EPA attributable burden calculation

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Input Data

I have already calculated following data sets. I hope I won't need to make too many adjustments to switch from the GBD exposure-response function to the one from EPA. Firstly, I have all-cause burden data by Race and Hispanic Origin measured in age-adjusted Death rates per 100.000:

```
print(total_burden)
```

```
##   Year                              Race        Hispanic.Origin    value
## 1 2010 American Indian or Alaska Native            All Origins 6466.826
## 2 2010        Asian or Pacific Islander            All Origins 3923.177
## 3 2010        Black or African American            All Origins 9287.966
## 4 2010                            White     Hispanic or Latino 5715.364
## 5 2010                            White Not Hispanic or Latino 7253.686
```

Secondly, I have estimated for each Ethnicity, how many persons (pop_size) are exposed to a given level of particulate matter concentration (pm).

```
head(pm_summ)
```

```
##   Year                              Race Hispanic.Origin   pm pop_size
## 1 2010 American Indian or Alaska Native     All Origins 1.53      347
## 2 2010 American Indian or Alaska Native     All Origins 1.55       12
## 3 2010 American Indian or Alaska Native     All Origins 1.58        2
## 4 2010 American Indian or Alaska Native     All Origins 1.59       26
## 5 2010 American Indian or Alaska Native     All Origins 1.80       38
## 6 2010 American Indian or Alaska Native     All Origins 1.81       21
```

Calculation

Calculating β as in your code.

```
## get the epa beta
## using the different parametric distributions in the EPA documentation
set.seed(5)
expa <- rtruncnorm(1000, a = 0, mean = 1.42, sd = 0.89)
expc <- rtruncnorm(1000, a = 0, mean = 1.2, sd = 0.49)
expd <- triangle::rtriangle(1000, 0.1, 1.6, 0.95)
expe <- rtruncnorm(1000, a = 0, mean = 2, sd = 0.61)
expg <- rtruncnorm(1000, a = 0, mean = 1, sd = 0.19)
expi <- rtruncnorm(1000, a = 0, b = 2.273, mean = 1.25, sd = 0.53)
expj <- rweibull(1000, 2.21, 1.41)
epa <- c(expa, expc, expd, expe, expg, expi, expj)
beta <- mean(epa / 100)
```

Now the actual calculation of the population attributable fraction (paf) and the attributable burden.

```
paf <- pm_summ %>%
  mutate(paf = (exp(beta * pm) - 1)) %>%
  group_by(Year, Race, Hispanic.Origin) %>%
  summarise(paf = weighted.mean(paf, pop_size))

attr_burden <- inner_join(total_burden, paf,
                          by = c("Year", "Race", "Hispanic.Origin")) %>%
  mutate(value = value * paf, paf = NULL)

print(attr_burden)
```

```
##   Year                              Race        Hispanic.Origin     value
## 1 2010 American Indian or Alaska Native            All Origins  693.2755
## 2 2010        Asian or Pacific Islander            All Origins  522.5717
## 3 2010        Black or African American            All Origins 1339.8480
## 4 2010                            White     Hispanic or Latino  741.2136
## 5 2010                            White Not Hispanic or Latino  901.0384
```

Line 2 $PAF = (e^{\beta \times pm} - 1)$ in the above code corresponds to line 85 in your code in https://github.com/burke-lab/wildfire-map-public/blob/main/work/14_figure3.R.

My questions

1. Does the above code correspond to how the EPA estimates are to be calculated? I am particularly uncertain, whether I understood the population scaling in line 127 in your code correctly.
2. The exposure-response function used is $burden_{attributable} = (e^{\beta \times pm} - 1) \times burden_{allcause}$. Can this formula be found in https://pubmed.ncbi.nlm.nih.gov/29962895/ or deduced from somewhere?
   - Equation 1 on page 3 looks similar, but is different and would yield very different results far from 0: $PAF = (1 - e^{-\beta \times pm})$
3. $burden_{attributable} = (e^{\beta \times pm} - 1) \times burden_{allcause}$ is not bounded in pm. In particular, it could theoretically exceed the all-cause burden. Am I misunderstanding something?
4. Where exactly are the parametric distributions in the calculation of β taken from? Could you please provide the position in the EPA Documentation you are referring to?