# Burden of Asthma estimation

## Intro

In this report I will discuss how to estimate the burden of asthma due to NO2 exposure in a step by step manner using R, by following the provided R script (Burden_NO2_children.R). I will also present the formulas and definitions used in the estimations, then present the results.

## Data sets

We will be using two data sets for each year:

- Census data set from the NHGIS with age and sex stratification (Steven Manson, Jonathan Schroeder, David Van Riper, 2017)
    - 2000 (nhgis0005_ds147_2000_block.csv)
    - 2010 (nhgis0012_ds172_2010_block.csv)
- NO2 data set form Bechle(Bechle, Millet, & Marshall, 2015)
    - 2000 (lur_2000_AnnualAverage.Rda)
    - 2010 (BechleLUR_annual2000-2010_2010blocks.csv)

## Steps of Burden estimations

The steps of should be followed using the available R script provided, the analysis will be done separately for each year (i.e. year 2000 data set than year 2010)

Step 1: Read the census dataset into R, (census dataset should be the specific data set provided)

Step 2: Clean the data set, remove unwanted columns and rename the columns

Step 3: Validate the population size, drop age groups > 18 years, and validate the child population size.

Step 4: Load the NO2 data set, merge the two data sets. (Note: you will now have a new data set named burden, we will then remove the two old data sets and some columns for reducing the size of the file)

Step 5: Estimate the burden of disease in the following order:

- Estimate the number of asthma cases
- Transform NO2 levels from ppb to ug/$m^3$
- Estimate RR of new exposure (RRnew), Attributable fraction (AF), Attributable cases (AC) with lower and upper limits
- Estimate the counts of cases attributable to NO2 exposure with upper and lower limits

## Definitions and formulas

- Asthma incidence rate among children = 12.5 per 1,000 (Winer, Qin, Harrington, Moorman, & Zahran, 2012)
- Number of asthma cases (cases) = total population of children * 0.0125 (IR)

Each formula is applied as a column variable

- NO2 response function = 1.05 (1.02, 1.07) per 4ug/$m^3$ (Khreis et al., 2017)
- NO2 ppb to ug/$m^3$ transformation (NO2ug) = NO2 in ppb * 1.88 (WHO, 2005)
- RR of new exposure (RRnew) = exp ((log (1.05)/4) *NO2ug))
- Attributable fraction (AF) = (RRnew - 1)/ ((RRnew - 1) +1))
- Attributable cases (AC) = AF*cases
- The sum function is then applied to AC to get the total Attributable cases

## Year 2000 estimations

- Total population = 279,583,437
- Population of children =71,807,328
- Asthma incidence among children = 12.5 per 1,000
- Number of all cause incident asthma cases among children = 897,592
- Attributable cases of asthma due to NO2 = 238,651 [108,540 – 308,692]

## Year 2000 estimation (After adjustment for at-risk population)

- At-risk population = total population – (total population * prevalence (12.4%))
- Number of all cause incident asthma cases among children = 786,290
- Attributable cases of asthma due to NO2 = 209,058 [95,081 – 270,414]

## Year 2010 estimations

- Total population = 306,675,006
- Population of children = 73,690,271
- Asthma incidence among children = 12.5 per 1,000
- Number of all cause incident asthma cases among children = 921,128
- Attributable cases of asthma due to NO2 = 164,463 [71,775 – 217,933]

## Year 2010 estimation (After adjustment for at-risk population)

- At-risk population = total population – (total population * prevalence (13.7%))
- Number of all cause incident asthma cases among children =
- Attributable cases of asthma due to NO2 = 141931 [61,942 – 188,067]

## Asthma prevalence

Prevalence of asthma among children in the US (age adjusted rates for years 2006-2011)(*Summary health statistics NHIS*, 2016)

| Year | Ever Asthma | Current Asthma | Note |
|---|---|---|---|
| 1999 | 10.8% | 5.3% | Current asthma question is: Had asthma attack in the past 12 months |
| 2000 | 12.4% | 5.5% | |
| 2001 | 12.7% | 5.7% | |
| 2006 | 13.6% | 9.4% | Current asthma question is: Still have asthma? |
| 2007 | 13.9% | 9.5% | |
| 2008 | 13.1% | 9.1% | |
| 2009 | 13.9% | 9.7% | |
| 2010 | 13.7% | 9.5% | |
| 2011 | 14.2% | 9.6% | |

Definition of at-risk population

- At-risk at beginning of time period is defined as ever diagnosed with asthma + first diagnosed in past year
- Incident case = first diagnosed in past year
- To estimate the at-risk population, we will the following formula:
    - At risk child population = Total child population – (Ever had asthma - Asthma diagnosed in the past 12 month)