



Published in final edited form as:

*J Adolesc Health*. 2015 August ; 57(2): 245–247. doi:10.1016/j.jadohealth.2015.04.013.

## Tracking Adolescents with GPS-enabled Cell Phones to Study Contextual Exposures and Alcohol and Marijuana Use: A Pilot Study

Hilary F. Byrnes, Ph.D.<sup>a,\*</sup>, Brenda A. Miller, Ph.D.<sup>a</sup>, Douglas J. Wiebe, Ph.D.<sup>b</sup>, Christopher N. Morrison, M.P.H.<sup>a,c</sup>, Lillian G. Remer, M.A., G.I.S.P.<sup>a</sup>, and Sarah E. Wiehe, M.D., M.P.H.<sup>d</sup>

<sup>a</sup>Prevention Research Center, Pacific Institute for Research and Evaluation, Oakland, CA

<sup>b</sup>University of Pennsylvania, Perelman School of Medicine, Department of Biostatistics and Epidemiology, Philadelphia, PA

<sup>c</sup>Monash University, Department of Epidemiology and Preventive Medicine, Melbourne, Australia

<sup>d</sup>Indiana University School of Medicine, Indianapolis, IN; Indiana University Purdue University, Indianapolis, IN; Regenstrief Institute for Health Care, Indianapolis, IN

### Abstract

**Purpose**—Measuring activity spaces, places adolescents spend time, provides information about relations between contextual exposures and risk behaviors. We studied whether contextual exposures in adolescents' activity spaces differ from contextual risks present in residential contexts and examined relationships between contextual exposures in activity spaces and alcohol/marijuana use.

**Methods**—Adolescents (N=18) aged 16–17 carried GPS-enabled smartphones for one week, with locations tracked. Activity spaces were created by connecting GPS points sequentially and adding buffers. Contextual exposure data (e.g., alcohol outlets) were connected to routes. Adolescents completed texts regarding behaviors.

**Results**—Adolescent activity spaces intersected 24.3 census tracts and contained 9 times more alcohol outlets than residential census tracts. Outlet exposure in activity spaces was related to drinking. Low SES exposure was related to marijuana use.

**Conclusions**—Findings suggest substantial differences between activity spaces and residential contexts, and suggest that activity spaces are relevant for adolescent risk behaviors.

### Keywords

activity space; contextual risk exposure; adolescent alcohol and risk behaviors; GPS

---

As teens age, risky behaviors (e.g., alcohol and marijuana use) increase at the same time that parental monitoring decreases, increasing unsupervised access to new environments [1]. Previously, contextual risk exposure was measured using administrative units around

---

\*Correspondence concerning this article should be addressed to Hilary F. Byrnes, Ph.D., Prevention Research Center, 180 Grand Avenue, Suite 1200, Oakland, CA 94612. hbyrnes@prev.org, Phone: (510) 708-2215.

adolescents' homes [2], which may not reflect where they spend time [3], as locations adolescents spend time in cut across traditional definitions of neighborhood (e.g., census tract) [2]. Activity space, the geographic area individuals move within during daily activities [4], may be a more accurate measure of contextual risks [3]. Global positioning system (GPS) devices have been used to study health behaviors primarily focused on environmental exposure and physical activity/dietary behaviors among adults [5–7]. Some studies have used GPS to study substance issues [8,9] among adults, examining craving rather than substance use [9], and some have examined girls' exposure to high-crime contexts [8]. Our study applies these techniques to adolescents' exposure to alcohol outlets and low-SES contexts, and how that relates to substance use.

Objectives were to: 1) Test whether contextual risk exposures in adolescents' activity spaces differ from contextual risks present in residential contexts and 2) Examine relationships between exposures in activity spaces and adolescent substance use.

## METHODS

A convenience sample of English speaking 16–17 year olds (N = 18) recruited through Craigslist completed online surveys and were tracked via issued GPS-enabled smartphones (AT&T Fusion2) over one week. Participants were sent text-prompted web surveys 10 times during the week to capture current behaviors. Marijuana use was illegal in the study area at the time of data collection. Study procedures were approved by an Institutional Review Board.

Locations were tracked every 60 seconds using ActSoft Comet Tracker (ActSoft Inc., Tampa, FL). There were 107,305 location records, with 95.9% of locations able to be identified with latitude/longitude values, rather than from cell towers. Participants were followed for a total of 143,373 minutes out of the total 167,256 (85.7%) minutes that they were participating in the study.

Half (50.0%) of participants were female. The average age was 16.5 (SD = 0.51). Participants were 61.1% White, 22.2% African-American, and 16.7% multi-ethnic, similar to the metropolitan area where the study was conducted [10].

Each text asked “Have you [had any alcoholic drinks/used marijuana] since the last text we sent you?” (response rate = 93%) For each participant, we calculated the total number of texts where substance use was reported over the tracking period.

### Low SES

Census data obtained from Geolytics, Inc. were used to create an index for the residential tract by summing the following proportions: unemployment, households receiving public assistance, persons below poverty-level (<100% poverty-level), low income persons (100%–149% poverty level), high school dropouts, female-headed households, renter-occupied houses, and moved in 2005 or later ( $\alpha = .85$ ). Low SES in the activity space was approximated by summing scores for the census tracts intersected by the activity spaces, weighted by the proportion of the buffer area within the tract.

## Alcohol outlets

Data and geocoded outlet locations were obtained from the state's Liquor Authority Mapping Project. Numbers of active alcohol outlets by residential census tract and activity space were tabulated for off- (e.g., liquor stores) and on-premise (e.g., bars) establishments.

Activity spaces were calculated by connecting GPS points from locations in time order to create one aggregated route for each participant. Buffers of 30, 100, and 200m were created for each person's route. The 30m buffer was used here as it represents a distance where youth would be able to see, and results were similar across buffers. SES and outlet data were spatially joined to each route.

There were 3,173 instances in which there was a break in GPS readings of between two and 60 minutes. Points were imputed for 1,851 (58.3%) of these instances in which the two readings were no more than 100m apart by Euclidean distance. Imputed points were equally spaced along a straight line at two minute intervals. Analyses were conducted for imputed and non-imputed data, but findings were similar and missing data minimal, so results with non-imputed data are presented.

## RESULTS

About one-quarter (22.2%) of adolescents reported no lifetime substance use. Adolescents reported using alcohol in 0.56 texts (SD = 0.86) and marijuana in 0.78 (SD = 1.59).

Activity spaces intersected an average of 23 census tracts (Figure 1). Adolescents were exposed to significantly more on- and off-premise outlets in activity spaces than were present in their residential census tract (Figure 2). SES indices for activity spaces (M=139.26) and residential tracts (M=149.18) were similar ( $p=.43$ ).

Correlations revealed a significant relationship between alcohol use and on-premise ( $r = .47$ ,  $p < .05$ ) and off-premise ( $r = .52$ ,  $p < .05$ ) alcohol outlet exposure in activity spaces but not outlets in residential tracts ( $p > .13$ ). Exposure to low SES areas was unrelated to alcohol use in either activity ( $r = -.08$ ,  $p = .76$ ) or residential spaces ( $r = .17$ ,  $p = .51$ ).

Marijuana use was significantly related to exposure to low SES areas in activity spaces ( $r = .52$ ,  $p < .05$ ), but not to low SES residential tracts ( $r = .40$ ,  $p = .11$ ). Marijuana use was unrelated to exposure to alcohol outlets in activity spaces (on-premise:  $r = -.06$ ,  $p = .83$ ; off-premise:  $r = -.04$ ,  $p = .88$ ) or the presence of outlets in residential tracts ( $p > .87$ ).

## DISCUSSION

Results suggest the importance of examining contextual exposures (e.g., to alcohol outlets) in activity spaces as they relate to youth substance use. There were substantial differences in contextual risks in activity spaces compared to residential areas, and these exposures were correlated with adolescents' substance use. This is in line with the uncertain geographic context problem [3], the issue that residential units typically used to define neighborhoods may not reflect where adolescents spend time. Our study contributes new findings as to relations of alcohol outlets and low SES in activity spaces with adolescent risk behaviors.

Limitations include the small sample size and resulting lower power to detect significant relationships. The convenience sample also lessens generalizability to a wider sample, although sample characteristics reflect those of the larger community.

By considering adolescents' actual exposure to contextual risks, new environmental prevention strategies may be identified. The technique used has promise for understanding other factors involved in adolescent risk behavior. Future studies might expand these initial efforts to further assess peer presence during daily activities and how peers impact health behaviors.

## Acknowledgments

Funding: This work was supported by Pacific Institute for Research and Evaluation Corporate Development Project 9360.12.01, "Youth Contextual Risks", PI: Byrnes, H.F.

## References

1. Voas RB, Kelley-Baker T. Licensing teenagers: Nontraffic risks and benefits in the transition to driving status. *Traffic Injury Prevention*. 2008; 9(2):88–97.
2. Basta LA, Richmond TS, Wiebe DJ. Neighborhoods, daily activities, and measuring health risks experienced in urban environments. *Social Science and Medicine*. 2010; 71(11):1943–1950. [PubMed: 20980088]
3. Kwan M-P. The uncertain geographic context problem. *Annals of the Association of American Geographers*. 2012; 102(5):958–968.
4. Gesler WM, Meade MS. Locational and population factors in health care-seeking behavior in Savannah, Georgia. *Health Services Research*. 1988; 23:443–462. [PubMed: 3403277]
5. Kirchner TR, Cantrell J, Anesetti-Rothermel A, et al. Geospatial Exposure to Point-of-Sale Tobacco Real-Time Craving and Smoking-Cessation Outcomes. *American Journal of Preventive Medicine*. 2013; 45(4):379–385. [PubMed: 24050412]
6. Zenk SN, Schulz AJ, Matthews SA, et al. Activity space environment and dietary and physical activity behaviors: a pilot study. *Health and Place*. 2011; 17(5):1150–1161. [PubMed: 21696995]
7. Christian WJ. Using geospatial technologies to explore activity-based retail food environments. *Spatial and Spatio-temporal Epidemiology*. 2012; 3(4):287–295. [PubMed: 23149325]
8. Wiehe SE, Kwan MP, Wilson J, et al. Adolescent health-risk behavior and community disorder. *Plos One*. In press.
9. Epstein DH, Tyburski M, Craig IM, et al. Real-time tracking of neighborhood surroundings and mood in urban drug misusers: Application of a new method to study behavior in its geographical context. *Drug Alcohol Depend*. 2014; 134(0):22–29. [PubMed: 24332365]
10. Bureau UC. 2013 American Community Survey. 2013. [http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS\\_13\\_1YR\\_DP05&prodType=table](http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_1YR_DP05&prodType=table)

**Implications and Contribution Summary Statement**

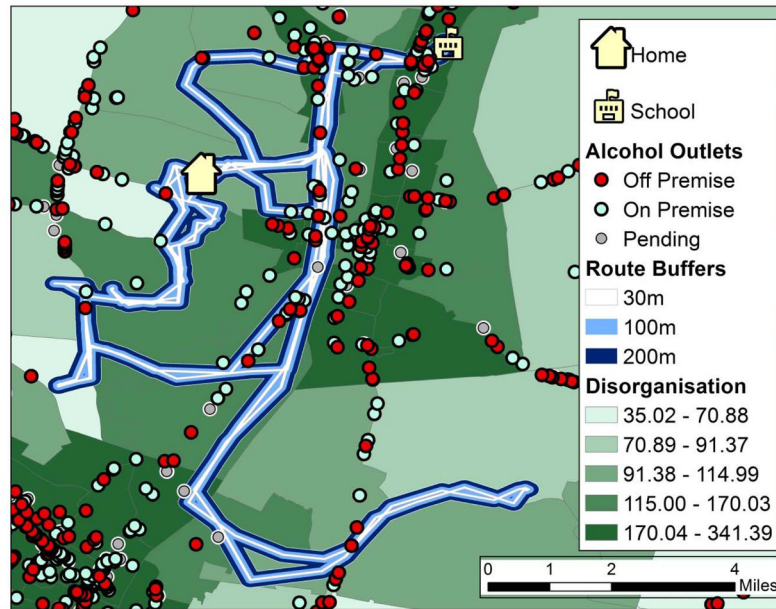
Findings provide preliminary evidence of differences between activity spaces adolescents are exposed to as compared to residential contexts. Results also suggest the importance of considering contextual exposure in activity spaces for adolescent substance use.

Author Manuscript

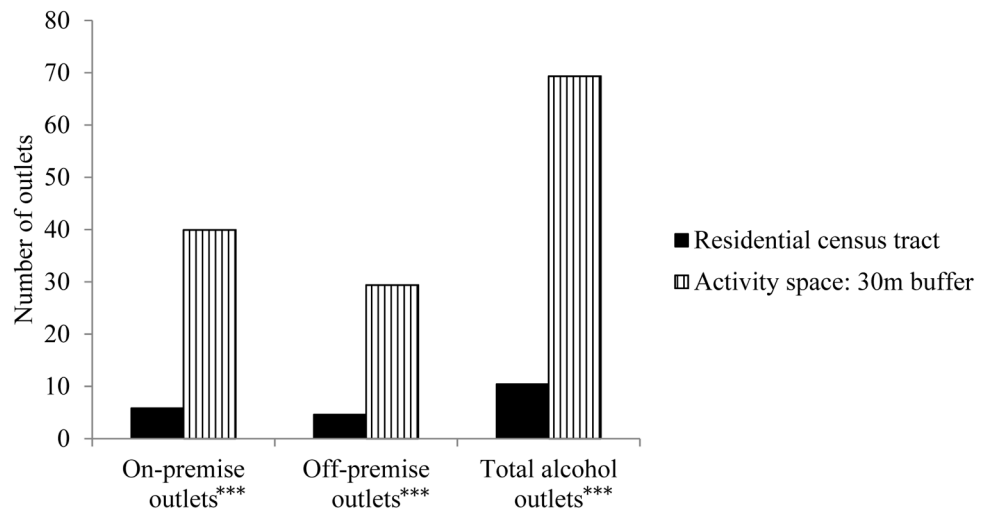
Author Manuscript

Author Manuscript

Author Manuscript



**Figure 1.**  
Example of a participant's activity space overlaid on census tracts, alcohol outlets, and low SES (disorganization) (quintiles)



**Figure 2.**  
Alcohol outlets in activity spaces and residential census tracts  
\*\*\*  $p < .001$