School Protection Brigades power calculations

Javier Osorio

v.1.2

Assumptions

The power calculation is based on the following assumptions:

- Each School Protection Brigade (SPB) is considered as a unit of analysis
- The pool of potential units includes all 2,242 schools in Mexico City
- The perimeter of interest has a radius of 300m around the school
- The treatment and control schools are balanced
- Violent crimes in the perimeter of interest are distributed as:
    - Mean = 48.924
    - Standard Deviation = 46.59
- The menu of violent crimes includes 84 different crime categories.[1]

Power calculations

The power analysis considers the following scenarios:

Case 1. Weak Effect

Sample size for a given power:

- Power = 80%
- Intervention effect = 4.6 less violent crimes
- Corresponds to a 10% decline

```
# Sample size for a given power
p.out1 <-power.t.test(power=0.8,
                      delta=4.6,
                      sd=46.59,
                      type="two.sample")
p.out1
```

```
##
##      Two-sample t test power calculation
##
##              n = 1611.263
##          delta = 4.6
##             sd = 46.59
##      sig.level = 0.05
##          power = 0.8
##    alternative = two.sided
##
## NOTE: n is number in *each* group
```

To detect an effect of -4.6 crimes with a probability of 80%, the study needs 1611 schools in each group.

Which corresponds to a total number of 3223 schools.

Unfortunately, the costs associated with covering such a large number of schools does not make this option feasible.

Case 2. Moderate Weak Effect

Sample size for a given power:

- Power = 80%
- Intervention effect = 7.3 less violent crimes
- Corresponds to a 15% decline

```
# Sample size for a given power
p.out2 <-power.t.test(power=0.8,
                      delta=7.3,
                      sd=46.59,
                      type="two.sample")
p.out2
```

```
##
##      Two-sample t test power calculation
##
##               n = 640.3688
##           delta = 7.3
##              sd = 46.59
##       sig.level = 0.05
##           power = 0.8
##     alternative = two.sided
##
## NOTE: n is number in *each* group
```

To detect an effect of -7.3 crimes with a probability of 80%, the study needs 640 schools in each group.

Which corresponds to a total number of 1281 schools.

Unfortunately, the costs associated with covering such a large number of schools does not make this option feasible.

Case 3. Moderate Effect

Sample size for a given power:

- Power = 80%
- Intervention effect = 9.3 less violent crimes
- Corresponds to a 20% decline

```
# Sample size for a given power
p.out3 <-power.t.test(power=0.8,
                      delta=9.3,
                      sd=46.59,
                      type="two.sample")
p.out3
```

```
##
##        Two-sample t test power calculation
##
##              n = 394.9273
##          delta = 9.3
##             sd = 46.59
##      sig.level = 0.05
##          power = 0.8
##    alternative = two.sided
##
## NOTE: n is number in *each* group
```

To detect an effect of -9.3 crimes with a probability of 80%, the study needs 395 schools in each group.

Which corresponds to a total number of 790 schools.

Case 4. Moderate Strong Effect

Sample size for a given power:

- Power = 80%
- Intervention effect = 12.2 less violent crimes
- Corresponds to a 25% decline

```
# Sample size for a given power
p.out4 <-power.t.test(power=0.8,
                      delta=12.2,
                      sd=46.59,
                      type="two.sample")
p.out4
```

```
##
##        Two-sample t test power calculation
##
##              n = 229.8947
##          delta = 12.2
##             sd = 46.59
##      sig.level = 0.05
##          power = 0.8
##    alternative = two.sided
##
## NOTE: n is number in *each* group
```

To detect an effect of -12.2 crimes with a probability of 80%, the study needs 230 schools in each group.

Which corresponds to a total number of 460 schools.

Case 5. Strong Effect

Sample size for a given power:

- Power = 80%
- Intervention effect = 13.9 less violent crimes
- Corresponds to a 30% decline

```
# Sample size for a given power
p.out5 <-power.t.test(power=0.8,
                      delta=13.9,
                      sd=46.59,
                      type="two.sample")
p.out5
```

```
##
##          Two-sample t test power calculation
##
##                  n = 177.3228
##              delta = 13.9
##                 sd = 46.59
##          sig.level = 0.05
##              power = 0.8
##        alternative = two.sided
##
## NOTE: n is number in *each* group
```

To detect an effect of -13.9 crimes with a probability of 80%, the study needs 177 schools in each group.

Which corresponds to a total number of 355 schools.

Power against sample size

The following graph presents the power calculation and the optima number of observations for scenarios 3, 4, and 5. This excludes scenarios 1 and 2, which are not feasible due to their large number of schools.

```
# Get power calculatons
samplesizes <- seq(from=0,to=800,by=10)
#pwr.1 <-power.t.test(n=samplesizes,delta=4.6  ,sd=46.59,type="two.sample")$power
#pwr.2 <-power.t.test(n=samplesizes,delta=7.3  ,sd=46.59,type="two.sample")$power
pwr.3 <-power.t.test(n=samplesizes,delta=9.3   ,sd=46.59,type="two.sample")$power
pwr.4 <-power.t.test(n=samplesizes,delta=12.2 ,sd=46.59,type="two.sample")$power
pwr.5 <-power.t.test(n=samplesizes,delta=13.9 ,sd=46.59,type="two.sample")$power

# Generate plot
plot(samplesizes, pwr.3, type="b", col="skyblue1", lwd=2, axes=FALSE, ylab="", xlab="" )
par(new=TRUE)
plot(samplesizes, pwr.4, type="b", col="dodgerblue", lwd=2, axes=FALSE, ylab="", xlab="" )
par(new=TRUE)
plot(samplesizes, pwr.5,type="b", col="mediumblue", lwd=2, axes=FALSE,
     xlim=c(0,800), xlab="Sample size", ylab="Expected power", ylim=c(0,1))
axis(1,at=c(0,200,400,600,800))
axis(2,at=c(0,0.2,0.4,0.6,0.8,1),labels=paste(c(0,20,40,60,80,100),"%"))
abline(h=0.8, col="red", lty=2)
abline(v=p.out3$n, col="skyblue1", lty=2)
abline(v=p.out4$n, col="dodgerblue", lty=2)
abline(v=p.out5$n, col="mediumblue", lty=2)
legend(500, 0.3, legend=c("delta=13.9", "delta=12.2", "delta=9.3"),
       col=c("mediumblue", "dodgerblue", "skyblue1"), lwd=2:2, lty=1:1, cex=0.8, box.lty=0)
```
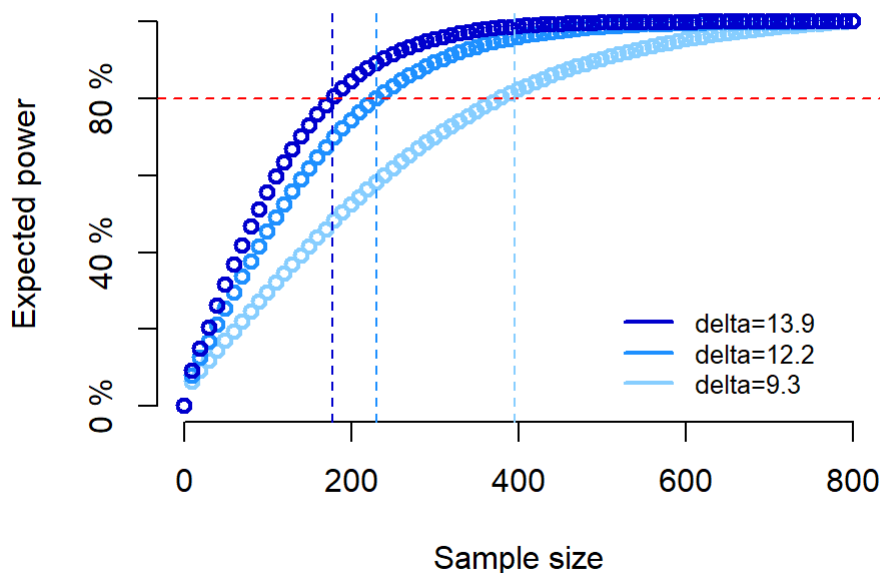
Summary

Based on the power calculations, the following scenarios indicate the number of schools necessary to detect with 80% probability an effect within a radius of 300m.

Effect	% effect	# Crimes	Schools per group	Total Schools	Feasible
Weak	-10%	-4.6	1611	3223	No
Moderate Weak	-15%	-7.3	640	1281	No
Moderate	-20%	-9.3	395	790	Yes
Moderate Strong	-25%	-12.2	230	460	Yes
Strong	-30%	-13.9	177	355	Yes

Selected Design

Based in the previous power calculation, the project will pursue the following research design:

```
# Effect for a given power and sample size
design.1 <-power.t.test(power=0.8,
                        n=300,
                        sd=46.59,
                        type="two.sample")
```

- **Number of schools in each group = 300**
- **Total number of schools = 600**
- **Power = 80%**
- **Expected intervention effect = 11 less violent crimes**
- **Expected effect proportion = -22.91%**

This research design represents the best possible balance between maximizing the probability of detecting a relatively moderate effect while keeping the project within the realm of cost feasibility, time of implementation, and operational capacity in the field.

Alternative Approaches

To increase the probability of detecting an effect, the research team could consider the following approaches:

1. **Focus on hot-spots**:

   - Conduct a preliminary analysis to identify hot-spots of violent crime around schools.
   - The set of hot-spots, would constitute the population from which we could draw the sample of schools for the intervention.
   - This assumes that schools in crime hot-spots have a higher mean and a smaller standard deviation than the ones considered here.
2. **Consider 911 calls**:

   - The analysis could consider 911 calls as indicator to assess the impact of the intervention.
   - This assumes that the number of 911 calls related to violent crimes is higher than the number of crimes reported in official statistics.

1. The specific violent crimes included in the sutdy are: Sexual Abuse; Sexual Harassment; Breaking and Entering; Threats; Attack on the Roads of Communication (Damage to Roads or Means of Transportation); Attack on the General Ways of Communication; Attacks on the Public Peace; Intentional Damage to Owned Property; Intentional Property Damage to Automobile; Intentional Property Damage to Real Estate Property; Intentional Property Damage to Home Room; Intentional Property Damage to Business; Intentional Damage to Own Property to Ways of Communication; Crimes Against Health (Drug trafficking); Forced Disappearance of Persons; Firearm Shots; Extortion; Feminicide; Homicide by White Gun; Homicide by Firearm; Homicide by Beating; Intentional Homicides (Other); Intimidation; Intentional Injuries; Intentional Injuries by White Weapon; Intentional Injuries by Firearm; Intentional Injuries from Strikes; Intentional Injuries and Vehicle Theft; Drug Possession for Purposes of Sale, Trade and Supply; Simple Drug Possession; Kidnapping; Carrying Prohibited Weapon; Carrying Firearm; Kidnapping and Vehicle Theft; Kidnapping; Kidnapping (To Perform A Sexual Act); Home Robbery Violence; Home Robbery and Vehicle with Violence; Business Robbery with Violence; Theft from Business and Vehicle with Violence; Robbery from Public Office with Violence; Theft of A Passenger / Taxi Driver with Violence; Robbery to Passenger on Board A Metro with Violence; Robbery to Passenger on Board A Metrobus with Violence; Robbery to Passenger on Board A Collective Bus with Violence; Robbery to Passenger on Board A Taxi with Violence; Robbery to Passenger on Board of Public Transportation with Violence; Robbery to Passenger on A Foreign Bus with Violence; Robbery to Passenger in Ecobus with Violence; Theft to Passenger in RTP with Violence; Robbery to Passenger in A Trolebus with Violence; Robbery to Dealer with Violence; Theft to Dealer and Vehicle with Violence; Theft to Bank Branch (Bank Assault) with Violence; Theft to Bank Branch (Supermarket) with Violence; Theft to Cell Phone with Violence; Robbery to Pedestrian in Hotel with Violence; Robbery to Pedestrian in Business with Violence; Robbery to Pedestrian in Parks and Markets with Violence; Robbery to A Restaurant with Violence; Robbery to Passenger in Passenger Terminal with Violence; Robbery to Bystanding on Public Road with Violence; Robbery to Pedestrian Leaving the Bank with Violence; Robbery to Passenger Leaving the Atm with Violence; Robbery to Pedestrian and Vehicle with Violence; Theft from Carrier and Heavy Vehicle with Violence; Theft of Machinery with Violence; Motorcycle Theft with Violence; Theft of a Transportation Service Vehicle with Violence; Theft of a Particular Service Vehicle with Violence; Theft of a Public Service Vehicle with Violence; Theft Inside a Company (Payroll) with Violence; Child Abduction; Extorsion Attempt; Homicide Attempt; Attempted Robbery; Vehicle Theft Attempt; Attempted Violation; Torture; Trafficking in Persons; Violation; Equipped Rape; Gang Rape; and Domestic Violence.↩