My partner and my neighbourhood: The built environment and social networks' impact on alcohol consumption during early pregnancy

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Health Place. 2020 Jan;61:102239.

My partner and my neighbourhood: the built environment and social networks' impact on alcohol consumption during early pregnancy.

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What is already known on this subject?
Pregnant women's alcohol consumption is associated with individual factors which include age, education, socioeconomic status, race, number of pregnancies/children, if a smoker, and pre-pregnancy alcohol consumption. However, some previous studies have also suggested associations with partners' alcohol consumption.

What does this study add?
The results of this study showed an association between pregnant women's alcohol consumption and their partners', in addition to associations with their neighbourhood's built environment and the influence of their social networks. This shows a

“neighbourhood effect” with similar alcohol-consumption behaviour for pregnant women located in the same area.

Abstract:

Maternal alcohol consumption during pregnancy is responsible for negative health outcomes. The literature shows that socio-economic and lifestyle factors are both related with alcohol consumption during pregnancy; nevertheless, the role of other factors is unclear. The objective of this study is to assess the role that partners' alcohol consumption plays, that played by accessibility to alcohol, and by social influence – when considering pregnant women's behaviour as regards alcohol. It presents the results from a follow-up study of children at risk of negative health outcomes associated with prenatal alcohol exposure; it shows that 68% of pregnant women included in the study reported alcohol consumption during early pregnancy. Results of the analysis showed association with partners' alcohol use, with density of bars and/or restaurants and with the number of pregnant women who drank in the neighbourhood. We concluded that the involvement of men in pregnancy healthcare, and urban policies which target the built environment and improve social networks could be important aspects for the control and prevention alcohol consumption during pregnancy in public health programs. Interventions and recommendations should include an ecological perspective on prenatal community-health programs – focusing on individual, social, and natural factors as well as the built environment.

1. Introduction

Prenatal alcohol is a known teratogen which can cause miscarriage, stillbirth, and a range of lifelong physical, behavioural, and intellectual disabilities [1–4]. These disabilities are known as foetal alcohol spectrum disorders (FASDs). In the European Union FASDs affect 3.7% of children [5]. In relation to this, there is no known safe level of alcohol consumption during pregnancy or while trying to get pregnant [6].

Alcohol consumption is a worldwide health problem. The 2018 WHO Global status report on alcohol and health found that 39.3% of the population aged 15 or over worldwide had drunk alcohol in the previous 12 months [7]. However, alcohol consumption levels are very heterogeneous across regions and countries, and the highest rates are found in Europe. In Spain, the 2011-2012 National Health Survey found that 66% of the Spanish population (over 15 years) had drunk alcohol in the previous 12 months [8]. For 15 to 44 year olds, 70% reported consuming alcohol in the past year. By sex, 75% of men had consumed alcohol, slightly higher than the 65% of women who had.

Health authorities make prenatal recommendations aimed at expectant mothers, but a number of pregnant women still drink alcohol. Approximately 25% of pregnant women in the EU consume alcohol, and this proportion can be as high as 70% in some regions [4,9]. The literature shows that the potential risk factors for alcohol consumption during pregnancy include age, education, socioeconomic status, ethnicity, number of pregnancies/children, smoking status, and pre-pregnancy alcohol consumption [10,11]. All of these risk factors focus on characteristics of the pregnant women themselves, considered here as individual factors. More recently, research has also considered women's partners' behaviour. These studies have concluded that partners' alcohol consumption is closely related [12–14]. A recent systematic review concluded that paternal alcohol consumption during preconception or pregnancy has an impact on that of the mother-to-be [15]. We can name this second level as partner-related factors.

As a part of the individual and partners' factors, in a behaviour-activity as culturally and socially influenced as alcohol consumption, the influence of the neighbourhood where expectant mothers' live also merits study. Recently, concern about how neighbourhood characteristics influence the alcohol consumption habits of its inhabitants has increased; for example, some authors have analysed the links between alcohol-outlet density and alcohol-related outcomes such as violence and hospital discharges for assault injures; they did indeed find potential positive associations between outlet-density and harm; nevertheless, the authors concluded that there was little evidence for a causal direction

[16]. From a different perspective, research into alcohol in urban environments has shown that urban populations are being continually exposed to an extensive range of alcohol products [17,18]. Furthermore, we should not ignore that alcohol consumption, as individual behaviour, is connected to individuals' decision-making processes. As regards this aspect, authors from the social sciences have studied social influences on individuals' decision-making in an attempt to understand the interrelated nature of decision-making in social situations [19]. In order to model social and neighbourhood influences, we used geographic analysis; this provides the required tools to perform the statistical analysis necessary to be able to evaluate the surrounding environment's potential influence [20].

The benefits of including geographical factors in a spatial analysis have already been recognised in alcohol research [21]; however, as far as we know, no study has as yet included information at georeferenced-individual level. The objective of this study is to analyse the role of both partner and neighbourhood as determinants of alcohol consumption during preconception and pregnancy in an urban environment at an individual level.

2. Methods

2.1 Population

The study population were pregnant women and their partners, belonging to Health Areas 1, 6, 7 and 9 of the Region of Murcia (Spain), and included in the "*Nacer y Crecer sin OH*" project [22]. "*Nacer y Crecer sin OH*" is a follow-up study of children at risk of neurobehavioral disorders associated with prenatal exposure to alcohol and/or other illegal drugs from the beginning of pregnancy until the end of adolescence. Future parents were identified during their first visit to the Obstetrics Department at the end of the first trimester of pregnancy and invited to participate in the study.

The Hospital's Ethics Committee and the Institutional Review Board approved the survey, and the study was carried out during between December 2009 and July 2010. A total of 1,745 pairs – each pair is a pregnant woman and her partner – were included in this study.

2.2 The 'Green Page' questionnaire

The "*Nacer y Crecer sin OH*" project uses a questionnaire on reproductive environmental health known as the Green-Page (GP) [23]. This questionnaire produces a standard clinical record of each pregnant woman, and includes a series of basic questions through which the healthcare professional can identify environmental exposures during gestation [4,24]. The interviews were conducted face-to-face with both parents during the first obstetrics visit (10.3 weeks of foetal development). A trained nurse, with expertise in environmental health and risk communication, conducted all the interviews. The completion of the GP questionnaire lasted approximately 10 minutes and informed consent was obtained from all parents-to-be.

2.3 Dependent variable and Control variables.

Dependent variable.

The exposure to alcohol was explored from the periconceptional stage up to the moment of the interview. Detailed information about alcohol consumption (daily intake of beer, wine, and/or spirits) was obtained and subsequently converted into grams of alcohol per day. For the analysis, we sorted this information into a binary variable with two categories: teetotaler/teetotal (no alcohol consumption, 0 g/day) and drinker (some alcohol consumption, >0 g/day). This decision was based on the previous literature which concluded that there is no known safe level of alcohol intake during pregnancy [10,25].

Control variables.

The GP questionnaire collected socio-demographic, lifestyle and reproductive data from the pregnant woman and her partner. Table 1 shows a detailed list of these variables. Additionally, the residential address of each pregnant woman was geo-referenced using Google Maps. Exact latitude and longitude were assigned to each woman. To obtain the number of alcohol outlets around each pregnant woman, the exact geographical coordinates of each bar and restaurant in the area under study were obtained from the SABI (Iberian Balance Analysis System) database [26]. A total of 1,076 bars/restaurants were identified in the region under study. Figure 1 shows the spatial distribution of the bars/restaurants and the pregnant women who drank/were teetotal.

Figure 1: Spatial distribution of bars/restaurants and pregnant women[†]

--- Figure 1 here ---

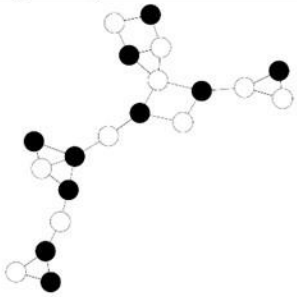
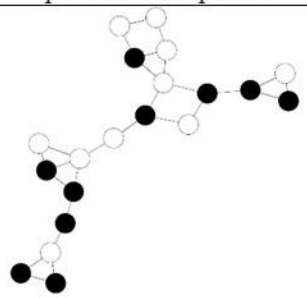
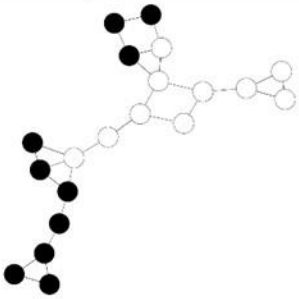
The distance between each pregnant woman and each bar/restaurant was calculated using the R package *geosphere* [27]. The number of bars/restaurants at a distance of less than 0.5 kilometres was associated with each individual in the sample.

2.4 Statistical Methods

In order to analyse the neighbourhood's effect on pregnant women's alcohol consumption, two methodologies were employed, Join-Count tests [28] and a spatial-probit model [29]. The Join-Count tests compare spatial co-localized patterns in dichotomy variables. In our case, every pregnant woman was classified as teetotaler (A) or drinker (D). Based on these categories, three different 'joins' were defined: AA, DD and AD. AA and DD represent a pair of pregnant women who fall in the same categories, while AD represents a pair where each falls into a different category. The statistics J_{AA}, J_{DD} and J_{AD} count the number joins of each type observed. The Join-Count statistics were assumed to be asymptotically normally distributed under the null hypothesis of no spatial autocorrelation.

Maps with different spatial configurations of a qualitative variable could appear as shown in Figure 2, which shows typical patterns using simulated data. A negative z-value reveals a number of the spatial interconnections of individuals in different categories higher than the expected (Figure 2 left), while a positive z-value indicates a spatial structure where there is a high probability of finding pregnant women in the same category (Figure 2, right). When the spatial distribution is random, no spatial co-localized pattern can be identified and the number of interconnections (AA, DD, AD) is not statistical significant (Figure 2, centre).

Figure 2: Example spatial correlations in dichotomic spatial processes[†]

Negative spatial autocorrelation			Spatial random process			Positive spatial autocorrelation		
								
Join-Count	Expected	z-value	Join-Count	Expected	z-value	Join-Count	Expected	z-value
$J_{AA}=2.0$	$J'_{AA}=4.7$	-2.33	$J_{AA}=4.0$	$J'_{AA}=4.7$	-0.63	$J_{AA}=8$	$J'_{AA}=4.7$	2.78
$J_{DD}=2.5$	$J'_{DD}=4.7$	-1.91	$J_{DD}=4.0$	$J'_{DD}=4.7$	-0.63	$J_{DD}=7.5$	$J'_{DD}=4.7$	2.35
$J_{AD}=15.5$	$J'_{AD}=10.5$	2.47	$J_{AD}=12.0$	$J'_{AD}=10.5$	0.73	$J_{AD}=4.5$	$J'_{AD}=10.5$	-2.99

† Drinker in black and abstainer in white. Links represent neighbour criterion of join. $J'_{AA}=E[J_{AA}]$; $J'_{AA}=E[J_{DD}]$; $J'_{DD}=E[J_{AD}]$.

For this study, we used geographical distance to calculate the joins, and we considered that each pregnant woman i was 'join' with j if the distance from i to j was less than 'd' kilometres. The R package *spdep* was used to produce the Join-Count tests.

In the second analysis we used a spatial-probit model to account for the spatial interdependence of the dependent variable. The spatial-probit model is represented as follows,

$$y = \begin{cases} 1 & \text{if} \quad y^* \geq 0 \\ 0 & \text{if} \quad y^* < 0 \end{cases}$$

$$y^* = \lambda W y^* + X\beta + \varepsilon, \quad \varepsilon \sim N(0, I_n)$$

where y is the observed value of the limited-dependent variable, y* is the unobserved latent dependent variable, and *X* is a matrix of explanatory variables; W is an n×n spatial weight matrix defining the neighbourhood structure; λ is the spatial autoregressive parameter. If λ=0 the spatial-probit model collapses to the standard probit model; otherwise, the vector Wy^* consisting of an average of neighbouring unobserved latent dependent variables creates a mechanism for modelling spatial interdependence in alcohol consumption choices. Finally, ε is the error term. The Moran's I test [30] was used to test spatial autocorrelation in the residual of non-spatial models. The R package *ProbitSpatial* was used to estimate the spatial-probit model [29].

Coefficients of the explanatory variables in a spatial-probit model are difficult to interpret [31]. The reason for this is that, because of the spatial lag of the latent dependent variable Wy*, changes in the value of the variable for pregnant woman j influence pregnant

woman i's decision. That is to say, with this model, the changes to the probability of a given pregnant woman's alcohol consumption i are twofold: i) that induced by a change in the own-value of the variable – the 'direct effect' in the literature; and, ii) that induced by a change in the value of the variable associated with another pregnant woman – denoted as the indirect effect. Finally, a total effect measure gathered the sum of the direct and all indirect effects. In essence, the idea is that spatial dependence expands the information set to include information on neighbouring individuals.

3. Results

Table 1 summarizes the list of variables included and presents a descriptive analysis. The majority of women (68%) reported drinking at least some alcohol. The majority of pregnant woman were European (91.7%) and between 16 and 47 years old (mean 33.6) had a mid-level family income (46.5%) and primary or secondary (56.6%) education. Only 32.0% were teetotaler and 35.7% smoked during pregnancy. Their partners were aged between 17 and 64 (mean, 35.62); the percentage of teetotaler men was 15.0%, while 11.0% reported drinking more than 40 g/day, and a high percentage of men (55.2%) smoked during their partner's pregnancies.

--- Table 1 around here ---

For the Join-Count tests we considered a variety of distances in order to establish the connections between women (d=0.5km and from d=1.0 to d=9.0km). The results for these tests (Table 2) indicate the existence of a spatial co-localized pattern. With the exception of d=0.5, the number of observed pairs of pregnant drinkers (J_{DD}) was significantly higher than the expected values (J'_{DD}). These results show that there is clustering of drinkers. Moreover, the spatial co-localized pattern of pregnant woman who belonged to different categories yielded negative results (last columns in Table 2), showing apparent repulsion between drinkers and the teetotaler. Finally, for the case of teetotaler pregnant woman (first columns in Table 2), the number of observed AA is close to the number of expected AA if $d \leq 1$, but for $d \geq 13$ the joint-count test J_{AA} showed a significant repulsion process. Figure 3 shows the z-values of the joint-count statistics, showing the changes in the spatial pattern of geographical association between pregnant drinkers and teetotaler women as the distance increases.

--- Table 2 around here ---

Figure 3: Spatial correlogram of Join-Count statistics

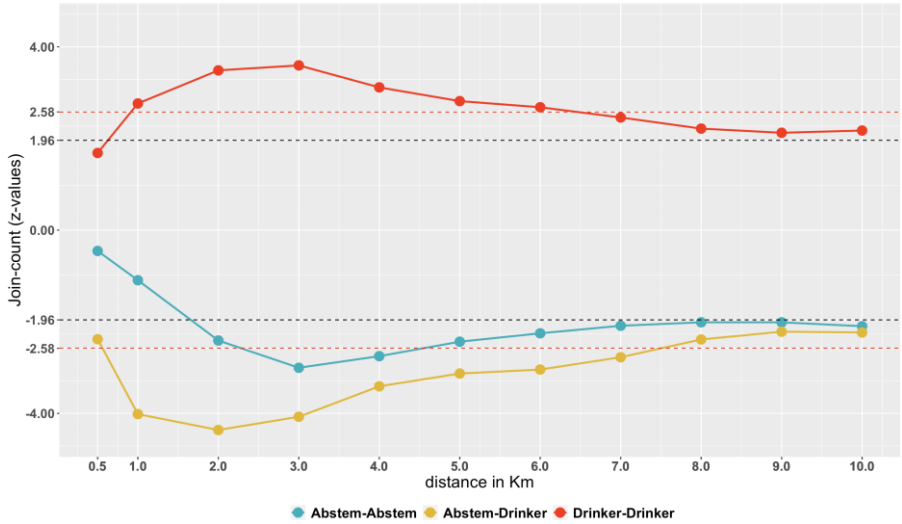


Table 3 shows the results of the probit models. The left-hand side column shows the baseline model (Model 0). The covariates – mother's age, smoker/non-smoker, a high level of family income and medium/high level of education – all increased the probability of alcohol consumption during pregnancy. Conversely, the number of previous pregnancies, the ethnicity (Latin American and Maghreb/Arab) all decreased alcohol-consumption probability. The second column shows the results for Model 1. The partner's alcohol consumption showed the strongest positive effect on the probability of pregnant women consuming alcohol. In contrast, the partner's age, if a smoker/non-smoker, and educational level did not have any observable impact. The results for Model 2 showed that the number of bars/restaurants around each pregnant woman also had a positive effect on alcohol-consumption probability. The Moran's I test on the residuals of Models 0, 1 and 2 displayed signs of spatial autocorrelation for $W_{d=1.0}$. This indicates that the spatial structure encountered by the Join-Count test in the dependent variable had not been resolved for d=1. Therefore, it is necessary to include a spatial factor to be able to correctly specify the model. Two alternative spatial-probit specifications could have been selected in this step, SAR-probit or SEM-probit, in order to include spatial effects in the model. The results obtained with the Joint-Count tests that showed a clustering process suggest interaction between individuals rather than the omission of relevant control variables in the model; therefore, *a priori* the inclusion of a spatial lag of the dependent variable (SAR-probit) was more appropriate. Model 3 includes the spatial factor Wy^{*} with a coefficient λ=0.154, which is significant and positive. The last columns of Table 3 show the direct, indirect and total effects for Model 3.

--- Table 3 here –

4. Discussion

The majority of the women, 68%, reported drinking at least some alcohol in the first weeks of their pregnancy, with no discernible differences between those who were actively trying to get pregnant and those who were not. Furthermore, the results of the present study show links between pregnant women's alcohol consumption and external factors. The results from the probit models showed associations with the main determinants found in the literature: mother's age; if a smoker; number of previous pregnancies; ethnicity; family income; education level; partner's alcohol consumption; and, finally, alcohol availability in the neighbourhood [11–13]. In addition, this paper presents evidence for the clustering of pregnant women who consume alcohol; this suggests a potential association between pregnant women's alcohol consumption and the place in which they reside. These results confirm that the determinants of alcohol consumption probability include: social interaction of pregnant women with their partners, with people in the neighbourhood in bars and restaurants, and with other pregnant women [32].

In the past few decades, concern about the effect partners' habits might have on pregnant women's behaviour has motivated a number of different studies. These researchers have reported that men may play a role as social facilitators of maternal alcohol consumption during preconception and pregnancy [4, 10]. In the early 90s, a U.S. study reported that pregnant women who drank heavily were more likely to have a partner who was a heavy drinker [33]. A more recent study of pregnant Australian women reported that more than 75% of women who drank during pregnancy usually drank with their partner, and that 40% of drinking occasions were initiated by their male partner [34]. A systematic review which focused on studying the role of the father in alcohol exposure during pregnancy provided evidence that paternal alcohol consumption during preconception or pregnancy had an effect on pregnant women's alcohol consumption [15]. Our results agree with this conclusion, and the strongest effect found was that associated with partners' alcohol consumption habits.

Furthermore, we divided the partner's alcohol consumption into three categories according to the WHO classification of risk from alcohol consumption [35]. Intakes between 0 and 40 gr/day are associated with a low risk of chronic harm and intakes over 40 gr/day with medium to high chronic-harm risk. Our objective was not to evaluate the direct effect of paternal alcohol use on the pregnant women and children's wellbeing; however, we should not forget the inherent potential for harm [36]. In this study, 10% of parents reported drinking more than 40 gr/day, and 85% reported at least some consumption.

Our findings are in agreement with the previous literature, and support the idea that the partner's drinking behaviour is a social facilitator of maternal drinking during pregnancy. This evidently has a significant potential for translational impact, particularly as regards developing policies focused on reducing or eliminating maternal alcohol consumption during pregnancy.

In this study we have evaluated neighbourhood effects through two different methodologies. First, the Join-Count tests showed aggregation of pregnant alcohol drinkers, which suggests that the neighbourhood environment and physical social interaction could encourage pregnant women to consume alcohol. To the best of our knowledge, this is the first time that the spatial aggregation of pregnant women with the same alcohol-consumption behaviour has been described.

Using the second methodological approach, the results showed that the number of bar/restaurants close to a pregnant woman's residence has an impact, and the behaviour of neighbouring pregnant women also seems to play a role. Concerning the number of alcohol outlets, previous research has tried to evaluate the influence of alcohol-outlet density on the health of the population. Nevertheless, to our knowledge this is the first investigation that studies the effect of this variable on pregnant women's alcohol consumption. The majority of alcohol-outlet density studies have been carried out in Anglo-Saxon countries, such as the USA, the UK or Australia, or in Scandinavian countries such as Sweden; and their targets have been alcohol-related outcomes, mainly violence [16,21]. In general, these studies have concluded that the causal impact of outlet density on alcohol consumption is not clear. Nevertheless, in Span, distinct from the aforementioned countries, alcohol is easily available. However, although people can purchase alcohol in supermarkets, corner shops and even in petrol stations with no real restrictions on hours of availability, Spanish culture tends towards drinking alcohol in bars and restaurants, for the most part. In addition, the traditional drinking pattern in Spain

is the so-called Mediterranean Drinking Pattern, which is defined by moderate alcohol intake during meals [37]. In contrast, in the countries which have contributed the majority of studies alcohol is consumed in greater volumes and as a psychotropic-relaxant [38]. Given these differences in cultural alcohol-consumption patterns, we do not think that conclusions from studies of non-Mediterranean populations can be straightforwardly applied to the Spanish population without accounting for cultural differences. In addition, current research is working to understand the built environment for alcohol in Spanish cities and its association with the quantities of alcohol actually consumed [17,18,39]. On the other hand, we should point out that the built environment includes all aspects of the environment that have been modified by humans, including streets, homes, schools, bar, workplaces and parks, among others things.

Finally, in the third analysis, we confirmed that there is a clustering process for pregnant women who consume alcohol. A pregnant woman surrounded by a high percentage pregnant women who drink is more likely to drink alcohol than a pregnant woman surrounded by teetotallers. The literature has also highlighted the influence of social networks on drug [40] and alcohol consumption [32,41] but as far as we know this is the first study which identifies this effect on pregnant women.

A key limitation of this study is recall bias. It is almost impossible to avoid recall bias when a questionnaire is used to obtain exposure data, and underreporting of alcohol consumption is quite likely. In order to reduce such recall bias, a trained professional conducted face-to-face interviews. Another limitation was that we were unable to explore possible environmental design features of the neighbourhoods. We limited our characterization of the social environment to neighborhood structure and relationships with partners, and did not completely account for other environmental and cultural factors. Despite these limitations, a key strength of our study is the large sample size – 1,745 pregnant women and their partners – while many other studies have samples of only a few hundred [11–14].

We are, however, only just starting to understand how the complexities of architectural and urban environments can act to encourage, or indeed discourage, healthier pregnancies. This study is unique in its examination of the relationships between alcohol consumption during pregnancy, social networks, and the built environment – carried out in a representative sample of urban-dwelling pregnant women.

5. Conclusion

Despite recommendations about avoiding alcohol consumption during pregnancy, a significant number of women still drink when they are pregnant. Our results suggest that – in addition to individual factors and the partner's influence – characteristics of their neighbourhood and social influence could also be associated with the likelihood of pregnant women consuming alcohol; and, therefore, with an increase in the risk of foetal alcohol spectrum disorders.

Understanding of both neighbourhoods' environmental profiles and social influence is needed to facilitate community-based research, as well as the development and implementation of community alcohol-prevention and -intervention programs during pregnancy. Successful strategies will require governments and local communities to work together to generate an ecological perspective on prenatal community-health programmes. An ecological model for health promotion in pregnancy should focus attention on individual, social, natural and built environment factors as targets for interventions. Support and backing from partners, other family members, friends and larger social networks will play a crucial role in encouraging and facilitating healthy pregnancies. Involving men in pregnancy healthcare – as well as urban policies that target the built environment, and improving social networks – could be important elements of public health programs aimed at controlling and preventing alcohol consumption during pregnancy.

Acknowledgments:

The authors gratefully acknowledge the project "*Nacer y Crecer sin OH*" (PND 2016. Murcia's Drug Commissioner Office and the National Plan on Drugs, Ministry of Health, Spain. Prof. Fernando A. López-Hernández, is also grateful for the financial support provided by the projects from the *Programa de Ayudas a Grupos de Excelencia de la Región de Murcia, Fundación Séneca* (#19884-GERM-15). The views expressed are those of the authors and not necessarily those of the Carlos III Institute of Health.

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