Analysis Notes for The Effectiveness of the 1994-2004 Federal Assault Weapon Ban in Controlling Mass Shooting Deaths: Analysis of Open-Source Data

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September 12, 2018

Contents

1 Data Entry, Prep and Cleaning

```r
# CREATE DATASET ALL MASS SHOOTINGS CONFIRMED FROM 3 SOURCES
# SEE RELATED LINK FOR DATA SOURCES

shootings <- read.csv("~/shootingAnalysis/data/confirmedX3.csv",
    header = T, stringsAsFactors = F)
str(shootings)
names(shootings)
sum(shootings$Fatalities > 3)

# restrict to 4 or greater deaths
shootings <- shootings[shootings$Fatalities > 3, ]

# create 'total' variable of fatalities plus injuries
shootings$total <- shootings$Injured + shootings$Fatalities

# aggregate fatalities and total to yearly
year.dat <- aggregate(shootings[c("Fatalities", "total")], list(shootings$Year),
    sum)
names(year.dat) <- c("Year", "Fatalities", "Total")

# read in cdc homicide data
homicides9916 <- read.csv("~/shootingAnalysis/Data/cdcGunHomicides9916.csv",
    header = T, stringsAsFactors = F)
homicides8198 <- read.csv("~/shootingAnalysis/Data/cdcGunHomicides8198.csv",
    header = T, stringsAsFactors = F)
deaths <- rbind(homicides9916[-19, c("Year", "Deaths", "Population")],
    homicides8198[-19, c("Year", "Deaths", "Population")])

# merge mass shooting and total firearm homicide data
yearlyDat <- merge(year.dat, deaths, by = "Year", all.y = T,
    all.x = T)

# add 2017 homicide deaths and US population estimates
yearlyDat$Deaths[37] <- 15593
yearlyDat$Population[37] <- 327200000

# convert NAs from years where no mass shootings to zeros
yearlyDat$Fatalities[is.na(yearlyDat$Fatalities)] <- 0
yearlyDat$Total[is.na(yearlyDat$Total)] <- 0

# create rate variable (mass shooting deaths by total firearm
# homicide deaths)
yearlyDat$Rate <- yearlyDat$Fatalities/yearlyDat$Deaths * 10000

# create assualt weapon ban period indicator
yearlyDat$Ban1 <- 0
yearlyDat$Ban1[yearlyDat$Year %in% 1994:2004] <- 1
yearlyDat$Ban2 <- 0
yearlyDat$Ban2[yearlyDat$Year %in% 1994:2004] <- 1
yearlyDat$Ban2[yearlyDat$Year %in% 2005:2018] <- 2



# ASSAULT WEAPON MASS SHOOTINGS CONFIRMED FROM 3 SOURCES

assaultIndicator <- grep(c("AK|AR|MCX|assault|Assault|semiautomatic"),
    shootings$Weapon.details)
length(assaultIndicator)  # 34
```

```r
shootings$Assault <- 0
shootings$Assault[assaultIndicator] <- 1
table(shootings$Assault)
assault.shootings <- shootings[shootings$Assault == 1, ]

# YEARLY ASSAULT WEAPONS FATALITIES DATA
assault.dat <- aggregate(assault.shootings[c("Fatalities", "total")],
    list(assault.shootings$Year), sum)
names(assault.dat) <- c("Year", "Assault.Fatalities", "Assault.Total")

# merge to all-weapons total fatality data

yearlyDat <- merge(yearlyDat, assault.dat, by = "Year", all.y = T,
    all.x = T)

# replace NAs with 0s
yearlyDat$Assault.Fatalities[is.na(yearlyDat$Assault.Fatalities)] <- 0
yearlyDat$Assault.Total[is.na(yearlyDat$Assault.Total)] <- 0

# calculate rates
yearlyDat$Assault.Rate <- yearlyDat$Assault.Fatalities/yearlyDat$Deaths *
    10000

yearlyDat
table(assault.dat$Year)


# save file
write.csv(yearlyDat, "~/shootingAnalysis/data/yearlyDat.csv")
```

2 Analyses

2.1 Descriptive

```
# read in data
yearlyDat <- read.csv("~/shootingAnalysis/data/yearlyDat.csv",
    header = T, stringsAsFactors = F)

str(yearlyDat)

plot(density(yearlyDat$Rate[!yearlyDat$Rate == 0]))
qqnorm(yearlyDat$Rate[!yearlyDat$Rate == 0])

sum(!yearlyDat$Rate == 0)

# ALL WEAPONS

sum(yearlyDat$Fatalities)  # 501
sum(yearlyDat$Total)  # 1460

sum(yearlyDat$Fatalities)/sum(yearlyDat$Total) * 100  #34.31507
library(binom)
binom.confint(sum(yearlyDat$Fatalities), sum(yearlyDat$Total)) *
    100
# method x n mean lower upper 1 NA 50100 146000 34.31507
# 31.92346 36.78900 2 NA 50100 146000 34.31507 31.87980
# 36.75034 3 NA 50100 146000 34.32580 31.89861 36.76503 4 NA
# 50100 146000 34.31507 31.88735 36.75408 5 NA 50100 146000
# 34.31507 31.87916 36.81425 6 NA 50100 146000 34.31507
# 31.92267 36.78987 7 NA 50100 146000 34.31507 31.91383
# 36.78139 8 NA 50100 146000 34.31507 31.90881 36.77631 9 NA
# 50100 146000 34.31507 31.90947 36.77651 10 NA 50100 146000
# 34.31507 31.89023 36.82338 11 NA 50100 146000 34.31507
# 31.92381 36.78865


sum(yearlyDat$Deaths)  # 489043
sum(yearlyDat$Fatalities)/sum(yearlyDat$Deaths) * 10000  # 10.2445



binom.confint(sum(yearlyDat$Fatalities), sum(yearlyDat$Deaths)) *
    10000
# method x n mean lower upper 1 NA 5010000 4890430000 10.2445
# 9.385387 11.18200 2 NA 5010000 4890430000 10.2445 9.347901
# 11.14110 3 NA 5010000 4890430000 10.2547 9.363933 11.15691
# 4 NA 5010000 4890430000 10.2445 9.380773 11.17531 5 NA
# 5010000 4890430000 10.2445 9.367364 11.18158 6 NA 5010000
# 4890430000 10.2445 9.385980 11.18145 7 NA 5010000
# 4890430000 10.2445 9.383049 11.17797 8 NA 5010000
# 4890430000 10.2445 9.373845 11.16742 9 NA 5010000
# 4890430000 10.2445 9.634146 11.26440 10 NA 5010000
# 4890430000 10.2445 9.376465 11.19181 11 NA 5010000
# 4890430000 10.2445 9.386243 11.18114

plot(yearlyDat$Year, yearlyDat$Fatalities, type = "h")

qplot(yearlyDat$Year, yearlyDat$Fatalities, geom = "bar")


library(ggplot2)
```

```r
library(ggthemes)

# plot yearly deaths

p1 <- ggplot(data = yearlyDat, aes(x = Year, y = Fatalities))
p2 <- p1 + geom_bar(stat = "identity") + ylim(0, 70)
(p3 <- p2 + theme_tufte(base_size = 14, ticks = F) + ylab("Number of Fatalities"))
ggsave("~/shootingAnalysis/jtacsWriteup/fatalitiesBar.jpg", p3)


# higher resolution for revision 3
jpeg("~/shootingAnalysis/jtacsWriteup/jtacsRev3/jtacsFig1_Rev3.jpg",
    units = "in", width = 3, height = 3, res = 400)
p2 + theme_tufte(base_size = 14, ticks = F) + ylab("Number of Fatalities")
dev.off()


# plot yearly case fatality

p1 <- ggplot(data = yearlyDat, aes(x = Year, y = Fatalities/Total *
    100))
p2 <- p1 + geom_point() + geom_smooth()
(p3 <- p2 + theme_tufte(base_size = 14, ticks = F) + ylab("Case Fatality per 100 Total Injuries"))
ggsave("~/shootingAnalysis/jtacsWriteup/CFR.jpg", p3)

# higher resolution for revision 3
jpeg("~/shootingAnalysis/jtacsWriteup/jtacsRev3/jtacsFig2_Rev3.jpg",
    units = "in", width = 5, height = 5, res = 400)
p2 + theme_tufte(base_size = 14, ticks = F) + ylab("Case Fatality per 100 Total Injuries")
dev.off()



# ASSAULT WEAPONS AS PROPORTION OF ALL MASS SHOOTING
# FATALITIES
sum(yearlyDat$Assault.Fatalities)  # 430
binom.confint(sum(yearlyDat$Assault.Fatalities), sum(yearlyDat$Fatalities)) *
    100

# method x n mean lower upper 1 NA 43000 50100 85.82834
# 82.48922 88.62222 2 NA 43000 50100 85.82834 82.77444
# 88.88224 3 NA 43000 50100 85.75697 82.67189 88.76191 4 NA
# 43000 50100 85.82834 82.45762 88.59648 5 NA 43000 50100
# 85.82834 82.46328 88.76310 6 NA 43000 50100 85.82834
# 82.49181 88.61677 7 NA 43000 50100 85.82834 82.55081
# 88.66140 8 NA 43000 50100 85.82834 82.59483 88.69640 9 NA
# 43000 50100 85.82834 82.59488 88.69639 10 NA 43000 50100
# 85.82834 82.39341 88.70034 11 NA 43000 50100 85.82834
# 82.50127 88.61017


# yearly assault weapons proportions
assault.prop <- yearlyDat$Assault.Fatalities/yearlyDat$Fatalities *
    100
assault.prop <- assault.prop[!is.na(assault.prop)]
sum(assault.prop == 100)
length(assault.prop)
sum(assault.prop == 100)/length(assault.prop) * 100
binom.confint(sum(assault.prop == 100), length(assault.prop)) *
```

```
    100
# method x n mean lower upper 1 NA 1500 2400 62.5 42.63913
# 78.91146 2 NA 1500 2400 62.5 43.13141 81.86859 3 NA 1500
# 2400 62.0 43.31398 80.16779 4 NA 1500 2400 62.5 40.30197
# 78.42091 5 NA 1500 2400 62.5 40.59364 81.20071 6 NA 1500
# 2400 62.5 42.17563 79.20322 7 NA 1500 2400 62.5 42.38154
# 79.65669 8 NA 1500 2400 62.5 42.58821 79.86949 9 NA 1500
# 2400 62.5 42.58785 79.87026 10 NA 1500 2400 62.5 40.75759
# 80.44981 11 NA 1500 2400 62.5 42.70996 78.84063



# proportion during the ban
yearlyDat2 <- yearlyDat[yearlyDat$Ban1 == 1, ]

yearlyDat2
assault.prop2 <- yearlyDat2$Assault.Fatalities/yearlyDat2$Fatalities *
    100
assault.prop2 <- assault.prop2[!is.na(assault.prop2)]
sum(assault.prop2 == 100)
length(assault.prop2)
sum(assault.prop2 == 100)/length(assault.prop2) * 100
binom.confint(sum(assault.prop == 100), length(assault.prop)) *
    100

nrow(yearlyDat2)
4/11
```

2.2 Analytic

```
library(ggplot2)
p.tot1 <- ggplot(data = yearlyDat, aes(x = Year, y = Rate))
(p.tot2 <- p.tot1 + geom_point() + geom_smooth(method = "lm") +
    ylim(-20, 100))

# function to add regression equation to ggplot
lm_eqn <- function(df) {
    m <- lm(Rate ~ Year, df)
    eq <- substitute(italic(y) == a + b %.% italic(x) * "," ~
        ~italic(r)^2 ~ "=" ~ r2, list(a = format(coef(m)[1],
        digits = 2), b = format(coef(m)[2], digits = 2), r2 = format(summary(m)$r.squared,
        digits = 3)))
    as.character(as.expression(eq))
}

(p.tot3 <- p.tot2 + geom_text(x = 1990, y = 75, label = lm_eqn(yearlyDat),
    parse = TRUE) + ylab("Rate per 10,000 Firearm Homicides") +
    theme_bw())

# undeniable increase in the proportion of these incidents as
# a cause of homicide firearm deaths since 1980, at the rate
# of an additional 1 death per 10,000 homicide firearm deaths
# per year.

ggsave("~/shootingAnalysis/jtacsWriteup/shootingsAsProportionHomicides.jpg",
    p.tot3)
```

```r
# plot pre-ban, ban and post-ban years:
p.tot1 <- ggplot(data = yearlyDat, aes(x = Year, y = Rate, shape = factor(Ban1,
    labels = c("No", "Yes"))))
(p.tot2 <- p.tot1 + geom_point() + geom_smooth(method = "lm") +
    ylim(-20, 100)) + labs(shape = "Assault Rifle Ban")
(p.tot3 <- p.tot2 + ylab("Rate per 10,000 Firearm Homicides") +
    theme_bw() + labs(shape = "Assault Rifle Ban"))
ggsave("~/shootingAnalysis/jtacsWriteup/shootingHomicideRateStrat1.jpg",
    p.tot3)


p.tot1 <- ggplot(data = yearlyDat, aes(x = Year, y = Rate, shape = factor(Ban2,
    labels = c("Pre", "Ban", "Post"))))
(p.tot2 <- p.tot1 + geom_point() + geom_smooth(method = "lm") +
    ylim(-20, 60)) + labs(shape = "Assault Rifle Ban")
(p.tot3 <- p.tot2 + ylab("Rate per 10,000 Firearm Homicides") +
    theme_bw() + labs(shape = "Assault Rifle Ban"))
ggsave("~/shootingAnalysis/jtacsWriteup/shootingHomicideRateStrat2.jpg",
    p.tot3)

# higher resolution plot for revision 3:
jpeg("~/shootingAnalysis/jtacsWriteup/jtacsRev3/jtacsFig3_Rev3.jpg",
    units = "in", width = 5, height = 5, res = 400)
p.tot2 + ylab("Rate per 10,000 Firearm Homicides") + theme_bw() +
    labs(shape = "Assault Rifle Ban")
dev.off()


# SUBSET PLOTS BY ASSAULT WEAPONS

p.tot1 <- ggplot(data = yearlyDat, aes(x = Year, y = Assault.Rate))
(p.tot2 <- p.tot1 + geom_point() + geom_smooth(method = "lm") +
    ylim(-20, 100))
(p.tot3 <- p.tot2 + geom_text(x = 1990, y = 75, label = lm_eqn(yearlyDat),
    parse = TRUE) + ylab("Rate per 10,000 Firearm Homicides") +
    theme_bw())

ggsave("~/shootingAnalysis/jtacsWriteup/shootingsAsProportionHomicides_Assault.jpg",
    p.tot3)

p.tot1 <- ggplot(data = yearlyDat, aes(x = Year, y = Assault.Rate,
    shape = factor(Ban2, labels = c("Pre", "Ban", "Post"))))
(p.tot2 <- p.tot1 + geom_point() + geom_smooth(method = "lm") +
    ylim(-20, 60)) + labs(shape = "Assault Rifle Ban")
(p.tot3 <- p.tot2 + ylab("Assault Rifle Rate per 10,000 Firearm Homicides") +
    theme_bw() + labs(shape = "Assault Rifle Ban"))
ggsave("~/shootingAnalysis/jtacsWriteup/shootingHomicideRateStrat_Assault.jpg",
    p.tot3)

# higher resolution plot for revision 3:
jpeg("~/shootingAnalysis/jtacsWriteup/jtacsRev3/jtacsFig4_Rev3.jpg",
    units = "in", width = 5, height = 5, res = 400)
p.tot2 + ylab("Assault Rifle Rate per 10,000 Firearm Homicides") +
    theme_bw() + labs(shape = "Assault Rifle Ban")
dev.off()


# LINEAR REGRESSIONS
```

```r
# ALL THE DATA

# effect of year alone
mod1 <- lm(Rate ~ Year, data = yearlyDat)
summary(mod1)  # year is (as in the graph) clearly meaninfully and statistically significant

# Call: lm(formula = Rate ~ Year, data = yearlyDat)
# Residuals: Min 1Q Median 3Q Max -15.670 -7.601 -2.620 5.059
# 30.208 Coefficients: Estimate Std. Error t value Pr(>|t|)
# (Intercept) -1411.9579 351.1999 -4.02 0.000294 *** Year
# 0.7116 0.1757 4.05 0.000270 *** --- Signif. codes: 0 '***'
# 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard
# error: 11.41 on 35 degrees of freedom Multiple R-squared:
# 0.3191, Adjusted R-squared: 0.2997 F-statistic: 16.4 on 1
# and 35 DF, p-value: 0.0002699


# effect of year and ban
mod2 <- lm(Rate ~ Year + Ban1, data = yearlyDat)
summary(mod2)  #

# Call: lm(formula = Rate ~ Year + Ban1, data = yearlyDat)
# Residuals: Min 1Q Median 3Q Max -18.238 -5.801 -1.630 2.492
# 28.869 Coefficients: Estimate Std. Error t value Pr(>|t|)
# (Intercept) -1409.3901 333.0214 -4.232 0.000166 *** Year
# 0.7116 0.1666 4.271 0.000148 *** Ban1 -8.6370 3.8915 -2.219
# 0.033233 * --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*'
# 0.05 '.' 0.1 ' ' 1 Residual standard error: 10.82 on 34
# degrees of freedom Multiple R-squared: 0.4053, Adjusted
# R-squared: 0.3703 F-statistic: 11.58 on 2 and 34 DF,
# p-value: 0.0001456




# ASSAULT RIFLE DATA

mod3 <- lm(Assault.Rate ~ Year, data = yearlyDat)
# year alone
summary(mod3)  #

# Call: lm(formula = Assault.Rate ~ Year, data = yearlyDat)
# Residuals: Min 1Q Median 3Q Max -13.247 -7.241 -3.547 1.995
# 32.813 Coefficients: Estimate Std. Error t value Pr(>|t|)
# (Intercept) -1221.7082 343.0637 -3.561 0.00109 ** Year
# 0.6157 0.1716 3.588 0.00101 ** --- Signif. codes: 0 '***'
# 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual standard
# error: 11.15 on 35 degrees of freedom Multiple R-squared:
# 0.2689, Adjusted R-squared: 0.248 F-statistic: 12.87 on 1
# and 35 DF, p-value: 0.00101

# year and ban
mod4 <- lm(Assault.Rate ~ Year + Ban1, data = yearlyDat)
summary(mod4)


# Call: lm(formula = Assault.Rate ~ Year + Ban1, data =
# yearlyDat) Residuals: Min 1Q Median 3Q Max -15.239 -6.225
# -2.531 1.487 30.820 Coefficients: Estimate Std. Error t
```

```r
# value Pr(>|t|) (Intercept) -1219.7156 333.8863 -3.653
# 0.000864 *** Year 0.6157 0.1670 3.686 0.000788 *** Ban1
# -6.7024 3.9016 -1.718 0.094923 .  --- Signif. codes: 0
# '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1 Residual
# standard error: 10.85 on 34 degrees of freedom Multiple
# R-squared: 0.3273, Adjusted R-squared: 0.2877 F-statistic:
# 8.27 on 2 and 34 DF, p-value: 0.001184


# RELATIVE EFFECTS

# Odds Ratio
(53 * 348528)/(448 * 140515)  # 0.2934356

# Relative Risk
(53/140515)/(448/348528)  # 0.2934356



library(epitools)

# odds ratio

epitab(c(sum(yearlyDat$Fatalities[yearlyDat$Ban1 == 1]), sum(yearlyDat$Deaths[yearlyDat$Ban1 ==
    1]), sum(yearlyDat$Fatalities[yearlyDat$Ban1 == 0]), sum(yearlyDat$Deaths[yearlyDat$Ban1 ==
    0])), method = "oddsratio")

# £tab Outcome Predictor Disease1 p0 Disease2 p1 oddsratio
# lower upper p.value Exposed1 53 0.1057884 140515 0.2873265
# 1.0000000 NA NA NA Exposed2 448 0.8942116 348528 0.7126735
# 0.2934356 0.2207187 0.3901094 9.860126e-23 £measure [1]
# 'wald' £conf.level [1] 0.95 £pvalue [1] 'fisher.exact'



# risk ratio
dat <- c(sum(yearlyDat$Fatalities[yearlyDat$Ban1 == 1]), sum(yearlyDat$Deaths[yearlyDat$Ban1 ==
    1]), sum(yearlyDat$Fatalities[yearlyDat$Ban1 == 0]), sum(yearlyDat$Deaths[yearlyDat$Ban1 ==
    0]))

epitab(dat[c(4, 3, 2, 1)], method = "riskratio")
```

2.3 Sensitivity Analyses and Alternate Model

```r
# I. regresion analysis restricted to data ending in 2016

yearlyDat2 <- yearlyDat[yearlyDat$Year != 2017, ]

mod6 <- lm(Rate ~ Year + Ban1, data = yearlyDat2)
summary(mod6)


# all: lm(formula = Rate ~ Year + Ban1, data = yearlyDat2)
# Residuals: Min 1Q Median 3Q Max -16.475 -5.771 -2.304 2.070
# 29.256 Coefficients: Estimate Std. Error t value Pr(>|t|)
# (Intercept) -1263.2917 340.4854 -3.710 0.000760 *** Year
# 0.6381 0.1704 3.745 0.000689 *** Ban1 -7.9753 3.8425 -2.076
# 0.045805 * --- Signif. codes: 0 '***' 0.001 '**' 0.01 '*'
```

```
# 0.05 ‘.’ 0.1 ‘ ’ 1 Residual standard error: 10.61 on 33
# degrees of freedom Multiple R-squared: 0.3511, Adjusted
# R-squared: 0.3118 F-statistic: 8.928 on 2 and 33 DF,
# p-value: 0.0007957


# II. regression with extrapolated CDC WISQARS
# denominator-based rates

library(Hmisc)
approxExtrap(1:36, yearlyDat2$Deaths, xout = c(0, 37))
# £x [1] 0 37 £y [1] 16348 15851

yearlyDat3 <- yearlyDat

yearlyDat3$Deaths[yearlyDat3$Year == 2017] <- 15851
yearlyDat3$Rate <- yearlyDat3$Fatalities/yearlyDat3$Deaths *
    10000

mod7 <- lm(Rate ~ Year + Ban1, data = yearlyDat3)
summary(mod7)

# Call: lm(formula = Rate ~ Year + Ban1, data = yearlyDat3)
# Residuals: Min 1Q Median 3Q Max -18.169 -5.796 -1.650 2.546
# 28.869 Coefficients: Estimate Std. Error t value Pr(>|t|)
# (Intercept) -1403.7169 332.1860 -4.226 0.000169 *** Year
# 0.7087 0.1662 4.265 0.000151 *** Ban1 -8.6113 3.8818 -2.218
# 0.033310 * --- Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’
# 0.05 ‘.’ 0.1 ‘ ’ 1 Residual standard error: 10.79 on 34
# degrees of freedom Multiple R-squared: 0.4047, Adjusted
# R-squared: 0.3696 F-statistic: 11.56 on 2 and 34 DF,
# p-value: 0.0001482




# III. regression with population denominator-based rates

yearlyDat$Rate2 <- yearlyDat$Fatalities/yearlyDat$Population *
    1e+07

mod8 <- lm(Rate2 ~ Year + Ban1, data = yearlyDat)
summary(mod8)

# Call: lm(formula = Rate2 ~ Year + Ban1, data = yearlyDat)
# Residuals: Min 1Q Median 3Q Max -0.7904 -0.2580 -0.1065
# 0.1205 1.1182 Coefficients: Estimate Std. Error t value
# Pr(>|t|) (Intercept) -52.770053 14.570089 -3.622 0.000943
# *** Year 0.026688 0.007289 3.662 0.000844 *** Ban1
# -0.406289 0.170260 -2.386 0.022730 * --- Signif. codes: 0
# ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 Residual
# standard error: 0.4734 on 34 degrees of freedom Multiple
# R-squared: 0.3597, Adjusted R-squared: 0.3221 F-statistic:
# 9.551 on 2 and 34 DF, p-value: 0.0005109


# IV. Poisson models

library(lme4)
```

```r
str(yearlyDat)

yearlyDat$Year2 <- yearlyDat$Year - 1981
m1 <- glmer(Fatalities ~ Year2 + Ban1 + (1 | Year2), offset = log(Population),
    family = poisson(link = log), data = yearlyDat)
m2 <- glmer(Fatalities ~ Year2 + Ban1 + (1 | Year2), offset = log(Deaths),
    family = poisson(link = log), data = yearlyDat)
summary(m1)  #model based on US population
# Generalized linear mixed model fit by maximum likelihood
# (Laplace Approximation) ['glmerMod'] Family: poisson ( log
# ) Formula: Fatalities ~ Year + Ban1 + (1 | Year) Data:
# yearlyDat Offset: log(Population) AIC BIC logLik deviance
# df.resid 247.8 254.3 -119.9 239.8 33 Scaled residuals: Min
# 1Q Median 3Q Max -0.76374 -0.59259 -0.04006 0.14276 0.35147
# Random effects: Groups Name Variance Std.Dev.  Year
# (Intercept) 2.224 1.491 Number of obs: 37, groups: Year, 37
# Fixed effects: Estimate Std. Error z value Pr(>|z|)
# (Intercept) -19.18675 0.64844 -29.589 < 2e-16 *** Year
# 0.09006 0.02707 3.327 0.000878 *** Ban1 -1.94327 0.66651
# -2.916 0.003550 ** --- Signif. codes: 0 ‘***’ 0.001 ‘**’
# 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 Correlation of Fixed Effects:
# (Intr) Year Year -0.866 Ban1 -0.185 -0.019


exp(0.09006)  # 1.09424

exp(-1.94327)  # 0.1432348

confInt <- exp(confint(m1))
confInt[-2, ]
# 2.5 % 97.5 % .sig01 2.89468379 9.0037300 Year2 1.04068382
# 1.1642592 Ban1 0.03194039 0.5046089





summary(m2)  #model based on total number of US firearm deaths
# Generalized linear mixed model fit by maximum likelihood
# (Laplace Approximation) ['glmerMod'] Family: poisson ( log
# ) Formula: Fatalities ~ Year + Ban1 + (1 | Year) Data:
# yearlyDat Offset: log(Deaths) AIC BIC logLik deviance
# df.resid 247.7 254.2 -119.9 239.7 33 Scaled residuals: Min
# 1Q Median 3Q Max -0.7605 -0.6063 -0.0320 0.1304 0.3623
# Random effects: Groups Name Variance Std.Dev.  Year
# (Intercept) 2.206 1.485 Number of obs: 37, groups: Year, 37
# Fixed effects: Estimate Std. Error z value Pr(>|z|)
# (Intercept) -9.53099 0.64793 -14.710 < 2e-16 *** Year
# 0.10543 0.02702 3.901 9.56e-05 *** Ban1 -1.83766 0.66251
# -2.774 0.00554 ** --- Signif. codes: 0 ‘***’ 0.001 ‘**’
# 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1 Correlation of Fixed Effects:
# (Intr) Year Year -0.867 Ban1 -0.188 -0.017

exp(0.10543)  # 1.111188

exp(-1.83766)  # 0.1591895

confInt2 <- exp(confint(m2))
confInt2[-2, ]
```

```
# 2.5 % 97.5 % .sig01 2.88031263 8.9297553 Year2 1.05692254
# 1.1821701 Ban1 0.03576668 0.5563576


# V. total prevented deaths

# multiply regression results, 9 per 10,000 homicides per
# year by number of homicides during non awb periods

sum((9/10000) * (yearlyDat$Deaths[yearlyDat$Ban1 == 0]))  # 313.6752

# total mass shooting deaths during the non-ban period
sum(yearlyDat$Fatalities[yearlyDat$Ban1 == 0])  # 448

314/448 * 100  # 70% (roughly consistent with the results of our generalized linear model...)
```