



# GEOFENCING AND GPS: GEOSPATIAL METHODS & TOOLS FOR SUBSTANCE ABUSE PREVENTION

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## INTRODUCTION

Smartphone apps, GPS tracking, and geofencing are emerging as promising primary and secondary substance use prevention and management tools that can help avert and reduce substance abuse and its consequences, aid in maintaining gains made in treatment, and prevent the onset of more serious problems. Geofencing—creating virtual boundaries around Global Positioning Systems (GPS) coordinates in order to detect a user’s presence in a specific area of interest, e.g. bars, clubs, liquor stores—and GPS tracking allow for real-time study of user behavior, as well as enhanced ability to influence it. **Related prevention and treatment apps bypass many of the barriers traditional interventions encounter, such as economic costs, substantial time commitments, and stigma while adding convenience, socioeconomic equitability, and tailoring to individual users.** Current research into the effectiveness of these methods is limited but encouraging, offering the potential to expand and improve substance use prevention and mitigation efforts.

Exploring the role of microsystems on adolescent substance use, Mason (2016) employed GPS tracking and participant surveys to assess environmental risk factors and protection afforded by participants’ activity spaces, finding that peer networks have significant interactive effects with family relationships that affect substance abuse, particularly for adolescents in risky environments.

Wray (2019) assessed the use of geofencing to address harmful alcohol use in gay and bisexual men, determining that it both improves the validity of research and provides a useful method to intervene at key instances when users are at high risk for heavy drinking.

Investigating smartphone app availability and efficacy, Hoepfner (2017) found that apps addressing alcohol use have a wide reach and proliferation, allowing numerous types of supports in helping manage problematic drinking. However, few employ tailoring to specific individuals’ needs, decreasing their popularity and user-rated quality.

Research by Nguyen (2017) similarly concluded that geofencing can be a moderately effective and accurate tool to track hospitalizations, offering the potential to facilitate healthcare research and patient care in a range of ways.

Using GPS tracking to examine the influence of various environments on adolescent substance use, Byrnes (2016) found that adolescents who used alcohol and marijuana were in proximity to

alcohol outlets more than non-users, with GPS technology proving to be a feasible method of informing prevention efforts.

**This research review investigates promising substance abuse applications and tools that leverage GPS and other mobile technologies for substance abuse prevention goals and outcomes.**

#### **ARTICLE 1: PARENTS, PEERS, AND PLACES: YOUNG URBAN ADOLESCENTS' MICROSYSTEMS AND SUBSTANCE USE INVOLVEMENT**

##### SUMMARY

To better understand and address urban adolescent substance use involvement, research into the contextual and interactive effects of microsystems—family relationships, peer networks, and place-based influences—can be improved by integrating social, psychological, and geographic data into broader ecological models of behavior that take into account environmental influences on risky behavior. Utilizing this approach, **Mason et al (2016) conducted a 12-month study of 248 adolescents in which participants were given smartphones that harnessed GPS tracking and provided participant surveys to develop a measure of relative environmental risk and protection afforded by each participant's activity space.** This method allowed for the collection of real-time data within participants' natural settings—data characterizing adolescents' moods, behaviors, and activities as well as location—enabling assessment of their real-world experiences (p. 1-4).

Study data found that the effect between relations with parents and substance use was significantly moderated by peer networks, and this moderation by peer networks was itself moderated by activity space, such that **“the effect of peer networks on the relationship between parental relations and substance use is greater for teens with riskier activity spaces.”** Accordingly, there was no significant peer-network moderating effect for adolescents who spent time in locations with less risk (p. 4-9).

The present study confirms previous research that found protective family, place-based, and peer effects for youth related to substance abuse, additionally indicating that the adolescent-parent relationship influence is greater for adolescents with riskier peer networks than for those with protective networks. **Results further suggest that for teens with particularly risky**

**peer networks and risky activity spaces, the effect of relations with parents on substance use is amplified**—the riskier an adolescent’s social and environmental surroundings, the more influential are the adolescent’s parents in minimizing substance use (p. 9-10).

Peer networks have a substantial interactive influence on family relationships that inform substance use, particularly for adolescents in risky environments. Study findings support the conclusion that substance use is a social practice situated within the unique geography of adolescents’ lives and highlight the need for continued research into the relationships among microsystems of urban adolescents. **Social influences are not independent of geography, but are rather embedded within locations (which can be monitored through the use of GPS), and “play an important role in creating adolescents’ experiences of place through social interactions that occur at particular locations” (p. 9-11)**

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#### CITATION

Mason, M., Mennis, J., Light, J., Rusby, J., Westling, E., Crewe, S., ... & Zaharakis, N. (2016). Parents, peers, and places: young urban adolescents’ microsystems and substance use involvement. *Journal of Child and Family Studies*, 25(5), 1441-1450.

#### ARTICLE 2: EXPLORING THE USE OF SMARTPHONE GEOFENCING TO STUDY CHARACTERISTICS OF ALCOHOL DRINKING IN LOCATIONS IN HIGH-RISK GAY AND BISEXUAL MEN

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#### SUMMARY

As heavy drinking is particularly unsafe as a key risk factor for HIV infection among gay and bisexual men, heavy alcohol use among this population is a vital public health concern. **This study examined the viability of using geofencing—creating virtual boundaries around Global Positioning Systems (GPS) coordinates in order to detect a user’s presence in a specific area of interest, e.g. bars, clubs, liquor stores—to investigate social and environmental factors connected with alcohol use and sexual perceptions in heavy-drinking gay and bisexual men who engage in high-risk sex (p. 900-902).**

Results from Wray et al (2019) showed that despite nearly 80% of participants having visited a bar at some point during the study, less than half ever received a location-based survey prompt. Additionally, almost a third of participants failed to identify any personal drinking

locations, and among those who identified at least one personal location, the percentage of those who ever received a survey increased only slightly over relying on geofences of public places alone. **Also, across both types of geofences, 2 in every 5 surveys prompted were “false alarms” in which a survey was delivered when the participants were not in the intended location (p. 902-904).**

An examination of characteristics of drinking locations and alcohol use suggests that no location type stood out for having especially inebriated attendees, as there was no difference in participants' perceptions of how intoxicated other patrons were. Participants rated gay-oriented bars/clubs significantly more “sexualized” than general bars/clubs and private residences. However, contrary to past studies, results suggest that participants did not drink more heavily on nights when they visited a gay-oriented bar or club versus other types of locations, yet did consume more when visiting locations in which they perceived higher levels of patron intoxication, indicating that individual drinking behavior may be influenced by norms of others at a given location (p. 904-906).

Smartphone geofencing has the potential to be a powerful method for both research on alcohol use and interventions aimed at reducing it. **To be most effective, researchers “should set geofences around more public drinking locations in the areas being studied to capture a larger volume of data, but also expect that doing so using existing tools may result in high false-positive rates.”** In addition to improving the validity of research, geofencing provides a method to intervene at the very times when users are at high risk for heavy drinking. However, while geofencing may prove to be a useful aspect of interventions once precision is improved and made widely available, in its current form it should be used carefully and with caution. (p. 905) (p. 905, 906).

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#### CITATION

Wray, T. B., Pérez, A. E., Celio, M. A., Carr, D. J., Adia, A. C., & Monti, P. M. (2019). Exploring the Use of Smartphone Geofencing to Study Characteristics of Alcohol Drinking Locations in High-Risk Gay and Bisexual Men. *Alcoholism: Clinical and Experimental Research*, 43 (5), 900-906.

### ARTICLE 3: THERE IS AN APP FOR THAT—OR IS THERE? A CONTENT ANALYSIS OF PUBLICLY AVAILABLE SMARTPHONE APPS FOR MANAGING ALCOHOL ABUSE

#### SUMMARY

From both clinical and public health perspectives, smartphone apps are emerging as an advantageous tool to assist in preventing and mitigating alcohol use and its consequences. Yet despite their growth as a promising method to prevent and support recovery, evidence examining their effectiveness remains limited, and it is unclear what type of apps are publicly available and to what extent these apps employ features to meet users' specific needs (p. 67-68).

To help inform healthcare professionals about types of apps their patients may choose and provide ideas about what tools and support such apps can provide, Hoepfner et al (2017) analyzed 266 Android apps for managing drinking available on Google Play, downloaded a total of 2,793,567 times between November 2014 and June 2015. The two primary methods the apps used for prevention and recovery support were blood alcohol concentration (BAC) calculators and providing general information, commonly in the form of e-books. Various apps also provided tracking calendars, support during intoxication, and assistance in avoiding drunk driving and social problems. **Tailoring to individual users—e.g. consumption and tracking calendars and information and motivation provision—was limited in publicly available apps,** yet it provided increased app popularity and user-rated quality. Additionally, apps were more likely to be downloaded if they were free of charge (p. 69-71).

The research suggests that persons seeking support from apps “should be able to find a tool that is most appropriate for them, ranging from in-the-moment tools to tools that support enduring, daily practices.” However, since many apps were short-lived, it remains difficult for healthcare providers to offer guidance in prescribing specific apps. In practice, price and tailoring matter, as they are positively related to reach and reported quality (p. 71- 72).

In public health terms, the reach of these apps is substantial, and their use has potential public health and clinical implications. However, they are not often used to provide public health messages such as recommended drinking guideline, nor do they tend to focus on information shown to be relevant to behavioral change. A lack of this type of information may be a missed opportunity for spreading public health information. **On whole, findings suggest that “smartphone apps to support recovery from and prevention of problematic alcohol use have**

a wide reach, but the public health impact of this important dissemination tool is as of yet far under-utilized” (p. 71- 72).

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#### CITATION

Hoepfner, B. B., Schick, M. R., Kelly, L. M., Hoepfner, S. S., Bergman, B., & Kelly, J. F. (2017). There is an app for that—or is there? A content analysis of publicly available smartphone apps for managing alcohol use. *Journal of Substance Abuse Treatment, 82*, 67-73.

#### ARTICLE 4: SMARTPHONE-BASED “GEOFENCING” TO ASCERTAIN HOSPITALIZATIONS

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#### SUMMARY

The use of geofencing in public health has emerged as a vital tool for monitoring public behavior and movement. Since geofencing is relatively new, however, this research review included studies from public health more broadly (i.e., beyond substance abuse prevention research) to investigate how geofencing is supporting public health initiatives. **In this study, authors Nguyen et al (2017) explored how geofencing provides another method for monitoring individuals movement in particular public health sites (i.e., visiting the hospital).** Tracking hospitalizations and cardiovascular events is crucial to investigating quality of care, disease occurrence, and the efficacy and adverse outcomes of various treatments. However, there is presently no optimal means of ascertaining these data. To test the ability of smartphone-based geofencing to reduce the measurement error of retrospective reporting, and allow real-time tracking of medical visits, researchers evaluated geofencing for tracking hospitalizations among participants with a known “in-person” hospital visit and participants with an app-detected “remote” visit. (p. 1-3).

**Geofencing for ascertaining hospitalizations showed moderate sensitivity for hospitalization detection and moderate correlation with hospital length of stay, with in-person users reporting a positive experience including high ease of use and high interest in continued use.**

Among participants using the Health eHeart app in the U.S., the study found a positive predictive value of approximately 70%. When hospital locations were correctly detected, nearly 90% of participants correctly used the app to confirm their visit (p. 3-5).

Additionally, geofencing has potential use in multiple areas—e.g. fitness centers, fast food restaurants, and grocery and liquor stores—and might be used to offer interventions to help

change health-related behaviors as they occur. Some individuals may not understand how their data is being tracked, or may refuse the technology due to privacy concerns, limiting the applicability of usage. However, keeping information private and secure and ensuring patients understand how their data will be used may obviate this concern. (p. 6-8)

Overall, the use of smartphone-based geofencing yielded a positive predictive value of 65%, indicating that it can enable the real-time tracking of hospital visits with moderate accuracy. **Given the growing ubiquity of smartphone use, and the importance of obtaining hospitalization data, geofencing may “provide an efficient and cost-effective method to collect, share, and react to such data in real-time.”** Future study should focus on increasing accuracy in collecting user feedback and detecting hospital locations, as well as applying geofencing to other types of specific locations to facilitate patient care and healthcare research. (p. 7-9).

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#### CITATION

Nguyen, K. T., Olgin, J. E., Pletcher, M. J., Ng, M., Kaye, L., Moturu, S., ... & Bettencourt, L. (2017). Smartphone-based geofencing to ascertain hospitalizations. *Circulation: Cardiovascular Quality and Outcomes*, 10(3), 1-10.

#### ARTICLE 5: BRIEF REPORT: USING GLOBAL POSITIONING SYSTEM (GPS) ENABLED CELL PHONES TO EXAMINE ADOLESCENT TRAVEL PATTERNS AND TIME IN PROXIMITY TO ALCOHOL OUTLETS

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#### SUMMARY

As individuals reach adolescence, risky behaviors such as marijuana and alcohol use increase as they gain freedom to access new environments unsupervised, and these risks may increase with more time spent in proximity to alcohol outlets. **Youth alcohol use and drinking problems are additionally related to greater outlet density in residential neighborhoods.** In this study, 16-17-year old participants' locations were tracked using GPS-enabled smartphones for one week during which their behaviors were assessed through 10 brief text-prompted web surveys (p. 65-66).

Participants had an overall 93% response rate to texts, with more than half responding to all texts. 28% of adolescents reported using marijuana and 39% reported drinking alcohol during



the week, with 25% of participants' time spent away from their residential area and 29% of their time away from home. Drinkers were in proximity to alcohol outlets about twice as much as non-drinkers during weekend afternoons and evenings. On weekdays, proximity to any alcohol outlet was also greatest after school and evenings, with drinkers in proximity to outlets about one-and-a-half times as much as non-drinkers. Proximity to alcohol outlets was more than twice as much on weekdays and weekends for marijuana users versus non-users (p. 66, 67).

**On whole, the study found that adolescents' proximity to alcohol outlets varied according to time of day and days of the week, with greater proximity in afternoons and evenings, and more difference on weekends and weekday evenings when comparing drinkers to non-drinkers. Drinkers had greater proximity during times when they may be better able to choose their surroundings, as they were in proximity to outlets 1.5 to 2 times more on weekends and weekday evenings compared to non-drinkers. Marijuana users were in proximity to outlets about twice as much as their non-using counterparts (p. 67-68).**

Preliminary study results using GPS technology show the feasibility of this method. More detailed information about adolescents' time in greatest proximity to environmental risk, and where they spend their time in general **"could inform adolescent prevention research by allowing for more accurate determinations of how environmental contexts influence adolescent health-related risk behaviors"** (p. 65-68).

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#### CITATION

Byrnes, H. F., Miller, B. A., Morrison, C. N., Wiebe, D. J., Remer, L. G., & Wiehe, S. E. (2016). Brief report: using global positioning system (GPS) enabled cell phones to examine adolescent travel patterns and time in proximity to alcohol outlets. *Journal of Adolescence*, 50, 65-68.

#### CONCLUSION

This research review investigated the emerging phenomenon in public health and substance abuse prevention of using geography-based systems, tools, and applications—such as geofencing and GPS—to connect individual and group behavior to specific areas (such as public health “hotspots”) for the purposes of providing targeted interventions and strategies to these spaces. This review found both promising results and reason for caution.

Mason et al (2016) investigated how adolescent substance use is related to family relationships, peer networks, and place-based influences, for the purposes of exploring the effect of environmental influences on risky substance use behavior. The authors found that for teens with particularly risky peer networks and risky activity spaces, the effect of relations with parents on substance use is amplified—the riskier an adolescent’s social and environmental surroundings, the more influential are the adolescent’s parents in minimizing substance use (p. 9-10).

Wray et al (2019) explored the possibility of using geofencing to investigate the social and environmental factors connected with alcohol use and sexual perceptions in heavy-drinking gay and bisexual men who engage in risky behavior, finding that geofencing revealed high rates of “false positives” (i.e., roughly 40%).

Hoepfner et al (2017) explored the viability of using smartphone apps for managing the use of alcohol, finding that while there is potential for public health benefit, they do not often provide valuable health information.

Nguyen et al (2017) explored the use of geofencing to monitor individual movement in and around a public health setting (i.e., hospital), finding that this method was accurate and reliable—suggesting the possibility for its use in data collection, sharing, and reporting.

Finally, Byrnes et al (2016) investigated the use of GPS tools to track adolescent behavior in relationship to alcohol outlets for the purpose of trying to make determinations about how environmental contexts influence adolescent behavior.

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## AUTHOR INFORMATION

Benjamin Gleason, PhD is the Director of Applied Research for the Prospectus Group. He earned a PhD in Educational Psychology & Educational Technology from Michigan State University, researching how to best support communities of learners through educational technology. Before academia, Benjamin has worked in youth and adult-serving learning spaces for almost fifteen years, from designing youth-initiated community service projects and teaching high school in Richmond, California, to working as a university instructor in Guatemala. Benjamin is also a founder of the Prospectus Group.

Tanner Brooks earned his BA in Political Science from Oberlin College and an MA (Distinction) International Studies and Diplomacy from the University of London School of Oriental and African Studies, where his thesis focused on examining the application of international human rights norms to the experience of child soldiers in Sierra Leone. He has a decade of experience in national and international activism, advocacy, and education, from working on political campaigns, nonprofits, and political action committees to writing and teaching politics and sociology as a professor in Tunisia. His most recent work involves mentoring and tutoring teenage survivors of sex trafficking.