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Commentary on Gmel et al., (2015): Are alcohol outlet densities strongly associated with alcohol-related outcomes? A critical review of recent evidence

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We read with interest the recent systematic review by Gmel, Holmes and Studer [1], summarizing the January 2009 to October 2014 literature regarding ecological relationships between alcohol outlet density and alcohol-related outcomes. Given the recent proliferation of studies in this area, an updated synthesis is timely and most welcome. However, we have a number of concerns about the methods and theoretical approach the authors used. In particular, we believe the review does not take into consideration the quality of the included studies, and that the authors overstate the effects of ecological bias and the modifiable areal unit problem. Moreover, by limiting the review to so narrow a timeframe, they missed an opportunity to assess recent studies within the context of a literature that dates back almost half a century [2, 3]. In our opinion, the main conclusion, that “it makes little sense to continue aggregate-level studies in which heterogeneous outlet types are aggregated”, does not do justice to the state of the science.

Heterogeneity in Studies of Alcohol Outlets

Gmel et al., make the pertinent observations that alcohol outlets are heterogeneous places and that aggregation based on broad categories can have major implications for interpretations of outlet effects. Regrettably, they do not recognise the substantial heterogeneity that exists in the scientific quality of studies included in their review. After disaggregating the eligible studies by study design (grouped into ecological studies, individual-level studies, and natural experiments) and outcome (intimate partner violence, assaultive violence, alcohol-consumption, and other outcomes), they weight all studies equally, making no attempt to assess or account for scientific rigor. This is a substantial omission from any review, but is a particular problem when evaluating population studies intended to examine ecological relationships and interactions. Such studies are known to have a number of potential biases that can lead to variation in effect estimates, including failures of unit independence (e.g., spatial autocorrelation and nesting; temporal autocorrelation in longitudinal designs [4]), specification bias (e.g., inappropriate spatial scale; density measures denominated by population vs. geographic characteristics), and attenuation of parameter estimates due to aggregation bias. These are all rather common concerns identified in the literature over the past several decades, a key point which Gmel et al. perhaps did not fully consider due to the limited extent of their review. Indeed, they suggest, aggregate categories tend to overlook diversity, but then group studies that have considerable internal checks to enhance the validity of stated outcomes with those that do not.

The authors introduce an example that helps make this point. Stockwell et al. [5–8] conducted a series of rigorously designed longitudinal studies in British Columbia, Canada, assessing the impacts of privatization of alcohol sales on health outcomes (e.g., mortality, hospital admissions, per capita alcohol sales). These authors examined outcomes across health service areas over time, focusing upon the differential exposures to outlets which occurred in response to regulatory change. The space-time units observed in these analyses were as exchangeable as such units can be in natural experiments, and statistical controls were put in place to address most sources of bias noted in the previous paragraph. Nevertheless, Gmel et al. prefer an alternative interpretation of the results, arguing that the increase in consumption observed in British Columbia began prior to increases in outlet density, and was less than that observed in other Canadian provinces. Curiously, this comparison draws upon highly aggregated population data from non-exchangeable units, a limitation of great concern to the authors in their critique of other studies. Moreover, the assertions are not correct; the consumption increase in British Columbia in fact occurred along with the gradual expansion of liquor outlets, and was greater than the contemporaneous increase in the rest of Canada [9].

Ecological Bias and the Modifiable Areal Unit Problem (MAUP)

In addition to our concern about methods of review, we also believe that two theoretical points made by Gmel et al. in their assessments of ecological studies are mistaken. The authors highlight two problems generally considered to apply in this area of study, which they use to justify their conclusion that aggregate analyses of relationships between outlets

and population outcomes should not be pursued: (i) ecological bias, and (ii) the modifiable areal unit problem (MAUP).

The authors argue that individual-level studies provide a higher level of evidence than studies using spatially aggregated data because of the potential for bias in ecological analyses. The “ecological fallacy”, that empirically observed aggregate relationships may be falsely interpreted in individual terms, has long been used to question findings from ecological studies. However, this criticism holds only when ecological researchers make inferences about individual-level relationships, and the complementary “individualistic fallacy” may arise when individual relationships are used to explain aggregate outcomes (a bias so common that it has come to be called “fundamental attribution error” in psychology [10, 11]). For example, a person’s reports of aggressive acts may be a function of his or her aggressive tendencies, interactions with others, and the environments in which he or she engages with aggressive others (like bars). Only the first of these is about the individual; the rest are determined by aggregate ecological effects. If the aim of public health research is to improve public health, and some aggregate change in access to alcohol demonstrably reduces alcohol-related health problems, whether or not this effect is reported by some set of individuals who live within a distance buffer of the outlet is of little consequence.

One particularly dangerous aspect of maintaining a bias toward individual-level studies is the neglect of critical information that bears upon the health of populations. In that context, Gmel et al.’s characterization of alcohol outlet density as a fixed exposure experienced by individuals within a neighbourhood becomes problematic. It is now well-established that geographic distributions of alcohol outlets are shaped by aggregate social dynamics common to retail markets [12, 13]. Outlets are for-profit businesses that seek to minimise costs and maximise profits in purely ecological settings. Competition for aggregate market share leads establishments to locate in areas proximate to demand with lower land and structure rents [14, 15], and to continually adjust their operating characteristics. All this competition leads to the great diversity in outlet types that Gmel et al. recognise, but it also displaces outlets from locations of high demand. Thus, after accounting for other area characteristics (e.g., population density), outlet density is greatest in lower income areas with low demand, and least in higher income areas with most demand [16]. Therefore, individual self-reports of use will generally be least where availability is greatest; an erroneous observation of some use to the commercial alcohol industry.

The authors’ concern about the modifiable areal unit problem is similarly misplaced for roughly similar reasons. They correctly note that MAUP can bias the findings of spatial analyses of aggregate data in either direction, but do not recognise that this is a statistical problem that, like the “ecological fallacy,” cannot be resolved in statistical terms. As the literature in this area has demonstrated over several decades, the solution to this problem lies either in the examination of longitudinal effects (e.g., [5]) or in conducting analyses using geographic units at multiple scales. In the latter case, this work can lead to a much deeper understanding of ecological impacts. For example, it is becoming apparent that outlets are related to violent assaults on quite small spatial scales [17], to motor vehicle collisions at local and city-wide scales [18, 19], and that they have different topological relationships to

populations in urban vs. rural areas [12, 13]. Much of the variation in study results, glossed over by the analyses presented in Gmel, et al., may be due to these issues.

In sum, while we welcome systematic assessments of the literature in this important area of public health research, we suggest Gmel, et al. are not even-handed in their discussion of aggregate versus individual-level studies.

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