Age Distributed Mortality and Population Counts in MITUS

It is physically impossible to preserve the shape of the mortality rates in the model with the current targets for age distributed mortality and population counts.

Below we compare the calculated mortality rate necessary in 2016 to hit both the mortality count targets (from CDC wonder) and the population counts (source unknown.) It should be noted that the denominators presented on CDC wonder for total population counts are higher than our population counts. Higher population counts could be part of the difference in mortality rates.

```
library(MITUS)
```

```
## Loading required package: Rcpp
## Loading required package: mvtnorm
## Loading required package: lhs
## Loading required package: parallel
## Loading required package: MCMCpack
## Loading required package: coda
## Loading required package: MASS
## ##
## ## Markov Chain Monte Carlo Package (MCMCpack)
## ## Copyright (C) 2003-2018 Andrew D. Martin, Kevin M. Quinn, and Jong Hee Park
## ##
## ## Support provided by the U.S. National Science Foundation
## ## (Grants SES-0350646 and SES-0350613)
## ##
## Loading required package: RColorBrewer
## Loading required package: mnormt
##
## Attaching package: 'MITUS'
## The following object is masked from 'package:base':
##
##     pi
```

```
model_load()
CalibDat$US_mort_age[18,]
```

```
##    Year  X0.4 X5.24 X25.44 X45.54 X55.64 X65.74 X75.84   X85.
## 18 2016 27206 38078 135408 173516 366445 512080 636916 854462
```

```
CalibDat$tot_pop16_ag_fb[,1:2]*1e6
```

```
##   age_grp     total
## 1      NA  19867000
## 2      NA  85042000
## 3      NA  83946000
```

```
## 4      NA  43460000
## 5      NA  40062000
## 6      NA  26355000
## 7      NA  13768000
## 8      NA   6057000
## 9      NA 318558000
```

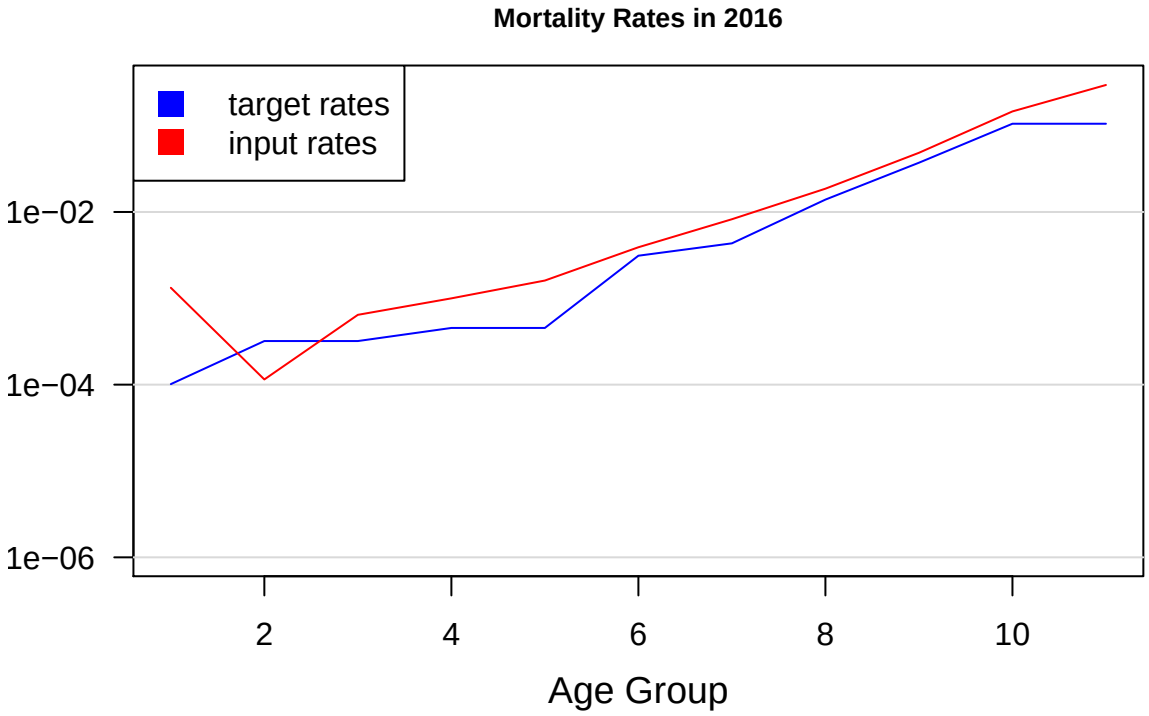
```
###calculate the mortality rates required to reach these 2016 counts
mort_rate<-rep(NA,11)
mort_rate[1]<-as.numeric(CalibDat$US_mort_age[18,1]/(CalibDat$tot_pop16_ag_fb[1,2]*1e6))
mort_rate[2:3]<-as.numeric(CalibDat$US_mort_age[18,2]/(CalibDat$tot_pop16_ag_fb[2,2]*1e6))
mort_rate[4:5]<-as.numeric(CalibDat$US_mort_age[18,3]/(CalibDat$tot_pop16_ag_fb[3,2]*1e6))
mort_rate[6:9]<-as.numeric(CalibDat$US_mort_age[18,4:7]/(CalibDat$tot_pop16_ag_fb[4:7,2]*1e6))
mort_rate[10:11]<-as.numeric(CalibDat$US_mort_age[18,8]/(CalibDat$tot_pop16_ag_fb[8,2]*1e6))

#plot our model inputted background mortality for
input_mort_rate <- as.numeric(Inputs[["BgMort"]][67,-1])

plot(1,1,ylim=c(0.000001,.30),xlim=c(1,11),xlab="",ylab="",axes=F,log="y")
axis(1);axis(2,las=2);box()
abline(h=axTicks(2),col="grey85")

lines(mort_rate, col="blue")
lines(input_mort_rate, col="red")

mtext("Age Group",1,2.5,cex=1.2)
mtext("Mortality Rates in 2016",3,.8,font=2,cex=0.8)
legend("topleft",c("target rates", "input rates"),
       pch=rep(15,2),lwd=rep(NA,2),lty=rep(NA,2),col=c("blue","red"),bg="white",pt.cex=rep(1.8,2))
```



With this inconsistency in mind, I propose using a constant mortality rate for the 85+ population equal to either the input that we currently use for the 85-94 age group.

If we take this approach these are the results:

```
model_load_demo()
Inputs$BgMort[,12]<-Inputs$BgMort[,11]
opt_par<-optim_demo(StartVal_demo,1)$par
```

```
## initial  value 2267.016905
## iter  10 value 349.832091
## final  value 349.781840
## converged
```

```
## Warning in as.POSIXlt.POSIXct(Sys.time()): unknown timezone 'zone/tz/2018f.
## 1.0/zoneinfo/America/New_York'
```

```
##   Nelder-Mead direct search function minimizer
## function value for initial parameters = 349.781840
##   Scaled convergence tolerance is 1.04243e-06
## Stepsize computed as 0.507499
## BUILD              5 387.010733 349.781840
## LO-REDUCTION       7 361.267780 349.781840
## LO-REDUCTION       9 355.202022 349.781840
## HI-REDUCTION      11 353.043827 349.781840
## LO-REDUCTION      13 351.176601 349.781840
## HI-REDUCTION      15 350.637586 349.781840
## LO-REDUCTION      17 350.625144 349.781840
## HI-REDUCTION      19 350.084493 349.781840
## HI-REDUCTION      21 349.976218 349.781840
## HI-REDUCTION      23 349.961143 349.781840
## LO-REDUCTION      25 349.910618 349.781840
## LO-REDUCTION      27 349.869102 349.781840
## LO-REDUCTION      29 349.853254 349.781840
## LO-REDUCTION      31 349.847390 349.781840
## LO-REDUCTION      33 349.805321 349.781840
## LO-REDUCTION      35 349.804704 349.781840
## LO-REDUCTION      37 349.801559 349.781840
## LO-REDUCTION      39 349.790066 349.781840
## LO-REDUCTION      41 349.788380 349.781840
## LO-REDUCTION      43 349.787644 349.781840
## LO-REDUCTION      45 349.787058 349.781840
## LO-REDUCTION      47 349.784099 349.781840
## HI-REDUCTION      49 349.783952 349.781840
## LO-REDUCTION      51 349.783802 349.781840
## HI-REDUCTION      53 349.782746 349.781840
## HI-REDUCTION      55 349.782560 349.781840
## LO-REDUCTION      57 349.782408 349.781840
## LO-REDUCTION      59 349.782330 349.781840
## LO-REDUCTION      61 349.782129 349.781840
## LO-REDUCTION      63 349.782015 349.781840
## HI-REDUCTION      65 349.781935 349.781840
## HI-REDUCTION      67 349.781933 349.781840
## HI-REDUCTION      69 349.781897 349.781840
## HI-REDUCTION      71 349.781895 349.781840
## LO-REDUCTION      73 349.781875 349.781840
## LO-REDUCTION      75 349.781869 349.781840
## LO-REDUCTION      77 349.781865 349.781840
## LO-REDUCTION      79 349.781853 349.781840
```

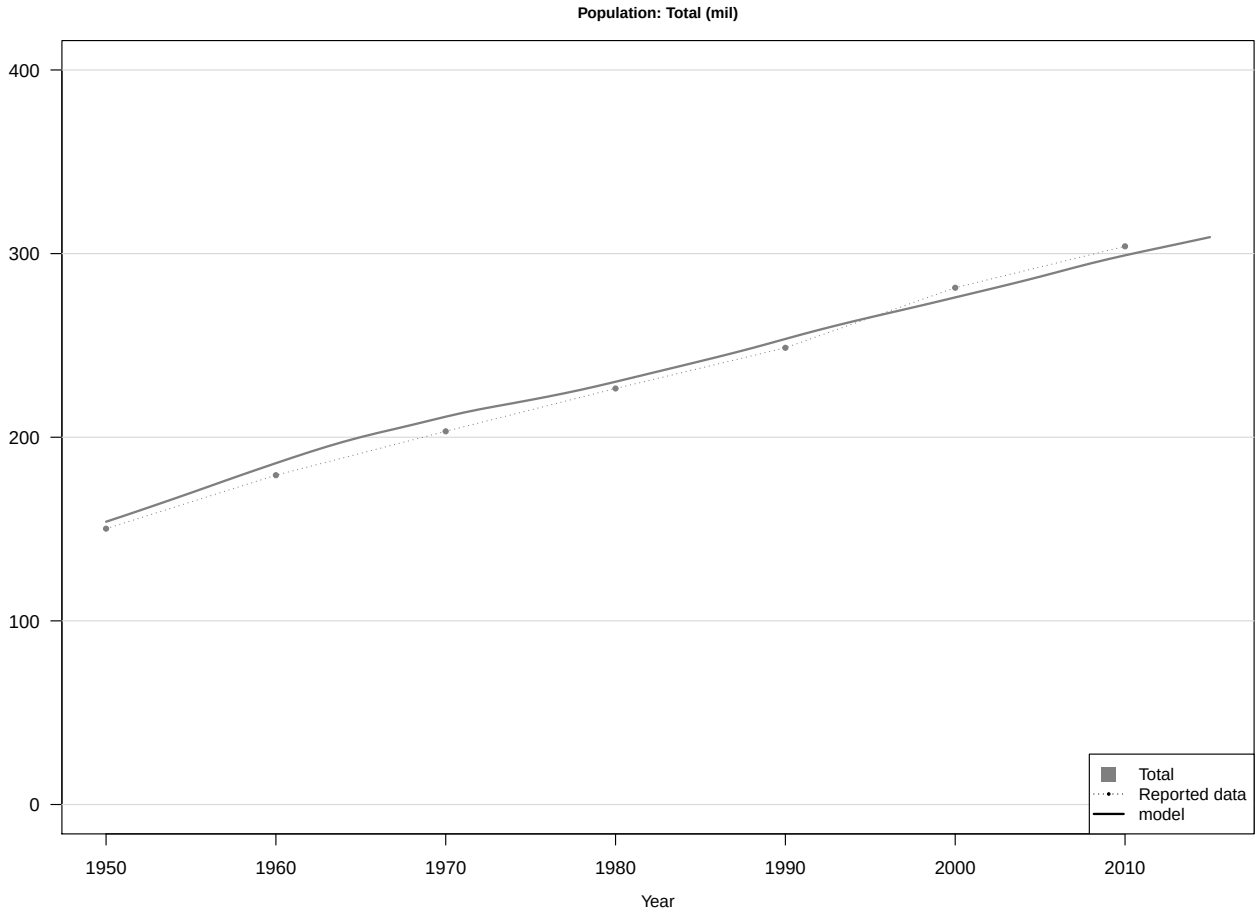
```
## LO-REDUCTION      81 349.781847 349.781840
## LO-REDUCTION      83 349.781845 349.781840
## HI-REDUCTION      85 349.781845 349.781840
## HI-REDUCTION      87 349.781842 349.781840
## HI-REDUCTION      89 349.781842 349.781840
## LO-REDUCTION      91 349.781842 349.781840
## LO-REDUCTION      93 349.781842 349.781840
## Exiting from Nelder Mead minimizer
##     95 function evaluations used
## initial  value 349.781840
## final  value 349.781840
## converged
##   Nelder-Mead direct search function minimizer
## function value for initial parameters = 349.781840
##   Scaled convergence tolerance is 1.04243e-06
## Stepsize computed as 0.507499
## BUILD              5 387.010758 349.781840
## LO-REDUCTION       7 361.267789 349.781840
## LO-REDUCTION       9 355.202030 349.781840
## HI-REDUCTION      11 353.043821 349.781840
## LO-REDUCTION      13 351.176597 349.781840
## HI-REDUCTION      15 350.637589 349.781840
## LO-REDUCTION      17 350.625147 349.781840
## HI-REDUCTION      19 350.084492 349.781840
## HI-REDUCTION      21 349.976220 349.781840
## HI-REDUCTION      23 349.961143 349.781840
## LO-REDUCTION      25 349.910618 349.781840
## LO-REDUCTION      27 349.869101 349.781840
## LO-REDUCTION      29 349.853254 349.781840
## LO-REDUCTION      31 349.847391 349.781840
## LO-REDUCTION      33 349.805321 349.781840
## LO-REDUCTION      35 349.804705 349.781840
## LO-REDUCTION      37 349.801559 349.781840
## LO-REDUCTION      39 349.790066 349.781840
## LO-REDUCTION      41 349.788381 349.781840
## LO-REDUCTION      43 349.787644 349.781840
## LO-REDUCTION      45 349.787058 349.781840
## LO-REDUCTION      47 349.784099 349.781840
## HI-REDUCTION      49 349.783952 349.781840
## LO-REDUCTION      51 349.783802 349.781840
## HI-REDUCTION      53 349.782746 349.781840
## HI-REDUCTION      55 349.782560 349.781840
## LO-REDUCTION      57 349.782408 349.781840
## LO-REDUCTION      59 349.782330 349.781840
## LO-REDUCTION      61 349.782129 349.781840
## LO-REDUCTION      63 349.782015 349.781840
## HI-REDUCTION      65 349.781935 349.781840
## HI-REDUCTION      67 349.781933 349.781840
## HI-REDUCTION      69 349.781897 349.781840
## HI-REDUCTION      71 349.781895 349.781840
## LO-REDUCTION      73 349.781875 349.781840
## LO-REDUCTION      75 349.781869 349.781840
## LO-REDUCTION      77 349.781865 349.781840
## LO-REDUCTION      79 349.781853 349.781840
```

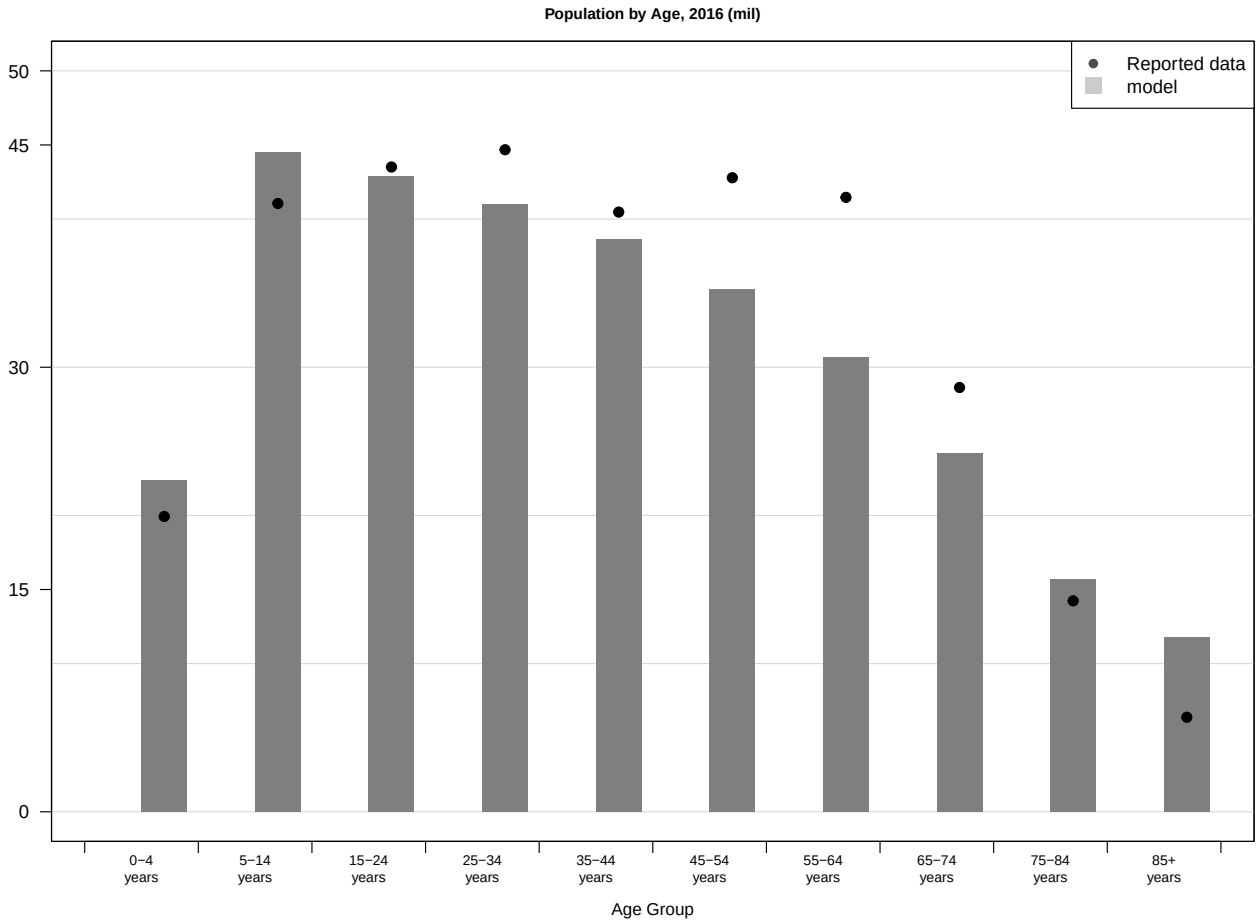
```
## LO-REDUCTION      81 349.781847 349.781840
## LO-REDUCTION      83 349.781845 349.781840
## HI-REDUCTION      85 349.781845 349.781840
## HI-REDUCTION      87 349.781842 349.781840
## HI-REDUCTION      89 349.781842 349.781840
## LO-REDUCTION      91 349.781842 349.781840
## LO-REDUCTION      93 349.781842 349.781840
## Exiting from Nelder Mead minimizer
##     95 function evaluations used
## initial  value 349.781840
## final  value 349.781840
## converged
##   Nelder-Mead direct search function minimizer
## function value for initial parameters = 349.781840
##   Scaled convergence tolerance is 1.04243e-06
## Stepsize computed as 0.507499
## BUILD              5 387.010812 349.781840
## LO-REDUCTION       7 361.267805 349.781840
## LO-REDUCTION       9 355.202047 349.781840
## HI-REDUCTION      11 353.043807 349.781840
## LO-REDUCTION      13 351.176591 349.781840
## HI-REDUCTION      15 350.637595 349.781840
## LO-REDUCTION      17 350.625152 349.781840
## HI-REDUCTION      19 350.084490 349.781840
## HI-REDUCTION      21 349.976222 349.781840
## HI-REDUCTION      23 349.961140 349.781840
## LO-REDUCTION      25 349.910618 349.781840
## LO-REDUCTION      27 349.869100 349.781840
## LO-REDUCTION      29 349.853255 349.781840
## LO-REDUCTION      31 349.847392 349.781840
## LO-REDUCTION      33 349.805321 349.781840
## LO-REDUCTION      35 349.804706 349.781840
## LO-REDUCTION      37 349.801560 349.781840
## LO-REDUCTION      39 349.790067 349.781840
## LO-REDUCTION      41 349.788381 349.781840
## LO-REDUCTION      43 349.787644 349.781840
## LO-REDUCTION      45 349.787058 349.781840
## LO-REDUCTION      47 349.784099 349.781840
## HI-REDUCTION      49 349.783952 349.781840
## LO-REDUCTION      51 349.783802 349.781840
## HI-REDUCTION      53 349.782746 349.781840
## HI-REDUCTION      55 349.782560 349.781840
## LO-REDUCTION      57 349.782408 349.781840
## LO-REDUCTION      59 349.782330 349.781840
## LO-REDUCTION      61 349.782129 349.781840
## LO-REDUCTION      63 349.782015 349.781840
## HI-REDUCTION      65 349.781935 349.781840
## HI-REDUCTION      67 349.781933 349.781840
## HI-REDUCTION      69 349.781897 349.781840
## HI-REDUCTION      71 349.781895 349.781840
## LO-REDUCTION      73 349.781875 349.781840
## LO-REDUCTION      75 349.781869 349.781840
## LO-REDUCTION      77 349.781865 349.781840
## LO-REDUCTION      79 349.781853 349.781840
```

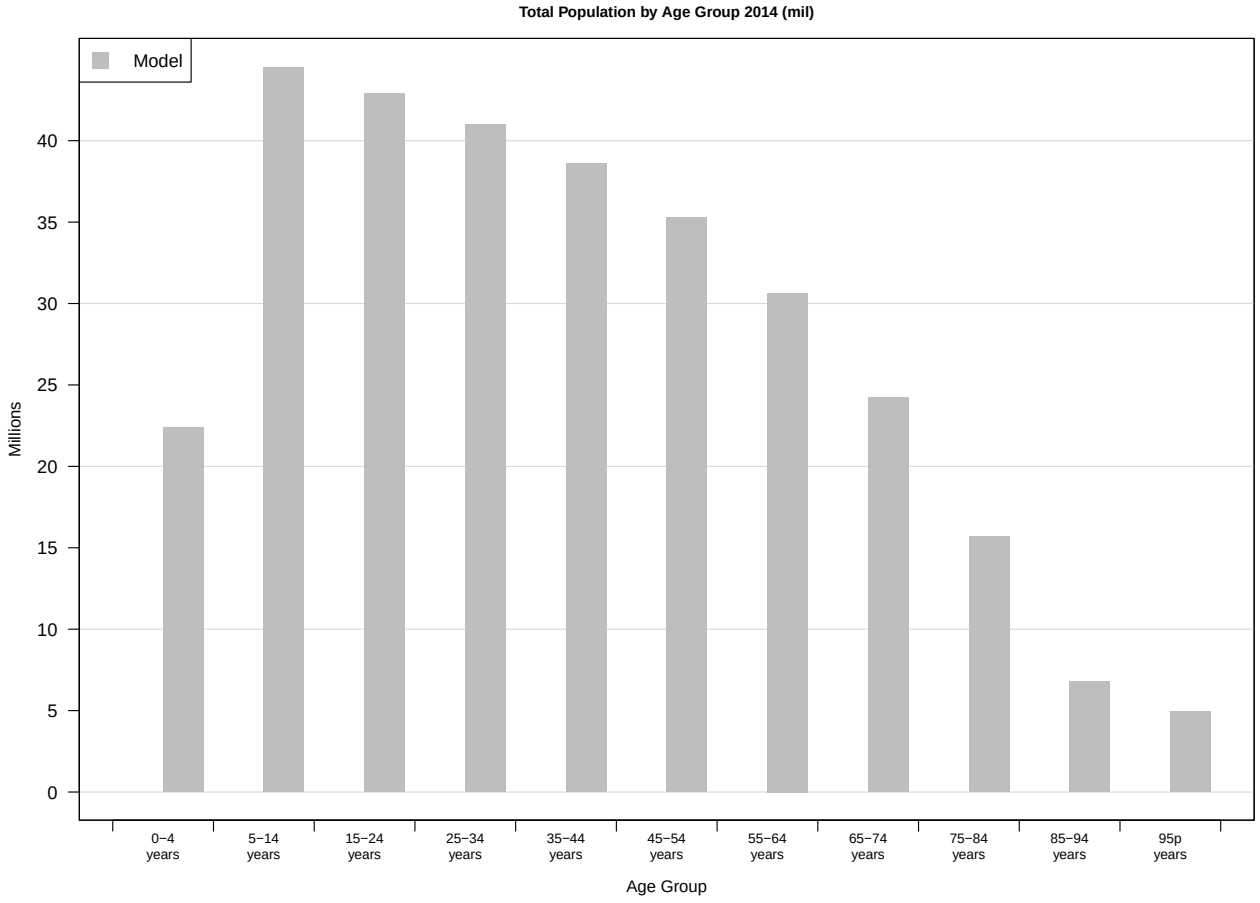
```
## LO-REDUCTION      81 349.781847 349.781840
## LO-REDUCTION      83 349.781845 349.781840
## HI-REDUCTION      85 349.781845 349.781840
## HI-REDUCTION      87 349.781842 349.781840
## HI-REDUCTION      89 349.781842 349.781840
## LO-REDUCTION      91 349.781842 349.781840
## LO-REDUCTION      93 349.781842 349.781840
## Exiting from Nelder Mead minimizer
##     95 function evaluations used
## initial  value 349.781840
## final  value 349.781840
## converged
```

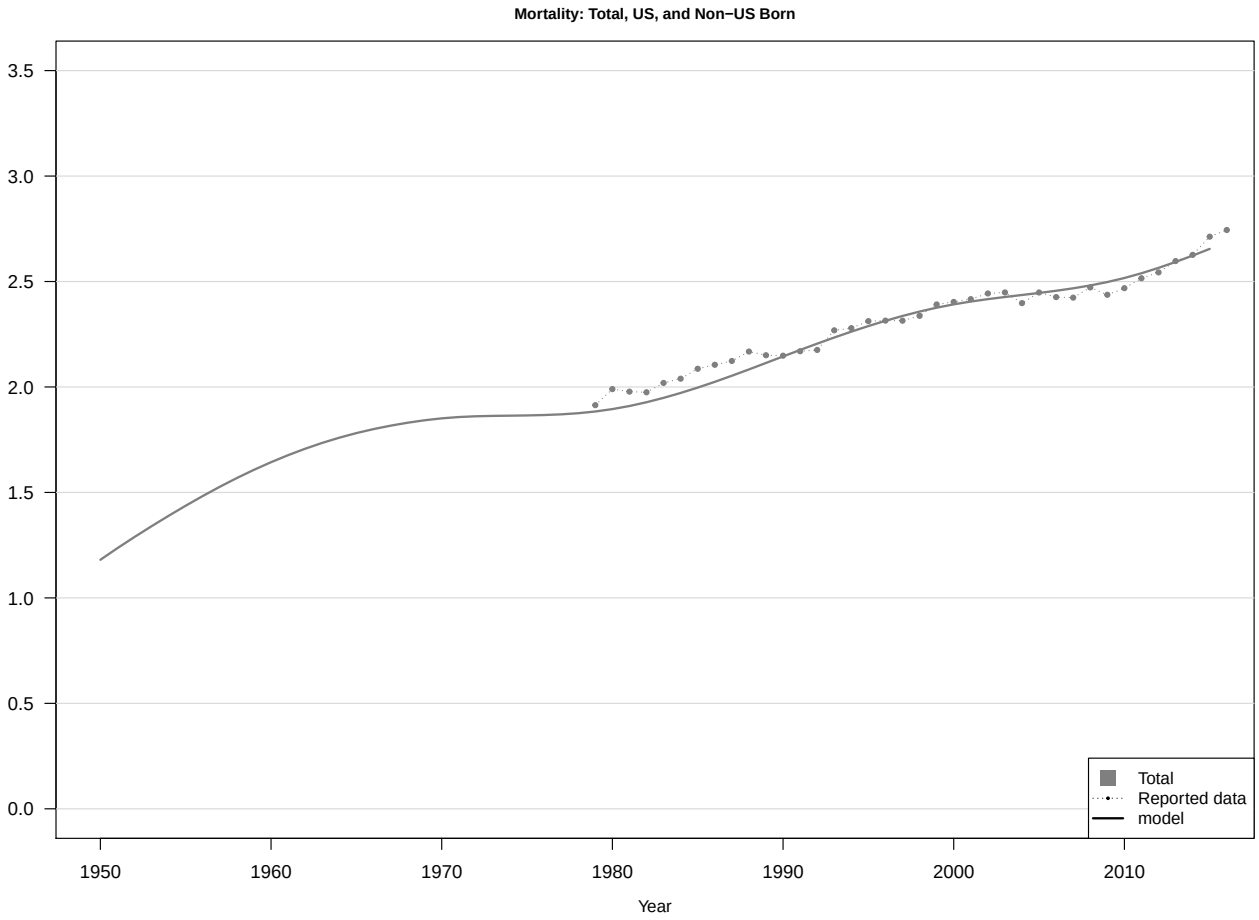
```
calib_demo_ag(1,opt_par,FALSE)
```

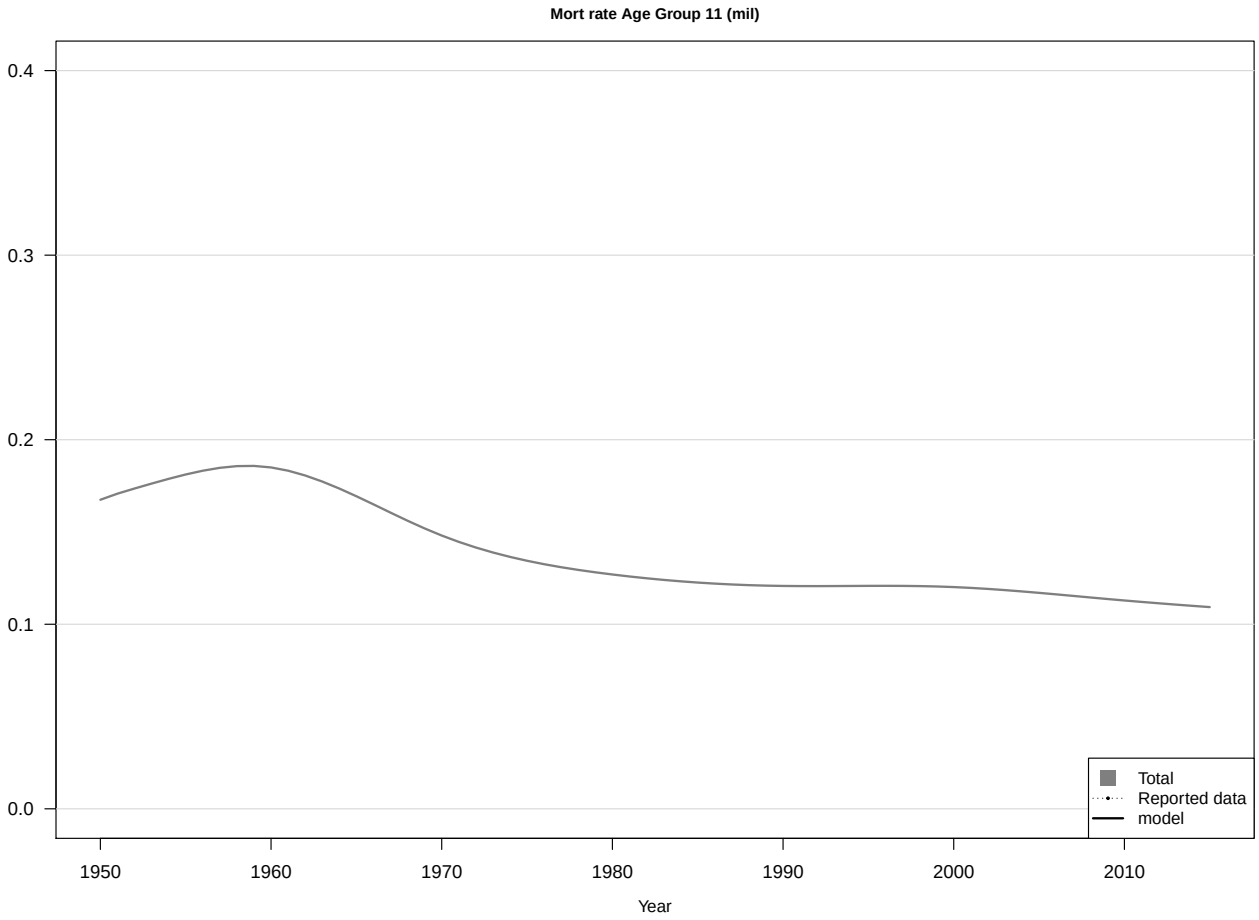
```
## null device
##           1
```

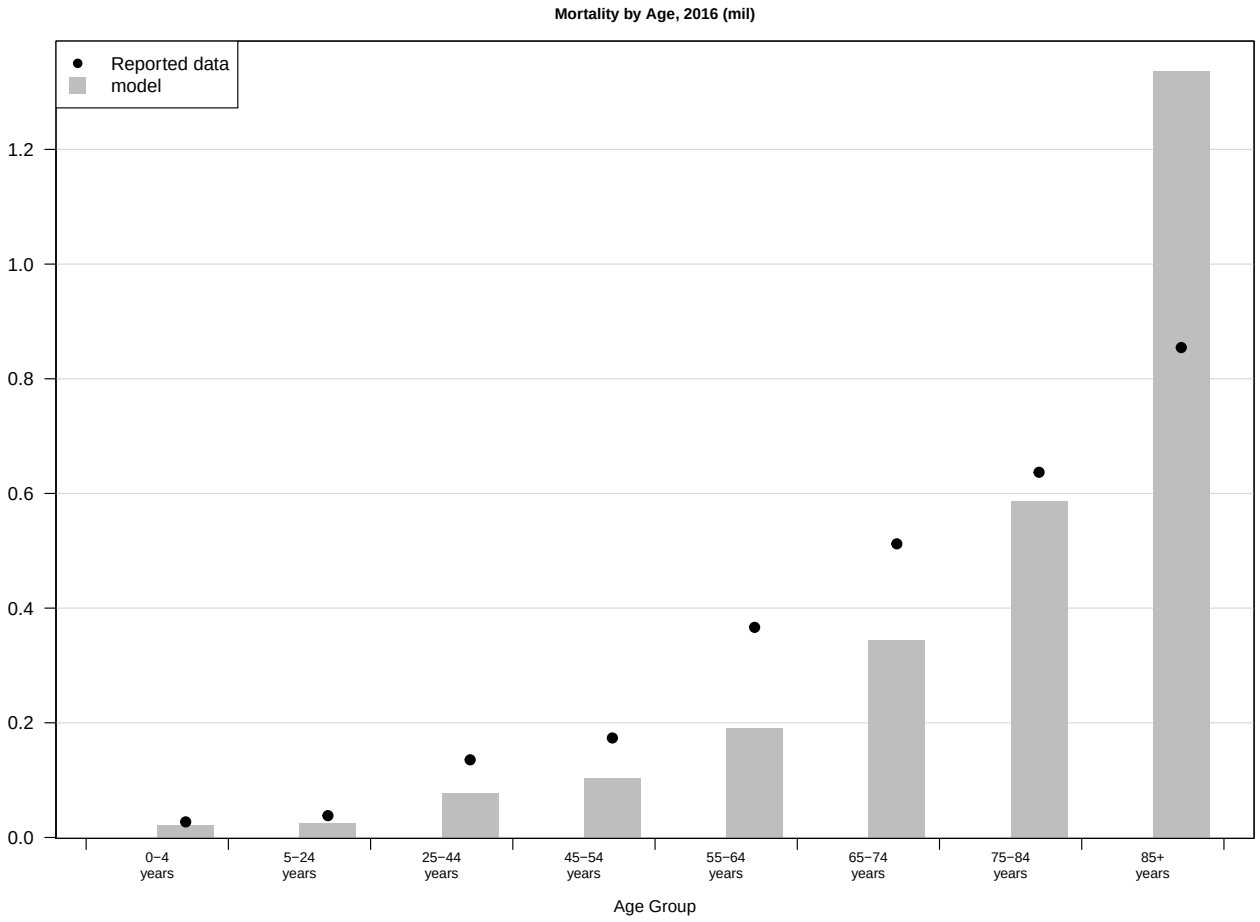


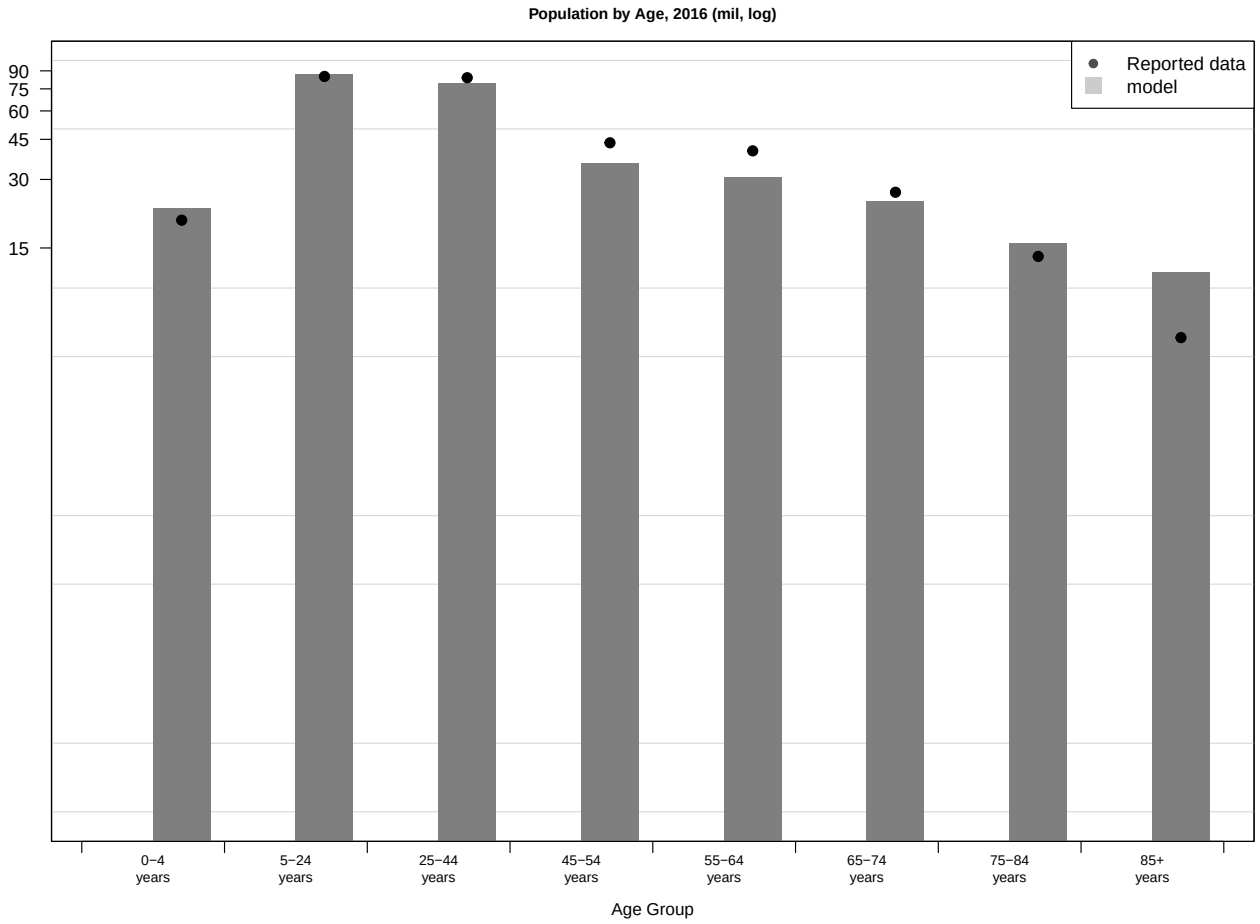

Population by Age, 2016 (mil)
Reported data
model
50
45
30
15
0
0−4 years
5−14 years
15−24 years
25−34 years
35−44 years
45−54 years
55−64 years
65−74 years
75−84 years
85+ years
Age Group

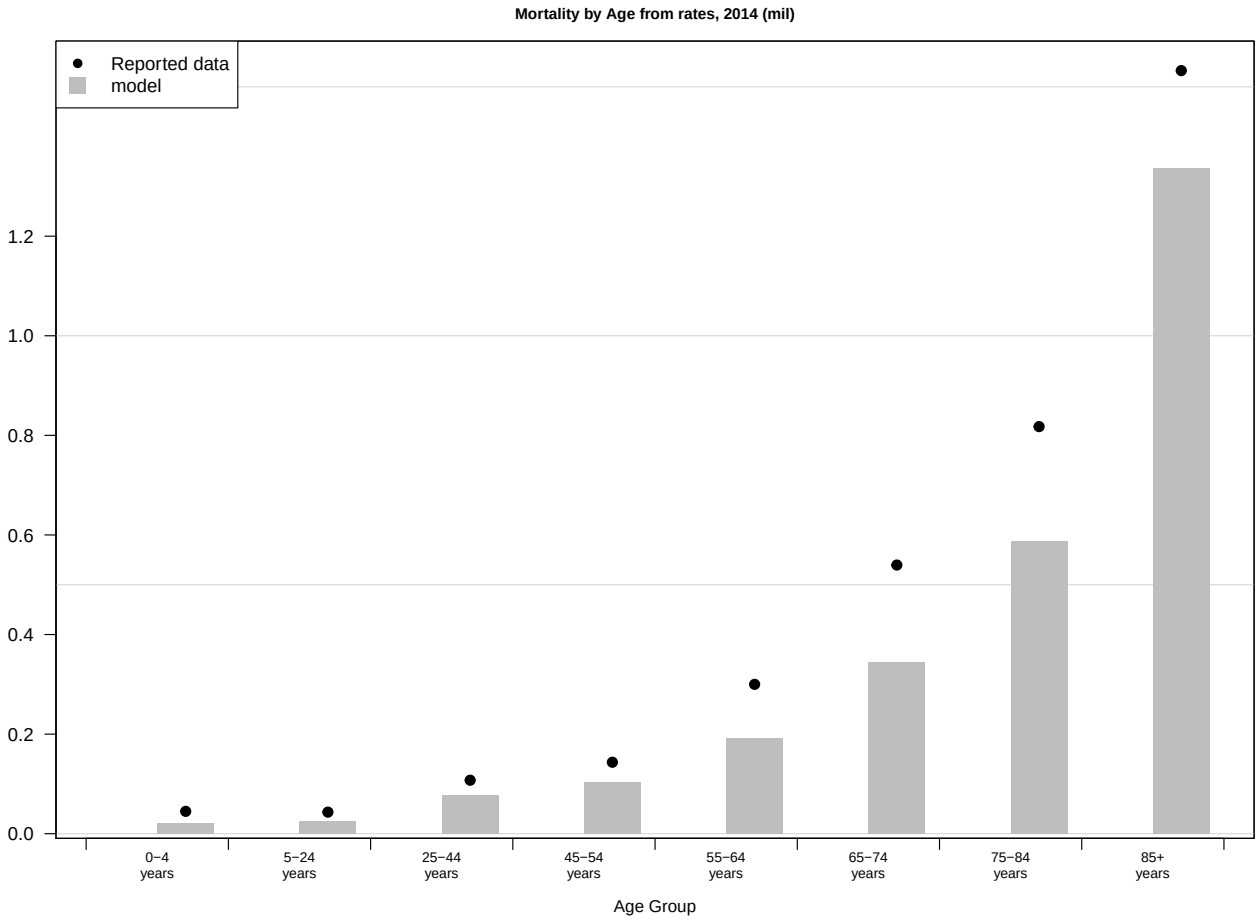

Total Population by Age Group 2014 (mil)
Model
Millions
0
5
10
15
20
25
30
35
40
0−4 years
5−14 years
15−24 years
25−34 years
35−44 years
45−54 years
55−64 years
65−74 years
75−84 years
85−94 years
95p years
Age Group


Mortality: Total, US, and Non−US Born
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1950
1960
1970
1980
1990
2000
2010
Year
Total
Reported data
model


Mort rate Age Group 11 (mil)
0.4
0.3
0.2
0.1
0.0
1950
1960
1970
1980
1990
2000
2010
Year
Total
Reported data
model


Mortality by Age, 2016 (mil)
Reported data
model
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0−4 years
5−24 years
25−44 years
45−54 years
55−64 years
65−74 years
75−84 years
85+ years
Age Group


Population by Age, 2016 (mil, log)
Reported data
model
90
75
60
45
30
15
0−4 years
5−24 years
25−44 years
45−54 years
55−64 years
65−74 years
75−84 years
85+ years
Age Group


Mortality by Age from rates, 2014 (mil)
Reported data
model
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0−4 years
5−24 years
25−44 years
45−54 years
55−64 years
65−74 years
75−84 years
85+ years
Age Group