

Building Demolitions and Police-Reported Crime in Philadelphia from 2013-2022

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**Abstract**

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**Introduction:** Vacant properties in urban cities have been shown to be associated with increases in all police-reported crime and violent police-reported crime incidents. Building demolitions conducted in the name of blight removal are of increasing interest as non-carceral violence prevention methods. **Objective:** Our study aim was to examine if buildings demolished for safety reasons in Philadelphia were associated with changes in counts of any police-reported crime and violent police-reported crime from the years of 2013-2022. **Methods:** Using open-source data from OpenDataPhilly, we identified a cohort of 3,331 safety building demolitions and established a 500-meter geographic buffer in which counts of any police-reported crime and violent police-reported crime pre-demolition would be compared to counts post-demolition. A quasi-experimental linear mixed effects model was used to test the association between

demolitions and crime. **Results:** An overall decrease in any criminal incidents reported to police across all years in the study was associated with safety demolitions. A similar association between decrease in incidents reported to police was observed for violent crime with a reduction by 4.706 counts (95% CI: 4.95, -4.46). **Conclusion:** These findings indicate safety building demolitions as a potential method of place-based violence interventions for all types of police-reported crime and violent police-reported crime.

## INTRODUCTION

The dramatic manufacturing decline in many major United States cities following the Industrial Revolution has contributed to urban disinvestment and suburbanization, which is often linked to vacant properties and associated incidents of crime.<sup>1,2</sup> Urban disinvestment causes pervasive deterioration of neighborhood conditions and as such, vacant properties have become a commonality in many post-industrial cities.<sup>3</sup> Clusters of vacant buildings have become “hot spots of crime” with all types of crime, violent crime, and property crime incidents occurring at higher counts compared to areas without vacant buildings.<sup>4,5,6</sup>

Unsafe vacant buildings that have yet to be demolished also have implications on community health and resident safety. Not only are these buildings structurally hazardous, but neighborhoods with large quantities of vacant properties are associated with increased risk of assaults, premature mortality, and drug-dependence mortality.<sup>7-9</sup> Furthermore, the Broken windows theory has been linked to vacant buildings with neighborhood disorder signifying that crimes committed in such areas are more likely to go without being apprehended compared to areas with lesser or no vacant buildings.<sup>10</sup> This creates decreased social connectiveness and an increase in fear of crime within neighborhoods.<sup>11</sup> Areas with higher concentrations of neighborhood disadvantage are correlated with more vacant buildings, increases in crime, and less neighborly trust.<sup>11-16</sup>

It is understood that there are relationships between crime and place, with some literature supporting the usage of place-based interventions such as building demolitions conducted in the name of blight removal as ways to stem violence.<sup>1,17</sup> Existing studies have taken place in post-industrial cities such as Cleveland, Detroit,

Baltimore, and Rochester, due to the large number of vacant buildings with prior findings having demonstrated mixed outcomes of building demolitions as methods of violence prevention. Some results have shown the effectiveness of demolitions as ways to stem violence, however, differing outcomes can be seen in few studies with little to no decrease in criminal incidents following vacant building demolitions.<sup>18, 19</sup> There is also little knowledge of how the type of building demolition impacts number of criminal incidents reported to the police. This study will focus on Philadelphia due to its large number of vacant buildings and fill the gap in the literature by first assessing the purpose of demolitions with subsequent analysis using multiple years of large-cohort demolition data and police-reported criminal incidents.

Philadelphia is a post-industrial city which has seen a similar trend of increasing vacant properties rates and subsequent building demolitions around areas of dense socioeconomic disadvantage, but the link between safety building demolitions and crime in this region is understudied. The Philadelphia Department of Licenses & Inspections (L&I) monitors demolitions processes with two options of demolitions: 1) building safety reasons and 2) permits given to private building owners.<sup>20</sup> Vacant buildings that have been demolished have been deemed as unsafe by L&I standards as it “dangers human life or the public welfare, [has] illegal or improper occupancy or inadequate maintenance.”<sup>20</sup>

In this study, we aimed to analyze if buildings demolished for safety reasons are associated with change in counts of any police-reported crime incidents and violent police-reported crime incidents in Philadelphia between the years of 2013-2022, utilizing open-source data from OpenDataPhilly.

## **METHODS**

### **I. STUDY DESIGN**

We used a quasi-experimental linear mixed effect model (LMM) to investigate the impact of buildings demolished for safety reasons on all police-reported crime and violent police-reported crime within a 500-meter buffer of the demolition in Philadelphia, Pennsylvania from January 2013 to December 2022.

### **II. MEASURES**

Our units of interest are land parcels with the exposure of this study being the safety demolition of a building on each land parcel. An exposed building will refer to a safety building demolition that has been completed. An unexposed building will refer to a building that has not yet been demolished due to safety reasons or is partially demolished/in-progress.

Our outcome of interest is counts of police-reported crime incidents within a 500-meter buffer of the completed building demolition. A 500-meter buffer represents the estimated typical area around a home where people tend to walk daily.<sup>21</sup> Thus, this geographic boundary serves as a representation for police-reported crime incidents that might appear within the environment surrounding each lot.

We analyzed all police-reported crime incidents and violent police-reported crime incidents separately.

All types of crime include violent crimes, firearm-involved violent crimes, drug-related crimes, crimes associated with vacant spaces (e.g. trespassing), sex-related crimes, and nuisance crimes.

In this study, we defined violent crime using the Federal Bureau of Investigation’s Uniform Crime Reporting (UCR) definition which includes murder, rape, assault, and robbery along with a more expansive non-UCR definition of violence.<sup>22</sup> This will allow for different forms of violence such as threats and harassment to be included within our definition of violence. Violence will be operationalized by police-reported crime incidents.

### III. STUDY SETTING

The study was conducted in Philadelphia, Pennsylvania with police-reported crime incidents sourced from this location during the period of January 2013 to December 2022.

### IV. STUDY POPULATION

There were 12,984 building demolitions in the dataset. We excluded 4,121 demolitions as they were not within our study period of January 1, 2013 to December 31, 2013. We are limiting the type of demolition to buildings which have violated safety codes and are deemed as dangerous by the Philadelphia Department of Licenses and Inspections (L&I), thus excluding 5,525 permit

demolitions. Further, 7 permit demolitions were excluded due to missing completion date data. We consider the final 3,331 demolitions related to safety violations to be our cohort of demolitions for analysis in this study.

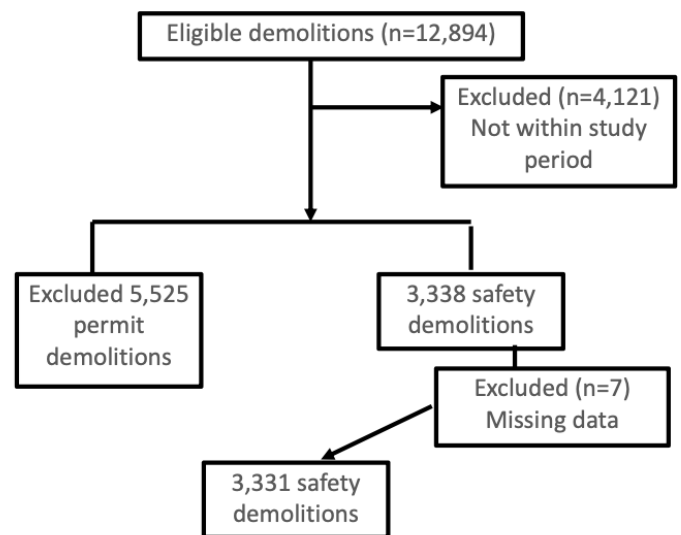


Figure 1: Building Demolition Eligibility Criteria

## V. DATA COLLECTION

OpenDataPhilly is an open data repository for the City of Philadelphia and includes data sets from many organizations in the region.<sup>23</sup>

The Philadelphia Police Department reports and uploads its crime incident data to OpenDataPhilly. Crime data for this study was obtained on January 1, 2024 and includes information on the type of crime, the date the crime was committed, and the location of the crime in latitude and longitude format. Police-reported crime data from January 1, 2014 to December 31, 2022 were included in this dataset.

Building demolition data is uploaded to OpenDataPhilly by the City of Philadelphia's Department of Licenses and Inspections (L&I). Demolitions are either performed by the city and authorized due to a safety violations case or performed by private owners/contractors due to a permit approved by L&I. Data on completed demolitions was obtained from OpenDataPhilly on January 1, 2024 and includes information on demolition start date and completion date, type of demolition (safety violations case or permit), and location of demolition in latitude and longitude. Safety demolition data from January 1, 2013 to March 20, 2020 were included in this dataset.

## VI. PRIMARY ANALYSIS

All statistical analysis was performed in R version 3.6.3.<sup>24</sup> The linear mixed-effects model (LMM) will be used where  $\beta_1$  refers to the impact of a demolition on crime incidents reported to the police. The model refers to the  $j$ -th observation in the  $i$ -th building and is specified as follows:

$$y_{ij} = \beta_0 + \beta_1 \text{Demolished}_{ij} + \beta_2 \text{CompletedDemolitionYear}_{ij} + b_{0i} + \epsilon_{ij}$$

$\beta_0$  is the fixed intercept

$\beta_1$  and  $\beta_2$  are associated fixed effect regression parameters

$b_{0i}$  is the random intercept for the  $i$ -th building

$\epsilon_{ij}$  is the residual error term

For the primary analysis of the relationship between all types of crime and safety demolitions, the LMM was fitted using the 'lme4' package in R.<sup>25</sup> As fixed effects, we entered our parameters of whether a building was demolished and the year of completed demolition (without interaction term) into the model. As random effects, we included the unique building identifier. The temporal unit of analysis is evaluated on a yearly basis. Whether a building was demolished is considered a binary variable with exposed buildings being demolished and unexposed buildings being not demolished or partially/in-progress. If a demolition has occurred within the calendar year of January 1 to December 31 of the completed demolition year, it is considered exposed for the entirety of the year. As an example, if a demolition is completed on June 15, 2015, it is considered exposed for the entirety of the year 2015 and for every year following. As such, this same building is considered unexposed for the year 2014 and every year prior in the study.

The LMM was also ran in R using the lme4 package as a primary analysis to investigate the relationship between violent crime and safety demolitions.

Finally, we plotted completed safety building demolitions in Philadelphia using the ggplot package in R to compare the spatial layout and density of demolitions with patterns of disadvantage within resident communities.<sup>26</sup>

## **VII. SENSITIVITY ANALYSIS**

Much like the primary analysis, the LMM was ran in R using the lme4 package to investigate the relationship between all types of police-reported crime incidents and violent police-reported crime incidents specifically.<sup>24, 25</sup> However, the temporal yearly unit of analysis has been changed so that if a demolition has occurred within the calendar year of January 1 to December 31 of the completed demolition year, it is considered unexposed until the demolition has entered another full calendar year. As an example, if a demolition is completed on June 15, 2015, it is considered unexposed for the entirety of the year 2015. It will become exposed starting January 1, 2016, and for every year following.

## **RESULTS**

In Table 1, we describe the quantity of completed building demolitions for each year in our study, as well as the yearly average of all criminal incidents and violent criminal incidents reported to police. We note that the number of demolitions in 2020 is substantially smaller than previous years due to the Philadelphia Department of Licenses & Inspections' pause in reporting because of the COVID-19 pandemic.

The temporal yearly unit of analysis for the primary model was established with the following criteria: if a building was demolished at any point during the calendar year, we would consider it exposed, even if the demolition occurred mid-year. Table 2 displays the average decrease in overall police-reported crime incidents and violence police-reported crime incidents associated with demolition for the primary and sensitivity analysis conducted. There was a decrease in police-reported crime incidents associated with demolition overall with 5.83 fewer crimes reported (95% CI: -6.13, -5.53). We saw a

similar trend with violent police-reported crime incidents as there was an overall reduction by 4.706 reports (95% CI: -4.95, -4.46) associated with demolition.

The results from the linear mixed model of the primary and sensitivity analyses displayed by year for all types of crime and violent crime are in the Appendix (Supplemental Table 1 – Supplemental Table 4).

## **DISCUSSION**

The main goal of this study was to investigate if buildings demolished for safety reasons are associated with changes in any police-reported crime incidents and violent police-reported crime incidents in Philadelphia.

The findings of this work reveal that safety building demolitions are largely associated with decreases in any police-reported crime incidents and violent police-reported crime incidents in Philadelphia. Across all years in the study, there was an overall reduction in police-reported crime incidents when comparing pre- versus post-demolition counts.

These results show strong support for previous literature addressing building demolitions as a method of non-carceral crime prevention within urban areas.<sup>1,7</sup> The varied decreases in incidents seen between all types of crime and violent crime suggest demolition may have a differential effect on violent crime specifically. Despite the association between safety demolitions and reductions in crime, we do not know what happens to a lot following building demolition as the space could become unmanaged, turning into a vacant lot or have new development. Numerous studies have demonstrated an association between vacant lots and influxes of crime in

Philadelphia.<sup>7,27-28</sup> This could account for the small discontinuity of results from existing studies in the realm of building demolition and violence and/or crime prevention.

However, this study suggests that the overall impact of safety demolitions is associated with reductions in all types of police-reported crime and violent police-reported crime.

## **I. IMPLICATIONS OF THIS RESEARCH**

Cities have vacant properties and need to decide what to do with them. One option, deriving from theories that abandoned buildings attract crime, is demolition in the name of blight removal. We tested the theory that blight removal prevents violence and found that it did, albeit under relatively strong assumptions. These findings may have significant impacts on improving health and quality of life for residents in areas surrounding vacant buildings.<sup>2,3</sup> Clusters of vacant buildings often coincide with a high density of residents that come from historically underrepresented communities and include Black, Indigenous, and other people of color (BIPOC), individuals of low socioeconomic status (SES), and neighborhoods of lower median rent and income.<sup>19, 29</sup> This can be visualized through mapped demolition data in this study. (Appendix: Supplemental Figure 1). Overall, the root causes of place-based violence around vacant buildings in Philadelphia signify the potential for safety demolitions as a protective mechanism for decreasing crime incidents reported to the police.

## **II. LIMITATIONS**

This study was subject to several limitations. Firstly, police-reported crime incidents do not encompass all crime that may occur in a specific area. Many communities within Philadelphia have deep historical mistrust in law enforcement due to consistent over policing, police brutality, and discrimination against the Black and Brown

community.<sup>30</sup> In fact, an early study on police shooting victims in the U.S. done in 1950 demonstrated that 90% of all people killed by police in Philadelphia were Black.<sup>31</sup> As a result, crime incidents reported to police in the Philadelphia region may underrepresent the true count of crime. However, this limitation should not disqualify our study as historical mistrust in law enforcement would not be differential before and after demolition.<sup>32</sup> This indicates that all studies done using the outcome of police-reported crime will likely have counts that underrepresents the true prevalence of criminal incidents.

Another limitation of this study is the 500-meter buffer established around building demolitions. This geographic buffer was chosen due to prior work establishing neighborhood size and may not represent the scope at which demolition might affect nearby crime in Philadelphia. Because vacant or structurally unsound buildings are likely to be situated in proximity of each other, there is potential for overlapping buffers. However, this should not be considered a disqualification of the results presented in this study. When all demolition buffers intersect, there is no misclassification of crime, and when no demolition buffers intersect, each unique demolition is misclassified, cancelling out of impact and biasing results towards the null.

Finally, all police-reported crime incidents and building demolitions data have been taken from OpenDataPhilly. There are concerns around secondary data and relying on administrative accuracy of databases. Despite the risk that violence may go underreported to police, police-reported crime remains the most comprehensive and spatially precise record of violence in Philadelphia.

### **III. FUTURE RESEARCH**

Future studies may seek to investigate what happens to a property lot following a safety demolition and how this impacts the counts of police-reported incidents in the area surrounding the demolition. This may further strengthen the support for place-based violence interventions and garner support for monetary and community investment in regions of Philadelphia affected by urban disinvestment. Additionally, future research may demonstrate that safety demolitions have the potential to increase valuation of communities through forms of blight removal.<sup>33</sup> This creates space for investment in new development or community spaces which may foster social connectedness and relationships, counteracting feelings of fear spurred by frequent criminal activity.

**TABLE 1: Description of completed demolitions and total number of all police-reported crime and violent crime incidents within 500m of 3331 land parcels by year in Philadelphia, January 1, 2013-March 20, 2020**

Year of Completed Demolition	Number of buildings demolished (n=3331)	Year of criminal incidents reported to police	Total number of all criminal incidents reported to police*	Total number of violent criminal incidents reported to police*
2013	435	2013		
2014	501	2014	107,516	65,268
2015	538	2015	101,523	60,684
2016	503	2016	98,222	59,884
2017	539	2017	101,861	60,385
2018	390	2018	97,025	53,457
2019	381	2019	95,576	58,584
2020	44	2020	79,537	38,464
		2021	69,467	36,893
		2022	75,827	39,855

\*Crime incidents may be counted more than once if they fall within 500m of more than one land parcel

**TABLE 2: Change in overall police-reported crime incidents and violent police-reported crime incidents within 500m of 3331 building demolitions in Philadelphia, January 1, 2013-March 20, 2020**

Primary Analysis		
	<b>Estimated Counts</b>	<b>95%CI</b>
Count of all police-reported crime incidents in reference year 2012	36.00	34.43, 37.57
Overall decrease in police-reported crime incidents from reference year	-5.840	-6.13, -5.53
Count of violent police-reported crime incidents in reference year 2012	23.40	22.16, 24.65
Overall decrease in violent police-reported crime incidents from reference year	-4.706	-4.95, -4.46
Sensitivity Analysis		
	<b>Estimated Counts</b>	<b>95%CI</b>
Count of all police-reported crime incidents in reference year 2012	36.36	34.81, 37.92
Overall decrease in police-reported crime incidents from reference year	-6.126	-6.39, -5.86
Count of violent police-reported crime incidents in reference year 2012	23.69	22.46, 24.92
Overall decrease in violent police-reported crime incidents from reference year	-4.928	-5.14, -4.71

## APPENDIX

**SUPPLEMENTAL TABLE 1: Primary Analysis for all counts of police-reported crime - Linear mixed model results by year with building exposure status and completed year of demolition as the fixed effects**

Parameter	Estimate	Std Error	P-Value	95% CI
Intercept	36.00	0.802	$<2^{-16}$	34.43, 37.57
Building Treated	-5.840	0.153	$<2^{-16}$	-6.138, -5.540
Completed Demolition Year 2013	-1.061	0.660	0.107	-2.354, 0.232
Completed Demolition Year 2014	-2.072	0.799	0.009	-3.637, -0.507
Completed Demolition Year 2015	-3.137	0.849	$<0.001$	-4.800, -1.473
Completed Demolition Year 2016	-4.240	0.863	$<9.13^{-7}$	-5.932, -2.545
Completed Demolition Year 2017	-6.237	0.877	$<1.21^{-12}$	-7.957, -4.513
Completed Demolition Year 2018	-5.534	0.900	$<6.64^{-10}$	-7.290, -3.776
Completed Demolition Year 2019	-5.345	0.923	$<7.21^{-9}$	-7.154, -3.535
Completed Demolition Year 2020	-5.050	1.229	$<4.03^{-5}$	-7.459, -2.63

**SUPPLEMENTAL TABLE 2: Primary Analysis for counts of violent police-reported crime - Linear mixed model results by year with building exposure status and completed year of demolition as the fixed effects**

Parameter	Estimate	Std Error	P-Value	95% CI
Intercept	23.40	0.633	2e <sup>-16</sup>	22.162, 24.645
Building Treated	-4.706	0.125	2e <sup>-16</sup>	-4.951, -4.462
Completed Demolition Year 2013	-1.587	0.538	0.003	-2.642, -0.5319
Completed Demolition Year 2014	-2.369	0.639	0.001	-3.622, -1.117
Completed Demolition Year 2015	-3.389	0.670	4.37e <sup>-7</sup>	-4.703, -2.074
Completed Demolition Year 2016	-4.159	0.678	8.82e <sup>-10</sup>	-5.489, -2.827
Completed Demolition Year 2017	-5.563	0.686	5.71e <sup>-16</sup>	-6.911, -4.214
Completed Demolition Year 2018	-5.428	0.699	9.17e <sup>-15</sup>	-6.800, -4.054
Completed Demolition Year 2019	-5.538	0.717	1.22e <sup>-14</sup>	-6.943, -4.131
Completed Demolition Year 2020	-5.754	0.957	1.86e <sup>-9</sup>	-7.630, -3.876

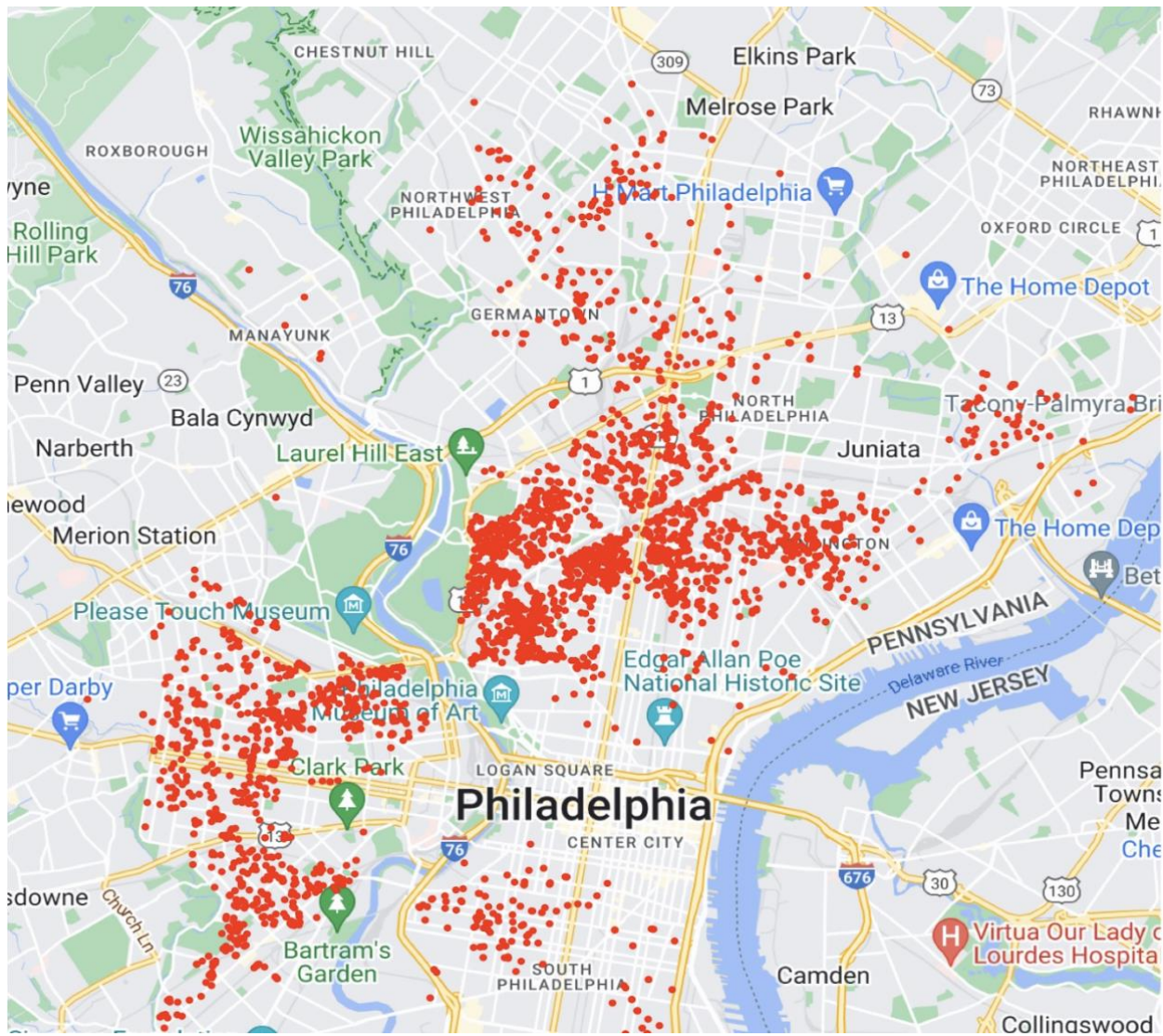
**SUPPLEMENTAL TABLE 3: Sensitivity Analysis for all counts of police-reported crime - Linear mixed model results by year with building exposure status and completed year of demolition as the fixed effects**

Parameter	Estimate	Std Error	P-Value	95% CI
Intercept	36.36	0.792	2e <sup>-16</sup>	34.80, 37.92
Building Treated	-6.126	0.134	2e <sup>-16</sup>	-6.390, -5.863
Completed Demolition Year 2013	-1.056	0.653	0.105	-2.335, 0.223
Completed Demolition Year 2014	-2.787	0.791	<0.001	-4.338, -1.236
Completed Demolition Year 2015	-4.579	0.843	5.57e <sup>-8</sup>	-6.230, -2.930
Completed Demolition Year 2016	-6.436	0.859	7.39e <sup>-14</sup>	-8.123, -4.747
Completed Demolition Year 2017	-5.760	0.868	3.42e <sup>-11</sup>	-7.463, -4.055
Completed Demolition Year 2018	-5.673	0.889	1.78e <sup>-10</sup>	-7.415, -3.931
Completed Demolition Year 2019	-6.173	0.918	1.80e <sup>-11</sup>	-7.972, -4.375
Completed Demolition Year 2020	-6.44	1.22	1.32e <sup>-7</sup>	-8.842, -4.053

**SUPPLEMENTAL TABLE 4: Sensitivity Analysis for counts of violent police-reported crime - Linear mixed model results by year with building exposure status and completed year of demolition as the fixed effects**

Parameter	Estimate	Std Error	P-Value	95% CI
Intercept	23.69	0.626	2e <sup>-16</sup>	22.16, 24.65
Building Treated	-4.928	0.110	2e <sup>-16</sup>	-4.951, -4.462
Completed Demolition Year 2013	-1.582	0.533	0.003	-2.642, -0.5319
Completed Demolition Year 2014	-2.923	0.634	3.99e <sup>-6</sup>	-3.622, -1.116
Completed Demolition Year 2015	-4.450	0.666	2.44e <sup>-11</sup>	-4.702, -2.074
Completed Demolition Year 2016	-5.809	0.676	2e <sup>-16</sup>	-5.489, -2.827
Completed Demolition Year 2017	-5.306	0.680	6.56e <sup>-15</sup>	-6.911, -4.213
Completed Demolition Year 2018	-5.660	0.695	3.96e <sup>-15</sup>	-6.800, -4.054
Completed Demolition Year 2019	-6.264	0.713	2e <sup>-16</sup>	-6.944, -4.131
Completed Demolition Year 2020	-6.897	0.951	4.37e <sup>-13</sup>	-7.630, -3.876

**SUPPLEMENTAL FIGURE 1: MAP OF PHILADELPHIA WITH COMPLETED BUILDING DEMOLITIONS FROM 2013-2020**



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