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Proximity of off-premise alcohol outlets and heavy alcohol consumption: A cohort study*

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Abstract

Background—Availability of alcohol has been associated with alcohol consumption in cross-sectional studies. We examined longitudinally whether change in proximity to off-premise (i.e., no consumption on the premises) beer and liquor outlets is associated with heavy alcohol consumption.

Methods—Distances from 54,778 Finnish Public Sector study participants' homes to the nearest off-premise beer and liquor outlets were calculated using Global Positioning System-coordinates. Between-individual analyses were used to study the effects of distance to the nearest outlet on heavy alcohol use, and within-individual analyses to study the effects of a *change* in distance on *change* in heavy use.

Results—Mean follow-up time in 2000–2009 was 6.8 (standard deviation 2.0) years. In a between-individual analysis, decrease from ≥500m to <500m (vs. remained ≥500m) in the distance to the nearest beer outlet increased the likelihood of incident heavy alcohol use in women (odds ratio 1.23, 95% CI 1.05–1.44), but not in men. In a within-individual analysis decrease from 500m to 0m in log-transformed continuous distance to the nearest beer outlet increased the odds of heavy alcohol consumption in women by 13% (odds ratio 1.13, 95% CI 1.01–1.27). For the corresponding change in distance to liquor outlet the increase was 3% (odds ratio 1.03, 95% CI 0.97–1.09).

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Conflicts of Interest
All authors declare no conflict of interest.

Conclusions—Change in distance from home to the nearest off-premise alcohol outlet affects the risk of heavy alcohol consumption in women. This evidence supports policies that restrict physical availability of alcohol.

Keywords

alcohol consumption; alcohol policy; availability; distance; longitudinal; Finnish Public Sector Study

1. INTRODUCTION

Heavy alcohol use is a worldwide public health problem with an important contribution to the burden of illnesses (Gronbaek, 2009; Rehm et al., 2009); among 15–44 year old men, more than every fifth death in the European and American WHO regions is related to alcohol use (WHO, 2011). The economic costs of excessive alcohol use are also remarkable, in the U.S., for example, the estimated costs in 2006 were $223.5 billion (Bouchery et al., 2011).

Studies have suggested that availability, as indicated by density of alcohol outlets within towns, zip code areas and census tracts (Campbell et al., 2009; Livingston et al., 2008; Popova et al., 2009; Schonlau et al., 2008; Treno et al., 2003) and other geographical areas (Connor et al., 2011; Kavanagh et al., 2011; Paschall et al., 2012; Stockwell et al., 2011), or distance from home to an alcohol outlet (Picone et al., 2010; Pollack et al., 2005; Scribner et al., 2000) is associated with alcohol consumption. Findings especially for the associations between off-premise outlets and heavy alcohol consumption have been mixed; studies using density measures have reported positive associations (Campbell et al., 2009; Connor et al., 2011; Kavanagh et al., 2011; Livingston et al., 2008), whereas associations for distance measures have not been found (Kavanagh et al., 2011; Truong and Sturm, 2007). However, prior research on alcohol availability has often been limited by cross-sectional designs (Connor et al., 2011; Kavanagh et al., 2011; Livingston et al., 2008; Paschall et al., 2012; Pollack et al., 2005; Schonlau et al., 2008; Scribner et al., 2000; Treno et al., 2003; Truong and Sturm, 2007) or the use of alcohol sales, instead of self-reported consumption data (Campbell et al., 2009). Further, density as the measure of availability within large administrative areas (Livingston et al., 2008; Popova et al., 2009; Schonlau et al., 2008; Stockwell et al., 2011; Treno et al., 2003) may provide unequal estimates for those living in the center versus the periphery of the area. We have shown that a change in distance to an on-site alcohol outlet (“a bar”) is associated with a change in heavy drinking (Halonen et al., 2012b), and want therefore examine whether the same is true for off-premise outlets (i.e., liquor outlets, grocery and convenience stores, and gas stations selling alcohol for consumption off-premises) that are more abundant. The answer would potentially inform about directions to which alcohol outlet policies should be developed.

In this study, the effect of proximity of an off-premise alcohol outlet (i.e., no consumption on the premises) on heavy alcohol consumption was longitudinally examined in a large adult sample. The aim was to determine whether distance to the nearest off-premise alcohol outlet, and a higher number of off-premise outlets within walking distance from home are associated with heavy alcohol consumption. The associations were determined between individuals using the whole sample of participants with two or more survey responses, and within individuals using data from participants whose distance to an outlet had changed and who had changed their drinking pattern between two surveys. The analysis within individuals means that we examined whether a *change* in distance to the nearest off-premise outlet is associated with a subsequent *change* in heavy alcohol consumption.

2. METHODS

2.1 Study population

Data are from the Finnish Public Sector study cohort, an ongoing prospective study of employees working in 10 towns and six hospital districts (Kivimaki et al., 2010) that are located in the Southern and Western Finland (Supplementary Figure 1[1]). The target organizations included all public sector workplaces, e.g., schools, day care centers, rest homes and health care centers, as well as 21 hospitals, and administration. The sex distribution of the present sample corresponds well with the Finnish public sector where most employees (teachers, nurses, etc.) are women. The eligible register cohort population included all employees who had been working for these organizations for a minimum of six months between 1991 and 2005, a total of 151,618 men and women. For 146,600 of them the geocoded latitude and longitude coordinates of their residential buildings in between Jan 1st, 2000 and Dec 31st, 2010 were obtained from the Population Register Center. They have reported that 90% of the residential building locations in whole Finland are correct with 20 m accuracy, and that in the city plan areas (where most participants resided) the coverage is the best (Väestörekisterikeskus [Population Register Centre], 2004).

Nested survey cohorts, based on current employees at the time of survey in the participating organizations (on average 75,000 eligible employees in each survey), have received questionnaires every four years between 2000 and 2008 (average response rate 69%). In 2005 and 2009, surveys were mailed also to those who completed questionnaires while employed, but had later left the organizations. The ethics committee of Hospital District of Helsinki and Uusimaa approved the study.

This study included all nested cohort members who were employed by the target organizations in 2000, 2004, and 2008 and responded to the surveys including questions on alcohol consumption in those years. These data were complemented with responses from the 2005 and 2009 surveys of the leavers. For 296 participants the residential coordinates were not available, and 1156 did not respond to questions related to alcohol use and they were excluded from the data. A total of 54,778 participants responded to at least two of these surveys and formed the analytic sample of this study. This sample is comparable to the eligible register cohort population in regard of sex distribution (81% in this sample, 78% in the eligible cohort), and age (44 years in this sample, 44 years in the eligible cohort).

2.2 Dependent variable: heavy alcohol consumption

The respondents reported their habitual frequency and amount of beer, wine, and spirits intake, which was transformed into grams of alcohol per week. The questions on alcohol consumption in this survey have also been used elsewhere (Kaprio et al., 1987; Poikolainen et al., 2005). One unit of pure alcohol (12 g) was equal to a 12 cl glass of wine, a 4 cl measure of spirits and a 33 cl bottle of beer. *Heavy alcohol use* was determined as 24 and 16 units (>288g and >192g) per week for men and women, respectively (Halonen et al., 2012b). These limits correspond with the medium risk levels of daily consumption set by the World Health Organization (WHO, 2000).

2.3 Independent variables: proximity and number of off-premise alcohol outlets

The street addresses of all off-premise alcohol outlets (i.e., no consumption on the premises) in Finland with an active liquor license in 2004 or 2008 were derived from the Regional State Administrative Agency, the only licensing authority in Finland. First, most grocery and convenience stores as well as gas stations have a license to sell alcohol beverages with a

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maximum alcohol content of 4.7% alcohol by volume (e.g., beer). These outlets are referred to as "beer outlets." Second, liquor outlets operate under a state monopoly in Finland and are the only off-premise outlets where stronger alcohol beverages, including beer, wine, and spirits, can be purchased. These outlets are referred to as "liquor outlets." In total, street addresses (with street numbers) of 92% of the beer outlets (n=5319), and 95% of the liquor outlets (n=313) were successfully geocoded by a geocoding service and by manual search. These latitude and longitude coordinates were used for calculating the distances between participants' residences and the outlets, as well as the number of beer outlets within 1 km (0.6 miles) zone from home of the participant. Because license information for beer outlets was incomplete for year 2000, outlet locations in 2004 were used also for year 2000.

2.4 Covariates

Age, sex, and occupational status were obtained from employers' administrative registers. Occupational status was used as a proxy for individual socioeconomic status, SES, and as a possible confounder because the effects of alcohol use may differ between SES groups (Nielsen et al., 2004). Individuals were classified into three SES groups: high, intermediate, and low, based on Classification of Occupations by Statistics Finland (Statistics Finland, 1987), as in our earlier studies (Halonen et al., 2012b; Kivimaki et al., 2007). Sub-optimal health (self-rated health of fairly poor or poor vs. other), and marital status (married or co-habiting vs. not) were also requested in the questionnaires.

Neighborhood socioeconomic characteristics have been associated with alcohol availability (Pollack et al., 2005). Measures of the possible confounding area characteristics in this study were calculated by Statistics Finland, and were based on the total population within each 250×250m map grid (Statistics Finland, 2007). An index of neighborhood socioeconomic disadvantage was calculated using the grid database information on median income, education attainment, and unemployment rate (Halonen et al., 2012a). Another area-level covariate was population density (residents per 1 km^2) that was used as a proxy for the degree of urbanization. These data were linked to the survey data using the GPScoordinates of the participants' home addresses.

2.5 Statistical analyses

The median distance from home to the nearest beer outlet was 0.45 (range 0–38.5) km (0.58, 0–23.9 miles). Change in distance to the nearest beer outlet between two surveys was categorized as: 1) Remained long=distance remained ≥500m (≥0.3 miles, reference), 2) Increased=distance increased from <500m to ≥500m, 3) Remained short=distance remained <500m, and 4) Decreased=distance decreased from ≥500m to <500m. For distance to the nearest liquor outlet the categorization was similar, with a cut-point at 2 km (1.25 miles) because the median distance was 1.9 (range 0–131) km (1.2, 0–82 miles). Number of beer outlets within 1 km (0.6 miles) zone from home has been used as an exposure variable in prior cross-sectional studies (Connor et al., 2011; Kavanagh et al., 2011). In this study, the median number of beer outlets within 1 km from home was 3, thus, the number of beer outlets variable was categorized as: 1) Remained low=number remained ≤3 (reference), 2) Decreased=number decreased from >3 to ≤3, 3) Remained high=number remained >3, and 4) Increased=number increased from ≤3 to >3.

2.5.1 Between-individual analyses—To estimate the effects of distance to the nearest off-premise alcohol outlet and the number of off-premise beer outlets within 1km zone on heavy alcohol use among all participants and at follow-up (i.e., those “incident users” who were not heavy users at baseline but were at the later survey), we used binomial logistic regression with the generalized estimating equations (GEE) method with neighborhood as the clustering variable (GENMOD procedure of SAS 9.2; SAS, 2001). This method includes

all participants with two or more survey responses. To test whether availability affects alcohol consumption differently in men and in women, we included an interaction term to the regression models (heavy consumption ~ sex × distance to (or number of) outlet(s)). All models were then adjusted for age, (sex), marital status, sub-optimal health, neighborhood disadvantage, population density, and the number of beer outlets (distance variables in the density models). As sensitivity analyses we run the models adjusting for distance to an onsite outlet (Halonen et al., 2012b) and used different cut-point distances for the exposures (25^{th} percentiles: 250m and 1 km, and means: 850m and 3.3 km). The results for the categorical availability measures are provided as odds ratios (OR) with 95% confidence intervals (CI).

2.5.2 Within-individual analyses—Within-individual analyses were run using a quasi-experimental fixed-effects approach with conditional logistic regression models (LOGISTIC procedure of SAS). This approach chooses and utilizes information from those who have reported heavy use in one of any survey (case) and no heavy use in one of any other survey (control), and whose distance to the nearest off-premise outlet changed between the surveys (n=5959; Allison, 2005). Thus, they could have either stopped or started heavy drinking, and the change in distance could be due to a move of the participant or due to an opening/closing of an outlet in the neighborhood. Because participants served as their own reference (within-individual), models were adjusted for time-dependent covariates only: age, marital status, sub-optimal health, employment status (stayed in vs. left the target organization between surveys), neighborhood disadvantage, population density, and the number of beer outlets (distance variables in the density models). Dichotomized change-in-distance variables (decrease from ≥500m to <500m vs. increase from <500m to ≥500m for beer outlets, and decrease from ≥2 km to <2 km vs. increase from <2 km to ≥2 km for liquor outlets) were first used. Distance cut-points at the 25^{th} percentile and at mean were used for sensitivity analyses. Because these variables only account for changes over the cut-point distances, analyses were also run using log-transformed continuous exposure variables that notice all changes in availability. To minimize the bias from voluntary move towards alcohol outlets, we ran a model with only those who did not change residential address (~64% of respondents), but for whom the distance to the nearest outlet changed. Results for the continuous distance analyses are provided as odds ratios (95% CI) per decrease from 500m to 0m in log-transformed distance (i.e., log(distance+1)/log(1.5)), and for the continuous number of outlets analyses as odds ratios (95% CI) per one additional outlet within 1 km zone from home.

3. RESULTS

The majority of the study population were women (81%), and the mean age of participants was 44.1 (standard deviation [SD] 10.1) years (Table 1). The Pearson correlation between distance to the nearest beer and the nearest liquor outlet was r=0.55 (p<0.0001). In the whole data, interactions between sex and distance to the nearest beer outlet (p<0.05), and liquor outlet (p<0.001), and the number of outlets within 1 km zone from home (p=0.05) were significant, thus, all analyses were performed by sex.

3.1 Between-individual analyses

During a mean follow-up of 6.8 (SD 2.0) years, decreased distance to the nearest beer outlet (vs. remained long) was associated with heavy alcohol use among all women (OR: 1.23, 95% CI 1.09–1.40) and incident female users (OR: 1.23, 95% CI 1.05–1.44; Table 2). In all men, decreased distance to the beer outlet (vs. remained long) was negatively associated with heavy use (Table 2). In all women, short distance to the nearest liquor outlet elevated the odds of heavy alcohol use, whereas decreased distance to the nearest liquor outlet was

associated with heavy use in all participants and incident users (Table 2). Estimates for all covariates are presented in Supplementary Tables 1 and 2[2]. When further adjusting for distance to on-site outlets, the association between decreased distance to beer outlet and heavy use remained positive in all women (OR 1.18, 95% CI 1.03–1.35) and negative in all men (OR 0.63, 95% CI 0.47–0.85). Increased vs. low number of beer outlets within 1 km from home was also associated with higher likelihood of heavy alcohol use among women, but not in men (Table 3). Longer distance cut-points resulted in positive significant findings in women (e.g., decreased distance to beer outlet OR 1.19, 95% CI 1.01–1.40), no associations were found in men (Supplementary Table 3[3]). The shorter cutpoint distances resulted in non-significant associations (see Supplementary Table 4[4]), possibly due to the fact that the effect of a very short distance is not much stronger than relatively close distances between 250 and 850m (50% of all distances in these data), now belonging to the large reference group.

3.2 Within-individual analyses

In the data for the within-individual analyses the mean follow-up time was 6.7 (SD=1.9) years. A decrease from ≥500m to <500m in the distance (vs. increase from <500m to ≥500m) to the nearest beer outlet increased the likelihood of heavy alcohol use in women by 20%. This increase was 17% when further adjusting for distance to on-site outlet (OR 1.17, 95% CI 1.00–1.37). For a change from ≥2 km to <2 km (vs. <2 km to ≥2 km) in the distance to the nearest liquor outlet the association with heavy use was non-significant (Table 4). In men, similar decrease in distance to liquor store was borderline significantly associated with increased heavy use (Table 5), and this association remained after adjusting for distance to bar (OR 1.31, 95% CI 0.97–1.77). An increase from ≤3 to >3 beer outlets within 1 km from home (vs. decrease from >3 to ≤3) did not elevate the odds of heavy drinking significantly (Tables 4 and 5). Cut-point distances at 25th percentile and at mean gave positive effect estimates for women (Supplementary Table 5[5]).

When using continuous log-transformed distance to the nearest beer outlet, a decrease from 500m to 0m was associated with a 13% increase in the likelihood of heavy alcohol use in women (Table 4) (OR 1.12, 95% CI 1.00–1.26 when adjusting for distance to on-site outlet). No significant associations were found in men (Table 5). The association for an additional beer outlet within 1 km from home with heavy alcohol use was positive, but non-significant (Tables 4 and 5). Among those women who did not move, decrease from 500m to 0m in the log-transformed distance to the nearest beer outlet elevated the odds of heavy alcohol use (1.23, 95% CI 0.94–1.61), and in non-mover men the same decrease in distance to liquor store elevated the odds of heavy drinking (1.17, 95% CI 0.94–1.46), although effect estimates were non-significant probably because of low numbers.

4. DISCUSSION

This study showed that living in close proximity of an off-premise alcohol outlet, especially a “beer outlet” (i.e., a grocery and a convenience store or a gas station with no consumption on the premises), can increase the risk of unhealthy alcohol consumption in women. The results from the within-individual analyses suggest that a *change* in distance to the nearest beer outlet is associated with *change* in heavy alcohol user status, and that this association may be exogenous, that is, independent of the person's decision to move closer to an outlet. The associations for liquor outlets were weaker than for the beer outlets, which is possibly explained by the smaller number of liquor outlets. However, these findings suggest that decision makers should consider actions to limit physical availability of alcohol, even the availability of mild alcohol beverages.

We are not aware of previous longitudinal studies examining the associations between change in distance to the nearest off-premise alcohol outlets and change in alcohol behaviors; therefore, our findings from the within-individual analyses are likely to be unique. However, these findings for women are in agreement with other data suggesting an association between increased number of bars in the neighborhood and increase in alcohol consumption (Picone et al., 2010). Previous longitudinal evidence also suggests that an increase in alcohol availability, in terms of the number or density of bars and off-premise outlets, may increase alcohol-related harm such as violence rates (Gruenewald and Remer, 2006; Livingston, 2011) and alcohol-related mortality (Stockwell et al., 2011).

Prior cross-sectional studies have reported mixed findings regarding the association between distance to an alcohol outlet and alcohol use. One investigation found that distance to an off-premise alcohol outlet was not associated with alcohol consumption at the individual level, although the population-level mean distance was associated with alcohol consumption (Scribner et al., 2000). Another study reported no association between living "near" or "far" from the nearest alcohol outlet and alcohol consumption (Pollack et al., 2005); however, neither of these studies examined the effects of change in availability on heavy alcohol use, as was done in our study. In an Australian study, the exposure and outcome variables were comparable to this study, but the authors found no association (Kavanagh et al., 2011). Studies from California have reported no association between distance to off-premise outlets and heavy use in adults (Truong and Sturm, 2007), and a positive association between having an off-premise outlet within 0.5 miles (0.8 km) from home and adolescent heavy drinking episode (Truong and Sturm, 2009), the latter being in line with our findings. Two more recent cross-sectional studies used availability measures "the number of outlets within 1 km zone from home" (Connor et al., 2011) and "the number of outlets within 1 km driving distance from home" (Kavanagh et al., 2011), that are comparable to the number of outlets measure of this study. In line with the current study, they reported a higher likelihood of heavy alcohol use in relation to higher number of outlets (Kavanagh et al., 2011), and an association between availability of off-premise outlets and binge drinking (Connor et al., 2011). One study has found that outlet density was more strongly associated with consumption in adolescent women than men (Treno et al., 2003), which is in agreement with our results. The sex differences considering beer outlets in the mixed effects analyses may indicate differences in consumption and purchasing habits. Women drink smaller amounts than men (Makela et al., 2012) and mainly beverages that have low alcohol content, and may therefore prefer purchasing alcohol from the beer outlet close to home. Men, on the other hand, may buy larger amounts of beer at once (e.g., 24-packs), which is why they drive to the outlet, and therefore the distance to outlet does not matter. Men’s heavy drinking may also include more the stronger alcohol beverages bought from liquor outlets.

There are some limitations to this study. First, even though a repeated survey data were used, there is a possibility of selection bias where people prone to heavy drinking choose to live close to alcohol outlets. To address the issue of self-selection, the models were adjusted for individual SES and area-level socioeconomic disadvantage, and the findings were robust to these adjustments. In addition, the analysis for non-movers suggests that the association between distance to an outlet and alcohol use is affected by factors other than voluntary move towards outlets.

Second, data on self-reported alcohol consumption were used, which may represent an underestimation of actual alcohol intakes (Ekholm et al., 2011). However, in the Finnish Public Sector cohort heavy alcohol use is a strong predictor of alcohol-related mortality (Halonen et al., 2012b), which gives support for the validity of the measure used in this study. It is also unlikely that the observed within-individual changes in drinking could be due to differences (e.g., in response style) between individuals (Allison, 2005). We had no

information about the number of drinks consumed on each drinking occasion, thus, we could not estimate the effects of off-site outlet proximity on heavy episodic drinking.

Third, some of the beer outlet addresses were repeated in the data due to a renewal of a license, or due to more than one outlet in the same address (e.g., shopping center). As we had no information about the reason for the repetition of any individual address, each address was treated as one outlet, and thus the results for the numbers of outlets may be underestimations. Possible inaccuracies in the geocoding may have led to exposure misclassification, which, however, would be non-differential as the misclassification would be equally present among heavy-users and others.

Fourth, the generalizability of the present results should be confirmed in future studies because the population of this study consisted of Finnish adults, the majority of whom were women and employed in the public sector. These results may be underestimations for unemployed and retired, because they may drink more alcohol than employed persons (Henkel, 2011; Zins et al., 2011). Also, drinking behaviors and cultural norms may vary between countries (Kendler, 2012; Stuckler et al., 2009). Therefore, longitudinal studies from other locations, also from developing countries (Babor, 2010), are needed. Finally, the distances from home to an outlet were calculated "as the crow flies", which may not completely correspond to the true traveled distance to the outlet. People may also purchase alcohol from other outlets than that closest to home, e.g., on the way from work to home. If availability near workplace was good, not being able to control for this may have attenuated the results.

In the present study, a decrease in distance from home to the nearest off-premise alcohol outlet was associated with an increased risk of heavy alcohol use in women. These findings suggest policies restricting physical availability of alcohol should be developed and evaluated in order to establish the most effective preventive actions.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Description of the study population.

	n missing	Men *n* (%)	Women *n* (%)
		10 223 (18.7)	44 555 (81.3)
Married/cohabiting	325	8344 (82.2)	32 893 (74.2)
SES, by occupation	920		
High		4266 (42.5)	12 986 (29.6)
Intermediate		2745 (27.3)	25 086 (57.3)
Low		3031 (30.2)	5744 (13.1)
Sub-optimal health [a]	205	3097 (30.4)	12 589 (28.4)
Heavy alcohol use	-	1093 (10.7)	4004 (9.00)
Distance to beer outlet			
Remained long [b]		3539 (34.6)	15 691 (35.2)
Increased [c]		1089 (10.7)	4677 (10.5)
Remained short [d]		4755 (46.5)	20 460 (45.9)
Decreased [e]		840 (8.22)	3727 (8.36)
Distance to liquor outlet			
Remained long [f]		4743 (46.4)	21 305 (47.8)
Increased [g]		104 (1.02)	355 (0.80)
Remained short [h]		829 (8.11)	2644 (5.93)
Decreased [i]		4547 (44.5)	20 251 (45.5)
Number of beer outlets			
Remained low [j]		3996 (39.1)	17 408 (39.1)
Decreased [k]		1046 (10.2)	4431 (9.95)
Remained high [l]		4332 (42.4)	18 670 (41.9)
Increased [m]		849 (8.30)	4046 (9.08)

[a] Self-rated health of fairly poor or poor vs. other

[b] ≥500m;

[c] change from <500m to ≥500m;

[d] <500m;

[e] change from ≥500m to <500m

[f] ≥2 km;

[g] change from <2 km to ≥2 km;

[h] <2 km;

[i] change from≥2 km to <2 km

[j] ≤3;

[k] change from >3 to ≤3;

[l] >3;

[m] >change from ≤3 to >3

Table 2

Distance to the nearest alcohol outlet and heavy alcohol use at follow-up (between-individual associations).

	Heavy alcohol use					
	Men [g]			Women [g]		
Variable	**OR**	**95% CI**		**OR**	**95% CI**	
Distance to Beer outlet						
All participants						
Remained long [a]	1			1		
Increased [b]	0.80	0.62	1.03	0.92	0.81	1.04
Remained short [c]	0.92	0.78	1.09	1.06	0.97	1.16
Decreased [d]	0.63	0.48	0.84	1.23	1.09	1.40
Incident users						
Remained long [a]	1			1		
Increased [b]	0.91	0.65	1.26	0.87	0.74	1.02
Remained short [c]	0.91	0.65	1.26	0.98	0.87	1.09
Decreased [d]	0.74	0.52	1.04	1.23	1.05	1.44
Distance to Liquor outlet						
All participants						
Remained long [e]	1			1		
Increased [f]	1.68	0.89	3.15	0.84	0.54	1.31
Remained short [g]	1.22	0.91	1.64	1.19	1.00	1.40
Decreased [h]	1.03	0.89	1.19	1.17	1.08	1.26
Incident users						
Remained long [e]	1			1		
Increased [f]	1.50	0.63	3.59	0.83	0.48	1.44
Remained short [g]	1.01	0.67	1.53	1.00	0.79	1.26
Decreased [h]	1.14	0.94	1.37	1.13	1.02	1.24

[a] ≥500m;

[b] change from <500m to ≥500m;

[c] <500m;

[d] change from ≥500m to <500m

[e] ≥2 km;

[f] change from <2 km to ≥2 km;

[g] <2 km;

[h] change from≥2 km to <2 km

[g] Model adjusted for age, SES, marital status, sub-optimal health, and neighborhood disadvantage, population density and number of beer outlets within 1 km zone.

Table 3

Number of beer outlets and heavy alcohol use at follow-up (between-individual associations).

	Heavy alcohol use					
	Men [e]			Women [e]		
Variable	**OR**	**95% CI**		**OR**	**95% CI**	
Number of beer outlets within 1 km zone						
All participants						
Remained low [a]	1			1		
Decreased [b]	0.77	0.60	1.01	0.91	0.80	1.03
Remained high [c]	1.12	0.95	1.32	1.06	0.98	1.16
Increased [d]	0.91	0.70	1.17	1.20	1.06	1.35
Incident users						
Remained low [a]	1			1		
Decreased [b]	0.99	0.71	1.38	0.91	0.78	1.07
Remained high [c]	1.22	0.98	1.52	1.03	0.92	1.15
Increased [d]	1.14	0.82	1.59	1.20	1.03	1.41

[a] ≤3;

[b] change from >3 to ≤3;

[c] >3;

[d] change from ≤3 to >3

[e] Model adjusted for age, SES, marital status, sub-optimal health, neighborhood disadvantage, population density, and distances to beer and liquor outlets

Table 4

The likelihood of a change in an individual's heavy alcohol user status following a change in distance to the nearest alcohol (beer or liquor) outlet and a change in the number of beer outlets (within-individual associations) in women.

	Heavy alcohol use, Women			
Variable	OR	95%	CI	p-value
Change in distance to a beer outlet (dichotomized)[a]	1.20	1.03	1.39	0.02
Change in distance to a liquor outlet (dichotomized)[a]	1.05	0.91	1.22	0.49
Change in beer outlet density (dichotomized)[b]	1.13	0.96	1.31	0.13
Age	1.27	1.20	1.35	<0.001
Marital status (single)	1.06	0.92	1.22	0.44
Sub-optimal health	1.03	0.91	1.16	0.66
Employment status	0.79	0.69	0.90	<0.001
Population density (per 1 SD)	0.98	0.91	1.06	0.64
Neighbourhood disadvantage (per 1 SD)	1.00	0.90	1.11	0.97
Change in distance to a beer outlet (continuous)[c]	1.13	1.01	1.27	0.03
Change in distance to a liquor outlet (continuous)[c]	1.03	0.97	1.09	0.34
Change in beer outlet density (continuous)[d]	1.06	0.93	1.20	0.39
Age	1.27	1.20	1.35	<0.001
Marital status (single)	0.95	0.83	1.10	0.50
Sub-optimal health [e]	0.97	0.86	1.09	0.61
Employment status [f]	1.27	1.12	1.45	<0.001
Population density (per 1 SD)	0.97	0.89	1.05	0.38
Neighbourhood disadvantage (per 1 SD)	1.00	0.90	1.11	0.98

[a] Decrease in distance from ≥500 to <500m vs. increase from <500 to ≥500m (beer outlet) or decrease from ≥2 to <2 km vs. increase from <2 km to ≥2 km (liquor outlet)

[b] Density increase from ≤3 to >3 vs. decrease from >3 to ≤3.

[c] Decrease in log-transformed distance from 500m to 0m

[d] Per one additional outlet within 1 km zone from home

[e] Self-rated health poor or fairly poor

[f] Left the organization between survyes

Table 5

The likelihood of a change in an individual's heavy alcohol user status following a change in distance to the nearest alcohol (beer or liquor) outlet and a change in the number of beer outlets (within-individual associations) in men.

	Heavy alcohol use, Men			
Variable	**OR**	**95%**	**CI**	**p-value**
Change in distance to a beer outlet (dichotomized)[a]	1.02	0.76	1.38	0.88
Change in distance to a liquor outlet (dichotomized)[a]	1.31	0.97	1.77	0.08
Change in beer outlet density (dichotomized)[b]	1.18	0.87	1.61	0.16
Age	0.99	0.88	1.11	0.87
Marital status (single)	1.08	0.81	1.45	0.59
Sub-optimal health	0.76	0.61	0.96	0.02
Employment status	0.55	0.42	0.72	<0.001
Population density (per 1 SD)	0.93	0.81	1.06	0.27
Neighbourhood disadvantage (per 1 SD)	1.03	0.83	1.28	0.79
Change in distance to a beer outlet (continuous)[c]	1.08	0.88	1.36	0.54
Change in distance to a liquor outlet (continuous)[c]	1.04	0.93	1.17	0.45
Change in beer outlet density (continuous)[d]	1.12	0.87	1.45	0.38
Age	1.00	0.88	1.12	0.93
Marital status (single)	0.93	0.69	1.24	0.60
Sub-optimal health [e]	1.32	1.05	1.65	0.02
Employment status [f]	1.81	1.38	2.37	<0.001
Population density (per 1 SD)	0.90	0.78	1.05	0.17
Neighbourhood disadvantage (per 1 SD)	1.03	0.83	1.28	0.81

[a] Decrease in distance from ≥500 to <500m vs. increase from <500 to ≥500m (beer outlet) or decrease from ≥2 to <2 km vs. increase from <2 km to ≥2 km (liquor outlet)

[b] Density increase from ≤3 to >3 vs. decrease from >3 to ≤3.

[c] Decrease in log-tranformed distance from 500m to 0m

[d] Per one additional outlet within 1 km zone from home

[e] Self-rated health poor or fairly poor

[f] Left the organization between survyes