Alcohol outlets, drug paraphernalia sales, and neighborhood drug overdose

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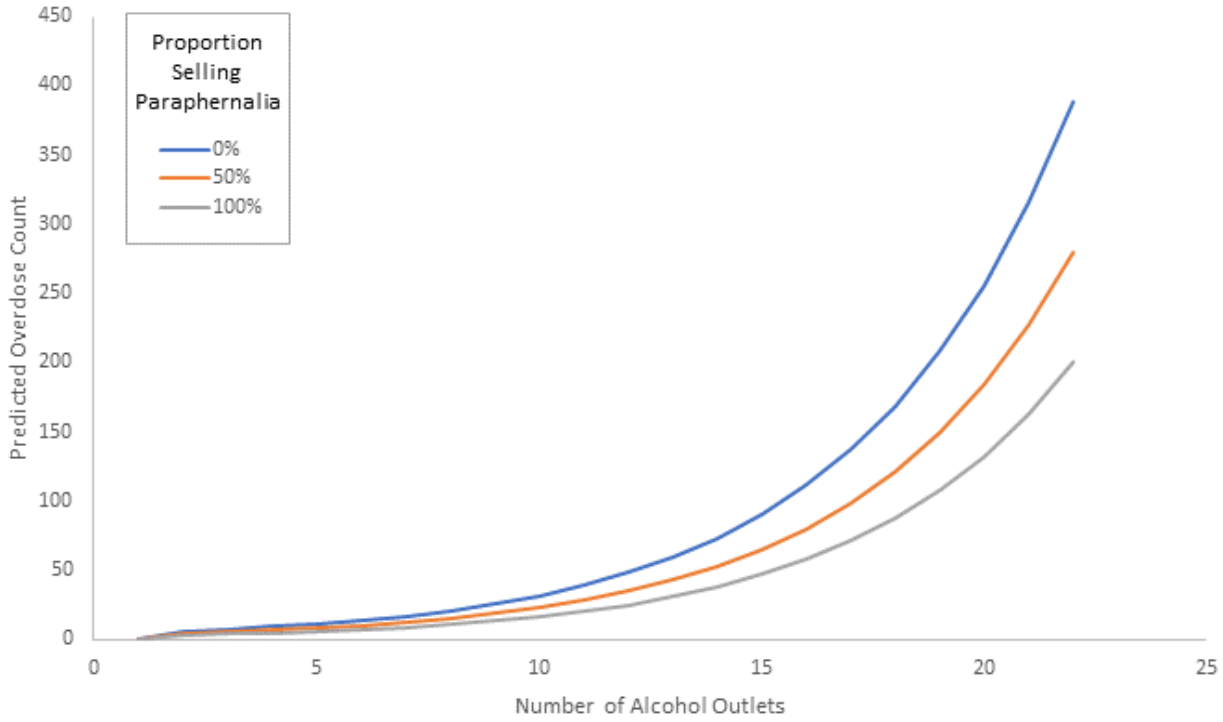
SUPPLEMENTAL MATERIAL

Figure A. Plot of predictions of neighborhood drug overdose count and proportion of off-premise alcohol outlets that sell drug paraphernalia



Note: Controlling for neighborhood disadvantage score and median household income (see Table 3).

Appendix A. Sample R code[1]

We used the MASS package[2] to build negative binomial models. We then used the spdep[3,4] package to calculate spatial residuals and Residual Moran's *I*. Sample R code is included below.

```
#Build Model
mod<-glm.nb(n~x1+x2+x3,data=bg_data)
#Exponentiated Betas
round(exp(coef(mod)),3)
#95% confidence intervals
round(exp(confint(mod)),3)
#p-values
coef(summary(mod))[,4]
#AIC
AIC(mod)

#Calculate residual values and align spatially
resids<-(mod$y-mod$fitted.values)/sqrt(mod$fitted.values)
geo<-as.geodata(cbind(dataset_run_15$x/5280,dataset_run_15$y/5280,resids))

#Produce model semivariogram
v<-variog(geo,max.dist=sqrt((max(map$y)-min(map$y))^2+(max(map$x)-
min(map$x))^2)/2)

#Calculate overdispersion
X.Model<-sum(resids^2)
X.Model

#Moran's test for spatial autocorrelation using a spatial weights matrix
moran.test(resids,nb2listw(map,style="B"))

#Permutation test for Moran's I statistic
moran.mc(resids,nb2listw(map,style="B"),nsim=999)
```


References:

1. R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing; 2018. http://www.r-project.org/.
2. Venables WN, Ripley BD (2002). *Modern Applied Statistics with S*, Fourth edition. Springer, New York. ISBN 0-387-95457-0, http://www.stats.ox.ac.uk/pub/MASS4/.
3. Bivand R, Wong DWS (2018). "Comparing implementations of global and local indicators of spatial association." *TEST*, **27**(3), 716–748. https://doi.org/10.1007/s11749-018-0599-x.
4. Bivand RS, Pebesma E, Gomez-Rubio V (2013). *Applied spatial data analysis with R, Second edition*. Springer, NY. http://www.asdar-book.org/.

Appendix B. Spatial lag of alcohol outlets

Because patrons of off-premise alcohol outlets may drink in nearby, uncontrolled environments, we expect the spatial scale for this mechanism to be very small, within 50-100m of the alcohol outlet; therefore, we expect most of the effect to be observable within the same block group as the alcohol outlet. However, it is possible that the rate for drug overdose in one census block group is spatially autocorrelated with the rate in adjoining block groups because areal units are arbitrary[1] and people freely travel across adjoining block groups. The spatial lag accounts for overdose rate associated with alcohol outlets in the surrounding census block groups, creating a weighted average of alcohol outlets over the local area.[2] This smooths the census block group overdose rate associated with alcohol outlets and suggests possible spillover effects that could arise due to people's movements across block groups. We investigated the spatial lag of off-premise alcohol outlets to account for spillover effects in drug overdose rates. This also separates the neighborhood overdose rate into two components—the rate associated with alcohol outlets within the block group and the rate associated with overdoses in the adjoining block groups. While the lagged variable was significantly associated with neighborhood overdose rate, the model with the lagged variable showed significant unexplained spatial variation. This suggests a need for further investigation into activity around alcohol outlets that may contribute to drug overdose.

Variable	**Off-Premise*** IRR (95% CI)	**p**	**Off-Premise (lagged)*** IRR (95% CI)	**p**
Off-premise alcohol outlets	1.17 (1.11, 1.23)	<0.001	1.09 (1.05, 1.13)	<0.001
Off-premise alcohol outlets (lagged)			1.05 (1.04, 1.06)	<0.001
Neighborhood disadvantage score (-5 to +5)	1.28 (1.18, 1.39)	<0.001	1.14 (1.05, 1.24)	<0.001
Segregation (ICE) (-1 to +1)	1.25 (1.03, 1.52)	0.002	0.95 (0.79, 1.14)	0.61
Median household income (in $10,000s)	0.90 (0.85, 0.96)	<0.001	0.89 (0.84, 0.95)	<0.001
AIC	3495		3413	
RMI	0.009	0.307	0.039	0.026

Note: From negative binomial regression
*Adjusted for other covariates in the column

References:

1. Coulton CJ, Korbin J, Chan T, Su M. Mapping residents' perceptions of neighborhood boundaries: a methodological note. Am J Community Psychol. 2001;29(2):371-383.
2. Bivand RS, Pebesma E, Gomez-Rubio V (2013). *Applied spatial data analysis with R, Second edition*. Springer, NY. http://www.asdar-book.org/.