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Measuring Alcohol Outlet Density: an Overview of Strategies for Public Health Practitioners

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Abstract

Context: Excessive alcohol use is responsible for 88,000 deaths in the U.S. annually, and cost the U.S. $249 billion in 2010. There is strong scientific evidence that regulating alcohol outlet density is an effective intervention for reducing excessive alcohol consumption and related harms, but there is no standard method for measuring this exposure.

Program: We overview the strategies available for measuring outlet density, discuss their advantages and disadvantages, and provide examples of how they can be applied in practice.

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Implementation: The three main approaches for measuring density are: container-based (e.g., number of outlets in a county), distance-based (e.g., average distance between a college and outlets), and spatial access-based (e.g., weighted distance between town center and outlets).

Evaluation: While container-based measures are the simplest to calculate and most intuitive, distance- or spatial access-based measures are unconstrained by geopolitical boundaries and allow for assessment of clustering (an amplifier of certain alcohol-related harms). Spatial access-based measures can also be adjusted for population size/demographics, but are the most resource-intensive to produce.

Discussion: Alcohol outlet density varies widely across and between locations and over time, which is why it is important to measure it. Routine public health surveillance of alcohol outlet density is important to identify problem areas and detect emerging ones. Distance- or spatial access-based measures of alcohol outlet density are more resource-intensive than container-based measures, but provide a much more accurate assessment of exposure to alcohol outlets and can be used to assess clustering, which is particularly important when assessing the relationship between density and alcohol-related harms, such as violent crime.

Keywords

Alcohol Drinking; Public Health Practice; Geographic Information Systems; Epidemiologic Methods; Population Surveillance

Introduction

Excessive alcohol use[a] is responsible for 88 000 deaths in the U.S. annually, including 1 in 10 deaths among working-age adults 20-64 years, and cost the U.S. $249 billion in 2010, or $2.05 per drink.[1,2] Retail alcohol outlets are licensed establishments that sell alcohol. High concentrations of alcohol outlets (i.e., high outlet density) is an environmental hazard that increases the risk of excessive drinking and related harms – including violence, alcohol-impaired driving, pedestrian injuries, disorderly conduct, noise, public nuisance, and property damage.[3] High density clusters of alcohol outlets lead to increased access to alcohol, increased price competition (which makes alcoholic beverages less expensive and therefore more accessible), and social aggregation of binge drinkers, particularly in neighborhoods located nearby.[3-5] Controlling for 28 other alcohol-related policies, researchers found that policies on alcohol outlet density had a strong and independent association with differences in adult binge drinking across states.[6]

In 2007, the Guide to Community Preventive Services reviewed research on regulating density for reducing excessive alcohol consumption and related harms.[3] The Community Preventive Services Task Force subsequently recommended “limiting alcohol outlet density through the use of regulatory authority (e.g., licensing and zoning)” based on strong scientific evidence of intervention effectiveness.[7] However, the studies included in the Community Guide review used a variety of approaches to measure density. Therefore, the

[a]Defined as *binge drinking* (≥4 drinks per occasion for women; ≥5 drinks per occasion for men); heavy drinking (≥8 drinks per week for women; ≥15 drinks per week for men); any alcohol consumption by those younger than age 21 years; or any alcohol consumption by pregnant women.

Community Guide did not advance a specific definition of high density or specific approaches for measuring it.

It is important to routinely measure and monitor density in states and communities, i.e., conduct public health surveillance of density, for several reasons. First, density varies dramatically within and across locations, reflecting differences in laws and regulations governing alcohol sales.[6,8-10] Second, identifying areas with high or increasing density can help local community planning and zoning departments and alcohol control agencies determine whether to issue new alcohol licenses, reissue old ones, increase enforcement of liquor laws, or some combination of these actions. Third, data on density can be used to evaluate the relationship between this exposure and the various health and social harms noted above. This article's purpose is to acquaint public health practitioners with the measurement strategies available to conduct public health surveillance of outlet density, and their strengths and weaknesses.

Strategies for Measuring Alcohol Outlet Density

The three predominant methods for measuring density are: container-based, distance-based, and spatial access-based (Figure 1).[11]

Container-based Measures

So-called "container-based" measures of density involve counting the number of outlets within a pre-defined area. "Containers" are often geopolitical units (e.g., counties, cities, census tracts, etc.), or they can be defined in an ad hoc manner, e.g., as a buffer zone around a school. Density is then calculated relative to the population, area, or length of roadways within the selected container.

Density is frequently calculated on a population basis. However, it is important to be aware that such density measures are subject to changes in the population itself, independent of any change in alcohol availability. For example, consider 10 alcohol outlets in a city of 1 000 people (density = 0.01 [10 outlets/1 000 people]). If the population doubles, the density would be 0.005 (10 outlets/2 000 people), suggesting a 50% decline in availability, even though twice as many people now have access to the same number of outlets in that area (i.e., the population level exposure has increased). Furthermore, if *both* the population and the number of alcohol outlets in that hypothetical city double, the population-based rate would remain the same, despite the fact that the number of alcohol outlets *and* the exposed population each increased by 100%. The inverse relationship between the size of the exposed population and density makes population-based measures of density inherently less stable than other container-based rates.

Area-based measures are generally more useful for assessing changes in density in the same geographic area because the size of the container usually remains fairly constant over time. However, the inverse relationship between size of the measurement area and density makes the choice of boundaries have a substantial impact on the estimate of outlet density. For example, 10 outlets in a 1 square mile area will have 10 times the estimated density as the same 10 outlets measured in a larger 10 square mile area. For this reason, it is important to exclude undeveloped land, parks, vacant lots, industrial areas, and natural features (e.g., lakes) from density calculations because their inclusion will artificially decrease density estimates. This is particularly important when comparing rates between locations with different amounts of undeveloped or rural land.

Since alcohol outlets are often located along roadways, density can also be assessed per roadway mile. In this case, the "container" becomes the roadway itself, and not the larger area where the roadway is located. As such, this approach may be more accurate than area-based measures because parks, lakes, and other undeveloped areas will not be included in the calculation. However, the overall length of the roadway and the specific sections of roadway that are included or excluded in the rate calculation can significantly influence the results. For example, consider a city where there are only 10 outlets, all of which are located in the same 300-foot block. If one included all the roadways in the city in the denominator, the rate would be far less than if one only included the 300-foot roadway where the outlets were located. Conversely, if this 300-foot stretch of roadway were excluded from the calculation, it would significantly reduce the density estimate.

Considerations When Using Container-Based Measures—Regardless of the denominator used, container-based measures effectively average the number of outlets across an entire population or geographic area, which tends to smooth over small area variations in density, and thus give the impression that alcohol outlets are evenly distributed in communities, which is generally not the case. This averaging also reduces the likelihood of identifying clusters. For example, consider two counties, each with 10 outlets contained in an area of 100 square miles: the first county has all the outlets spread evenly along the border, while the other one has all 10 outlets within one block. The density rate for both counties would be 0.1 (10/100) because a container-based measure is unable to characterize the distribution of outlets within a measurement area.

Container-based measures also ignore border effects. For example, a "dry" county may not have any alcohol outlets within its borders, but there could be a large number of outlets located just across the county border, which will not be included in the county's density estimate, even though these cross-border outlets may be readily accessible to county residents.

Distance-Based Measures

Distance-based measures of density are calculated based on the *actual* minimum, median, or mean distance between a designated reference point (e.g., town center) and surrounding alcohol outlets. The number of outlets that are included in the calculation can significantly affect the results, as well as the validity of comparisons with other areas.

There are three main approaches to measuring the distance between two locations: 1) as the crow flies (Euclidean); 2) the actual route people use to get to outlets (*network* distance, also known as Manhattan distance); and 3) network travel times. Network distances/travel times account for specific roadway features (e.g., speed limits, one-way streets, turn restrictions, etc.), and thus provide the most accurate estimate of the effort involved in traveling from a reference point to an outlet. However, the calculation of network distances and travel times is more complex than the calculation of the Euclidean distance and requires access to highly detailed street network data as well as the use of geographic information systems.

The approach used to measure distance can have a significant effect on the resulting density measure. For example, the distance between a school on the bank of a 100-foot-wide river and three alcohol outlets located on the opposite side of the river would appear to be very different if it was measured by drawing a straight line from the school to the outlets, as opposed to measuring it based on the actual distance one would need to travel to get from the school to the outlets, particularly if the bridge crossing the river was miles away. This example also emphasizes the importance of using consistent distance measures when comparing densities.

Considerations When Using Distance-Based Measures—Distance-based measures have some major advantages over container-based measures (e.g., distance-based measures can better reflect the uneven distribution of outlets in communities and the presence of outlets just outside the container border). However, distance-based measures do not account for contextual factors, such as the type of community (e.g., urban, suburban, or rural) or the size of the exposed population. Distance-based measures may also not reflect clustering. For example, in Figure 2, the *mean* distances between the four hypothetical alcohol outlets and the reference point in examples A and B are all 50 meters despite the differences in outlet aggregations and proximities to the reference points. In addition, the number of outlets that are included in this calculation can significantly affect the results of density calculations, and in turn, the comparability of distance-based measures across locations. Use of distance to only a single outlet can produce unstable measures and should be avoided.

Spatial Access-Based Measures

There are two types of spatial access-based measures: 1) the spatial accessibility index and 2) the population-weighted distance. The spatial accessibility index is a measure of the spatial proximity of a specified number of outlets (sometimes referred to as a “choice set”) relative to a particular reference point (e.g., town center). In contrast to distance-based measures, spatial accessibility indices weight outlets closer to a selected reference point more heavily than those located further away, and thus better reflect proximity to a reference point. Larger spatial access indices indicate that outlets are in closer proximity to a selected reference point; lower spatial access indices indicate that they are farther away. For example, the spatial access indices in Figure 2 *increase* from example A to B, whereas the distance-based measures are identical. This difference reflects the fact that most of the outlets in B are closer to the reference point than in example A.

Population-weighted distance measures take spatial accessibility indices one step further by incorporating the local population distribution that is directly exposed to the outlets into the measure.[12] This is important because the more people that are exposed to a high concentration of outlets, the greater the risk of harm. For example, if two locations had identical density based on their spatial accessibility indices, but one location had 1 000 residents and the other location had 100 000 residents, there would be a 100-fold difference in the number of residents who would be exposed to the same concentration of outlets, which would substantially increase the risk of excessive drinking and related harms in the area with the larger population. In short, population-weighted distance measures not only allow for the assessment of spatial proximity to alcohol outlets within communities, but also the assessment of this exposure in relation to the population that lives nearby. Again, the number of outlets that are included in the calculation of density and the approach that is used to calculate distance can significantly affect final density estimates.

Considerations When Using Spatial Access-Based Measures—Spatial access-based measures avoid two critical limitations of container-based measures. First, they are not constrained by a boundary, and thus can reflect the uneven distribution of outlets among communities, while also weighting more heavily outlets that are located close to a reference point. Second, spatial access-based measures can incorporate other factors (e.g., outlet size and volume of alcohol sales – if available) in the calculation, and can be linked to other spatial data which identify point locations of alcohol-attributable outcomes (e.g., violent crime) to assess the relationship between the two. However, the calculation of spatial access-based measures is more complex than other measures of density,[12] requires technical expertise in geospatial analysis, and may raise jurisdictional issues when density measures and outcomes cross boundaries of administrative units.

Interpretation of Density Measures

When comparing densities, it is important to know if the same type of outlets were included or excluded from the measure. Outlets encompass on-premises outlets (e.g., bars, restaurants, clubs) which sell alcohol for consumption on-site, and off-premises outlets (e.g., liquor stores, big-box retailers, grocery and convenience stores) which sell alcohol for consumption elsewhere. The distinction is important as people tend to drink differently in different settings (e.g., binge drinkers who drink in bars tend to consume more drinks on average than those who drink in restaurants).[13]

The public health impact of density can also be affected by various contextual factors. For example, having a large number and concentration of outlets near a college or military base is likely to result in higher rates of underage drinking than if this same exposure were located in an area with an older population. Similarly, a low concentration of on-premises alcohol outlets in a rural area may be associated with a much higher risk of alcohol-attributable motor vehicle crashes than if the same number of outlets were located in an urban area – where travel distances and speed limits are lower.

Aggregation (clustering) of alcohol outlets may also amplify the risk of excessive drinking and related harms. However, because there is no standard definition of a “cluster,” the criteria used to define one may vary from one location to another. Thus, caution should be used when comparing clusters, unless they have been defined in a similar manner.

Application of Density Measurement Strategies in Practice

All three measurement strategies make different theoretical assumptions about access to outlets and what aspects of density matter most. Container-based measures assume access to outlets is equal within geographic areas. Distance-based measures assume distances to outlets are the most important determinant of access. Spatial access-based measures assume access declines with distance. Accordingly, all these measurement strategies have strengths and weaknesses that need to be considered when deciding which strategy to use in a particular situation. For example, container-based measures do not allow users to differentiate outlets based on their proximity to a reference point (e.g., the middle of a city), but instead provide an overall assessment of the number of outlets in a particular area. In contrast, distance-based and spatial access-based measures allow users to assess the geographic proximity of outlets to a reference point, but don’t necessarily account for overall exposure to outlets across larger areas (e.g., a county). As a result, studies have shown that one can get very different impressions of outlet density (and outcomes) depending on the measurement strategy used.[14,15]

For example, researchers using spatial access-based methods found that a 3% reduction in outlet density in the Buckhead area of Atlanta during 2003–2007 resulted in a two-fold greater relative decline in violent crime in that neighborhood compared with other areas of Atlanta.[16] When the analysis was done using a container-based strategy (based on number of outlets in police beats), a decline in outlet density was identified. However, this strategy was unable to detect the significant decrease in violent crime that was associated with the decline in outlet density because it couldn’t 1) account for the uneven distribution of outlets and violence within police beats, nor 2) include outlets and crimes just beyond the border of a police beat.[17]

Given these differences, the selection of a measurement strategy should be guided by how the measure will be used, and its performance and limitations in practice (Table 1). For example, if the purpose is comparison, then a rate-based measure is preferable to a count so as to standardize the measure. If the purpose is to detect clustering, then either a distance-based or spatial access-based measure should be used. If the purpose is to study the relationship between *on-premises* outlet density and violent crime – which often occurs in close proximity to alcohol outlets – then spatial access-based measures would be preferable. On the other hand, if the goal is to assess the relationship between *off-premises* outlet density and alcohol-related motor vehicle crashes – which can occur far away from outlets – a larger container-based measure (e.g., a county) might be the better choice. The spatial scale of effects (what distances matter) related to outlets can be very large.

It should also be noted that in some jurisdictions, density measures have been developed for regulatory purposes. For example, some jurisdictions specify a minimum distance from an alcohol outlet to a sensitive location, such as a school; others specify a maximum population-based rate of alcohol outlets. However, the measurement of density to specifically assess compliance with such regulatory requirements is different than the broader measurement of density within a particular geographic area to assess this exposure as an environmental risk factor for excessive drinking and related harms (e.g., violent crime), though both of these measurement activities may still share the common goal of informing efforts to regulate alcohol availability.

The selection of a measurement strategy should also consider the perspective of the intended user of this information. For example, neighborhood residents may be particularly concerned about the local impacts of having a high density of bars on their quality of life (e.g., noise, traffic, property damage). Conversely, a county health department or alcohol control agency may be more concerned about the number of high density clusters of outlets within a particular geographic area, since these are known to amplify the risk of alcohol-attributable harms.

In general, as one moves from container-based, to distance-based, to spatial access-based measures of density, the richness of information revealed increases, along with the complexity and resource requirements. If feasible, distance- or spatial access-based measures offer many advantages over container-based measures because they are not constrained by geopolitical boundaries. In addition, distance- or spatial access-based measures allow for the assessment of outlet clustering. Spatial access-based measures can also be weighted to account for differences in population size, and, if a census-based unit is used, adjusted to account for demographics. However, if resources are limited, and the goal is simply to monitor exposure to outlets within a specified area (e.g., a county), then a container-based approach may be sufficient. Once a strategy has been selected, detailed guidance is available on how to implement it.[11,12,14-16]

Monitoring environmental health hazards, such as high alcohol outlet density, is an essential public health function.[18] Accordingly, public health agencies are encouraged to collect and report alcohol outlet densities consistently to help guide prevention efforts. Towards this end, any measurement of alcohol outlet density is better than none, as long as one is fully aware of the limitations of the measurement approach that is being used.[11]

In summary, there is strong scientific evidence that regulating alcohol outlet density is an effective strategy for reducing excessive alcohol consumption and related harms. Consequently, it is important for public health agencies to assess density on an ongoing basis to plan and evaluate strategies for regulating this environmental risk factor, and identify areas that could also benefit from other evidence-based strategies for reducing excessive drinking (e.g., enhanced liquor law enforcement). As more health departments conduct density surveillance, a clearer picture of the distribution of alcohol outlets will emerge, along with a clearer understanding of the relationship between density and alcohol-attributable harms, both of which can help guide state and local decisions on the regulation of alcohol outlet density.

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References

1. Stahre M, Roeber J, Kanny D, Brewer RD, Zhang X. Contribution of excessive alcohol consumption to deaths and years of potential life lost in the United States. Prev Chron Dis. 2014;11:130293 DOI: 10.5888/pcd11.130293.
2. Sacks JJ, Gonzales KR, Bouchery EE, Tomedi LE, Brewer RD. 2010 national and state costs of excessive alcohol consumption. Am J Prev Med. 2015;49(5):e73–e79. [PubMed: 26477807]
3. Campbell CA, Hahn RA, Elder R, et al. The effectiveness of limiting alcohol outlet density as a means of reducing excessive alcohol consumption and alcohol-related harms. Am J Prev Med. 2009;37(6):556–569. [PubMed: 19944925]
4. Livingston M, Chikritzhs T, Room R. Changing the density of alcohol outlets to reduce alcohol-related problems. Drug Alc Rev. 2007;26:557–566.
5. Parker R Alcohol and theories of homicide In Adler F and Laufer WS (eds), New Directions in Criminological Theory: Advances in Criminological Theory. New Brunswick, NJ: Transaction Publishers 1993;4:113–141.
6. Xuan Z, Blanchette J, Nelson TF, et al. The alcohol policy environment and policy subgroups as predictors of binge drinking measures among US adults. Am J Pub Health. 2014;105:816–822. [PubMed: 25122017]
7. Task Force on Community Preventive Services. Recommendations for reducing excessive alcohol consumption and alcohol-related harms by limiting alcohol outlet density. Am J Prev Med. 2009;37(6):570–571. [PubMed: 19944926]
8. Mosher JF, Treffers R. State pre-emption, local control, and alcohol retail outlet density regulation. Am J Prev Med. 2013;44:399–405. [PubMed: 23498107]
9. CDC Prevention Status Reports. Alcohol—related harms. Website at https://wwwn.cdc.gov/psr/NationalSummary/NSARH.aspx. Accessed on December 25, 2017.
10. Hahn RA, Middleton JC, Elder R, et al. Effects of alcohol retail privatization on excessive alcohol consumption and related harms: a Community Guide systematic review. Am J Prev Med. 2012;42(4):418–427. [PubMed: 22424256]
11. Centers for Disease Control and Prevention. Guide for Measuring Alcohol Outlet Density. Atlanta, GA: Centers for Disease Control and Prevention, US Dept of Health and Human Services; 2017.
12. Zhang X, Lu H, Holt JB. Modeling spatial accessibility to parks: a national study. Int J Health Geogr. 2011;10:31. doi:10.1186/1476-072x-10-31. [PubMed: 21554690]
13. Naimi TS, Nelson DE, Brewer RD. Driving after binge drinking. Am J Prev Med. 2009;37:314–320. [PubMed: 19765503]
14. Lu H, Zhang X, Holt JB, Kanny D, Croft JB. Quantifying spatial accessibility in public health practice and research: an application to on-premise alcohol outlets, United States, 2013. Int J Health Geogr 2018;17:23 10.1186/s12942-018-0143-y [PubMed: 29945619]
15. Grubesic TH, Wei R, Murray AT, Pridemore WA. Comparative approaches for assessing access to alcohol outlets: exploring the utility of a gravity potential approach. Population Health Metrics 2016;14:25 doi: 10.1186/s12963-016-0097-x [PubMed: 27486385]
16. Zhang X, Hatcher B, Clarkson L, et al. Changes in density of on-premises alcohol outlets and impact on violent crime, Atlanta, Georgia, 1997–2007. Prev Chron Dis. 2015;12:140317 Doi: 10.5888/pcd12.140317.
17. Hatcher B. 4520 - Police beat level analysis of alcohol outlet density and crime in Atlanta, 1997-2007. Session on Alcohol Abuse: Associated Consequences with Injury and Chronic Disease; Council of State and Territorial Epidemiologists Conference; 2010 Jun 8.

18. Harrell JA, Baker EL. The essential services of public health. Leadership Public Health. 1994;3:27–30.

Implications for Policy and Practice

- Routine public health surveillance of alcohol outlet density can identify areas with high or increasing outlet density.
- These data can help jurisdictions determine whether to issue new alcohol licenses, reissue old ones, increase enforcement of liquor laws, or some combination of these actions.
- These data can also be used to evaluate the relationship between this exposure and various health and social harms.

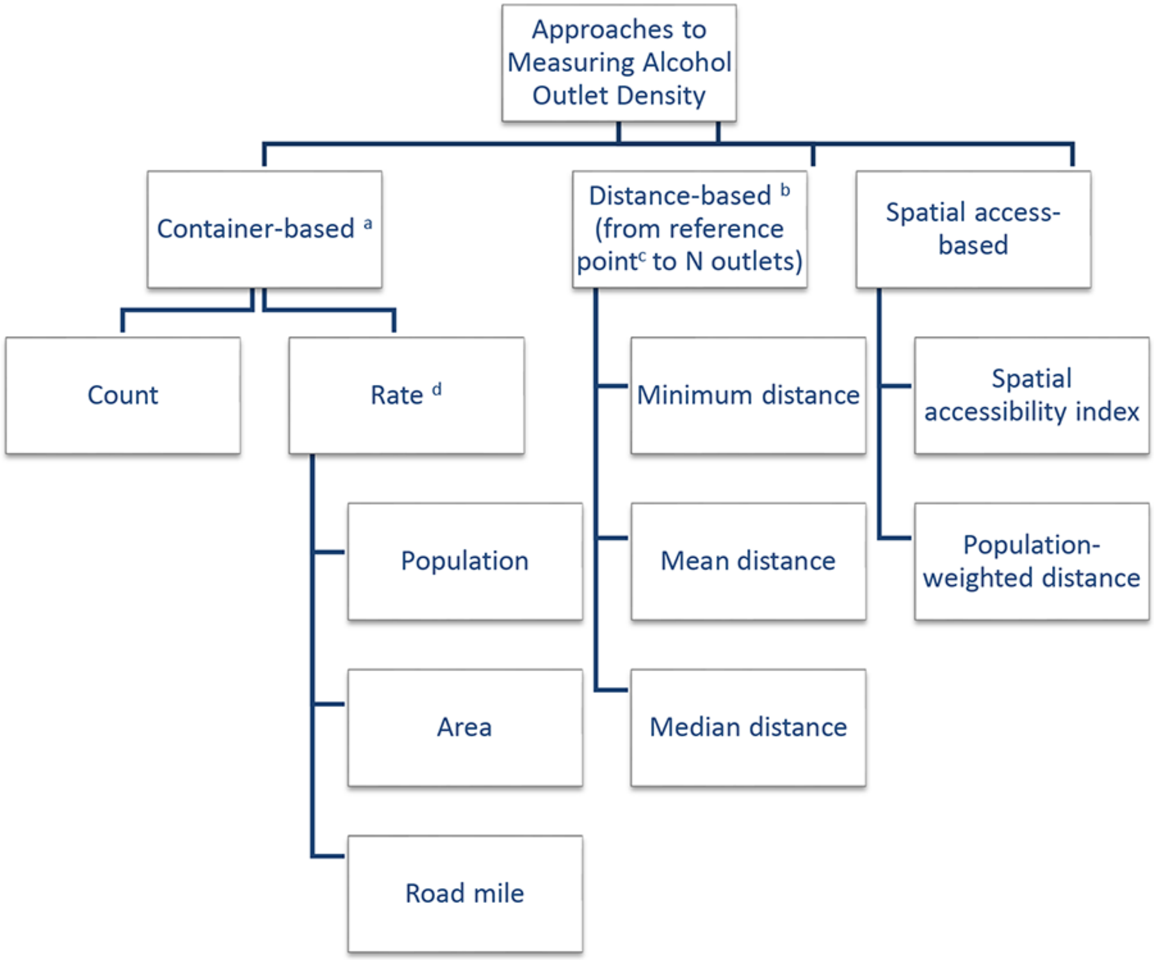

Figure 1. Overview of approaches to measuring alcohol outlet density

Notes:

[a] Container can be pre-defined (e.g., geopolitical: county, city, census block) or user-defined (buffer zone or ad hoc). A user-defined buffer zone can be specified through any of the following three approaches: a) Euclidean; b) street network distance; or c) driving time. User specifies the values to be used for the chosen approach (e.g., "one-mile Euclidean distance"; "one-mile driving distance"; or "5-minutes driving time") – in turn, these values define the container's shape and size. An ad-hoc container can be defined using standard geopolitical building blocks (e.g., groupings of census tracts or neighborhoods).

[b] Distance can be thought of as either "spatial distance" or "time". It can be determined through any of the following three approaches: a) Euclidean – or "crows' flight" – distance; b) street network – or "Manhattan" – distance; or c) driving time, which accounts for street networks and traffic speeds. The user specifies the reference value(s) for the chosen approach (e.g., "one-mile Euclidean distance"; "one-mile driving distance"; or "5-minute driving time"). The distance reflects the economic/convenience cost of access.

[c] Reference point can be any user-specified point, such as: a) a street address or point of interest (e.g., school, household); b) geometric or population-weighted centroid (of a county, census tract, block group, etc.); or c) other alcohol outlet.

[d] Denominators for rates can be any of the following three choices: a) population within the container; b) total land area within the container; or c) road miles within the container. "Container" can be either predefined or user-defined.

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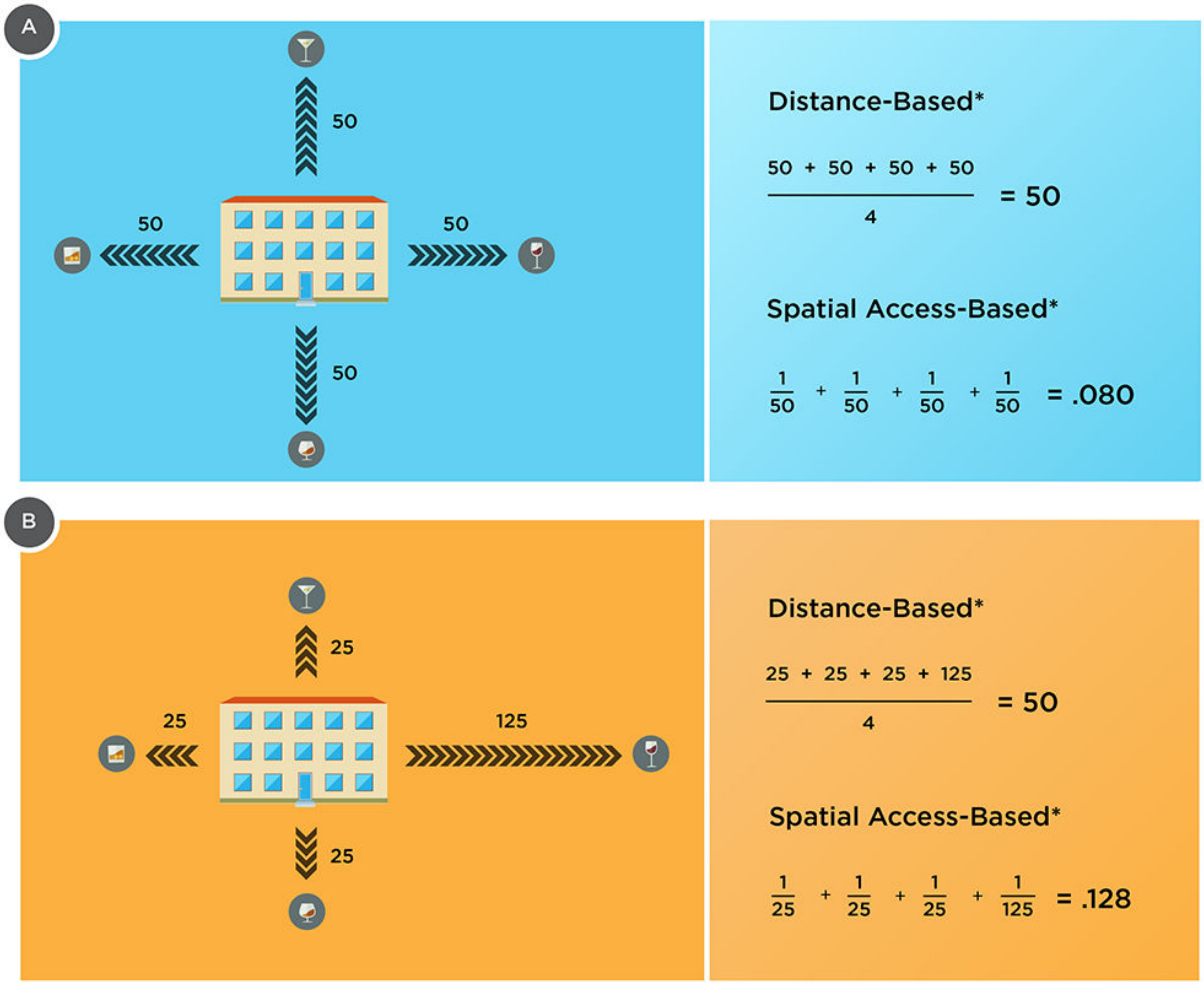

Figure 2 - Comparison of distance-based and spatial access-based measures of distance (in meters) for assessing alcohol outlet density.

Note: This example demonstrates how a spatial access-based measure of distance can better reflect proximity to alcohol outlets than a distance-based measure. Closer proximity to alcohol outlets is associated with increased risk of alcohol-attributable harms (e.g. violent crime).

Table 1.

Performance of various alcohol outlet density measurement strategies

Rating Criterion	Measurement Strategy		
	Container-based	**Distance-based**	**Spatial access-based**
Able to assess clustering	3[a,b]	2[a]	1[a]
Able to assess directly exposed population	3	2	1
Suitable for evaluating harms	3	2	1
Addresses access potential (reflects convenience cost)	3	2	1
Low cost (personnel, equipment and data requirements)	1	2	3
Easy to calculate (simplicity)	1	2	3
Easy to communicate (understandability)	1	2	3

[a] 3 = worst; 2 = intermediate; 1 = best

[b] Smaller containers, e.g., census blocks, perform better at assessing clustering than larger containers like counties.