3.0 Asthma and Respiratory Disease

The air children breathe is an important source of exposure to substances that may potentially harm their health (US EPA 2003). Exposures in early childhood when the lungs and immune systems are not fully developed raise concerns that children may respond more adversely than adults would (Schwartz 2004). The specific health concerns associated with exposure to air pollutants can vary considerably depending on the pollutant of concern and the nature of the exposure.

The indicators presented in this chapter reflect the “common” air-borne pollutants of concern present in outdoor air and other select sources of indoor air pollutants and the associated respiratory illness and disease. As illustrated in the MEME diagrams, some of the measures presented here address environmental sources of exposure (e.g., outdoor air pollutants) while others address health outcomes (e.g., asthma).

Section 3.1 presents indicators of exposure to common air pollutants of concern to human health. These indicators indirectly measure the potential for exposure for a population (United States). Where population-based indicators are not available, air quality monitoring data (Canada) and air quality index data (Mexico) are presented.

Section 3.2 presents data on the number of children exposed in the home to environmental tobacco smoke (Canada and the United States) and to non-vented biomass emissions (Mexico). These two sources of pollution in indoor environments are considered important factors in the development and exacerbation of asthma and respiratory diseases in children.

Section 3.3 provides data and trends on the prevalence of asthma among children in all three countries. This indicator provides a direct measure of the prevalence of the disease, using survey data (Canada and the United States) and physician reporting (Mexico).
### 3.1 Outdoor Air Pollution

**Purpose:** This indicator provides information on children’s potential exposure to outdoor air pollution, with a focus on common air contaminants.

**CEC Council target indicator:** “Percent of children living in urban areas where air pollution levels exceed relevant air quality standards.”

**Current indicator:** Percentage of children living in areas where air pollution levels exceed relevant air quality standards. (The target indicator was revised to encompass urban and non-urban areas).

Children spend more time outside and inhale more air per unit body weight compared to adults, potentially exposing them to higher concentrations of outdoor air pollutants emitted from traffic, power-plants, and other sources. These exposures can begin before a child’s immune system and lungs are fully developed, giving rise to concerns that their responses may be different from those of adults.

Air pollution has long been considered a source of exacerbation of asthma and other respiratory conditions; however, recent studies of the effects of air pollution on children’s health suggest that air pollution is associated with infant mortality and the development of asthma, and may influence lung development, causing lasting effects on respiratory health (Schwartz 2004). A long-term study of the effects of chronic air pollution in California on children’s respiratory health indicated that children’s health is adversely affected by current ambient levels of air pollution. The study’s results indicated that children’s lung function growth was adversely affected by the chronic exposures and that new cases of asthma and asthma exacerbations were also associated with these levels (Peters et al. 2004).

Particulate matter, a common air pollutant, has been associated with acute bronchitis in children. Research has shown that rates of bronchitis and chronic cough are reduced when particulate levels decline. There is new evidence that air pollution may also play a role in adverse birth outcomes, such as early fetal loss, pre-term delivery and lower birth weight associated with prenatal exposures (Schwartz 2004).

Air pollutants such as ground-level ozone can also cause a variety of respiratory health effects from short-term exposure, including inflammation of the lung, reduced lung function, and respiratory symptoms such as cough, chest pain, and shortness of breath. Short-term exposures to ambient concentrations of ground-level ozone have been associated with the exacerbation of asthma, bronchitis and respiratory effects serious enough to require emergency room visits and hospital admissions (US EPA 2003).

Other air pollutants of concern include carbon monoxide, nitrogen dioxide, sulfur dioxide and lead. Ground-level ozone and particulate matter are two common pollutants of concern to public health and are the focus of national air quality standards in all three countries.

As the multiple exposure–multiple effects (MEME) model for ambient air pollution in Figure 2 suggests, a number of air contaminants—individually or in combination—can produce a number of health outcomes (Briggs 2003). Conversely, a single health outcome may be associated with multiple exposures to multiple substances over time.

Socio-economic conditions and other factors affect the risk of exposure, as well as the health outcomes. For example, families living in low-income housing in crowded inner city environments may be at increased risk from higher concentrations of airborne pollutants, in particular where there is close proximity to high-traffic density (Peters et al. 2004). Other conditions such as a
region's geography and weather patterns may contribute to greater (or lesser) exposures. Adverse health outcomes associated with exposure to outdoor air pollution may have a greater impact in communities where there is limited access to health care services and medications.

Each country uses different air quality standards to report on their indicators (for more information, please see the country reports). Current scientific evidence does not point to discernable thresholds for ambient air pollutants below which there are no adverse health effects. As a result, even air pollutant levels below current air quality standards should be treated with caution. Even in areas that meet a nation's air quality standards, there are likely some children who could experience adverse health effects, especially children with pre-existing medical conditions.

The indicator, "percentage of children living in areas where air pollution levels exceed relevant air quality standards," is intended to reflect the percentage of children that are exposed to exceedances in national standards. To present information on this indicator, countries require ongoing local or regional air quality monitoring that can be combined with population census data to determine the percentage of children that are experiencing exposures above the established standards over time.

Figure 2: MEME Framework for Issues Covered in the Section on Outdoor Air Pollution

Source: Adapted from Briggs 2003.

Note: * The United States includes lead in its list of criteria lead contaminants.
3.1.1 Canada

In Canada, the ability to adequately model the spatial dispersion of specific air pollutants and to link this information to populations in matching areas was not sufficiently developed to present information on the current indicator at this time. Canada is currently reviewing options to address the outdoor air pollution indicator identified in Section 3.1, including an assessment of the national ambient monitoring network. In the interim, Canada presents information based on data collected at ambient monitoring stations.

Chart 3-1 displays peak levels of ground-level ozone for selected regions of Canada for the period 1989–2002.

Chart 3-2 illustrates the number of days in 2002 on which ground-level ozone levels exceeded the Canada-wide Standard of 65 ppb, for various locales across Canada.

Chart 3-3 presents the number of days in 2002 on which PM$_{2.5}$ levels exceeded the Canada-wide Standard of 30 µg/m$^3$ in various locales across Canada.
Chart 3-1: Peak Levels of Ground-level Ozone, for Selected Regions of Canada, 1989–2002


Note: The yearly values for each station were calculated by averaging the peaks (i.e., four highest measurements over eight hours) for three consecutive years. The yearly values for each station were then averaged for the region.
Chart 3-2: Number of Days in 2002 on which Ground-level Ozone Levels Exceeded the Canada-wide Standard

Source: National Air Pollution Surveillance Network Database, Environment Canada (consulted March 2004).

Note: The points represent the number of days on which 8-hour ground-level ozone measurements exceeded the Canada-wide Standard of 65 ppb. The standard comes into force in 2010 and achievement will be measured using three years of data.
Chart 3-3: Number of Days in 2002 on which PM$_{2.5}$ Levels Exceeded the Canada-wide Standard

Source: National Air Pollution Surveillance Network Database, Environment Canada (consulted March 2004).

Note: The points represent the number of days on which 24-hour PM$_{2.5}$ measurements exceeded the Canada-wide Standard of 30 ppb.

Key Observations:

- Although ground-level ozone levels fluctuate from year to year, they have not decreased significantly in the Prairies, Ontario and Quebec over the last 13 years (Chart 3-1).
- Ground-level ozone levels have decreased in British Columbia and the Atlantic provinces (Chart 3-1).
- In 2002, southern Ontario experienced the highest numbers of days on which ground-level ozone levels exceeded the Canada-wide Standard. The number of high-ozone days will fluctuate from year to year, which can partly depend on the occurrence of hot, stagnant weather conditions (Chart 3-2).
- Southern Ontario experiences the highest number of days with elevated PM$_{2.5}$, followed by the eastern Ontario/southern Quebec region (Chart 3-3).

3.1.2 Mexico

Mexico does not currently have the ability to link local air quality monitoring data to population-based data for the corresponding locales. Therefore, Mexico was unable to report the current indicator. Instead, Mexico presents data on the exceedances of its national air quality standards for “common” pollutants in key urban centers.
Chart 3-4 presents the percentage of days on which the Metropolitan Air Quality Index (Indice Metropolitano de la Calidad del Aire—Imeca) was exceeded in key metropolitan zones during the period 1999–2002. The Imeca is a 100-point index in which each pollution standard corresponds to a value of 100.

Chart 3-5 illustrates metropolitan areas with air quality programs including air monitoring. This chart also presents the Imeca information for ground-level ozone and PM10 for each of the metropolitan areas.

Chart 3-4: Percentage of Days on which the Air Quality Index (Imeca) was Exceeded in Key Metropolitan Areas in Mexico, 1999–2002*

Source: Instituto Nacional de Ecología (INE).

Note: * 4-year arithmetic mean.
    ** 3-year arithmetic mean, 1997–99.
Chart 3-5: Metropolitan Areas in Mexico with Air Quality Programs Including Air Monitoring, 1999–2002*

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>Percentage of Days Exceeding the Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexicali</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td>Tijuana</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td>Monterrey</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td>Ciudad Juárez</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td>Vall de México</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td>Toluca</td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
<tr>
<td></td>
<td>Ground-level ozone: 0.0%  PM10: 0.0%</td>
</tr>
</tbody>
</table>


Note: *4-year arithmetic mean; but for Mexicali and Tijuana, 3-year arithmetic mean, 1997–99.

Key Observations:

- The percentage of days for which the Imeca level for suspended particles was exceeded in a number of metropolitan zones was 20 percent or above; for PM$_{10}$, for example, approximately 35 percent of days were in exceedance in Mexicali, and Guadalajara, and in Ciudad Juárez and Monterrey, the daily percentage of exceedance topped 20 percent (Chart 3-4).
- The daily percentage of exceedance for ground-level ozone was over 80 percent in the Mexico City Metropolitan Zone (MCMZ) (Chart 3-4).
- In Mexicali, approximately 35 percent of days were in exceedance for PM$_{10}$ and 19 percent of days were in exceedance for carbon monoxide levels (Chart 3-4).
A number of metropolitan zones have air quality monitoring programs. Daily percentages of exceedences for the Imeca level for particulate matter were above 20 percent in Mexicali, Guadalajara, Ciudad Juárez and Monterrey. Daily ozone exceedence percentages were more than 80 percent in Valle de México (Chart 3-5).

3.1.3 United States

The United States reports the current indicator by using EPA air quality data from counties with monitors across the United States as compared to the National Ambient Air Quality Standards (NAAQS). The indicator shows the percentage of children living in counties where any of the standards was exceeded at any time during the year. These children may be exposed to poor daily air quality at some point during a year. The measure includes air quality data for ozone, particulate matter, lead, and carbon monoxide (nitrogen dioxide and sulfur dioxide had essentially no exceedances). This measure does not differentiate between counties in which the indicators are exceeded frequently or by a large margin, and counties in which indicators are exceeded only rarely or by a small margin.

Chart 3-6 presents the percentage of children living in counties in which air quality standards were exceeded for 1990–2003. The measure indicates whether the level of any standard was exceeded at any time during a year. This measure does not differentiate between counties in which the indicators are exceeded frequently or by a large margin and counties in which indicators are exceeded only rarely or by a small margin.
Chart 3-6: Percentage of Children Living in Counties in the United States in which Air Quality Standards were Exceeded, 1990–2003


Data Source: US EPA, Office of Air and Radiation, Aerometric Information Retrieval System

Note: It should be noted that this measure is slightly different from the air quality standard used by EPA to identify areas that must develop plans to lower air pollution levels. For example, for ozone, the standard for developing plans is based on the day with the fourth highest eight-hour average ozone concentration.

Key Observations:

- The highest number of exceedances is consistently reported for ground-level ozone. In 1990, approximately 61 percent of children lived in counties in which the eight-hour ozone standard was exceeded on at least one day per year. In 2003, approximately 60 percent of children lived in such counties (Chart 3-6).
- In 1999, approximately 33 percent of children lived in counties that exceeded the annual PM$_{2.5}$ standard. In 2003, approximately 21 percent of children lived in such counties. The standard for particulate matter was revised in 1997 to include PM$_{2.5}$. The standard is intended to protect against both short-term and long-term health effects (Chart 3-6).
- In 1990, approximately 14 percent of children lived in counties in which the carbon monoxide standard was exceeded. In 2003, approximately 1 percent of children lived in such counties (Chart 3-6).
From 1990 to 2001, the percentage of children living in counties that exceeded the one-day standard for PM$_{10}$ fluctuated, but was as high as 10 percent in 1990, 1991, and 1999. The percentage remained around 5 percent during 2000–2003 (Chart 3-6).

In 1990, about 2 percent of children lived in counties that exceeded the three-month standard for lead. In 2003, only one county had lead measurements that exceeded the standard for lead (Chart 3-6).

Few exceedances of the sulfur dioxide and nitrogen dioxide standards have occurred since 1993. Consequently, they were not included on the graph (Chart 3-6).

### 3.1.4 Opportunities for Strengthening Indicators of Outdoor Air Pollution in North America

All of the indicators for outdoor air pollution rely on ambient air quality monitoring for national data. Only the United States was in a position to combine population data with air quality monitoring data to report the percentage of children that are exposed to degraded air quality. The following opportunities were identified for future improvement:

- Determining the percentage of children living in areas where air pollution levels exceed relevant air quality standards requires a more common understanding of the relationship between population and air quality monitors among the three countries.

- The ability to identify the specific geographic areas of high pollutant levels (e.g., along main transportation corridors or downwind from pollutant sources), would improve our ability to identify potential populations at risk.

- The percentage of children living in areas where air pollution levels exceed relevant air quality standards does not provide a complete measure of the degree of exposure for the population. For example, the indicator does not tell the user where the highest rates of exceedance for multiple pollutants occur, nor does it reveal how high the pollution was above the standard. Future efforts could attempt to provide more information relative to the intensity of local/regional exceedances.

- Future efforts to improve the utility of this indicator could include linking of ambient concentrations of air pollutants with health outcomes. This could include links with health outcome data such as emergency room visits and admissions for respiratory and other related illnesses, school absenteeism and medication usage.

- There is a need to improve the understanding of the chemistry of pollutants in the atmosphere, their migration and the health effects associated with aggregate exposure to multiple air pollutants in children (Canada, Environment Canada 2005).

- The ideal indicator would provide for consistent measures across all three countries over a reasonable time period (e.g., 10 years) so that trends could be monitored. The indicator would provide information that was nationally relevant to all children within a country while providing detail on the situation in various subpopulations according to their race/ethnicity, economic status, and specific geographic locales.

- These outdoor air indicators reflect only a few of the pollutants of concern to children’s health. There are other air pollutants of concern to children’s health that could be included in future indicators work.
3.2 Indoor Air Pollution

**Purpose:** This indicator provides information on children’s potential exposures to indoor air pollution, with a focus on environmental tobacco smoke and emissions from the burning of biomass fuels.

**CEC Council target indicator:** “Indoor air quality.”

**Current indicator:** Indoor air quality: Measure of children exposed to environmental tobacco smoke (Canada, United States); measure of children exposed to emissions from the burning of biomass fuels (Mexico).

Children who are exposed to environmental tobacco smoke (ETS) indoors are at increased risk of adverse health effects. Exposure to ETS\(^6\) is associated with an increased risk for bronchitis, pneumonia, lower respiratory tract infections, otitis media (fluid in the middle ear), and sudden infant death syndrome (SIDS) (President’s Task Force on Environmental Health Risks and Safety Risks to Children 2000a, US EPA 2003, Health Canada 2005). Furthermore, ETS is one of the irritants known to trigger asthma attacks and plays a role in the development of asthma (US EPA 2003). Other contributions to the cause and exacerbation of asthma remain the subject of ongoing research.

Children who are exposed to biomass emissions from the burning of wood are also at risk for a number of health effects. These may include susceptibility to sinus and respiratory infections, bronchitis, exacerbation of asthma, and decreased lung function (California Air Resources Board 2005). The World Health Organization notes that “there is consistent evidence that exposure to indoor air pollution can lead to acute lower respiratory infections in children under five” (World Health Organization 2005a). Indoor smoke contains a number of pollutants associated with potential health effects, including: particles (complex mixtures of chemicals in solid form and droplets), carbon monoxide, nitrous oxides, sulphur oxides (mainly from coal), formaldehyde and carcinogens (chemical substances known to increase the risk of cancer) such as benzo[a]pyrene and benzene (World Health Organization 2005b). Indoor air pollution in homes, caused by the burning of firewood or charcoal for cooking, is a public health problem in Mexico (see Mexico’s Country Report).

Other pollutants of concern that may be found in North American homes include PM\(_{2.5}\); dusts and allergens such as pet dander; moulds; gases and aerosols from consumer products such as cleaners and furniture polishes; pesticides; and other gases and vapors associated with combustion sources in the home. Outdoor air pollution that finds its way into the home is another source of pollution.

As the MEME model in Figure 3 indicates, the measures for indoor air pollution present surrogate exposure measures of the percentage of children exposed to ETS in their homes in Canada and the United States, and fugitive emissions from the burning of biomass indoors in Mexico. The United States also provides an additional measure of exposure with blood cotinine levels (cotinine is a breakdown product of nicotine and is a marker for recent exposure to ETS) (US EPA 2003). Blood cotinine provides a marker of exposure to ETS from all exposure sources, including exposure to ETS in the home and in public places.

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\(^6\) Canada refers to fugitive emissions associated with smoking as “second-hand smoke” (SHS) Mexico refers to fugitive emissions associated with smoking as “passive smoke.”
3.2.1 Canada

Canada addresses the current indicator by using data obtained from the Canadian Tobacco Use Monitoring Survey (CTUMS) Report and the National Population Health Survey (NPHS).

**Chart 3-7** Shows the percentage of children exposed to environmental tobacco smoke in Canadian homes, for ages zero to five years, six to 11 years, 12 to 14 years, and 15 to 19 years.
Chart 3-7: Percentage of Children Exposed to Environmental Tobacco Smoke in Canadian Homes, by Age Groups, 1999–2002

Source: Canadian Tobacco Use Monitoring Survey (CTUMS) Report and the National Population Health Survey

Key Observations:

- Generally, the percentages of children (in all four age categories: zero to five, six to 11, 12 to 14, and 15 to 19) exposed to ETS in Canadian homes is decreasing (Chart 3-7).
- In 2002, more than one in four children aged 15 to 19 years were exposed to tobacco smoke in the home (Chart 3-7).
- Approximately 14 percent of infants and young children (aged zero to five years) were exposed in 2002, down from 23 percent in 1999 (Chart 3-7).
- It is also evident that for all four years, (1999–2002) exposure to ETS was highest among children aged 15 to 19 years and lowest among those aged zero to five years (Chart 3-7).

3.2.2 Mexico

Mexico reports on the current indicator by providing information on the use of biomass fuels, which includes wood and charcoal, at the municipal level in Mexico. Data on the percentage of children exposed to environmental tobacco smoke in Mexican households is not available. However, environmental tobacco smoke is recognized as a significant public health threat in Mexico. Mexico, therefore, provides data on smoking prevalence in urban and rural populations,
as well as survey data of smoking percentages of urban adolescents, in its country report (see Mexico’s Country Report).

Chart 3-8 is a map of the geographical distribution of the percentage of total households of fuel wood users, at the municipal level, in Mexico.

Chart 3-8: Percentage of Fuel Wood Users, at the Municipal Level, in Mexico, 2000


Key Observations:
- The heaviest biomass usage is in southern Mexico and north central Mexico, where areas of 90–100 percent utilization may be found in some locales. These are largely rural states with some of Mexico’s poorest populations (see Mexico’s Country Report) (Chart 3-8).

3.2.3 United States

The United States presents several measures of ETS exposure in children to fulfill the current indicator. National surveillance data, which are collected annually, provide information on smoking in the home, where children are present. The United States also has included an additional indicator, serum cotinine, which is a bio-marker for ETS exposure.

Chart 3-9 shows the percentage of children aged six and under who are regularly exposed to environmental tobacco smoke in US homes, for the years 1994–2003.
**Chart 3-10** shows the percentage of children aged four to 11 with detectable levels of blood cotinine, by race and ethnicity, in the United States for the periods 1988–94 and 1999–2000.

**Chart 3-9:** Percentage of Children Aged Six and Under Regularly Exposed to Environmental Tobacco Smoke in US Homes, 1994–2003


Note: Cotinine is detectable at or above 0.05 nanograms per milliliter (ng/mL) in both the 1988-94 and the 1999–2000 data sets.

Key Observations:

- The percentage of children ages six and under who are regularly exposed to environmental tobacco smoke in the home decreased from 27 percent in 1994 to 20 percent in 1998 and 11 percent in 2003 (Chart 3-9).

- In 1999–2000, the median levels of cotinine in children aged three to 11 and 12 to 19 were more than twice the median levels in non-smoking adults. (Data not shown; see the Centers for Disease Control and Prevention, 2003, Second National Report on Human Exposure to Environmental Chemicals, <http://www.cdc.gov/exposurereport/>.)

- The percentage of children exposed to environmental tobacco smoke, as indicated by presence of detectable blood cotinine levels, dropped between the periods 1988–94 and 1999–2000. Overall, 64 percent of children ages four to 11 had cotinine in their blood in 1999–2000, down from 88 percent in 1988–94 (Chart 3-10).
• In 1999–2000, 86 percent of Black, non-Hispanic children ages four to 11 were exposed to environmental tobacco smoke, compared with 63 percent of White, non-Hispanic children and 49 percent of Mexican American children (Chart 3-10).

3.2.4 Opportunities for Strengthening Indicators of Indoor Air Pollution in North America

Exposure to environmental tobacco smoke and biomass emissions are important environmental indicators for child health because of the substantive health risks associated with these sources of indoor air pollution. A number of indicators have been presented, as well as suggestions to improve the quality and comparability of the indicators for future reports.

• Different time frames and age groups have been used to reflect household exposure to environmental tobacco smoke (Canada and the United States) and biomass emissions (Mexico). Use of standard age groups and time periods would improve subsequent reports and provide better comparability of results.

• Some of the surveillance activities (e.g., national surveys) are not annual events, thus it would be helpful to look for the most comprehensive sample period, as well as make efforts to synchronize future survey periods.

• Biomonitoring data (e.g., blood cotinine levels) provide an excellent source of information that can augment data obtained by surveys. Biomonitoring of blood cotinine levels in Canada and Mexico would provide additional information on exposure to environmental tobacco smoke.

• The need for better monitoring of exposure to environmental tobacco smoke during the age bracket birth-to-three-years was identified. This is an important area for improvement, given the concerns over the susceptibility of infants.

• Cotinine levels in the United States, by race and ethnicity, and indoor biomass use in Mexico, by municipality, suggest that in these countries’ socio-economic conditions are important factors influencing exposure to environmental tobacco smoke and fugitive emissions from biomass use. These indicators suggest that increased attention should be paid to subpopulations at risk in future reporting efforts.

• The focus on environmental tobacco smoke and biomass emissions present two priority indoor air issues, however there are numerous other indoor pollutants of concern. Future efforts could develop indicators for other sources of indoor air pollutants such as consumer products and radon, particularly those most likely to impact children. Additionally, other indoor environments frequented by children, such as day-care centers and schools, could be included in indicators reporting.
3.3 Asthma

**Purpose:** This indicator tracks asthma in children.

**CEC Council target indicator:** "Prevalence of asthma in children."

**Current indicator:** Prevalence of asthma in children.

Asthma is a chronic inflammatory disease of the lungs that affects millions of children and adults in North America (National Institutes of Health 1997). It is a major cause of child hospitalization and is the most common chronic disease of childhood in North America. Asthma can produce wheezing, difficulty in breathing, and chest pain, (US EPA 2003) symptoms that can be triggered and exacerbated by numerous environmental factors. Thus, children with asthma are considered to be among the most sensitive to the respiratory effects of air pollution (US EPA 2003). Many children and family members suffer from poor quality of life associated with asthma and asthma-related morbidities. Children with severe and uncontrolled asthma have to reduce their levels of physical activity and require regular and heavy use of medications to effectively manage their asthma.

While the prevalence of asthma varies in North America, it has been noted that its prevalence among children has been increasing for several decades. In some regions of North America there has been a four-fold increase in asthma prevalence in the last 20 years. The increase in the prevalence of asthma represents a tremendous human and economic burden for millions of children and adults in North America (President’s Task Force on Environmental Health Risks and Safety Risks to Children 2000b).

The exact cause of asthma in children is unknown, (President’s Task Force on Environmental Health Risks and Safety Risks to Children 2000b) but it appears to be the result of a complex interaction of many factors (see Canada’s Country Report):

1. **Predisposing factors**, such as atopy—a tendency to have an allergic reaction to foreign substances.
2. **Environmental causal factors**, such as indoor air pollutants (e.g., environmental tobacco smoke and house dust mite antigen) and outdoor air pollutants (e.g., ground-level ozone).
3. **Aggravating factors**, which increase the frequency and/or severity of asthma episodes and include environmental tobacco smoke, certain indoor air allergens, outdoor air pollutants, including PM and ground-level ozone, and respiratory infections.

While heredity plays a role in the development of asthma; it alone cannot adequately explain the large increase in asthma prevalence (US EPA 2003). Research into the causes of asthma have identified factors in the environment as being important to the frequency and severity of asthma episodes. More recent evidence suggests environmental exposures such as smoking (or environmental tobacco smoke) and poor air quality are attributed to pro-inflammatory effects and airway remodeling (Black and Johnson 2002). A long-term study investigating the chronic effects of air pollution on children’s health identified an association between outdoor air pollutants and the development of the disease among healthy children (Peters et al. 2004). There is growing evidence that exposure to dust mite antigen and environmental tobacco smoke in very young children can cause development of new-onset asthma. Other indoor pollutants such as nitrogen dioxide, pesticides, plasticizers, and volatile organic compounds may play a role in the development of the disease (US EPA 2003). Some pollutants may cause the development of asthma, and precipitate wheezing and coughing episodes in asthmatic children (Schwartz 2004).
Asthma is known for its disproportionate burden on certain populations (US EPA 2003). For example, lower-income inner city populations are at greater risk to develop asthma because of sub-optimal levels of care and control and because they may have higher exposures. Therefore, lower-income inner city populations may suffer more from morbidities associated with the disease.

In Mexico, it has been reported that the residents of coastal states are more likely to exhibit asthma. Researchers have speculated that this may be due to the high ambient humidity, where dust in homes has a higher probability of entering the respiratory tract in the form of suspended particles. The higher prevalence of asthma in these regions has also been attributed to the use of air conditioning systems, which harbor a large quantity of dust and moulds that can trigger asthmatic episodes (see Mexico’s Country Report).

Asthma is a complex disease. Diagnosing asthma is often a challenge in infants, where bronchiolitis, is common in children under six years of age, who may have common wheezing disorders that may not be associated with asthma. Clinical diagnosis of asthma in young children is often based on reported risk factors, symptoms, and response to medications. Therefore, the clinical definitions of asthma may vary between countries. As well, the surveillance techniques used in identifying asthmatics vary amongst countries. For example, as of 1997 the US National Health Interview Survey began differentiating between those children who may no longer have asthma and those whose asthma is well controlled. Based on these differences, the indicators...
presented should be interpreted with caution and comparisons between countries should be avoided.

### 3.3.1 Canada

Canada reports on the percentage of children who have been diagnosed with asthma by their physician. This information is provided through the National Longitudinal Survey of Children and Youth, which poses questions to parents on the health of their children. The survey provides data on the percentage of children who have reported a diagnosis of asthma. Since it is difficult to differentiate in the survey those with other respiratory conditions (such as wheezing) from those with asthma, children under the age of four were excluded from the analyses.


Key Observations:

- Since 1994, asthma prevalence has increased among children (except for boys aged four to seven years) (Chart 3-11).
- Boys of all ages have a higher prevalence of asthma than girls (Chart 3-11).
- Currently, approximately 20 percent of boys aged eight to 11 have been diagnosed with asthma, the highest prevalence group among children (Chart 3-11).

3.3.2 Mexico

Mexico presents data on childhood asthma. Furthermore, Mexico also includes national surveillance data for acute respiratory infections (ARI), a condition that is also associated with exposure to air pollution.

Chart 3-12 depicts the incidence of asthma for the age groups of under one, one to four and five to 14 years. Incidence rates were calculated as number of new cases per 10,000 population and were provided for the years 1998 to 2002.

Chart 3-13 depicts incidence of acute respiratory infections. This chart provides ARI rates for 1998 to 2002, based on the number of new cases per 100,000 population.

Chart 3-12: Incidence of Asthma among Children, by Age Group, in Mexico, 1998–2002

Key Observations:

- The highest rates of asthma consistently appear for the group aged one to four years, with a trend of increase, from 54 new cases per 10,000 children in 1998 to 63 new cases per 10,000 children in 2002 (Chart 3-12).
- The asthma incidence rate in children less than 1 year old showed a decline since 2000, and currently remains at 33 new cases per 10,000 population. As opposed to a true change in disease incidence, this decline was directly attributable to a change in the immediate notice form (Epi-1 2000) for medical unit reporting. This occurred due to the difficulty in diagnosing asthma in this age group.
- In the five to 14 age group, the rates have grown slightly, from 28 to 32 new cases per 10,000 children over the sampling period (Chart 3-12).
- For acute respiratory infections (ARI), the most affected population is children below one year of age, with annual new cases averaging 16,000 per 100,000 children. Only in 1998 were fewer new cases reported during this period. Children aged one to four years showed a slight increase in new cases, from 7500 in 1998 to 8100 per 100,000 children in 2002. The lowest rates are observed for children aged five to 14 years (Chart 3-13).
3.3.3 United States

The United States reports on the current indicator by providing national asthma surveillance data obtained through the National Health Interview Survey.

Chart 3-14 shows the percentage of children with asthma, taken from annual survey results since 1980. This indicator covers the period 1980 to 2003.


Source: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey.

Note: The survey questions for asthma changed in 1997; data before 1997 cannot be directly compared to data in 1997 or later.

Key Observations:

- In 2003, about 13 percent of children had been diagnosed with asthma at some time in their lives, though some of those children may no longer have asthma (Chart 3-14).
- About 9 percent of children were reported to currently have asthma. These include children with active asthma symptoms and those whose asthma is well-controlled (Chart 3-14).
- Between 1980 and 1995, the percentage of children with asthma (as measured by “children with asthma in past twelve months”) doubled, from 3.6 percent in 1980 to 7.5
percent in 1995. A decrease in the percentage of children occurred between 1995 and 1996, but it is difficult to interpret single-year changes (Chart 3-14).

- Prior to 1997, the percentage of children with asthma was measured by asking parents if a child in their family had asthma during the previous 12 months. In 1997–2000, a parent was asked if his or her child had ever been diagnosed with asthma by a health professional. If the parent answered yes, then he or she was asked if the child had an asthma attack or episode in the last 12 months. The percentage of children with an asthma attack in the last 12 months measures the population with incomplete control of asthma. For 1997–2000, available data do not distinguish between those children who may no longer have active asthma and those whose asthma is well controlled. In 2001, a question was added to ask the parents if their child currently had asthma (Chart 3-14).

- Approximately 6 percent of all children had one or more asthma attacks in the previous 12 months. These children have ongoing asthma symptoms that could put them at risk for poorer outcomes, including hospitalizations and death. About two-thirds of children who currently have asthma have on-going asthma symptoms (Chart 3-14).

### 3.3.4 Opportunities for Strengthening Indicators of Asthma and Respiratory Disease in North America

The prevalence of asthma in all three countries appears to be stable or increasing. However, the specific rate of increase may be confounded by a number of issues related to the definition of the illness and the methods of surveillance. The following suggestions have been made to increase the reliability of data and the comparability of future indicators on asthma prevalence and on the incidence of pneumonia and other forms of acute lower respiratory infection:

- The data periods reported by each country currently differ. Some standardization of reporting periods and definitions would improve future comparability. To achieve a better view of trends, future reports of asthma prevalence could include historical data or narrative that is several decades in duration (e.g., 20–30 years, where possible).
- Changes to definitions (e.g., ever diagnosed vs. active illness) and data collection methods (e.g., Canada and the United States use surveys, while Mexico data are based on physician reporting) have increased the challenges associated with comparing within and between countries. Where possible, the clinical and survey definitions of asthma used by the three countries should be made uniform or at least be described in detail so that variations can be addressed in future reports. Common diagnostic criteria for young children (i.e., aged zero to five) could assist with more consistent diagnosis in an age group where differential diagnosis is difficult. Through the CEC and other fora, the three countries have begun to work together towards more comparable asthma surveillance systems.
- Further efforts of the international community (International Study of Asthma and Allergies in Childhood—ISAAC) to develop globally applicable asthma diagnostics could enhance future comparability of North American indicator efforts with other international asthma initiatives.
- Future research initiatives that collect information on environmental factors that may contribute to the development of asthma and to the triggering and severity of asthma attacks could provide further opportunities for indicator development and analysis.
- Acute lower respiratory infections are most closely correlated to indoor smoke from biomass burning. It would be useful to have acute lower respiratory infections (rather than all respiratory infections) as a separate indicator. Furthermore, this indicator could be broken down by state to synchronize with the biomass fuel use indicator.