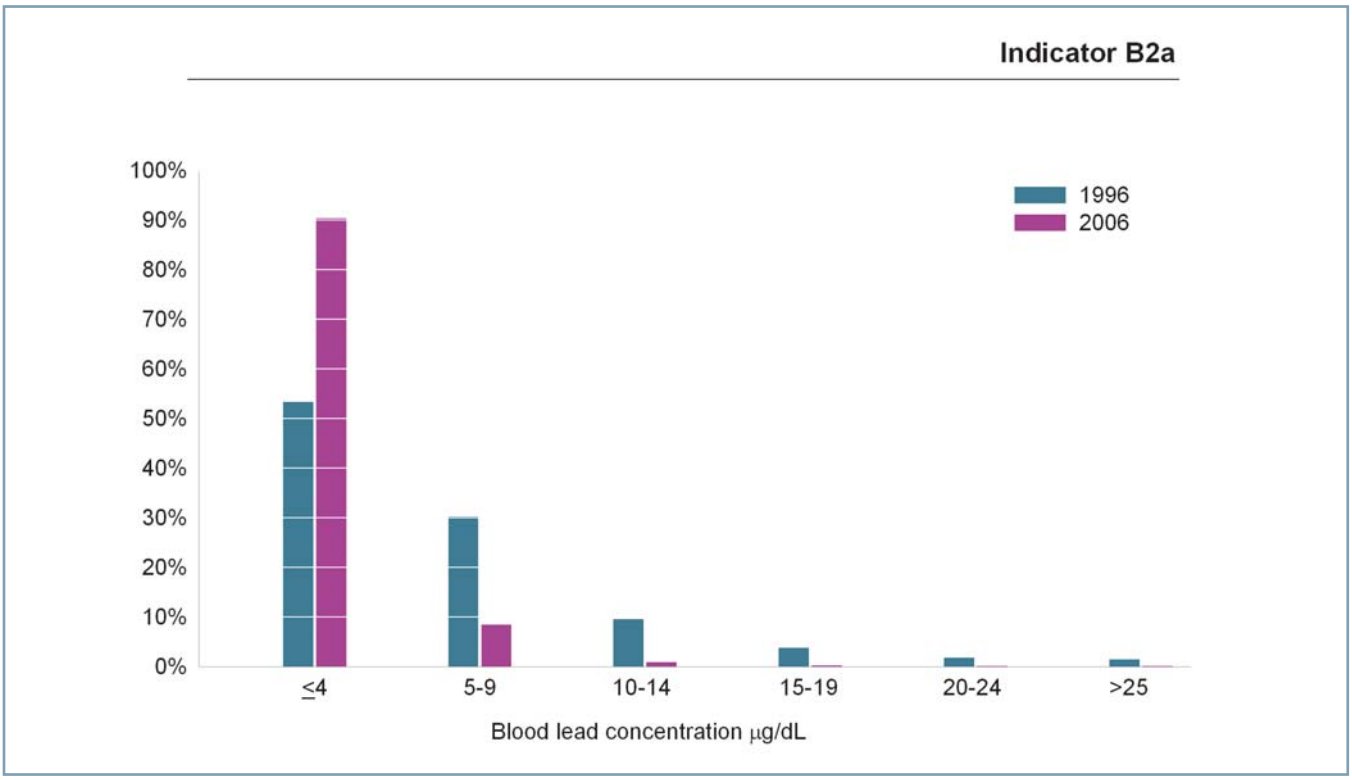

Figure 19. Percentage of Children 0 – 72 Months of Age by Blood Lead Level, 1996 and 2006
Source: Maryland Childhood Lead Registry

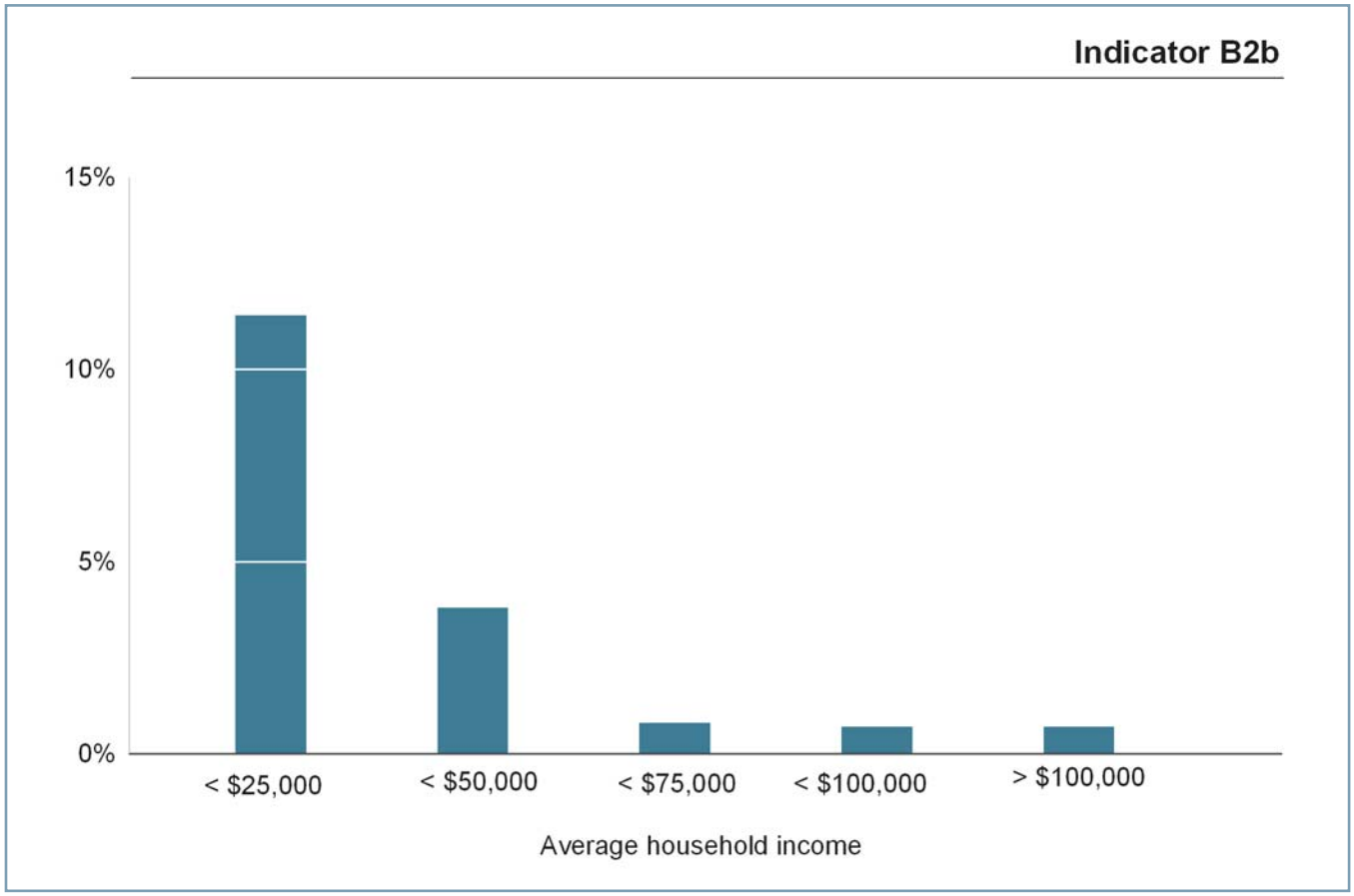

Figure 20. Percentage of Children 0 – 72 Months with Blood Lead Levels ≥ 10 µg/dL, by Household Income, 2002 – 2004

Source: Maryland Childhood Lead Registry. Average household incomes are based on the Census tract of residence, using U.S. Census 2000.

Blood lead levels in children in Maryland are shown in Figure 19. The time period allowed for medical care narrows to a matter of few days as blood lead levels increase beyond 45 µg/dL.

Figures 20 and 21 show the percentage of children 0 – 72 months of age with blood lead greater than 10 µg/dL by household income and location.

- Among children tested for lead statewide, the percentage of children with blood lead levels at the lower end of the spectrum (≤ 4 µg/dL) increased from 53.4 percent in 1996 to 90.4 percent in 2006. During the same time period, the percentage of children with lead "poisoning," defined as a blood lead level greater than 20 µg/dL, decreased from 1.8 percent to 0.1 percent.
- Most instances of blood lead greater than 10 µg/dL occur in families with annual incomes below $25,000.

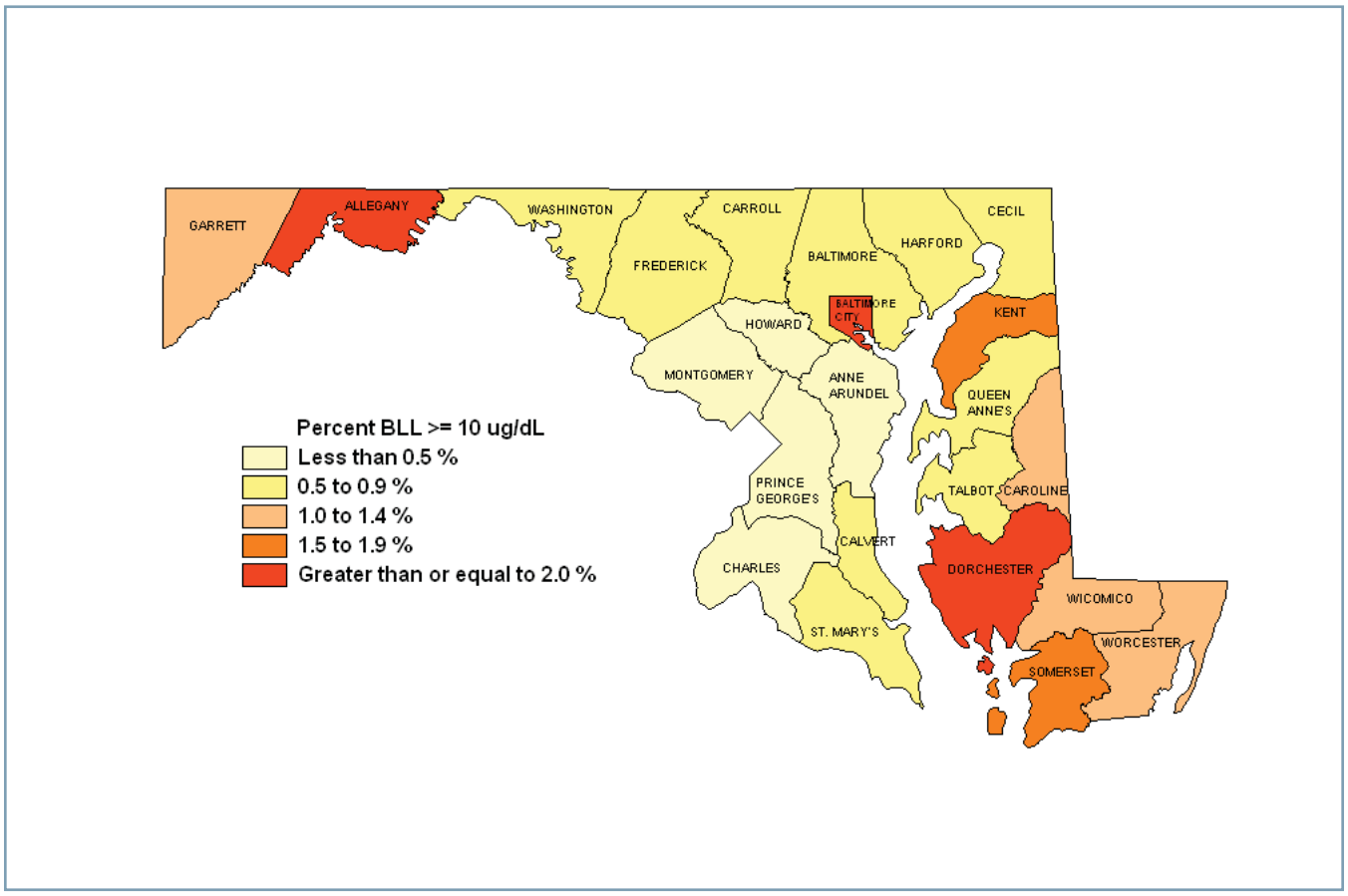

Figure 21. Percent of Children 0 – 72 Months Tested for Lead with Blood Lead Levels >=10 µg/dL, 2004 – 2006

Source: Maryland Department of the Environment, Lead Poisoning Prevention Program: Childhood Lead Registry

- The jurisdictions with the highest percentage of children with blood lead levels (greater than 10 µg/dL) are Baltimore City, Dorchester and Allegany Counties. Relatively high rates of elevated blood lead levels also occur in counties on the Eastern Shore and in far western Maryland.

Healthy People 2010: Objective 8-25 of Healthy People 2010 focuses on reducing exposure of the population to pesticides, heavy metals, and other toxic chemicals, as measured by blood and urine concentrations of the substances or their metabolites (8-25c—Lead). Maryland Health Improvement Plan 2000 – 2010: Child and Adolescent Health—Focus Area 2: Preventing Childhood Lead Poisoning.