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Pregnancy persistently reduces alcohol purchases: Causal evidence from scanner data

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ABSTRACT

We analyze household-level changes in alcohol consumption in response to pregnancy. Using scanner data, we identify households with a pregnant household member. Within an event study and a dynamic difference-in-differences estimation, we find that during a first pregnancy, households reduce their alcohol purchases by 36%. After pregnancy, purchases of alcohol are 34% lower than before pregnancy. We do not find any effect during the second pregnancy. One possible explanation for our result is that lower consumption during pregnancy changes habits and reduces consumption in the long term. We discuss other explanations and comment on policy implications.

KEYWORDS

Alcohol, habits, pregnancy

JEL CLASSIFICATION D12, D91, I12

1. Introduction

Alcohol is the third leading cause of preventable death in the United States (NIAAA, 2019), and the costs of excessive drinking in the United State were $249 billion in 2010 (Sacks, Gonzales, Bouchery, Tomedi, & Brewer, 2015). Apart from the immediate risk of addiction, a habit of alcohol consumption may come with health costs.1 Nevertheless, alcohol consumption is a common habit.2 According to surveys, 25% of Americans would like to reduce their alcohol consumption (Davies, Conroy, Winstock, & Ferris, 2017). However, changing habits is hard.3 Pregnancy is a time of manychanges,andoneofthesemaybethereductionofalcoholintake.Whilethedeterminantsofbehaviorchangeare complex, many recommendations are made to pregnant women to improve diet and lifestyle, and evidence shows that pregnant women can have high motivation for making improvements (Clissold, Hopkins, & Seddon, 1991; Gardner et al., 2012; Lindqvist, Lindkvist, Eurenius, Persson,& Mogren,2017). Even if increased motivation to change is present, there can also be factors creating barriers to change, such as pregnancy's physiological effects or the social environment (Nash, Gilliland, Evers, Wilk, & Campbell, 2013; Watson & McDonald, 2009). Moreover, if one reduces alcohol intake during pregnancy, how long the changes may last or whether consumption returns to prepregnancy patterns is unknown.

This study generates estimates of the effect of pregnancy on household alcohol consumption over time, thereby providing empirical evidence of behavioral changes and how long they persist. There could be several mechanisms behind persistent changes. The first is a change of habits. For example, reducing consumption of alcohol during pregnancy could break a habit, which leads to persistently reduced consumption after pregnancy. By reporting on observed changes, we provide initial empirical evidence to suggest how past consumption patterns may influence subsequent consumption. A second hypothesis is that the birth of a newborn and associated childcare in the following time period shifts preferences toward a lifestyle involving lower alcohol consumption. In this case, the change of circumstances rather than habits explains the changes. While we do not disentangle the mechanism empirically, we discuss the channels in detail.

Using detailed household-level purchase data from the Kilts-Nielsen Consumer Panel, we study how household purchases of alcohol change from before pregnancy to during and after pregnancy. First, we use the purchase data to infer the months of pregnancy, based on purchases of pregnancy- or newborn-related products. The panel covers the years 2004–2017, so we can observe consumption over an extended period as households can stay in the panel for several years. Second, we evaluate the effect of pregnancy on alcohol purchases. We start with an event study approach with fixed effects and rich controls. A first pregnancy reduces households' alcohol consumption by 29% compared with prepregnancy levels. The effect is long-lasting and observable over our entire horizon of study. The effect is the same for households that purchase baby milk formula, suggesting that breastfeeding does not explain the long-lasting reduction of alcohol. We do not find any effect of consumption during or after pregnancy for the second pregnancy.

Our main empirical strategy is a dynamic difference-in-differences approach, following Fadlon and Nielsen (2019). To estimate the causal effects of pregnancy on changes in households' alcohol purchases, we use as a control group households who got pregnant but at a later point in time. We can infer causality for the alcohol consumption of households with the first pregnancy. We show that compared to before pregnancy, households with a pregnant household member decrease their monthly alcohol purchases by 36.3% (a decrease of 1.22 l) during pregnancy. Also, compared to before pregnancy, monthly alcohol purchases decrease by 33.6% (−1.13 l) during the first 6 months after pregnancy. Furthermore, we find similar effects when solely evaluating purchases of beer or wine. Our results for alcohol purchases suggest that pregnancy is associated not only with immediate changes but also with changes following pregnancy.

Our article adds to the medical and economic literature. While the contribution on the health side lies in presenting a novel causal estimate of pregnancy on long-term alcohol consumption using observational scanner data, the contribution in economics is based on the discussion of potential mechanisms that change households' alcohol consumption in the long term.

On the health side, a multitude of studies have explored in detail the effects of diet, including alcohol consumption, on newborns' health outcomes, which inform many of the changes pregnant women are advised to make. In many dimensions, there appears to be a consensus, and several health-related changes are recommended for pregnant women. High alcohol intake can have a strong detrimental effect on fetal health (and even newborn health via breastfeeding) and may lead to fetal alcohol spectrum disorder (Briggs, Freeman, & Yaffe, 2012). The American Academy of Pediatrics (AAP) recommends that during pregnancy, no amount of alcohol intake should be considered safe (AAP, 2015). Nevertheless, medical studies attest that a low intake of alcohol does not harm the fetus (Oster, 2013), for further discussion). While we do not comment on the necessity of changes in consumption during pregnancy, this study provides evidence from observational data that households change their alcohol purchases during pregnancy as recommended. The majority of studies in the medical literature are survey methods. Households or mothers are surveyed before and after pregnancy. Our data source allows us to conduct a larger and more sophisticated study. First, the sample is based on a large consumer panel not chosen for reasons of pregnancy. Furthermore, we do not rely on self-reported, potentially biased alcohol consumption data but instead use scanner data.[4] Additionally, the length of the panel allows us to employ a dynamic difference-in-differences estimation to reduce the bias of changes that happen already before pregnancy. For example, households may change consumption habits already before pregnancy and a simple comparison of pregnant to nonpregnant households may overestimate effects. Our dynamic difference-in-differences approach chooses control groups of other households that get pregnant 2 years later. Overall, we add to the literature by generating a causal estimate of the effect of pregnancy on household alcohol consumption that is based on a new and different data source.

We show that alcohol consumption decreases not only during pregnancy but in the long term. While there is existing evidence of changes during pregnancy, we show novel evidence of the persistence of these changes. We discuss several reasons for such a long-term impact. The first reason is habits. From the perspective of the psychological literature, pregnancy may be associated with an opportunity for changing habits. Following the literature, we think of habits as automatic behavioral responses to environments, which develop by repetitive behavior (Lally & Gardner, 2013). Pregnancy may help with breaking habits; however, there can also be barriers to change, such as the physiological effects of pregnancy or lack of social support (Coll, Domingues, Gonçalves, & Bertoldi, 2017; Sui, Turnbull, &

Dodd, 2013). To illustrate, pregnancy can be an opportunity for changing lifestyle habits as there are many positive reasons to do so and individuals may thus shift priorities (Lindqvist et al., 2017; Szwajcer, Hiddink, Maas, Koelen, & Van Woerkum, 2008). Some evidence of changes during pregnancy has been found in survey-based or small-scale studies (Eren et al., 2015; Savard et al., 2019). Studies have shown that alcohol intake decreases during pregnancy in comparison with prepregnancy intake (Crozier et al., 2009; Pinto, Barros, & dos Santos Silva, 2009). Furthermore, Hillier and Olander (2017) provide a recent review of studies examining women's dietary changes during pregnancy and report that the most consistent findings were an increase in fruit, vegetable, and dairy intake and a decrease in caffeine intake. However, making health changes may depend not just on motivation but also on the capability and opportunity to change (Olander, Smith, & Darwin, 2018). For example, some changes may be seen as more important or easier to implement, such as taking a prenatal vitamin, whereas other changes may be harder to implement or viewed as less important, and also could be subject to less social pressure.

A segment of the economics literature has focused on habit formation and its impact on economic outcomes. Consumers may form habits in consumption, with the result that their current utility might depend on past as well as present consumption. Evidence of habit formation at the individual or household level depends on the particular category of consumption goods (Browning & Collado, 2007; Dynan, 2000; Havranek, Rusnak, & Sokolova, 2017; Jiménez-Martín, Labeaga, & López, 1998). Consumers' habits could affect demand responses, price elasticities, and other economic outcomes. In addition, habits are an important factor to consider for the design of public health policies relating to behavior change.[5]

We argue that a temporary shift in circumstances affecting behavior, such as pregnancy, could lead to a structural break in habits. This study therefore adds to the psychological literature on changing habits by providing an empirical exercise based on observational data and a difference-in-differences identification strategy. Furthermore, we discuss one possible explanation related to the theory of rational addiction (Becker & Murphy, 1988). In the theory of rational addiction, consumption of an addictive good may be rational in the sense that it involves maximization by forward-looking consumers.[6] Considering that the current utility of alcohol consumption is positively related to previous consumption, households tend to consume alcohol repeatedly. One key result of Becker and Murphy (1988) is the existence of multiple equilibria. In the model, one equilibrium involves low or zero consumption, while another equilibrium involves high consumption. Consumers tend to consume either a high amount or a low/zero amount of an addictive good. Data also show such a bimodal consumption distribution of addictive goods (Becker & Murphy, 1988). During pregnancy, the marginal utility of alcohol decreases due to the negative health implications for the fetus. Due to lower consumption during pregnancy, the stock of past consumption decreases. The temporary event of pregnancy may shift consumption into the equilibrium of low consumption. Our empirical observation is in line with the prediction from the theory. We further show that breastfeeding does not drive the effects and that the second pregnancy does not lead to any further changes in behavior. The observation can be explained with the theory of rational addiction. Households change their behavior during a first pregnancy, and consumption does not revert to prepregnancy levels. Until and during the second pregnancy, households' consumption remains stable.

However, we cannot exclude that the birth of children affects the preferences of households, and the reduction during pregnancy is not necessarily directly related to lower alcohol consumption after the birth of the first child. Instead, parents may change their behavior as recommended during pregnancy and then maintain the new behavior during parenthood to create a health-promoting environment for the child (Edvardsson et al., 2011). Another explanation could be that the birth is related to a negative income shock, and we observe the income elasticity of demand. However, we do not observe such a negative income shock in our sample of households.

Our study documents effects during and after a first pregnancy on the household level. We are not able to differentiate which household members reduce their actual consumption. However, we find effects of the first pregnancy on immediate and long-lasting purchases on each category of alcohol, that is, on beer and wine as well as on all alcoholic beverages.[7] We believe that the size of the effect as well as the simultaneous effect on all categories is due to changes made by all household members. Therefore, this article adds to the literature on peer effects. Research has shown that peer effects play a crucial role in alcohol consumption. For example, Fletcher and Marksteiner (2017) show causal health spillover effects.

Our study has an impact on policy considerations. We find that pregnancy does not only affect households during pregnancy but also changes consumption habits in the long term. Thus, the impending birth of a child can change behavior with respect to alcohol consumption and improve health for an entire household. Policies that involve funding incentives for families could take the health dimension of such changes into account. Furthermore, a direct relationship between the reduction of alcohol consumption during pregnancy to consumption after pregnancy is important for policy makers. Strong recommendations to reduce alcohol consumption (AAP, 2015) may reduce consumption during pregnancy and help to change habits in the long term.

2 | DATA

We use data from the Nielsen Consumer Panel. The dataset covers the years 2004–2017. Panelists (40,000–60,000 households) from across the United States record all their purchases intended for in-home use. Prices, quantities, and product categories are recorded, along with other product information. Purchases are recorded at the household level, thus capturing both individual effects and spillovers to the household. Households report demographic data such as household size, composition, and income.

2.1 | Identification of households with a pregnant household member

We use demographic data to identify households who experience a pregnancy while in the panel, and we use purchase data to more closely identify the timing of the pregnancy. Panelists report the year of birth of each household member retrospectively on an annual basis, which we use to identify pregnant households. We then use a subset of pregnant households, defined as those who are in the panel for at least 3 years (the year before the birth, the year of birth, and the year after the birth) so that we have data on purchases before, during, and after pregnancy.

We use the information on the timing of a household's purchases of particular products to infer the birth month and, therefore, the preceding 9 months of pregnancy, in order to estimate the time period of pregnancy as closely as possible. Four product types that are associated with pregnancy and a newborn baby are used: (1) disposable diapers, (2) baby milk formula, (3) pregnancy tests, and (4) pureed baby food. Implementing a hierarchical decision rule, we go through each product category. Therefore, we evaluate whether we can determine a birth month from diapers, and if we cannot, we investigate purchases of baby formula. If we cannot find the birth month, we continue with pregnancy tests and baby food sequentially.

Detailed rules for inferring pregnancy from these product categories differ: For diapers, we record the last date of purchase of newborn size diapers (usually for up to 1–2 months old) and assign that month as the month of birth. We use the last occasion of purchase to deal with the issue that initial diaper purchases are made in advance to prepare for the baby's arrival. If a household does not purchase any newborn size diapers, we look at size one diapers (usually for a 2–4 month old) and consider the last purchase date for the same reason and subtract 2 months from that date to infer the birth month. We use 2 months since if we do not observe any newborn size diaper purchases, then it is likely that those babies may use size one from birth to 2 months of age instead.

Second, if a household has no recorded purchases of diapers, we use the first date of purchase of formula to infer the birth month. Third, we take the last date that the household records a purchase of a pregnancy test (during the year of birth or the year before) and add 8 months to infer the birth month. Lastly, pureed baby food is suitable for babies to start eating from 4 to 6 months, so we take the first purchase of pureed baby food and subtract 4 months to infer the birth month.

We identify 2838 households that had a household member who was pregnant during the household's participation in the panel and where that household participated in the panel for at least 3 years (the year before the birth, the birth year, and the year after the birth). We can infer the birth month for 94% of these households, or a total of 2662 households.[8] We restrict the sample to those households with any alcohol consumption in the sample period, thus reducing the sample to 1967 households.

Some of the households had multiple pregnancies. We consider two distinct samples. In the first sample, we limit the households to those that experience a first pregnancy. Thus, we exclude households in which children younger than 6 years are present during the first birth. To analyze effects after pregnancy and to exclude the possibility that a new pregnancy drives the results, we exclude households where we observe a second pregnancy within 2 years after the first pregnancy. Our second sample consists of households that experience a second birth.[9] Again, we ensure that we do not observe a birth 2 years before and after the second birth. Our sample of first pregnancies consists of 1306 unique households, and the sample of second pregnancies consists of 202 households.

Panel A of Table 1 presents descriptive statistics of the sample of pregnant households. Comparing the samples, we observe slight differences between the sample of first births and the sample of second births. Households having a second pregnancy have a higher household income and a higher share of female heads with a college education. The

TABLE 1 Summary statistics

	Full	1st Preg.	2nd Preg.
A: Household characteristics			
Number of households	1967	1306	202
Household size	3.62 (1.25)	3.23 (1.21)	4.09 (1.18)
Fraction married	0.83 (1.25)	0.78 (1.21)	0.93 (1.18)
Mean age of female household head	39.99 (10.59)	41.51 (11.27)	37.68 (8.93)
Conditional age <50	35.89 (5.99)	36.26 (6.39)	35.09 (4.89)
Household income in USD	71,402 (32,635)	70,738 (33,003)	75,415 (32,112)
Before pregnancy	-	68,309 (34,133)	76,939 (32,003)
After pregnancy	-	73,286 (34,635)	79,001 (33,417)
Fraction of female household heads with college degree	0.57 (0.47)	0.54 (0.47)	0.68 (0.46)
B: Time			
Years in panel	8.42 (3.47)	6.33 (1.6)	5.9 (2.34)
Before pregnancy	-	2.99 (1.32)	2.44 (1.66)
After pregnancy	-	2.76 (0.94)	1.8 (1.24)
C: Alcohol			
Alcohol purchases in liters	2.55 (7.28)	2.98 (8.63)	4.34 (3.38)
Before pregnancy	-	3.41 (9.89)	3.92 (3.61)
During pregnancy	-	2.69 (9.16)	5.06 (4.66)
After pregnancy	-	2.71 (7.99)	4.4 (4.3)
Beer purchases in liters	2.3 (7.26)	2.59 (8.58)	6.36 (5.19)
Before pregnancy	-	3.57 (10.93)	6.06 (4.71)
During pregnancy	-	2.81 (10.18)	6.03 (6.46)
After pregnancy	-	2.59 (8.58)	6.36 (5.19)
Wine purchases in liters	0.58 (1.52)	0.7 (2.29)	2.38 (3.16)
Before pregnancy	-	0.85 (2.2)	2.65 (4.08)
During pregnancy	-	0.5 (2.16)	2.67 (2.68)
After pregnancy	-	0.7 (2.29)	2.38 (3.16)
D: Baby formula			
Fraction of households with baby formula purchases	-	0.83 (0.37)	0.27 (0.44)

Notes: This table presents summary statistics on three samples. The first column refers to all identified married households. The second column represents households experiencing their first pregnancy, and the third column represents households experiencing their second pregnancy. Note that not all households report a female household head. Furthermore, the household head can be different from the pregnant household member. Household income is a categorical variable, and we use midpoint coding. "Alcohol" refers to all beverages with alcohol content. See the Appendix S1 for a description of the exact subcategories of beer and wine. We consider a household to be either a user of baby formula or not. A household is a user of baby formula if we observe baby formula purchases during the 2.5 years after pregnancy. Standard deviations are in parentheses.

Abbreviation: USD, US Dollar.

mean household incomes within all our samples are similar to that of the general population. We observe a particularly high age of female heads in all households. However, the female head of the household does not necessarily represent the pregnant household member. We also show the average age of the household head omitting those older than 50 years, as we believe that some households consist of multiple generations and the oldest generation is reported as the household head.

2.2 | Outcome variables

We aggregate daily purchase data to monthly observations, which provides an estimate of purchase behavior with reduced noise from day-to-day variation. In our benchmark model, we measure alcohol consumption by the aggregated quantity in liters across different categories such as beer, wine, and liquor. We show robustness by differentiating between categories and by examining expenses instead of aggregated quantities.[10]

Panels C and E of Table 1 present descriptive statistics of the outcome variables for the different samples. On average, a household consumes 2.55 liters of alcohol per month. For the first observed pregnancies, the alcohol consumption before pregnancy is higher than during and after pregnancy. In contrast, for the second pregnancy, we observe higher consumption during and after pregnancy compared with prepregnancy consumption. The variation across households is high.

3 | EMPIRICAL STRATEGY

We employ two identification strategies to estimate the effect of pregnancy on household consumption of alcohol. Both estimation methods try to investigate whether purchases of alcohol are reduced during pregnancy. Furthermore, we evaluate whether households purchase less alcohol after pregnancy than before pregnancy. In the event study, we evaluate two additional outcome variables. First, we investigate whether households with a first pregnancy differ from households with a second pregnancy. Second, we evaluate the difference between households who purchase baby formula during the 2.5 years after pregnancy and those that do not.[11]

3.1 | Event study

The outcome of interest Y_{it} of household i in a quarterly period t is the average monthly alcohol consumption in liters.[12] We use quarterly instead of monthly observations. We calculate the average monthly values to avoid fluctuations in the monthly outcome due to stockpiling by households. We estimate the impact of pregnancy for each half year before and after household i had a pregnant household member. The regression evidence is described in the following model:

$$Y_{it} = \sum_{q=-5}^{5} \beta_q [\text{HalfYearsToPregnancy}_{it} = q] + \rho_i + \mu_t + \lambda X_{it} + \varepsilon_{it}, \tag{1}$$

where $[\text{HalfYearsToPregnancy}_{it} = q]$ is an indicator for half years before and after pregnancy.[13] Note that $q = 0$ corresponds to a household in the 9-month period of pregnancy.[14] For example, $q = 1$ corresponds to households 6 months after pregnancy. In this model, ρ_i are household-fixed effects, and μ_t are period-fixed effects. Furthermore, X_{it} controls for household characteristics that vary over time. We control for household income (income brackets), household size, household composition (relation between household members), the occupation of female and male household heads, employment status, education and age, marital status within a household, the presence and age of kids, and race. We include 10 regressors of interest with one default value. However, the sample size shrinks as we move further away from the time of the pregnancy, as fewer households are present in the sample across longer time periods.

3.2 | Difference-in-differences design

We employ a difference-in-differences design, following Fadlon and Nielsen (2019), to identify causal effects of pregnancy on household consumption behavior. This strategy enables us to overcome selection effects given that the timing of pregnancy is not always random, and pregnancy could be correlated with unobservables on the household level, such as health-specific knowledge or higher probability of changing their consumption path. It is, however, likely that the exact month of pregnancy is random within a certain window, given that it is not possible to choose precisely when one becomes pregnant (but households may start to change their behavior prior to pregnancy if they intend to become pregnant). Following Fadlon and Nielsen (2019), we use the potential randomness of the timing of a pregnancy to create a quasi-experimental research design. We construct counterfactuals for pregnant households using households that experienced pregnancy 2 years in the future. Choosing a 2-year period involves a trade-off between comparability and analysis horizon, as described further in Fadlon and Nielsen (2019). The identifying assumption is that within 2 years, the particular month in which households become pregnant is random. We compare households in the treatment group with households in the control group who got pregnant in the same month, but 2 years later, to try to control for possible seasonality effects (e.g., we compare households who got pregnant in December 2010 to households who got pregnant in December 2012).

Nevertheless, we acknowledge potential limitations of the identification assumption. In particular, it is possible that even in the 2-year time horizon, pregnancy is nonrandom. For example, households that get pregnant may already have lower alcohol consumption compared to households that get pregnant later. The downward trend of consumption before pregnancy would lead to a violation of the parallel trend assumption, and our estimates would be biased downwards. We therefore show that the parallel trend assumption holds, and we do not observe different trends of alcohol consumption between the treatment and control groups prior to pregnancy.

To investigate the dynamics of household changes in consumption before, during, and after pregnancy, we use the following difference-in-differences equation:

$$Y_{it} = \beta_1 \text{treat}_{it} + \sum_{r=-1}^{2} \beta_{2,r} \times \text{time}_{r,it} + \sum_{r=-1}^{2} \gamma_r \times \text{treat}_{it} \times \text{time}_{r,it} + \rho_i + \mu_t + \lambda X_{it} + \varepsilon_{it} \quad (2)$$

where treat_{it} is a dummy that takes the value 1 if household i is in the treatment group and time_{it} are indicators for time relative to the time period of pregnancy (i.e., pregnant if in the treatment group or not pregnant at the same time of year in the control group). Note that Y_{it} represents an outcome for household i at month t.[15] We also include household fixed effects ρ_i, time fixed effects μ_t, and time-variant household-specific characteristics X_{it}. Again, we control for household income (income brackets), household size, household composition (relation between household members), the occupation of female and male household heads, employment status, education, age, marital status within a household, the presence and age of kids, and race.

The parameters γ_r estimate the effects of pregnancy in period r on household-level outcomes relative to the baseline, which is $r = -2$. The baseline is thus the time 1 year to 6 months before pregnancy, which we selected given that households may start to change their behavior before pregnancy. We estimate effects for before and after pregnancy at the 6-month level. The estimate for the time of pregnancy ($r = 0$) is at the 9-month level.[16] We evaluate the parallel trend assumption, that is, that the control and treatment groups have similar trends before the time of treatment.

We use the example illustrated in Figure 1 to describe the construction of the treatment and control groups. Household A is both in the treatment group and in the control group, but it is not a control to itself. Household A is a control to Household B, and Household C is instead a control for Household A when Household A is in the treatment group. Some observations of Household A overlap from control to treatment. We follow Fadlon and Nielsen (2019) in using the overlapping sample for the main analysis. Thus a household may be part of a control group and a treatment group at the same time. Note that we do not require that a control or treatment group be present for the full time period of the data.[17]

3.3 | Heterogeneity analysis

We extend our analysis by evaluating how alcohol purchases in liters during and after a first pregnancy differ across different type of households. Within the heterogeneity analysis, we use the dynamic difference-in-differences estimation for subsets of households. The following are household characteristics according to which we examine subsets of the full sample: (1) single-parent households, (2) married household heads, (3) household income above/below-median income in the sample, (4) household head with/without college education, and (5) alcohol purchases before pregnancy above/below the median. For each subset of households we use the model described by Equation (2) to show regression evidence.

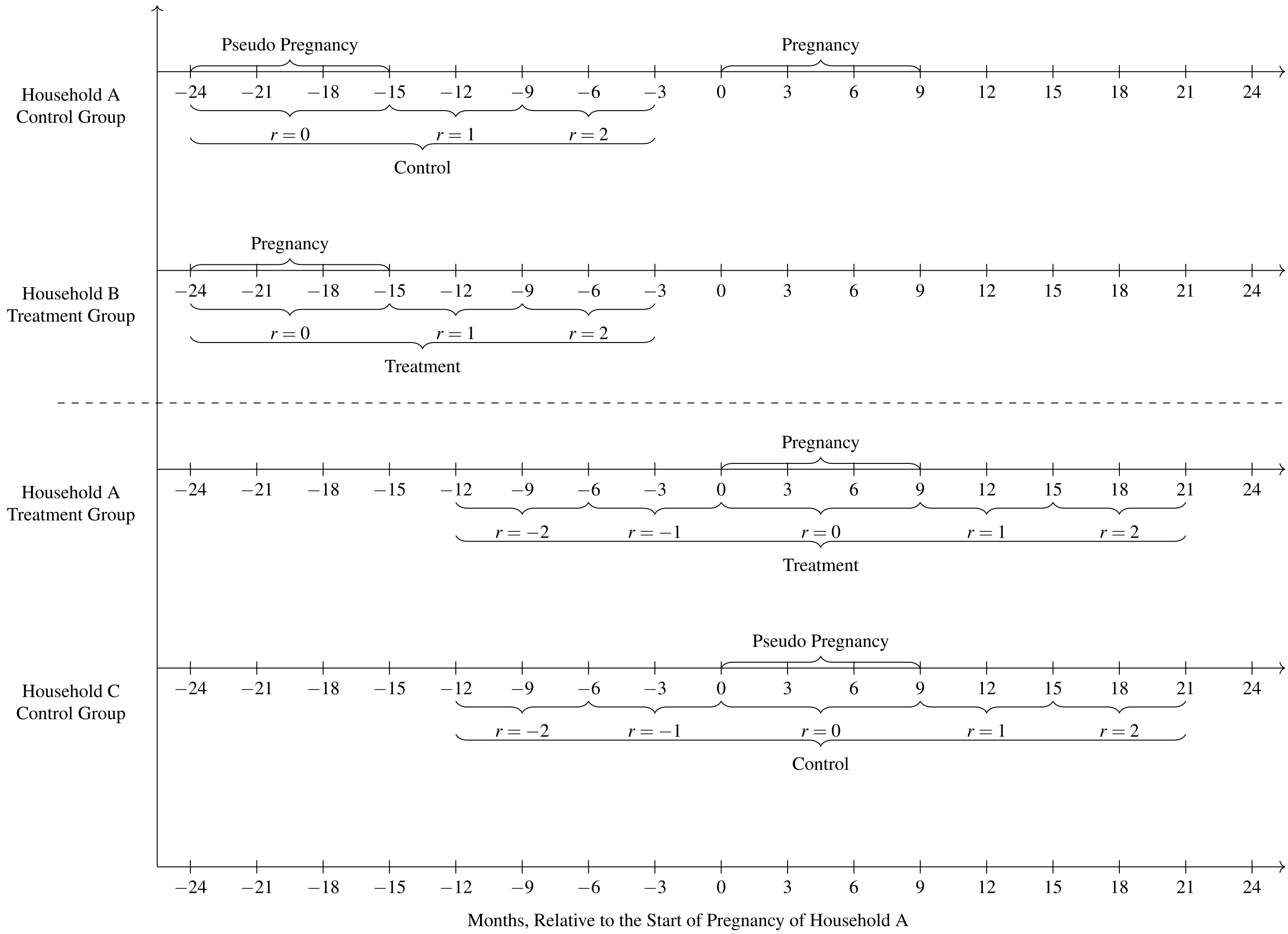

FIGURE 1 Construction of treatment and control groups. Example of construction of control and treatment groups. Each time interval represents 3 months. Time periods *r* are defined in relation to the time of pregnancy in the treatment household and corresponding time of pseudo pregnancy in the control household. Calendar time is fixed across timelines. We normalize calendar time to the pregnancy start of household A

4 | RESULTS

4.1 | Event study

Figure 2 describes the results of the event study. The outcome is the average monthly consumption of alcohol in liters.[18] It shows the coefficient β_q of each indicator variable $[\text{HalfYearsToPregnancy}_{it} = q]$. Considering multicollinearity, we use one of the regressors q as a reference level. As our date of pregnancy start is an estimate (see Section 2.1) and it is possible that we estimate a date too early for part of the sample, we use $q = -2$ (1 year to 6 months before pregnancy) as a reference level. The coefficients in both figures are based on a regression using household-fixed effects and period-fixed effects as well as controls.[19] The figure further describes separate estimation results of the different household samples: households experiencing a first pregnancy, those with first pregnancies and observable baby formula purchases after pregnancy, and households with a second pregnancy.

Prepregnancy periods are associated with stable average monthly alcohol purchases for first pregnancies. Households that experience a second pregnancy have lower alcohol consumption 9–15 months before pregnancy. The result can be rationalized as some families still are affected from a first pregnancy. During pregnancy the average monthly alcohol consumption decreases for the sample of first as well as second pregnancies. For the sample of households experiencing the first, past pregnancy, pregnancy is associated with 0.91 l less alcohol consumption compared with purchases 12–6 months before pregnancy. As households purchase on average 3.14 l of alcohol, the

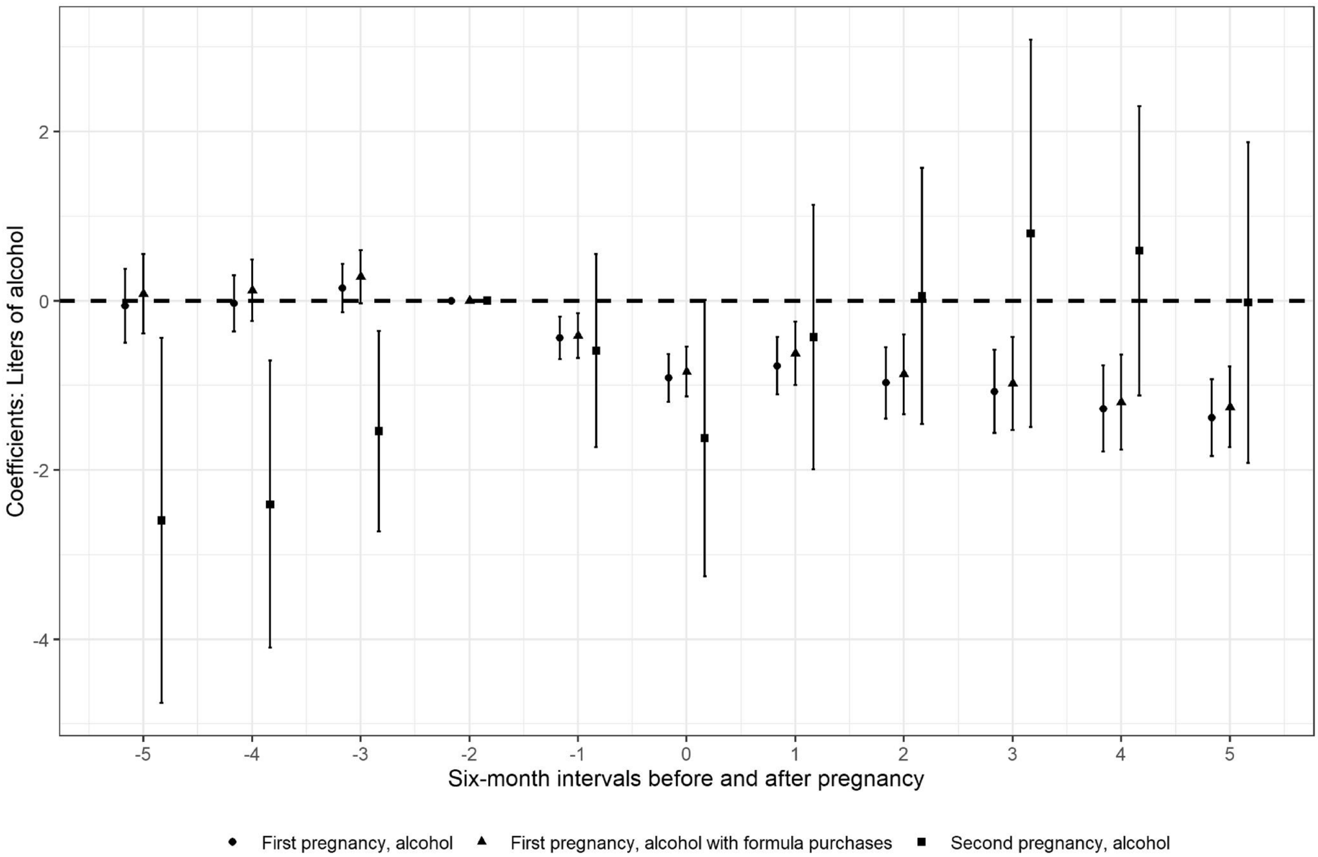

FIGURE 2 Event study. The figure shows coefficients of the event study for households' alcohol consumption in liters. One observation corresponds to average monthly purchases of a household during a 3-month period. The outcomes are liters of alcohol. Regression results are presented in the Appendix S1. The regression includes household and time fixed effects. We control for household income (income brackets), household size, household composition (relation between household members), the occupation of female and male household heads, employment status, education, age, marital status within a household, the presence and age of kids, and race. Note that variables are often discrete and included by dummies to allow for nonlinear effects. Results are robust without controls (see Appendix S1). The plotted coefficients of $q = -5$ to $q = -1$ correspond to 6-month intervals before pregnancy, while $q = 1$ to $q = 5$ describe 6-month intervals after pregnancy. The coefficient of $q = 0$ shows results for the 9 months during pregnancy. The default value is $q = -2$. The error bars represent 95% confidence intervals. Standard errors are clustered on the household level and adjusted for heteroskedasticity

households reduce their purchases by 29%. For those households that purchase baby formula after pregnancy, pregnancy is associated with a 0.77 l decrease in alcohol purchases compared with prepregnancy (24% decrease). In comparison, we do not observe lower alcohol consumption after pregnancy for those households that experience a second pregnancy. Considering alcohol consumption for the first pregnancy, we do not observe alcohol purchases reverting to prepregnancy levels after birth. Indeed, households that experience the first pregnancy purchase approximately 30% less alcohol after pregnancy compared with before pregnancy. This result is identical for the subsample of households that purchase baby formula. In comparison, we observe slightly higher alcohol purchases after pregnancy compared with before pregnancy for the households experiencing their second pregnancy, but the result is not significantly different from zero.

4.2 | Difference-in-differences design

Table 2 presents the results for the estimation of Equation (2) with alcohol consumption in liters as the outcome variable. Differentiating between the quantity and expenditure as well as different categories of alcohol, we display estimates of the γ_r coefficient for each of the periods relative to pregnancy, with $r = 0$ representing the time of

TABLE 2 Dynamic difference-in-differences results

	All alcohol		*Beer*		*Wine*	
	Liters	**Expenses**	**Liters**	**Expenses**	**Liters**	**Expenses**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
−1	−0.499* (0.217)	−1.266 (0.779)	−0.555* (0.280)	−0.572 (0.625)	−0.138 (0.088)	−1.032 (0.591)
0	−1.217*** (0.343)	−5.301*** (1.074)	−1.016* (0.489)	−1.928 (1.078)	−0.397** (0.122)	−3.084*** (0.788)
1	−1.127** (0.351)	−4.185*** (1.126)	−1.116* (0.478)	−2.177* (1.079)	−0.202 (0.121)	−1.772* (0.795)
2	−1.155*** (0.319)	−4.730*** (1.101)	−1.262** (0.404)	−2.518** (0.892)	−0.200 (0.110)	−2.025* (0.793)
Fixed effects	HH and time	HH and time	HH and time	HH and time	HH and time	HH and time
Control effects	Yes	Yes	Yes	Yes	Yes	Yes
Outcome	3.35	12.68	3.32	7.14	0.75	5.27
Percent change, pregnancy	−36.33	−41.81	−30.6	−27	−52.93	−58.52
Percent change, 6 months after birth	−33.64	−33	−33.61	−30.49	−26.89	−33.62
N	68,115	68,115	44,815	44,815	45,604	45,604
R^2	0.728	0.576	0.751	0.665	0.523	0.470

Notes: Results of the dynamic difference-in-differences estimation for the responses of household consumption of alcohol to pregnancy using the specification in Equation (2). One observation corresponds to a household monthly purchase. The outcome variables for the six models are as follows: (1) monthly purchases of alcohol in liters, (2) expenses for alcohol in USD, (3) monthly purchases of beer in liters, (4) expenses for beer in USD, (5) monthly purchases of wine in liters, and (6) expenses for wine in USD. Ciders and beer-based mixed drinks are included in the beer category. Exact categorization is provided in the Appendix S1. The table displays estimates for the γ_r parameter of the interaction between the treatment group indicator and the indicators for time with respect to the shock from −1 to 2. The baseline period is −2 (not reported). Time 0 represents the 9 months of pregnancy (or pseudo pregnancy in the case of the control group). The other periods are 6-month periods with respect to the shock. All models include time and household-fixed (HH) effects as well as time-varying household characteristics as controls. We control for household income (in discrete income brackets), household size, household composition (relation between household members), the occupation of female and male household heads, employment status, education, age, marital status within a household, the presence and age of kids, and race. Note that variables are often discrete and included by dummies to allow for nonlinear effects. Results are robust without controls (Appendix S1). We show the average outcome and the percentage effects during pregnancy ($q = 0$) and in the initial period after pregnancy ($q = 1$). Standard errors are clustered on the household level, adjusted for heteroskedasticity, and reported in parentheses.

Abbreviations: HH, household; USD, US Dollar.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

pregnancy. The coefficients are interpreted with respect to the baseline, which is the period 6–12 months before pregnancy. During pregnancy, alcohol consumption decreases significantly compared with the baseline level on average, and this effect persists for the two periods after birth. To put the effect into context, it corresponds to a 36.33% decrease in average monthly household alcohol purchases in liters during pregnancy and a decrease of 33.64% for the period up to 6 months after birth. The results are similar in size when considering alcohol expenditures in US Dollar (USD) as well as when evaluating beer or wine purchases.

4.2.1 | Parallel trends

Within the difference-in-differences estimation it is crucial that the parallel trend assumption across treatment and control groups is valid. Control and treatment groups should not experience a different trend in purchases of alcohol before the time of the birth. In Figure 3, we visualize the trends in the outcome variables by plotting the monthly averages of alcohol consumption in liters. We argue that the plot illustrates similar prepregnancy trends. To extend our analysis, we show in the Appendix S1 that trends before treatment are not significantly different with or without household or time fixed effects.

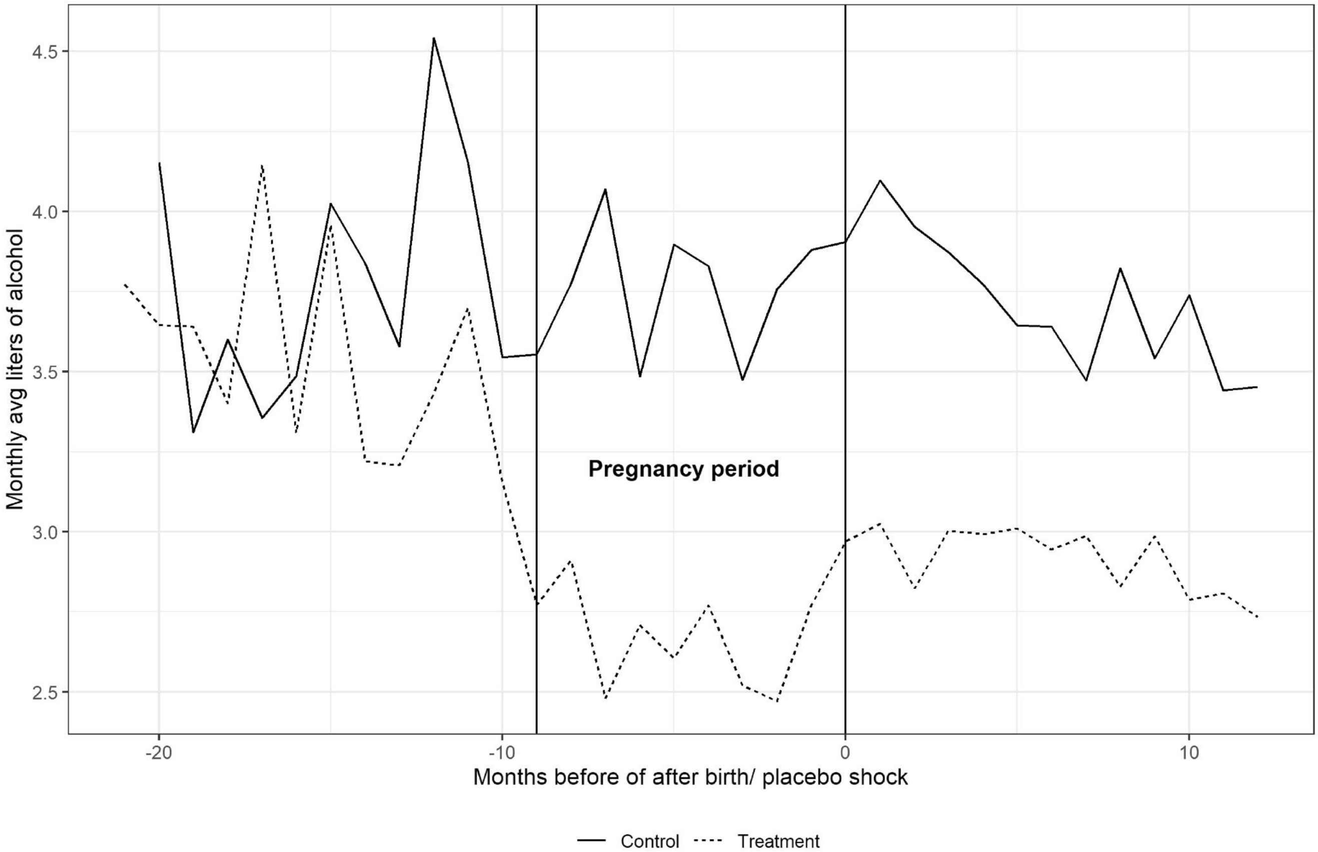

FIGURE 3 Average monthly purchases of alcohol. The figure shows average alcohol consumption in liters for each time period *r*. For *r* = 0, the average for the 9-month period during pregnancy is shown. For all other time periods, 6-month averages are shown. The space between the vertical lines represents the time of pregnancy (or pseudo pregnancy for the control group)

4.3 | Heterogeneity analysis

Figure 4 presents the results of our heterogeneity analysis. For each subsample, we present γ-coefficients of the difference-in-differences regression model presented in Equation (2). The three coefficients for each subsample show the effect on alcohol purchases in liters during pregnancy, during the 6 months after pregnancy, and 7–12 months after pregnancy relative to the purchases 7–12 months before pregnancy. Note that we include household and period-fixed effects.

All households experience a decrease in alcohol purchases during pregnancy. However, the changes are different in size and not always significant. For example, single-parent households or households with below-median alcohol purchases before pregnancy experience only small and nonsignificant declines in alcohol consumption, while households with above-median alcohol purchases before pregnancy show an especially high decline during pregnancy. For married households, the decline during pregnancy is higher compared with single-parent households. Households with higher incomes show less decline than households with above-median income. Households with households heads older than 30 years show a slightly higher decline than households with a household head under 30 years of age. We do not observe differences across education levels.

Also, results after pregnancy differ. Except for households with low alcohol purchases before pregnancy, we observe persistence in effects among all household subsamples. For most cases, the effect in the 6 months after pregnancy and in the 7–12 months after pregnancy are similar to the effects during pregnancy. However, two observations differ. First, the decrease for single-parent households is largest during the time after birth, with the largest decrease in the period 7–12 months after pregnancy. Second, for households with a higher education level, we observe a less strong coefficient, while households with lower education levels show larger decreases after birth.

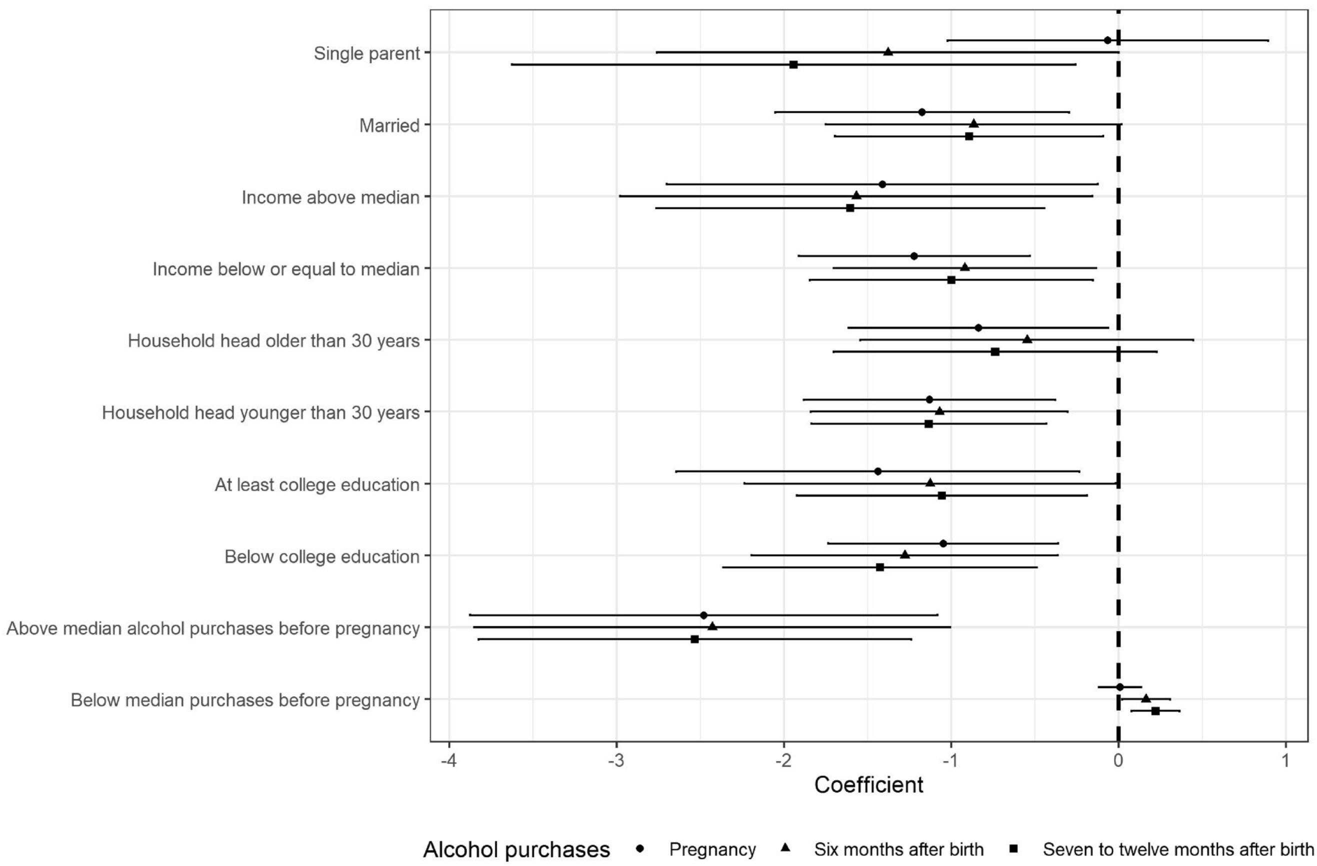

FIGURE 4 Heterogeneity Analysis. The figure shows results of regression model 2 for separate subsamples. We display γ-coefficients for each individual regression that only considers households with the displayed characteristics. The three coefficients for each subsample show the effect on alcohol purchases in liters during the pregnancy, during the 6 months after the pregnancy, and from 7 to 12 months after the pregnancy, relative to the purchases 7–12 months before pregnancy. Each regression includes household and time-fixed effects. We control for household income (in discrete income brackets), household size, household composition (relation between household members), the occupation of female and male household heads, employment status, education, age, marital status within a household, the presence and age of kids, and race. The error bars represent 95% confidence intervals. Standard errors are clustered on the household level and adjusted for heteroskedasticity

5 | DISCUSSION

We estimate the effects of pregnancy on alcohol purchases. Decreased alcohol consumption is a habit change that is recommended for pregnant women but also is consistent with general health recommendations. We show the expected result that households who experience a first pregnancy reduce their purchases of alcohol. We further show that households' purchases do not revert to prepregnancy levels but remain low after pregnancy. While the effect during pregnancy is in line with previous research (Crozier et al., 2009; Pinto et al., 2009), the observation of persistence is novel. Here, we discuss potential behavioral explanations in relation to the lack of observed changes following second pregnancies and findings in the literature. We also discuss policy implications.

5.1 | Change of habits

Our results are consistent with the formation of habits, where past consumption influences subsequent consumption. Adapting the definition from psychology, habits are an automatic behavioral response to environments, which develops by repetitive behavior (Lally & Gardner, 2013). Breaking habits is hard, but one potential way is to break exposure to habit cues. Purposive context changes may be a successful intervention strategy, as they offer a "window of opportunity" in which old habits can be broken (Lally & Gardner, 2013; Verplanken, Walker, Davis, & Jurasek, 2008;

Verplanken & Wood, 2006). Pregnancy may offer such an opportunity. During pregnancy, households reduce consumption of alcohol because alcohol is connected to risk for the fetus. Thereby, the households break the habit, and consumption stays on a lower level.

The intuition of breaking habits can also be presented in an economic model-theoretic framework. Suppose nonpregnant consumers follow a behavior as outlined in the theory of rational addiction (Becker & Murphy, 1988), in which past consumption increases the marginal utility of current consumption ("reinforcement effect").[20] Consumers are forward-looking and maximize their present and discounted future utility. An addictive good such as alcohol increases current utility by providing relaxation. The stock of past consumption of the addictive good increases the marginal utility of current consumption. However, the addictive good lowers the level of health, so greater past consumption lowers current utility, everything else being equal ("tolerance effect"). As a result, the reinforcement effect increases consumption over time for specific households. Becker and Murphy (1988) show that the model has multiple equilibria. Specifically, there are two steady states: one in which consumption is close to zero and one that involves higher consumption. Indeed, Becker and Murphy (1988) argue that the distribution of households consuming an addictive good is bimodal. Some consume small quantities of an addictive good; others consume large quantities.

Pregnant women's alcohol consumption over a certain threshold may affect the health of a fetus. Therefore, during pregnancy, not only the stock of past alcohol consumption but also current consumption reduces health and utility. The household member reduces consumption due to the lower marginal utility of consumption. After the birth, the stock of the addictive good has decreased. Following Becker and Murphy (1988), it is possible that some consumers shift from high consumption to the low consumption steady state.

Our empirical findings are in line with the model of rational addiction and changes in equilibrium consumption due to pregnancy. We find reduction not only during but also after pregnancy. The changes are different in size, but observable for almost all types of household. Specifically, effects after pregnancy are observable for different levels of education, age, and household size. Additionally, we rule out that breastfeeding drives the results, as households that purchase baby formula do not differ from those that do not.

We also find that a second pregnancy is not related to a reduction in purchases after pregnancy. This observation can be rationalized using the theory of rational addiction. We do not find equilibrium changes as households already changed their behavior and equilibrium during the first pregnancy. Finally, the shift of equilibria from a high to a low consumption equilibrium implies that those households with high consumption before pregnancy that show a large decrease during pregnancy are more likely to reduce consumption in the long term compared with households that did not reduce consumption from a high initial level. Only for sufficiently low consumption during pregnancy, the households converge to the new steady state of low consumption as described in Becker and Murphy (1988). We observe a correlation between the quantitative change in pregnancy and the postpregnancy consumption. Specifically, controlling for prepregnancy consumption, a 10% decrease in a household's monthly alcohol purchases during pregnancy compared with the year before pregnancy is associated with a statistically significant 0.15-l reduction in monthly purchases in the year after pregnancy.[21] That is, the greater the change during pregnancy, the lower are the absolute purchases after pregnancy. This result is in line with the interpretation that a change in alcohol consumption habits due to pregnancy causes long-lasting effects due to a change of equilibria.

5.2 | Change in preferences

Another explanation for the change in consumption is a shift of preferences. In detail, it is possible to explain the results even without reference to habits, meaning that past alcohol consumption affects the utility of alcohol consumption today. During pregnancy, mothers may follow health recommendations. After pregnancy, households have an incentive to reduce their consumption due to the presence of children. Parents may want to be role models or increase their life expectancy for the benefit of their children or create a health-promoting environment.[22] It may also be possible that the opportunity costs of alcohol consumption increase as parents prefer to spend time or monetary resources on their children. In the case of a preference shift, one does not necessarily assume that individuals have habits and that lower consumption during pregnancy is directly responsible for lower postpregnancy consumption. Instead, consumption decreases in both periods for different reasons: health recommendations during pregnancy and a change in preference after pregnancy. We cannot rule out that solely a change in preferences drives the observed empirical observations. Indeed, it is possible that consumers' past consumption does not affect utility and we still observe persistent lower consumption during and after pregnancy.

5.3 | Income elasticity of demand

A final possibility is that our observations are based on the households' disposable income. Pregnancy and birth could be connected to a negative income shock that decreases the consumption of alcohol. Furthermore, it is possible that newborn-related expenses decrease the available household budget for non-essential items. This could also explain the fact that we see slightly larger declines of purchases among households that have an income below the median as well as for single-parent households. However, we believe that this possibility does not explain the empirical results. First, the households in our sample do not experience a negative income shock.[23] Furthermore, previous research has shown that the alcohol-specific income elasticity of demand for the US population is low. Nelson (2013) shows in a meta-analysis that the demand for alcohol is inelastic with respect to income.[24] Because of the low fraction of household income that is spent on alcohol, we do not expect income to play a crucial role. Finally, an income shock would also not explain the lack of observed changes during the second pregnancy.

5.4 | Peer effects

The observations in this article are on the household level. Thus, our results show that the entire household reduces alcohol consumption during and after the first pregnancy. It is possible that only a mother decreases consumption or that peer effects lead to lower consumption by entire households. Indeed, peer effects are important when it comes to risky health behavior (Fletcher & Marksteiner, 2017). It is especially likely that a spouse supports the pregnant partner's alcohol reduction by lowering the spouse's own intake.

We are not able to distinguish between household members. Nevertheless, we may use educated reasoning on consumption patterns across different alcohol categories as an indication for gender-specific consumption changes. According to marketing surveys (Gallup, 2017), the US-based women prefer wine, while men choose beer as their favorite alcoholic drink. The results of the difference-in-differences estimation show that beer as well as wine consumption decreases during and after pregnancy compared with prepregnancy consumption (from Table 2, beer consumption decreases 28% during pregnancy and 31% 6 months after pregnancy; wine consumption decreases 50% during pregnancy and 24% 6 months after pregnancy). The rationale that men drink most of the beer suggests that nonpregnant household members change their consumption during and after pregnancy. This would strengthen the argument that peer effects play a crucial role and pregnancy changes the consumption behavior of the entire household.

5.5 | Impact on policy

In the following, we turn to policy implications. We specifically comment on two conclusions: First, we show the value of social policies that affect households' fertility. Second, we evaluate the importance of official alcohol consumption recommendations for pregnant women. The impact on social policy is independent of the mechanisms, that is, it does not depend on whether the effect is based on habits or preferences. In comparison, the evaluation of health recommendations assumes that the persistent change in households' alcohol consumption is due to a break in habits.

First, and independent of the mechanism, pregnancy induces lower household alcohol consumption not only during pregnancy but also in the longer term. If individuals reduce their lifetime alcohol consumption after the first pregnancy, parents may experience improved lifetime health and life expectancy. Numerous social policies such as health insurance coverage or maternity leave possibilities influence households' decisions on family planning, and some policy tools are specifically intended to increase fertility rates.[25] A policy maker could take the improved health outcomes into account when employing a cost-benefit analysis of a potential reform. While our research does not evaluate any direct policy, we argue that a policy that affects fertility should consider the benefit of improving lifetime health after the birth of a child.

A second implication of our research concerns the value of alcohol consumption recommendations during pregnancy if the persistent effect is driven by a change of habits. The general intention of the recommendations is to reduce alcohol consumption during pregnancy to avoid severe damage to a newborn such as fetal alcohol spectrum disorder. Low alcohol consumption during pregnancy has been found to be less risky than previously believed (Oster, 2013). However, official recommendations often promote abstinence. Even when considering that low alcohol consumption during pregnancy is less risky, an official recommendation to abstain from alcohol entirely has the positive side effect of breaking a habit of consumption. In comparison, a recommendation that solely promotes reduction to a lower level of consumption may not break the habit and may increase consumption after pregnancy. If a change in habits reduces consumption in the long term, lower consumption during pregnancy could reduce consumption after pregnancy. Therefore, more strict recommendations could lead to more healthful behavior in the long term independent of the health impact on the fetus. Changing to more lenient recommendations for alcohol consumption during pregnancy would follow recent research on the health impact on the fetus but could come at the cost of higher alcohol consumption among entire households.

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CONFLICT OF INTEREST

The authors have declared that they have no conflict of interest.

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ENDNOTES

[1] Griswold et al. (2018) show that any amount of alcohol may cause harm.

[2] Note that alcohol may have positive utility effects, such as relaxation.

[3] There is psychological literature on why habits are hard to break (Lally & Gardner, 2013).

[4] For example, Alvik, Haldorsen, Groholt, and Lindemann (2006) show that concurrently reported alcohol consumption during pregnancy is under-reported.

[5] See the literature on public health policy in the tobacco market (Chaloupka & Warner, 2000).

[6] For a mathematical derivation, see Becker and Murphy (1988), Gruber and Köszegi (2001), or Chaloupka (1991). The theory of rational addiction has been tested using alcohol consumption and tobacco consumption (Baltagi & Griffin, 2002, Chen & Lin, 2012; Murphy, Grossman, & Becker, 1994).

[7] According to marketing surveys (Gallup, 2017), preferences for alcoholic beverages differ across gender, with women preferring wine and men preferring beer.

[8] To evaluate how well we were able to match the birth month, we show the frequency of birth months across all pregnant households in the Appendix S1.

[9] We select those households that experience a second birth during the panel period as well as those households where we observe the first birth within the panel period but with a child under the age of 6 years present.

[10] We believe that consumption in liters, rather than monetary expenditure, more clearly represents the changes in alcohol consumption that can have implications for health.

[11] We assume that the purchase of formula during the 2.5 years after pregnancy indicates a possible absence of breastfeeding.

[12] We use quarterly instead of monthly observations. We calculate the average monthly values to avoid fluctuations in the monthly outcome due to stockpiling by households.

[13] We show robustness for 3-month period length in the Appendix S1.

[14] Note that Y_{i0} also corresponds to a 9-month pregnancy.

[15] In comparison to the event study approach, here we use monthly purchases, as our dynamic difference-in-difference approach is based on overlapping control and treatment groups. We include time-fixed effects to reduce the effects of stockpiling, which may be higher in particular months.

[16] We show robustness for 3-month period length in the Appendix S1.

[17] As households enter and exit the panel and households need to be present for longer time to be categorized in a control group, we do observe more treatment than control observations. In detail, we observe 41,031 treatment and 27,242 control observations. In the Appendix S1, we reduce the sample to time periods in which the number of control and treatment observations is more balanced. Results do not change.

[18] All regression tables are in the Appendix S1.

[19] For results without fixed effects and without controls, see the Appendix S1. The results are robust. The Appendix S1 also presents results for different outcome variables such as expenditures or liters of specific alcohol categories.

[20] See also Gruber and Köszegi (2001) and Chaloupka (1991) for further discussion and empirical tests. Baltagi and Griffin (2002) show that liquor consumption in the United States is in line with the implications of the rational addiction theory.

[21] The result stems from a regression where one observation corresponds to an individual household. We regress the logarithm of alcohol consumption after pregnancy on the logarithm of the change in pregnancy to before pregnancy controlling for the set of household characteristics used in model 1 as well as birth date, that is, $Y_i^{\text{After}} = \alpha + \beta_1 \log(Y_i^{\text{Before}} - Y_i^{\text{Pregnancy}}) + \beta_2 Y_i^{\text{Before}} + X_i + \text{Birth}_i \varepsilon_i$. β_1 is -1.127 (s.e. 0.308). See the Appendix S1 for a regression table.

[22] Psychological literature shows a link between parents' and kids' alcohol consumption (Edvardsson et al., 2011; Smit et al., 2018.) conduct surveys and show that parents tend to build a healthy environment after birth.

[23] Note that this does not reflect the general US population, but could be explained by the high proportion of married and educated couples in the sample. Stanczyk (2020) shows that income shocks due to birth are very low for married, highly educated households.

[24] The income elasticity is around 0.59, which puts it in the range of the income elasticity for cigarettes (Gallet & List, 2003).

[25] An example is the baby bonus, a lump-sum government payment to parents of a newborn. Among others, Australia, France, Italy, and Singapore offer a baby bonus. The reason for such specific tools are usually a low, sub-replacement fertility rate.

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