Use of a ‘microecological technique’ to study crime incidents around methadone maintenance treatment centers

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ABSTRACT

Aims Concern about crime is a significant barrier to the establishment of methadone treatment centers (MTCs). Methadone maintenance reduces crime among those treated, but the relationship between MTCs and neighborhood crime is unknown. We evaluated crime around MTCs. Setting Baltimore City, MD, USA. Participants We evaluated crime around 13 MTCs and three types of control locations: 13 convenience stores (stores), 13 residential points and 10 general medical hospitals. Measures We collected reports of Part 1 crimes from 1 January 1999 to 31 December 2001 from the Baltimore City Police Department. Design Crimes and residential point locations were mapped electronically by street address (geocoded), and MTCs, hospitals and stores were mapped by visiting the sites with a global positioning satellite (GPS) locator. Concentric circular ‘buffers’ were drawn at 25-m intervals up to 300 m around each site. We used Poisson regression to assess the relationship between crime counts (incidents per unit area) and distance from the site. Findings There was no significant geographic relationship between crime counts and MTCs or hospitals. A significant negative relationship (parameter estimate −0.3127, \( P < 0.04 \)) existed around stores in the daytime (7 am–7 pm), indicating higher crime counts closer to the stores. We found a significant positive relationship around residential points during daytime (0.5180, \( P < 0.0001 \)) and at night (0.3303, \( P < 0.0001 \)), indicating higher crime counts further away. Conclusions Methadone treatment centers, in contrast to convenience stores, are not associated geographically with crime.

Keywords Crime, geocoding, methadone maintenance, neighborhood, spatial analysis.

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INTRODUCTION

The aim of this study is to determine whether there is a geographic relationship between methadone treatment centers (MTCs) and neighborhood crime. Methadone maintenance is well established as an effective treatment for opiate dependence [1–3]. Opioid dependence is a global public health problem, with an estimated 24–32 million opioid users (12–14 million heroin users) worldwide in 2009, including 3.1–3.5 million users in Europe [4]. Nevertheless, access to treatment is limited in many communities that oppose the establishment of new methadone maintenance treatment centers (MTCs), due largely to concerns about crime [5,6]. This resistance exists despite extensive research over several decades, showing that methadone maintenance treatment decreases crime among treated patients. For example, a study of 1075 heroin users found that methadone maintenance plus psychosocial treatment decreased crime, resulting in decreased societal costs [7].

Community concerns about MTCs causing crime reflect a difference between ‘clinical’ and ‘ecological’ perspectives. While the clinical perspective has established that successfully treated patients commit fewer crimes [8], there is no empirical evidence on the ecological relationship between MTCs and neighborhood crime. Three
possible relationships could exist, and plausible theories support each relationship. MTCs could decrease neighborhood crime by treating opiate users who live nearby, thereby decreasing their risk of criminal behavior. MTCs could increase crime if they attract untreated or partially treated users into the neighborhood, thereby increasing the local density of people likely to commit crimes [9]. Finally, MTCs could have no crime impact if neighborhood crime relates largely to other factors.

This study addresses the debate by evaluating relevant empirical data with a technique that has not been applied previously to this issue. Previous studies of the geographic (spatial) relationship between locations of substance availability (e.g. alcohol outlets, location of illegal drug possession and sales) and crime have used relationships between locations and crime rates averaged over large areas, typically postal codes or census tracts [9–11]. This study is the first of which we are aware to use a more fine-grained ‘microecological’ approach. Instead of studying a population of patients or a large geographic area where the MTCs are located, we evaluated crime rates in terms of increasing spatial distance within individual MTC neighborhoods.

The study was conducted in Baltimore, MD, USA, an urban environment with a high rate of heroin use [12,13] and high crime rate [14]. The city had 16 methadone treatment centers (MTCs) in operation during the study period. A comparison of crime before and after the establishment of MTCs was not possible, because most of the MTCs in Baltimore had been in operation before the advent of geocodable electronic crime data.

**METHODS**

Details of the ‘microecologic technique’ have been published previously [15]. In brief, we obtained a database listing all Federal Bureau of Investigation (FBI) Uniform Crime Report ‘Part I’ crimes [homicide, sexual assault, robbery, aggravated assault, burglary, larceny (including theft from a motor vehicle), auto theft and arson] [16] in Baltimore City, MD, from 1 January 1999 to 31 December 2001 from the Baltimore City Police Department. We identified 16 MTCs operating in Baltimore during this study period. One was excluded because it was located on the sixth floor of a general medical hospital, making it impossible to differentiate its crimes from those associated with the hospital. Three of the remaining MTCs were analyzed as one clinic, because their front entrances were within 25 m of each other, making it impossible to analyze their crime data separately. Thus, we included data from 13 MTC’s whose characteristics we obtained by telephone survey (Table 1). Of these, eight were on the campus of or near a hospital, but not in the same building as the hospital. Four MTCs offered buprenorphine for opioid detoxification or maintenance therapy, in addition to methadone.

To help assess the significance of any relationship between MTCs and crime, we evaluated crime around three types of control sites in Baltimore City, MD. MTCs might have more crime than adjacent locations because of having higher foot traffic. High foot-traffic areas (areas with higher density of people) may have more crime than low foot-traffic areas because offenders are more likely to meet victims/targets in such areas [17]. Therefore, we selected two ‘high foot-traffic’ sites (general hospitals and convenience stores) and one ‘low foot-traffic’ site (residential points) as controls. General medical hospitals (10 in operation in Baltimore during the study period) were chosen because they, like MTCs, provide medical care. ‘Convenience stores’ were those defined as such on the Switchboard.com [18] website. Residential points were defined as addresses in the middle of a block on a small secondary street within a geographic area identified as ‘residential’ by local zoning maps.

Thirteen convenience stores and 13 residential sites were matched to the 13 MTCs based on 20 relevant census and crime variables (Table 2). which previous factor analytical research has shown can identify neighborhoods with high rates of violent crime [19]. These variables were entered into a factor analysis by Baltimore City Census Block Group (CBG); the analysis was predefined to generate a single factor score. Control sites were chosen for each clinic so that the factor scores of their CBGs were closest to the factor score of their matched clinic. Hospitals could not be matched to the MTCs due to the limited number of hospitals (10) available for matching.

**Data and geocoding**

Crime locations and residential control sites were mapped electronically by ‘geocoding’ their street addresses using the ArcGIS 9 computer program [20]. Geocoding is a computerized process in which a street address is con-

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### Table 1 Characteristics of 13* Baltimore City, Maryland methadone maintenance treatment centers (MTCs) operating 1 January 1999 to 31 December 2001.

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening time</td>
<td>5:30 am</td>
<td>11 am</td>
<td>7 am</td>
<td></td>
</tr>
<tr>
<td>Closing time</td>
<td>4 pm</td>
<td>7:30 pm</td>
<td>6 pm</td>
<td></td>
</tr>
<tr>
<td>Daily patient census</td>
<td>55</td>
<td>600</td>
<td>298</td>
<td>300</td>
</tr>
</tbody>
</table>

*Includes combined data from three MTCs whose entrances were within 25 m of another MTC (see text).
verted into a map location (latitude and longitude) [21]. The locations of MTCs, convenience stores and hospitals were determined by visiting the sites and reading the latitude and longitude on a global positioning satellite (GPS) locator. Site visits were necessary in these cases, because street addresses of non-residential sites are sometimes not precise enough to generate an accurate latitude and longitude. For example, convenience stores are sometimes located in large parking lots or malls, along with other stores. In order to maintain the privacy of people living at the residential sites, the locations of the residential sites were found by geocoding, rather than by visiting the site.

**'Buffering' sites and counting crimes**

We used a ‘buffer’ methodology to determine the geographic relationship between study sites and neighborhood crime. Concentric circular, non-overlapping, doughnut-shaped buffers were defined at 25-m intervals for up to 300-m radius around each study site. Crimes were counted within each buffer. In order to compare crime quantitatively across buffers of increasing size, the number of crimes was corrected for the area of each buffer to generate crime counts per unit area ('crime counts'). To avoid crime counts <1, the ‘unit area’ was defined as 1962.5 m² [the size of the smallest (25-m) buffer]. Similar buffer methodologies have been used to study crime around housing projects [22] and supportive housing [23].

**Statistical analysis**

Poisson regression analyses were used to evaluate the relationship between crime counts and distance from a site. First, a generalized additive model (GAM) with a spline term was used to fit a line to scatter-plots to visualize the data. The GAM graphs indicated that most of the variation in crime incidents was within the first 100 m (first four buffers) of the sites (data not shown). Thus, further data analysis included only crime incidents within 100 m of the study sites. Further analyses used a Poisson distribution and generalized linear model to analyze crime counts around the study sites, generating a parameter estimate (β) through a least-squares analysis. A significant positive β (‘positive crime slope’) indicates a higher crime rate with increasing distance from the study site, while a significant negative β (‘negative crime slope’) indicates a higher crime rate closer to the study site. All analyses were performed with SAS version 9.1 [24].

‘Within-group’ comparisons to evaluate the relationship between crime counts and distance from the study site (crime slopes) were performed separately for MTCs, convenience stores, hospitals and residential points. Because crimes can occur at night, when MTCs are closed, we controlled for time of day by analyzing separately crimes occurring during the day (7 a.m.–7 p.m.), the hours when most MTCs are open (Table 1), and at night (7 p.m.–7 a.m.).

**RESULTS**

There was no significant change in crime counts with increasing distance from MTCs or hospitals (Fig. 1), as indicated by non-significant values for parameter estimates of crime slopes (Table 3). In contrast, there was a significant decrease in crime counts with increasing distance from convenience stores during both daytime and night-time (Fig. 1, Table 3, daytime parameter estimate −0.3127, P < 0.04, night time parameter estimate −0.3235, P < 0.0623). Around residential sites, there was a significant increase in crime counts, with increasing distance from the site during both daytime (0.5180, P < 0.0001) and night-time (0.3303, P < 0.0001).

**DISCUSSION**

This study found no significant change in crime counts with increasing distance (up to 100 m) from MTCs, suggesting that MTCs are not a geographic focus for crime. In contrast, there was a significant decline in crime counts with increasing distance from convenience stores and a significant increase in crime counts with increasing...
Figure 1  Crime rates around methadone maintenance treatment clinics, general medical hospitals, convenience stores and residential points in Baltimore City, MD (1999–2001). Crimes were all Federal Bureau of Investigation (FBI) Part 1 crimes [homicide, sexual assault, robbery, aggravated assault, burglary, larceny (including theft from a motor vehicle), auto theft, and arson] reported in Baltimore City, MD between 1 January 1999 and 31 December 2001. Crime rate—crimes per ‘unit area’ (1962 m², the area of a 25-m circle/buffer). Buffer distance—radius of circular/doughnut-shaped areas defined around study sites. Study sites were 13 methadone maintenance treatment centers (MTCs), 10 general medical hospitals, 13 convenience stores and 13 residential points (residential addresses in the middle of the block on secondary streets). Convenience stores were matched to the MTCs by neighborhood characteristics (see text for details). Mapping of locations was based on street address for crime locations and residential sites and global positioning satellite (GPS) for other sites. (a) Crimes between 7 a.m. and 7 p.m., when MTCs are open. (b) Crimes between 7 p.m. and 7 a.m., when MTCs are closed.
distance from the residential sites, indicating that the microecological technique is capable of detecting places that are or are not geographic foci of crime. The observed crime pattern around convenience stores (high foot-traffic areas) and around residential sites (low foot-traffic areas in the middle of small residential blocks) is consistent with the previously shown positive correlation between crime and increased density of people at a site [17]. Overall, the pattern of findings supports the validity and sensitivity of our microecological technique, and strengthens confidence in our primary finding of no significant increase in crime counts closer to MTCs.

An estimated 282,000 Americans were dependent on or abusing heroin and another 1.72 million were dependent on or abusing prescription pain relievers in 2008 [25]. In contrast, only about 265,000 patients were receiving opiate agonist treatment in 1108 US treatment facilities [26]. The European Union had more than 1 million regular opioid users in 2006, but only 25,000 patients receiving methadone maintenance treatment [27]. Thus, there is a public health need for more MTCs to treat the large numbers of people addicted to opiates. Our finding that MTCs are not associated with increases in neighborhood crime addresses a major impediment to the establishment of new clinics, and should lead to greater availability of methadone maintenance treatment for the many people who need it.

This study has several strengths, including the use of a microecological technique that evaluates geographic neighborhoods rather than patient populations, use of control sites matched to the MTCs to minimize confounding by degree of foot traffic and other neighborhood characteristics known to influence crime rates, and the inclusion of data from all but one of the MTCs operating in Baltimore City during the study period.

This study has several limitations. First, the data show substantial variability, as reflected in large confidence intervals. For example, although methadone clinics and residential points have different crime slopes (different sign for the parameter estimate), there is no significant interaction term between the two groups when they are compared in a between-groups comparison. Secondly, this study has uncertain external validity because it involved a relatively small number [15] of MTCs in a single city. However, there is no obvious manner in which Baltimore City MTCs differ from those in other areas of the United States or abroad, nor is there any reason that the neighborhood factors influencing crime in Baltimore should differ from those elsewhere. Indeed, Baltimore may be an ‘ideal’ setting for this type of study, given its high rate of heroin use (Baltimore has been called the ‘heroin capital’ of the United States [12,13]), urban environment, and high crime rate [14].

The stigma against methadone maintenance treatment, including concerns about crime, exists throughout the world [28–31], regardless of whether methadone is dispensed in centralized methadone treatment centers or by prescription through community pharmacies. For example, a survey of pharmacists in England found that many expressed concern about shoplifting and aggression if they were to begin to dispense methadone [32]. Residents both in the United Kingdom and Canada voice fears that methadone treatment centers may increase crime, resulting in difficulty opening or keeping open methadone clinics [33–35]. This study provides strong evidence against a major reason for the social stigma concerning methadone maintenance, i.e. concerns about crime. A major issue in the NIMBY (‘not in my back yard’) phenomenon for MTCs is the need for patients to come in daily for dosing. Buprenorphine, an opioid partial agonist now used in many countries for opioid substitution, can be prescribed by physicians and dispensed for home administration. Because there is no need for patients to come to a specialized clinic for regular dosing, the hope is

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### Table 3 Poisson regression analysis of the relationship between crime counts and distance (≤100 m) from study site.

<table>
<thead>
<tr>
<th>Type of site</th>
<th>Time of day</th>
<th>Parameter estimate</th>
<th>Standard error</th>
<th>Lower confidence limit</th>
<th>Upper confidence limit</th>
<th>Z</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTC [13]</td>
<td>Day</td>
<td>−0.0938</td>
<td>0.2243</td>
<td>−0.5334</td>
<td>0.3457</td>
<td>−0.42</td>
<td>0.6757</td>
</tr>
<tr>
<td></td>
<td>Night</td>
<td>−0.1614</td>
<td>0.2167</td>
<td>−0.5862</td>
<td>0.2634</td>
<td>−0.74</td>
<td>0.4564</td>
</tr>
<tr>
<td>Convenience</td>
<td>Day</td>
<td>−0.3127</td>
<td>0.1553</td>
<td>−0.6171</td>
<td>−0.0083</td>
<td>−2.01</td>
<td>0.0441</td>
</tr>
<tr>
<td>Site [13]</td>
<td>Night</td>
<td>−0.3235</td>
<td>0.1735</td>
<td>−0.6635</td>
<td>0.0166</td>
<td>−1.86</td>
<td>0.0623</td>
</tr>
<tr>
<td>Residential</td>
<td>Day</td>
<td>0.3303</td>
<td>0.0511</td>
<td>0.3020</td>
<td>0.4304</td>
<td>6.47</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Site [13]</td>
<td>Night</td>
<td>0.518</td>
<td>0.0947</td>
<td>0.3325</td>
<td>0.7035</td>
<td>5.47</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>General medical</td>
<td>Day</td>
<td>0.086</td>
<td>0.1353</td>
<td>−0.1792</td>
<td>0.3511</td>
<td>0.64</td>
<td>0.5251</td>
</tr>
<tr>
<td>hospital [10]</td>
<td>Night</td>
<td>−0.056</td>
<td>0.1533</td>
<td>−0.3564</td>
<td>0.2443</td>
<td>−0.37</td>
<td>0.7146</td>
</tr>
</tbody>
</table>

*Crime count: number of crime incidents per area in each concentric ring at 25-m intervals around the site. *Parameter estimate: estimated ‘crime slope’ relating crime counts with distance from study site. Positive parameter estimate indicates increasing crime counts with increasing distance from the site. Negative parameter estimate indicates decreasing crime counts with increasing distance from the site. *MTC: methadone maintenance treatment center. *Day: 7 a.m.–7 p.m. *Night: 7 p.m.–7 a.m. Italics indicate significant results.
that buprenorphine treatment will be less stigmatized and better accepted than methadone treatment.

Finally, a key conceptual issue for any study involving crime is how to quantify crime. Three major parameters have been used to measure crime in social science studies, each with its own advantages and disadvantages: crime incidents (used in this study), arrests and 911 calls. Crime incidents, being generated from complaints of crime, are not subject to policy changes in police enforcement, unlike arrest data. However, incident data have the disadvantage of not recording ‘victimless’ crimes, such as many drug crimes. Databases of 911 calls have the disadvantage of containing a large number of ‘unfounded’ events; that is, when the police arrive at the scene of the call, there is no evidence of the reported crime. However, 911 databases may be a more sensitive measure of community concerns about crime.

Overall, our data show that MTCs are not a geographic focus of crime, thus providing both strong evidence to alleviate neighborhood concerns about the establishment and operation of MTCs and quantitative information to combat the stigma of methadone substitution treatment. As more MTCs open and more geocodable crime data become available, future research can attempt to confirm and expand our findings using before-and-after designs and different types of crime data.

CONCLUSION

This study found no significant increase in crime around MTCs, while finding the expected significant increase around convenience stores, which also have high foot traffic. These results do not support the common neighborhood concern of MTCs as geographic foci of crime, and may ease the establishment of new MTCs. Studies using the microecological technique may inform more clearly the social and political debate around the siting of MTCs.

Declarations of interest

SB is Medical Director of the Baltimore Veterans Affairs Medical Center Opiate Agonist Treatment Program. Otherwise, the authors have no conflicts of interest in relation to this study or connection with the tobacco, alcohol, pharmaceutical or gaming industries. There are no contractual constraints on publishing this study.

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