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PRICE SENSITIVITY AND INFORMATION BARRIERS TO THE TAKE-UP OF NALOXONE

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ABSTRACT

We conducted a field experiment that randomized advertisements, advertisement content, and prices across 2,204 counties in the United States to study the impacts on online purchases of naloxone, an opioid overdose reversal drug. Advertising increased website users but only impacted purchases when combined with a price reduction. Messages emphasizing the discreet nature of online sales had no additional impact on purchases. Comparing counties with advertisements featuring a highly discounted price to those featuring the full price, we estimate a price elasticity of demand for online naloxone of -1.3. Price is a significant barrier to online purchases of this life-saving medication

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A randomized controlled trials registry entry is available at
https://www.socialscienceregistry.org/trials/5333/history/

1 Introduction

The opioid crisis in the United States is a worsening national emergency. Despite numerous federal, state, and local policies aimed at reducing overdose deaths, progress has been limited. In 2021, over 100,000 Americans died of an overdose, continuing an escalating trend driven by opioids (Spencer et al., 2022). Improving access to naloxone, an overdose-reversing and life-saving drug, is one of the central pillars of the federal response to the opioid crisis and to local efforts to address rising overdose death rates (CDC, 2019; Kerensky and Walley, 2017; Guy et al., 2019).[1]

To help increase access to naloxone, every state has liberalized naloxone dispensing, often permitting pharmacists to dispense naloxone to consumers without a prescription (Smart et al., 2021; Davis and Carr, 2015; PDAPS, 2022). Although these legal changes have dramatically increased pharmacy-based distribution of naloxone (Smart et al., 2023; Xu et al., 2018; Gertner et al., 2018; Guy et al., 2019; Gangal et al., 2020), naloxone dispensing to the general public remains low. An estimated 83% of naloxone units in 2017 were supplied to non-retail settings, primarily non-federal hospitals and clinics (FDA, 2018). This rate has not improved. In 2021, 84% of naloxone doses continued to be distributed outside of retail pharmacy settings (Reagan-Udall Foundation, 2023). While non-retail entities may supply first-responders (Smart et al., 2022), they are unlikely to provide naloxone kits at any scale to individuals who are either themselves at high risk of an overdose or who know people who are. Efforts to reduce barriers to naloxone access recently culminated in FDA approval of Narcan – a brand-name version of naloxone – as an over-the-counter product (FDA, 2023).

Increasing naloxone distribution to "laypersons" is one of the most cost-effective distribution options (Townsend et al., 2020). An overdose can take as little as a few minutes to result in a death, meaning bystanders may not have enough time to successfully intervene if they are not already armed with naloxone (Sporer et al., 1996; Somerville et al., 2017).[2] Community-based overdose prevention programs increasingly provide naloxone to laypersons, but many states lack these programs (Mueller et al., 2015; Wheeler et al., 2015; Moustaqim-

[1] In April 2018, then Surgeon General Jerome Adams, issued an advisory to individuals using high-dose opioids – licit or illicit – and their family and friends to learn how to use naloxone and keep it nearby. See `https://www.hhs.gov/surgeongeneral/priorities/opioids-and-addiction/naloxone-advisory/index.html`.

[2] In a small sample of fentanyl deaths, 90% of decedents were pulseless upon arrival of emergency services (Somerville et al., 2017).

Barrette et al., 2021; Courser and Raffle, 2021). Despite a push to encourage co-prescription of naloxone along with high-dose opioids, only 7.7% of high-dose prescription opioids are dispensed with naloxone (Stein et al., 2021).[3] Because overdose risk is particularly high among users of heroin and fentanyl (Bohnert et al., 2010) and recent increases in overdose deaths have been fueled by these illicit opioids, such co-prescribing of naloxone may have limited impact anyway.

Several other barriers limit widespread distribution of naloxone to the general public. First, audit studies in states that allow pharmacy dispensing without a prescription demonstrate that many pharmacies do not carry naloxone (e.g., Puzantian and Gasper (2018); Graves et al. (2019); Lozo et al. (2019); Gilbert et al. (2021)) or still require a physician's prescription even when not required by law (Guadamuz et al., 2019). In states where naloxone stocking rates are high (Evoy et al., 2018; Egan et al., 2020; Eldridge et al., 2020; Wu et al., 2020; Hill et al., 2021), pharmacy purchase of naloxone requires face-to-face interaction, and many have expressed concerns about stigma as a barrier to uptake (Green et al., 2017). Furthermore, individuals may not realize they can purchase naloxone without a prescription in a pharmacy or online. The cost of naloxone is also believed to be a significant barrier (Gupta et al., 2016; Rosenberg et al., 2018). Although naloxone is covered by many health insurance plans, prices paid by the uninsured increased by over 600% between 2015 and 2018 to $250 (Peet et al., 2022).[4] Even the insured can face high out-of-pocket costs. Peet et al. (2022) report that in 2018, the average out-of-pocket payment for naloxone was over $35 for the privately-insured. Rigorous evidence on the impact of price on naloxone purchasing is quite limited, however, as is evidence more generally on ways to increase naloxone uptake (Agarwal et al., 2022).

In this work, we partnered with Script Health,[5] the only online platform licensed to sell and distribute naloxone by mail in the United States, to evaluate the role of prices, advertising, and messaging aimed to reduce stigma and improve information on naloxone demand and purchasing.[6] Between April 22, 2020 and February 22, 2021, Script Health dedicated $20,000 for a Google Ads campaign, a pay-per-click advertising platform, to con-

[3]Calculated by authors using Table 1 and Table 2 of Stein et al. (2021). Guy et al. (2021) also find low rates.

[4]Price hikes have been a concern. See `https://www.markey.senate.gov/news/press-releases/senators-demand-answers-about-outrageous-price-hike-for-lifesaving-anti-opioid-drug`.

[5]Script Health was previously named Fiduscript.

[6]French et al. (2021) describe the use of free mailed naloxone during the pandemic through harm reduction organizations partnering with local public health departments. Many of these programs have continued. See `https://nextdistro.org/pennsylvania` for one example.

duct a targeted advertising campaign based on search keywords for their online naloxone store at `www.naloxoneexchange.com`. We leveraged the company's advertising campaign to implement a pre-registered randomized controlled trial (AEARCTR-0005333) that varied the price and information content of advertisements displayed across 2,204 counties. Sales through Script Health were and remain low overall. However, by connecting ads to search, the campaign targeted individuals with some demonstrated interest in the advertised product, naloxone. This helped address the "statistical power problem" typical of many online ad campaigns (Lewis and Rao, 2015; Johnson et al., 2017), providing a reasonable basis for estimating the effect of advertising on naloxone purchases.[7]

While this paper sheds light on the role of price and messaging in naloxone purchases, it also contributes to the broader literature on the economics of advertising. Work on the effectiveness of pharmaceutical advertising, primarily direct-to-consumer television advertising, typically relies on quasi-experimental variation and demonstrates that advertising can increase prescription drug sales and utilization (Alpert et al., 2023; Sinkinson and Starc, 2019; Shapiro, 2018, 2022; Iizuka and Jin, 2005, 2007; Anderson et al., 2016; Avery et al., 2012).[8,9] Despite these findings, McGranaghan et al. (2022) find that people are more likely to leave the room during television advertisements for prescription drugs, suggesting important externalities on other advertisements (Wilbur et al., 2013). We are unaware of any work studying the impact of *online* pharmaceutical advertising on prescription drug sales. To our knowledge, our study is the first to analyze the impact of online advertising on prescription drug sales and the first to randomize advertising for a prescription pharmaceutical.

Studies of advertising for broader categories of products have demonstrated small or even negative returns to advertising, including both television advertising (Shapiro et al., 2021)[10] and internet search advertising Blake et al. (2015).[11] A series of field experiments on eBay, a very different setting than the one studied in this paper, demonstrated that while paid search ads generated no overall short-term benefits, they did increase sales to new and

[7]As detailed in Lewis and Rao (2015), because sales linked to a retailer's digital advertisements are typically quite volatile, estimating the impact of advertising on sales can be challenging without millions of data points.

[8]See Mukherjee et al. (2013) for an earlier review.

[9]Ellison and Ellison (2011) consider the decision to advertise among incumbents as patent expiration approaches.

[10]Bagwell (2007) provides a survey on the economic analysis of advertising, including what is known about the effectiveness of advertising.

[11]Liu-Thompkins (2019) provide a summary of the literature on the effectiveness of online advertising. Also see Lewis and Reiley (2014) and Goldfarb (2014).

infrequent buyers (Blake et al., 2015), consistent with findings in Ackerberg (2001). Tadelis et al. (2023) implemented field experiments on Facebook and Instagram, finding a high variance for the returns to advertising and an important role for learning-by-doing among advertisers. In the case of naloxone, where most consumers are likely to be new and infrequent users and information barriers may be large, paid search ads may be effective.

Our randomized design lends itself to studying the returns to advertising since a control group of counties received no paid search advertising. Across our treatment arms, we also varied the information content of online ads. Anderson and Renault (2006) and Anderson et al. (2013) consider why some advertisements include little information about the product, pointing to a trade-off between informative and persuasive content. We did not seek to persuade consumers but rather to test the value of including information content. We also studied the role of price and discounts in improving sales with online advertisements. In a different context, Sahni et al. (2017) evaluate the scope of targeted email advertisements with coupons to increase sales.

Specifically, we randomized counties where Script Health was licensed to sell naloxone to one of four types of search-generated advertisements or to no advertisements (control). Our base advertisement stated that the website permitted naloxone to be purchased online and shipped directly to the consumer and showed the full $110 cost of a naloxone kit ("base, $110"). In a second advertisement arm, we featured the same ad content but listed the naloxone kit for $20 ("base, $20"). The third advertisement arm listed the full $110 kit cost but contained a message that aimed to reduce stigma and provide information by highlighting that naloxone can be purchased for a friend or loved one and emphasizing the discreet nature of the purchase ("information/stigma, $110"). The final treatment arm featured the same ad content but with the $20 naloxone kit price ("information/stigma, $20"). While the advertisements specify the naloxone kit, the site sells other naloxone products, such as Narcan. Individuals in the counties receiving ads listing a $20 kit price were effectively given one $90 coupon that could be applied to any naloxone product purchased on the site.

We pre-registered outcomes related to both website visits, referred to as site users in Google Ads, and sales. Our examination of website users was motivated by several considerations. First, Script Health has a small market share and sales rates are low. Site users are more frequent, increasing power, and represent a proxy for potential interest in purchasing naloxone. Second, Script Health is required to provide information and ask a long series of questions prior to purchase, imposing a time burden and, at least the perception of, personal

information costs on the potential costumer. These non-monetary costs, which are themselves policy levers, could reduce sales in this setting. Thus, the number of unique site users relative to purchases provides some data on potential customers lost due to administrative and/or psychological burdens.

We find that in counties receiving any of the four advertisements, individuals were more likely to visit the Script Health website and purchased more naloxone. We find little evidence that messages emphasizing the reduced stigma of online purchasing further increased interest or sales. Rather, additional purchases are attributable primarily to the $90 coupon. Our estimates imply a price elasticity of -1.3, which suggests that online naloxone purchases are sensitive to price. We also find suggestive evidence that price primarily impacts people purchasing naloxone for themselves; purchases reported to be for friends, family members, or others were less price elastic.[12] Unfortunately, we were unable to determine whether these online sales represent additional purchases or whether they crowded out pharmacy sales. Because online sales are low, we are unlikely to be able to identify crowd-out in pharmacy data, a potential but very costly source of naloxone purchase data.

As the country searches for effective policy responses to the opioid crisis, we need a firmer understanding of mechanisms to improve naloxone uptake. These considerations have become more relevant as the FDA now permits Narcan, a branded version of naloxone, to be sold over-the-counter. Similarly, harm reduction options are constantly evolving to keep pace with changes to the opioid crisis. As concerns about the effectiveness of naloxone in response to overdoses involving increasingly potent fentanyl (Torralva and Janowsky, 2019; Coffin et al., 2022), new technologies are being developed, such as an intranasal nalmefene formulation, approved by the FDA in May 2023. These technologies are designed to operate similar to nasal naloxone but with the potential to work more effectively against synthetic opioids. As these innovations are approved and brought to market, many of the same concerns about access and distribution will emerge.

The rest of the paper proceeds as follows. We discuss naloxone and barriers to naloxone access in section 2. Section 3 presents our experimental design. Section 4 provides our results and section 5 concludes.

[12]This evidence is based on a question asking who the purchaser is intending that the naloxone product may potentially be used on.

2 Background

2.1 Naloxone and Barriers to Naloxone Access

Naloxone is a life-saving drug that can reverse an overdose as it is occurring. There are different formulations of naloxone, but the most common is Narcan, which was the first marketed non-injectable form of naloxone.[13] Narcan is an intranasal spray that can be administered with very limited training, in contrast to injectable formulations. Naloxone must be administered by another person,[14] but people misusing opioids may carry it in the hopes that someone else will access and administer the drug to them if they are overdosing. Naloxone products typically carry an expiration date of 18 to 24 months, though research has found that naloxone degradation is extremely slow and expired naloxone products are likely effective even years later (Pruyn et al., 2019). To stem the rise in opioid overdose deaths, both government and public health officials increasingly encourage people who know someone at risk of an overdose and even the general public to carry naloxone (Adams, 2018).

As of 2018, all US states and the District of Columbia have some form of naloxone access law (NAL) aimed at reducing barriers to naloxone dispensing, acquisition, and use (Smart et al., 2021). These policies generally address who can prescribe or dispense naloxone and under what conditions. A growing literature considers how state NALs alter naloxone dispensing (Smart et al., 2023; Xu et al., 2018; Gertner et al., 2018; Guy et al., 2019; Gangal et al., 2020) and downstream outcomes such as overdose deaths (Abouk et al., 2019; Rees et al., 2019; Lee et al., 2021; Doleac and Mukherjee, 2022; Erfanian et al., 2019; Tabatabai et al., 2023). Studies of NALs generally find that they increase naloxone distribution; evidence on downstream outcomes is more mixed, although studies tend to show increases in opioid-related emergency department visits, which is consistent with greater naloxone use, and reductions in overdose mortality (see Smart et al. (2021) for a review of the literature). While moral hazard effects of naloxone – that the availability of life-saving medication might increase opioid use – cannot be clearly ruled out, evidence to support it is relatively limited (Doleac and Mukherjee, 2022; Erfanian et al., 2019). Smart et al. (2021) conclude that most studies find that naloxone access reduces overdose mortality. A recent pragmatic trial of pharmacy-based co-prescribing of naloxone and opioid pain medications found no difference

[13] Prior to Narcan, some community groups would dispense naloxone with atomizers.

[14] There are rare cases of self-administration with some help from bystanders (Green et al., 2014).

in opioid risk behaviors (Binswanger et al., 2022).[15]

Although the legal environment has eased naloxone access, many barriers to take-up remain (Weiner et al., 2019). First, ethnographic research suggests that consumer concerns about stigma are major factors deterring purchase (Green et al., 2017). Potential consumers may be reluctant to purchase naloxone in a public setting that requires face-to-face interactions with pharmacists. Concerns about stigma partially motivated the FDA's recent decision to permit Narcan to be sold over-the-counter (OTC), which in principle will eliminate the need to interact with a pharmacist (Evoy et al., 2021). Some harm reduction experts worry that, in practice, many pharmacies will put Narcan in a locked glass box or continue to store it behind the pharmacy counter, thereby requiring customers to interact with staff to purchase the medication.[16] More broadly, stigma hinders treatment in many settings and for many conditions, such as HIV/AIDS (Katz et al., 2013; Mahajan et al., 2008), depression (Givens et al., 2007) and other mental illnesses (Corrigan et al., 2014; Henderson et al., 2013), alcohol disorders (Keyes et al., 2010), and opioid dependence (Cheetham et al., 2022; Corrigan and Nieweglowski, 2018).

Second, naloxone is expensive and cost is a commonly cited hurdle to pharmacy stocking (Spivey et al., 2020) and consumer purchase (Gupta et al., 2016; Rosenberg et al., 2018; Salvador et al., 2020; Walsh and Bratberg, 2021). Although naloxone itself is a generic drug, user-friendly delivery systems are not. A branded easy to use auto-injection device that delivers naloxone (Evzio) cost several thousand dollars during our study period, although it has since been discontinued. Even with coupons, naloxone nasal spray (Narcan) typically costs over $100 for a set of two.[17] In its announcement authorizing OTC sale of Narcan, the FDA explicitly urged the manufacturer to make the product available at an "affordable price" (FDA, 2023). Current co-pays for Narcan can be low or even zero for those with insurance. Since over-the-counter medications are not typically covered by insurance, however, FDA approval of Narcan for OTC sale could have the perverse effect of raising the cost for some potential customers.[18] Peet et al. (2022) report that the average out-of-pocket payment for naloxone products in 2018 was $250 for the uninsured, a population with an especially high

[15]Bruzelius et al. (2023) find no relationship between NAL adoption and adolescent heroin or injection drug use.

[16]See `https://www.nytimes.com/2023/03/29/health/narcan-over-the-counter.html`, last accessed April 27, 2023.

[17]See `https://www.goodrx.com/narcan`

[18]See `https://www.nytimes.com/2023/03/29/health/narcan-over-the-counter.html`, last accessed April 27, 2023

overdose death rate (Altekruse et al., 2020). Like co-pays and adherence to highly effective heart or diabetes medications, individuals may overweigh the immediate cost of naloxone, a drug they hope not to use, relative to the drug's life-saving potential. If subject to this type of "behavioral hazard" (Baicker et al., 2015), optimal policy design might directly subsidize naloxone purchases.

Third, information barriers may be significant. Individuals may not realize, for example, that they can purchase the medication with the intention of using it on someone else. A survey of laypersons receiving naloxone found that only 11.7% of recipients characterized themselves as friends or family members of persons using opioids compared to 81.6% reporting that they themselves used opioids (Wheeler et al., 2015). This disparity may partially reflect a lack of awareness that one can purchase and carry naloxone for the purpose of saving someone else's life. We can (imperfectly) assess this information gap by analyzing purchases for oneself versus purchases for someone else and whether such purchases respond differently to information ad content. In addition, some individuals may not realize they can purchase naloxone online at all. Although advertising can help inform people about online sales, the information may have been viewed with skepticism by some.

Finally, stocking of naloxone in brick and mortar pharmacies can be uncertain. Many audit studies, particularly ones published prior to 2020, find that less than half of pharmacies carry naloxone (e.g., Puzantian and Gasper (2018); Graves et al. (2019); Guadamuz et al. (2019); Lozo et al. (2019); Gilbert et al. (2021)). Other studies, particularly more recent ones, tend to find higher stocking rates (Evoy et al., 2018; Egan et al., 2020; Eldridge et al., 2020; Wu et al., 2020; Hill et al., 2021), though still below 70%.

A handful of papers study how out-of-pocket costs (measured indirectly or directly) to consumers affect naloxone purchases. Frank and Fry (2019) and Sohn et al. (2020) find that the Affordable Care Act (ACA) Medicaid expansions, which should have decreased out-of-pocket costs, increased naloxone purchases. Murphy et al. (2019) estimate a generalized structural equation model, jointly modeling naloxone dispensing and price. Exogenous variation in price is generated from time series variation in the number of naloxone manufacturers (as a measure of market competition) and the average producer price index for pharmaceutical preparation manufacturing (as a proxy for production costs). They estimate a demand elasticity of -0.27. The difficulty of estimating a price elasticity from observational data suggests the importance of revisiting this estimate.

During the COVID-19 pandemic, naloxone prescriptions decreased substantially

(O'Donoghue et al., 2021), although dispensing levels remained higher than in 2019 (Cremer et al., 2022). Importantly, at the start of the COVID-19 pandemic, fatal overdoses (Faust et al., 2021), non-fatal opioid overdose visits to the emergency department (ED) and opioid overdose calls for EMS service increased sharply in many parts of the US, despite a general decline in ED visits and EMS calls during this period (Ochalek et al., 2020; Slavova et al., 2020).

Our experiment took place during the pandemic. As an alternative measure of naloxone demand during this time period, we analyzed Google Trends searches for "Narcan," "naloxone," or "nalaxone" (a common misspelling). While people may search for these terms for a variety of reasons, we observe trends consistent with a decline in demand relative to before March 2020 in Figure 1. This decline persists through the end of our experiment before increasing sharply soon after. For the purposes of our experiment, this decline may reduce power but does not introduce bias.

2.2 Script Health

Our partner for this field work, Script Health, began as an online naloxone retailer in 2019. They expanded their reach over time as more states passed legislation that permitted the selling of naloxone without a formal prescription. Script Health does not itself provide naloxone but, instead, partners with local suppliers in each state. Orders are made on their website and the product is delivered within 2 days. To place an order, the consumer must supply basic demographic information, watch an instructional video about naloxone use, and provide additional health information. These steps are required by law. The product is then shipped in discreet packaging.

At the time of our experiment, Script Health could not accept insurance, which resulted in high out-of-pocket prices for many potential consumers. Thus, we observe the final price paid by all consumers. We launched our experiment on April 22, 2020.

3 Experimental Design, Data, and Methods

3.1 Experimental Design and Data

Our experiment was conducted in 38 states and 2,204 counties where Script Health was licensed to operate during the advertising campaign. Figure 2 provides the randomization

flowchart.[19] We randomly assigned counties to a control arm that did not receive advertisements[20] or one of four treatment arms that received advertisements, re-randomizing counties to improve balance on the opioid overdose rate (Banerjee et al., 2020) until differences in the mean and quintiles of the overdose rate across arms were sufficiently small. We randomized at the county level because it is not possible to directly identify or target individuals interested in naloxone through Google Ads. Individuals in a treatment county who searched Google for naloxone during the campaign period would have been exposed to one of our treatment advertisements.[21] Clicking on the advertisement would send the individual directly to the website shown in Figure A1.

Treatment Arm 1 consisted of our "baseline" advertisement and specified "$110 for Naloxone kit," which was the standard price for the most commonly purchased kit of 2 naloxone nasal atomizer sprays. Arm 2 consisted of the baseline advertisement but specified "$20 for Naloxone kit." Arm 3 included messaging about concern for a friend or loved one as well as emphasizing that the naloxone purchase would be shipped discreetly to the purchaser. The cost was listed at $110. Arm 4 included this same messaging but listed a price of $20. A sample ad for the "information/stigma, $110" arm is shown in Figure A2. Due to concerns about power, we did not separate the stigma and information content. Our "information/stigma" message content was motivated by the idea that many people are not aware about who can purchase naloxone or that it can be purchased by someone with no personal intent to misuse opioids. Thus, our message was meant to both briefly inform consumers about this possibility while also destigmatizing purchases by highlighting that they can be made out of concern for others.

Each "arm" consisted of four possible ads. The ads within an arm did not vary the price or general messaging. There was, however, some variation in ad copy *within* treatment arms. While the overall message was similar, we included four options with minor variations of the message. Google Ad's algorithm favors more effective ads, and Script Health required

[19] We originally randomized across the 40 states where Script Health planned to be operational. After initiating the campaign, our implementing partner informed us that the site was not yet operational in two of the 40 states (New York and Ohio), corresponding to 160 counties included in the original randomization (see Figure 2). Operation was delayed in these states for administrative reasons unrelated to the advertising campaign. North Carolina, where Script Health was operating, was excluded from the outset since they were running an independent campaign in several counties in the state in partnership with a local nonprofit.

[20] Script Health was not running other advertising campaigns at the same time so the control counties would not have seen any advertisements.

[21] Ad terms are pre-specified in the campaign and included terms such as "buy naloxone online discounted, narcan delivery, narcan delivered home." Narcan is the branded version of naloxone but is commonly used to refer to any version of naloxone.

use of this optimization feature, even if the possible gains were marginal. The variation in messaging for each arm is shown in Table A1 (for the baseline ad) and Table A2 (for the information/stigma ad), which provide the messaging inputs for the advertisements.

Treatment and control arms were well-balanced on the distribution of counties across quintiles of the sample opioid overdose rate as well as along several other dimensions (see Table 2). Specifically, we compared arms based on county urbanicity, share of the population White, share Black, and share Hispanic, the share ages 25-44 and the county opioid overdose rate (in addition to the quintile). Urbanicity was determined using the 2013 Rural-Urban Continuum Codes from the Office of Management and Budget (OMB) (Office of Management and Budget, 2020). Demographic information (race/ethnicity and age) were from the Surveillance, Epidemiology, and End Results (SEER) Program (Surveillance, Epidemiology, and End Results Program, 2022). The overdose rate was calculated from a geocoded, restricted version of the National Vital Statistics System (NVSS) Multiple Causes mortality files (CDC, 2022). We used opioid overdoses (by county of residence) for 2014-2018 scaled by total population (using SEER).

In no case can we reject the null that counties across arms were similar on any of these dimensions at the 5% level. We can reject the null at the 10% level that the distribution of the county share Hispanic was the same across arms but the quantitative difference across any two arms was small. Moreover, we cannot reject the null that all characteristics were jointly equal across all arms. A map – excluding Alaska and Hawaii (which were both included in the experiment) – of our treatment arms in Figure 3 shows that the treatments were not geographically clustered.

Our primary, pre-specified outcome was the quantity of naloxone products purchased within a county. A naloxone product is a Narcan nasal spray kit, injectable naloxone kit, or naloxone with nasal atomizer box. Individuals could purchase more than one product at a time, although the modal purchase was 1 (the maximum number in the data was 5).[22] With sample sizes of about 440 counties in each arm, assuming that a naloxone kit was purchased in 10% of counties in the control group and using standard assumptions of 80% power and a 5% level of significance ("alpha"), our study had a minimum detectable effect in arm by arm comparisons of 6.38 percentage points or about 26 kits off a base of 44 kits, equivalent

[22]We discuss later that we only observe the county in which the purchase was delivered, which may differ from the county in which it was purchased (i.e., treatment arm exposure).

to a 59% increase.[23]

As secondary outcomes, we considered and pre-specified website users, which are the number of unique Google cookies that visited the site during the study period. We also considered (but did not pre-specify) the number of unique buyers, purchases by naloxone brand, as well as sessions and new sessions. Sessions are similar to site users but end after 30 minutes of inactivity on a website. In this way, a site user can generate multiple sessions even within a relatively short period of time (>30 minutes). A new session is a session from a new user, meaning a user without a prior tracking cookie. Outcomes that were not pre-specified are considered exploratory.[24]

Website visits or users are often used as a surrogate outcome in the literature on online advertising (see the review in Liu-Thompkins (2019)). Our motivation for studying site users and related measures was that these outcomes, which are more common than purchases and thus comparatively well-powered, provide information on whether and by how much advertising draws traffic to the site. Treatment-driven changes in site users represent interest in online naloxone sales and have the potential to increase brand awareness and long-term sales, outcomes we cannot measure here but that contribute to the returns to advertising. Relatedly, the conversion to short-term sales may provide insight on the hassle costs of online naloxone sales. Primarily due to legal requirements, online naloxone purchases require input of a substantial amount of information, some of which may be considered private health information by potential consumers, and the playing of an informational video. These non-monetary costs, which are imposed by policy choices, may deter visitors from purchasing naloxone. Understanding the gap between interest in purchasing naloxone (users), a proxy for "potential sales," and actual sales may shed light on the cost of these choices.

We also analyzed data on product-specific purchases. Nasal naloxone kits, which include two doses of naloxone and an atomizer, are the most popular product and the one directly mentioned in the advertisement. However, the site sells and the coupons could also be used towards the purchase of Narcan, Injectable Naloxone Kits, and Evzio. Likely due to its price, there were no Evzio sales during our time period. The site also collects data on whom the buyer was purchasing the product for (i.e., who the product would be potentially used on in case of an overdose): "myself when using opiates," "for a family member, loved

[23]In the parametric equation (discussed below), the price effect had a minimum detectable effects of 3.98 percentage points.

[24]We also pre-specified as secondary outcomes both ad impressions and clicks but neither were captured by our implementing partner. Rather, they only tracked users, sessions, and new sessions.

one, or a friend who uses opiates or heroin," "to carry Naloxone as a bystander," or other. We characterize purchases as for "self" or for "other" (aggregating the latter three categories) and study the quantity of purchases in a county in which the buyer reported purchasing the product for themselves versus someone else. These outcomes, which were not pre-specified and thus are exploratory, may shed some light on the potential impact of information/stigma messaging and possible sources of heterogeneity in the price elasticity estimates. Notably, however, we cannot distinguish between the actual versus reported recipient of a purchase and our treatments could have affected reporting.

3.2 Analytic Approach

Our primary analysis, which was pre-registered prior to the receipt of any data, specified count models of the following form:

$$E[P_c] = F\left(\alpha + \beta_1 \mathbf{1}_c^{\text{base,20}} + \beta_2 \mathbf{1}_c^{\text{base,110}} + \beta_3 \mathbf{1}_c^{\text{info,20}} + \beta_4 \mathbf{1}_c^{\text{info,110}}\right), \tag{1}$$

where P_c, our primary outcome, is the quantity purchased within a county over the treatment period and $\mathbf{1}_c^{\text{base,20}}$ and $\mathbf{1}_c^{\text{base,110}}$ are indicators for counties randomized to receive the basic ad and a \$20 price or \$110 price, respectively. Analogous indicators are included for counties randomized to the information/stigma treatment with coupon or no coupon. Our parameters are estimated relative to control counties, which did not receive any advertising. To gain power, we pre-specified a pooled model of the effect of any advertising and advertising with the reduced price:

$$E[P_c] = F\left(\alpha + \gamma_1 \mathbf{1}_c^{\text{any ad}} + \gamma_2 \mathbf{1}_c^{\text{any ad,20}}\right), \tag{2}$$

where $\mathbf{1}_c^{\text{any ad}}$ is an indicator equal to 1 if the county received any type of advertisement; $\mathbf{1}_c^{\text{any ad,20}}$ is equal to 1 if the advertisement included the \$20 price instead of the \$110 price.

We estimated these specifications using Poisson regression (i.e., $F(\cdot) = \exp(\cdot)$), given the robustness of Poisson, which only requires correct specification of the conditional mean without additional distributional assumptions (Wooldridge, 1999; Santos Silva and Tenreyro, 2006).[25] We estimate heteroscedastic-robust ("Huber-White") standard errors (White, 1980).

[25] Alternative estimators (e.g., negative binomial regression) require additional assumptions related to the form of conditional heteroskedasticity.

In exploratory analysis, we estimated models with county-specific control variables (2014-2018 opioid overdose rates, quintiles of the overdose rate, share White, share Black, share Hispanic, share ages 25-44, urbanicity) and, separately, state fixed effects. The control variables were included primarily to increase precision. The value of state fixed effects is that they control flexibly for state policies and unobserved factors and allow us to leverage our within-state variation.

4 Results

4.1 Descriptive Statistics

The Script Health advertising campaign resulted in 187,232 impressions across the four treatment arms. We present summary statistics on site users and purchases in Table 1 and totals by treatment arm in Table A3. Naloxone sales and website users for Script Health are low. This site is still establishing itself; most people are likely unaware they can purchase naloxone online. In counties with no ads, we observe an average of 4 site users during our time period and an average of 0.13 products purchased, corresponding to the purchase of 56 kits across all control counties. The treatment arms had much higher rates of each of these outcomes. Counties receiving advertising had between 7 and 12 site users and 0.18 and 0.34 products purchased during the study period, corresponding to between 77 and 149 kits purchased per treatment arm. We observe especially high numbers of both site users and products purchased for the baseline advertisement with the $20 price. Counties assigned to the base ad with the $20 price highlighted had 12.2 site visits and 0.34 purchases over the study period, corresponding to a total of 149 kits sold across all counties in this arm.

An important point to note from Table 1 is that coupon use is observed in every arm. As expected, it is highest in the "Base Ad, $20" and "Information/stigma Ad, $20" arms, the only two arms randomized to ads with coupons, but some purchases in the control and non-coupon treatment arms are made with coupons. There are a variety of reasons this might have occurred. First, we can only link purchases to treatment arms based on where a product was shipped while some purchases may have been made in coupon counties but sent to non-coupon counties. Second, individuals may have reached the Script Health site while using an internet-enabled device in a coupon county. Consistent with the idea that rates of observing ads with the $20 price should be much starker in the targeted treatment arms, there are nearly four times as many purchases with coupons in the $20 arms compared to the

other arms. If we assume that the rate of purchase with a coupon conditional on seeing an ad with a $20 price is the same across arms, which should hold due to randomization, then people who would purchase and ship naloxone to a treated county were nearly four times as likely to observe an advertisement with a coupon.

Estimates from equation 1 and 2 with the number of coupons as the outcome are provided in Table A4. Counties with ads specifying a $20 price had substantially higher (and statistically significant) rates of coupon use. Ultimately, we conduct an intention-to-treat analysis, where purchases are linked to treatment and control arms based on assignment status. To the extent that coupons were available to individuals in non-coupon counties, our estimates should be treated as lower bounds. These concerns should not impact the results concerning site visits and users. We discuss this issue further in Section 4.4.

4.2 Main Results

We study the relationship between the treatments and our main outcomes–site users and naloxone purchases–more formally in Table 3. The first column shows results from the basic pre-specified equation (1) regression. The second column adds controls. Because results are similar across models, we focus on our pre-specified results in column 1. For "Base Ad, $20", we estimate a coefficient of 1.08, implying that this treatment increased the number of site users by 194% relative to control, i.e., counties not receiving any Script Health Google advertisements.[26] This treatment had the largest point estimate of the four treatment arms. For the "Info/stigma, $20" arm, we estimate an increase in site users of 72%. Estimates for the "Base Ad, $110" and "Info/stigma $110" imply increases in users of 89% to 101%, respectively. Table 2 also includes the results of tests of pairwise comparisons for the four treatment arms in Panel B. In terms of the impact of ads on users, we cannot statistically reject that any two of the treatment arms generate the same increase in users.

In Columns 3 and 4, we parameterize the treatment arms to isolate the effect of the price difference in the arms offering the reduced price, first without and then with controls. We find that advertising increased the number of site users, but as suggested by the less parametric specification, we do not observe a statistically significant price effect. Based on the pre-specified model in column 3, the advertising effect (without the coupon effect) is statistically significant from zero and implies that counties with ads had 95% more site users than the control counties, equivalent to about 3.3 more users per county.

[26] We report $100 \times \big(\exp(\beta) - 1\big)$ % throughout the text.

We explore quantity purchased in Columns 5-8, with odd columns including the pre-specified models and even columns adding controls. We again observe the largest increases in the "Base Ad, $20" treatment arm. The Column 5 estimate implies a 167% increase in sales, equivalent to an increase of about one additional sale for every 5 counties or 93 more kits purchased across all counties in this treatment arm. This treatment arm's effect on sales is statistically different from both treatment arms advertising $110 naloxone kits at the 10% level (5% when controls are included in the model). The second biggest estimate is for the "Info/stigma, $20" treatment arm, which implies a 96% increase in sales, suggesting an important role for the price reduction in driving sales. When we estimate our more parametric model (Columns 7-8), we find similar evidence that sales are quite sensitive to price. Based on the pre-specified model, the price reduction increased sales by 64%. The estimate with controls is similar (70%) and both estimates in Columns 7 and 8 are statistically different from zero at the 5% level. While the estimated effects of advertising on the quantity purchased are positive and range from about 28 to 42%, neither is statistically different from zero. Results from models that include state fixed effects to control, for example, for differences in state opioid policies are generally similar (see Table A5).

We study complementary outcomes in Table A6. Similar to the results for site users, we find large effects of advertising on the number of sessions and the number of new sessions, but less evidence of price effects on these dimensions. These results imply that search engine advertising, rather than coupons, generates traffic to the Script Health website. Since ads are directly tied to product search, it should not be surprising that sessions respond more to advertising than price.

We study the number of buyers in columns 9-12 of Table A6. Similar to the estimates for purchases, we find large price effects and positive but smaller and imprecise advertising impacts. The number of buyers increased by about 80% in response to the reduced $20 price. The estimates are larger, although not statistically different, for the number of buyers than for the quantity purchased, suggesting that the coupons worked primarily by increasing the number of buyers to the site and that the marginal buyers induced by coupons were even more likely than those induced by advertising alone to purchase one product.

4.3 Results by Product and Consumer Type

In Table 4, we present results for purchases by product type. While the ads listed the price ($20 or $110) of a Nasal Naloxone Kits, consumers could buy any product. Those offered a

$20 Nasal Naloxone Kit were effectively given a $90 coupon to be used on the site. We find evidence of important price effects for both Narcan and Nasal Naloxone Kits. The estimates (Columns 2 and 4) imply sales increases of 71% and 113%, respectively, due to the reduced price. We find no evidence of equivalent impacts for injectable naloxone kits, which are somewhat more effective than the intranasal version but require a higher level of training to use (Dietze et al., 2019). Demand for this product appears relatively inelastic to price and messaging, although the estimates are noisy.

In Table 5, we evaluate purchases based on whom buyers reported purchasing naloxone for — self or other (as defined in Section 3.1). With the caveat that our experiment is not designed to test whether price changes whom one purchases naloxone for, there are two notable findings in Table 5. First, the number of purchases for self (Column 3) is more price elastic than the number of purchases for others (Column 7). In fact, we cannot statistically reject that purchases made for others are insensitive to price.

Second, a comparison of the results for the baseline ad relative to the information/stigma ad in Column 1 of Table 5 suggests that the messaging may have decreased the number of full price purchases for self. In contrast, as shown in Column 5, the information/stigma ad increased the number of full price purchases for others (though the differences relative to the base advertisements are not statistically significant). This pattern at least suggests that the messaging provided new information to some that naloxone could be purchased to save the life of someone else. On the other hand, by emphasizing the discreet nature of the purchase, the messaging may have heightened stigma for those who would have otherwise purchased naloxone for themselves, possibly decreasing sales to this group. Since the differences across the baseline and information/stigma arms (holding price constant) in Table 5 are never statistically significant, however, this evidence is merely suggestive.

Furthermore, because these data are self-reported, the information/stigma messaging might have caused some customers who would have purchased naloxone even without the messaging to report that they were purchasing for others. Although we cannot rule out this possibility, we suspect that it is not the main channel since the messaging did not change the incentive to answer this question in a specific way and the available answers to this multiple-choice question did not vary across arms. If these customers had previously been unaware that they could purchase naloxone on behalf of someone else, then they would have learned so while answering this question. Thus, the point estimates are also consistent with the ads providing new information to potential consumers that naloxone can be purchased to

save someone else's life during an opioid overdose and increasing sales for that reason.

4.4 Elasticity Estimates

In this section, we discuss translating our regression estimates into price elasticities. To estimate the true price elasticity, we need to know the prices faced by everyone, including those who did not make a purchase. Unfortunately, we do not directly observe who saw an ad with (or without) a coupon since we only observe where naloxone was shipped, not the county/treatment arm where a buyer or potential buyer saw (or would have seen) an advertisement. Consequently, purchases may be assigned to an "observed treatment arm" that differs from "true treatment arm." It is, however, straightforward to calculate an "intention-to-treat" price elasticity based on the following transformation of the parameter estimate of the impact of price on quantity purchased from regression equation (2):

$$\text{Price Elasticity} = \frac{\exp\left[\hat{\gamma}_2\right] - 1}{-90/110}.$$

Based on the "intention-to-treat" estimate from Table 3, Column 7, the implied elasticity is -0.78. Since this calculation assumes no spillovers, however, it serves as a lower bound elasticity estimate.

To estimate the true elasticity, we must estimate the difference in observed prices, which requires an estimate of the probability that a person saw a coupon based on the arm in which his/her purchases were observed. Thus, we want to know two parameters:

$$\gamma \equiv P(\text{Saw Coupon}|\text{Purchases Made in Coupon Arm}),$$
$$\delta \equiv P(\text{Saw Coupon}|\text{Purchases Made in Non-Coupon Arm}),$$

where "Coupon Arm" is either of the two arms advertising \$20 prices and "Non-Coupon Arm" is any of the three arms not advertising \$20. Per our data, the parameters above condition on the treatment arm based on county of *purchase* – i.e., where the purchases were sent (or would have been sent if a purchase were made) – not the actual treatment experienced by the person.

From the summary statistics (Table 1), we know that "Coupon Arm" counties had 0.185 coupon purchases while "non-coupon counties" had 0.054. We assume that the purchase rate, conditional on observing a coupon, is the same across arms such that

$P(\text{Purchase Naloxone}|\text{Saw Coupon}) = c$ for all arms of the experiment. This should hold due to randomization. Under this assumption, the frequency of purchases made with coupons provides the relative rate of observing coupons such that:

$$\gamma = \frac{0.185}{0.054}\delta. \tag{3}$$

There is misalignment between treatment arm assignment and actual treatment, i.e., whether or not an individual had access to a coupon. We assume that the probability of seeing an unassigned ad, is equal within and across all arms such that

$$\begin{aligned} &2 \times P(\text{Did Not See Coupon}|\text{Purchases Made in Coupon Arm}) \\ &= 3 \times P(\text{Saw Coupon}|\text{Purchases Made in Non-Coupon Arm}), \end{aligned} \tag{4}$$

In addition, there is the identity:

$$\begin{aligned} &P(\text{Saw Coupon}|\text{Purchases Made in Coupon Arm}) \\ &+P(\text{Did Not See Coupon}|\text{Purchases Made in Coupon Arm}) = 1. \end{aligned} \tag{5}$$

Combining equations (4) and (5): $2 \times [1 - \gamma] = 3 \times \delta$.

Equation (4) accounts for the fact that there are more non-coupon counties than coupon counties (3 non-coupon arms, 2 coupon arms). We have two equations, equation (3) and equation (4), and two unknown parameters. Solving, we get $\delta = 0.20, \gamma = 0.70$.

These parameters imply that the average price difference experienced by individuals in (observed) \$20 treatment arms relative to \$110 arms is $0.70 \times \$20 + 0.30 \times \$110 - \big(0.20 \times \$20 + 0.80 \times \$110\big) = -\$45$. Our main, pre-specified estimate of the impact of a coupon on sales is 0.492 (see Table 3, Column 7), implying an elasticity estimate of $\frac{\exp(0.492)-1}{-\$45/\$92} = -1.3$, where \$92 is the average price in the non-coupon counties.

Thus, we find that online naloxone purchases are very responsive to price. Our "intention-to-treat" estimate implies an elasticity of -0.78 and represents a lower bound. If we adjust for the use of coupons in the "non-coupon counties," then we estimate an elasticity of -1.3 under reasonable assumptions.

5 Discussion

Widespread naloxone access is considered crucial to reversing worsening trends in opioid overdose mortality. Despite a substantial easing of legal barriers to naloxone access, naloxone purchases by individuals remain uncommon. Research to understand the causes of low purchase rates is also quite limited.

This work studies a potentially important channel for improving naloxone access – online sales. An online naloxone retailer offers an interesting solution to some of the potential barriers to naloxone use by reducing the need for face-to-face encounters and establishing a national market. We partnered with the country's only online naloxone retailer as the company began selling in markets across the United States. While online sales were low due to the nascency of this market, our interventions still increased site users and sales.

While online purchasing eliminates some barriers to access, it also imposes other ones. It requires internet access and a place to send the naloxone (i.e., stable housing). It also involves a short delay between purchase and receipt of the naloxone. More generally, price sensitivity for online purchases may not generalize to price sensitivity for in-person settings. Our work provides evidence on the price elasticity of naloxone but it is worth noting that our setting is unique and thus our estimates may differ from pharmacy-specific elasticities. Since people may not realize that naloxone can be delivered by mail, some people may have ignored the advertisements under the assumption that they were not legitimate. If these people differ systematically from those who did respond to the ads, then the elasticity might change as people become more accustomed to online naloxone purchasing.

With these caveats in mind, we find that advertising does matter for this market, potentially because most people are unaware of the existence of online naloxone sales. Advertising increased site users, though the evidence is weaker that it independently increased sales, consistent with work demonstrating small or even negative returns to advertising (Blake et al., 2015; Shapiro et al., 2021). In the current setting of a new market, however, building "brand" awareness may be an important, unmeasured, benefit of advertising. We find little evidence that providing information and addressing stigma, on average, increased site visits or sales. This result is, of course, only relevant to the manner in which we operationalized it. Alternative ads to address stigma and information gaps may be more effective, but due to power concerns, we limited the number of treatment arms in the experiment. We find suggestive evidence that the information content increased purchases made with the intent

of trying to save someone else from an overdose. We find clear evidence that advertisements accompanied with a price decrease have large effects on sales, consistent with findings in Sahni et al. (2017).

Our findings make clear that price is a key barrier to naloxone purchases. Our preferred elasticity from our pre-registered specification, but adjusted for coupon use in non-coupon counties, is -1.3. This estimate implies that a 10% reduction in price would increase naloxone purchases by 13%. To the extent that the low rate of purchase of naloxone is suboptimal (e.g., due to behavioral hazard or high prices interacting with borrowing constraints), reducing the out-of-pocket costs would improve welfare. We find suggestive evidence that purchases for oneself are more price elastic, which would indicate scope for addressing behavioral hazard inefficiencies. On the flip side we find suggestive evidence that the number of naloxone purchases for others is relatively price inelastic, implying less latitude for subsidizing positive spillovers in this manner. However, this conclusion implicitly assumes that whom one purchases for (oneself versus others) does not change in response to price, which may not be true.

Although naloxone is highly effective at reversing opioid overdoses (Boyer, 2012) and public access to naloxone has been promoted by multiple presidential administrations (The White House Office of the Press Secretary, 2016, 2019, 2021), naloxone purchases remain low. Price is often cited as a key barrier to naloxone purchase, although few policies or proposals directly address the cost of naloxone.[27] Our work suggests that consumer price reductions could greatly expand naloxone uptake. Because we cannot observe other pharmacy purchases, however, it is possible that purchases on our site at least partially substitute for purchases that would have been made elsewhere. How purchases translate to ultimate naloxone use is beyond the scope of the current study but is an important area for future research.

[27] See `https://www.washingtonpost.com/opinions/one-easy-cost-free-thing-trump-can-do-to-ease-the-opioid-crisis/2018/06/11/16165efa-69a9-11e8-9e38-24e693b38637_story.html`.

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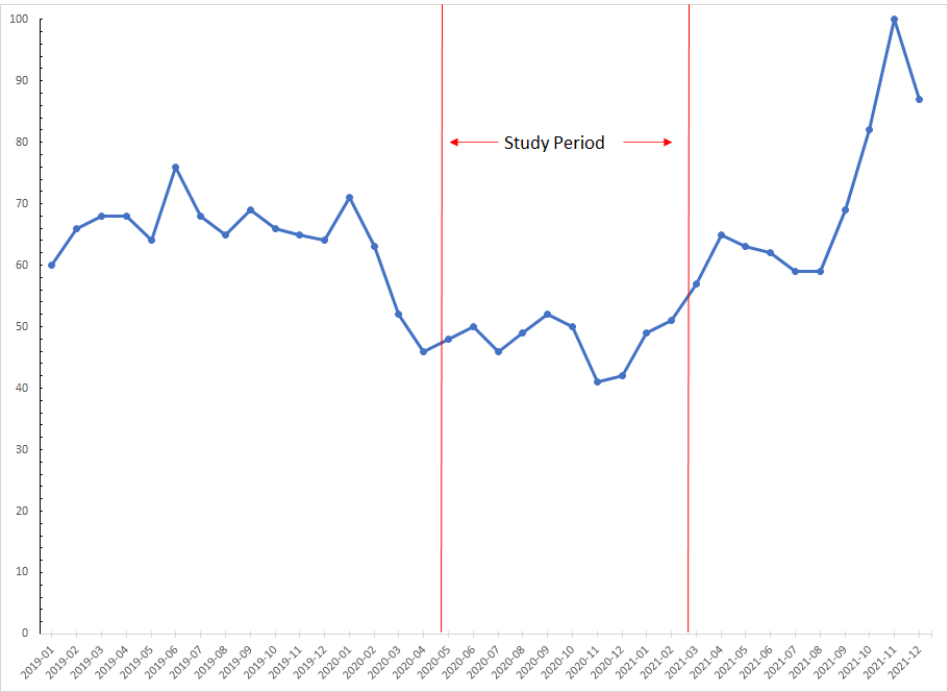
Figures

Figure 1: Google Searches (Normalized to 100 at Peak)



Source: Google Trends
Notes: The y-axis is normalized to 100 by Google Trends at the highest value during the selected time period. The outcome is searches for "Narcan," "naloxone," or "nalaxone" (a common mispelling).

Figure 2: Randomization Flowchart

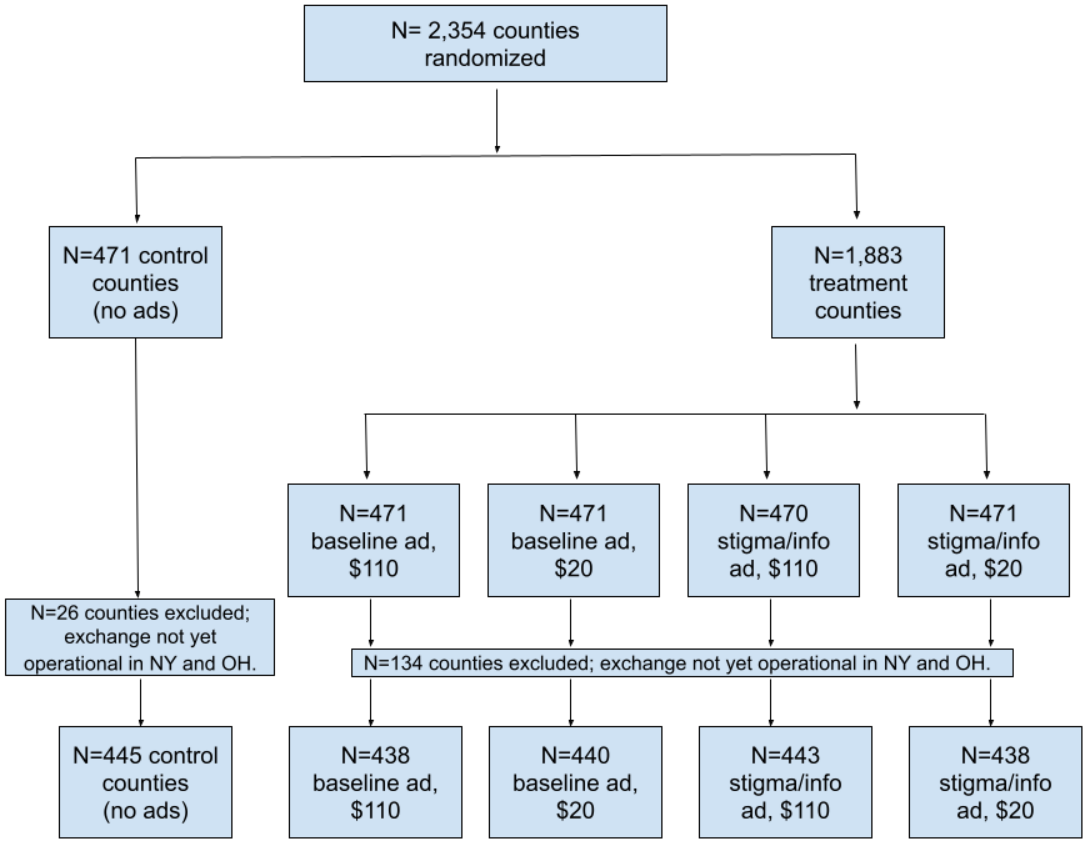
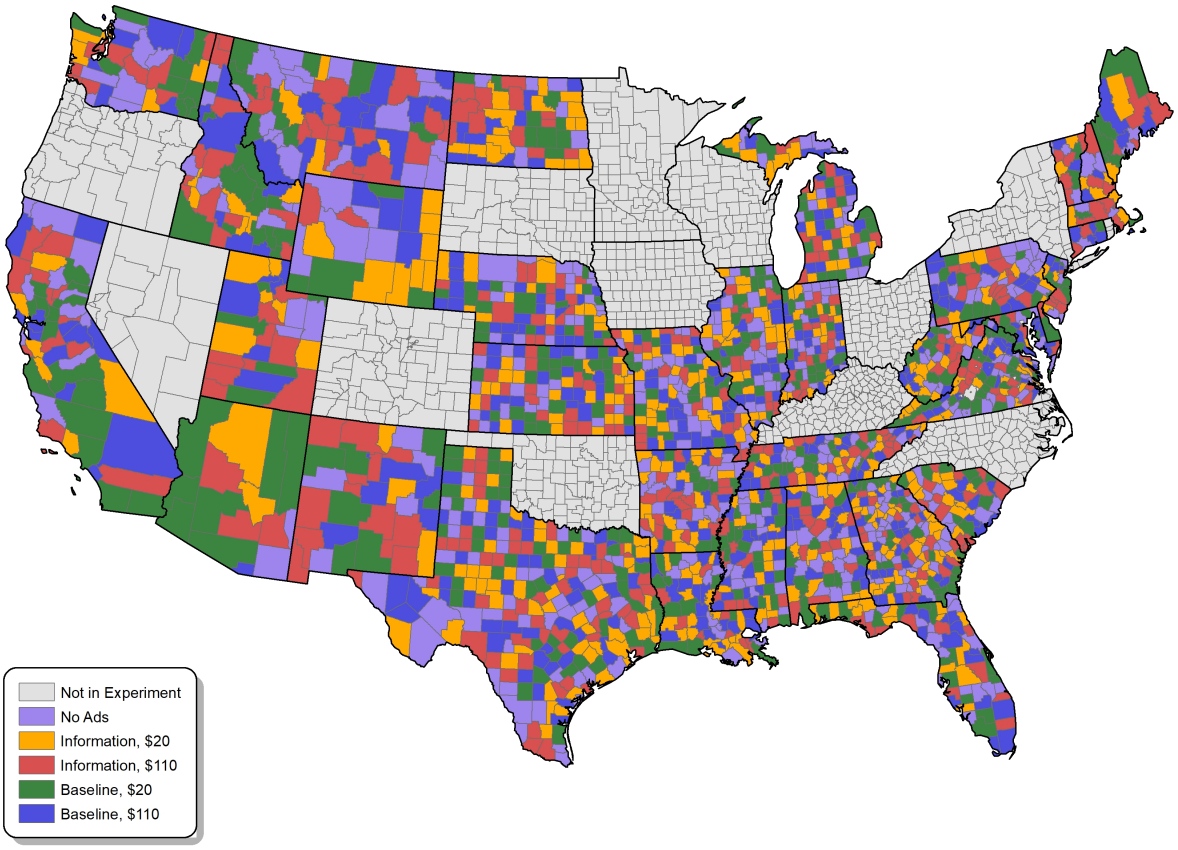


Figure 3: Continental United States County Treatment Status



Notes: Alaska and Hawaii are included in the experiment but are not shown here in order to simplify the map.

Tables

Table 1: Summary Statistics – County Averages

	Control Arm no Ads	Baseline Ad $20	Baseline Ad $110	Information/Stigma $20	Information/Stigma $110
Site Users	4.13	12.16	7.82	7.10	8.31
Quantity Purchased	0.13	0.34	0.18	0.25	0.18
Number of Buyers	0.11	0.32	0.14	0.22	0.15
Number of Coupons Used	0.06	0.23	0.05	0.14	0.05

Notes: County averages from April 22, 2020 to February 22, 2021. Quantity Purchased, Number of Buyers, and Number of Coupons Used are based on county that purchase was shipped to.

Table 2: Balance Across Treatment and Control Arms

	Control Arm no Ads	Baseline Ad $20	Baseline Ad $110	Information/Stigma $20	Information/Stigma $110	p-value H_0: Equality Over all Arms
Opioid Overdose Rate Distribution						
Quintile 1 (lowest)	0.229	0.173	0.215	0.187	0.196	0.243
Quintile 2	0.196	0.211	0.180	0.215	0.199	0.719
Quintile 3	0.218	0.209	0.176	0.194	0.203	0.567
Quintile 4	0.169	0.195	0.199	0.226	0.212	0.262
Quintile 5 (highest)	0.189	0.211	0.231	0.178	0.190	0.318
Opioid Overdose Rate (per 100,000)	8.1	8.9	9.3	8.8	8.7	0.336
Demographics						
Urbanicity	0.364	0.398	0.358	0.402	0.377	0.587
Share White	0.841	0.849	0.842	0.842	0.856	0.555
Share Black	0.119	0.109	0.117	0.121	0.103	0.335
Share Hispanic	0.111	0.112	0.105	0.093	0.121	0.086
Share ages 25-44	0.236	0.234	0.235	0.238	0.235	0.440

Notes: A joint statistical test across all of these variables results in a p-value of 0.336. Inference used heteroscedastic-robust standard errors. All variables are expressed in shares, except for the mean opioid overdose death rate. Overdose rates constructed using the 2014-2018 NVSS. Demographic information collected from SEER. Urbanicity is defined by the OMB.

Table 3: Main Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Main Estimates		**Site Users**				**Quantity Purchased**		
Any Ad			0.669***	0.519**			0.348	0.244
			(0.203)	(0.213)			(0.256)	(0.263)
$20 price			0.178	0.235			0.492**	0.530**
			(0.236)	(0.199)			(0.226)	(0.207)
Base Ad, $20	1.080***	0.932***			0.983***	0.888***		
	(0.302)	(0.288)			(0.332)	(0.324)		
Base Ad, $110	0.638***	0.519**			0.334	0.264		
	(0.234)	(0.225)			(0.298)	(0.297)		
Info/stigma, $20	0.542*	0.494*			0.673**	0.631**		
	(0.281)	(0.271)			(0.297)	(0.309)		
Info/stigma, $110	0.698***	0.519**			0.361	0.224		
	(0.257)	(0.259)			(0.290)	(0.291)		
Panel B: P-Values								
Base ad, $20=Base ad, $110	0.169	0.103			0.051	0.029		
Base ad, $20 = Info $20	0.132	0.136			0.349	0.376		
Base ad, $20 = Info, $110	0.260	0.150			0.056	0.021		
Base ad, $110 = Info, $20	0.749	0.917			0.255	0.173		
Base ad, $110 = Info, $110	0.829	0.999			0.926	0.879		
Info, $20 = Info, $110	0.624	0.928			0.281	0.138		
Mean of Untreated	4.13	4.13	4.13	4.13	0.126	0.126	0.126	0.126
Controls?	No	Yes	No	Yes	No	Yes	No	Yes
N	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204

Notes: *10%, **5%, ***1% statistical significance. Heteroscedastic-robust standard errors presented in parentheses. "Site Users" are number of unique Google cookies that visit the company's website. Panel A provides Poisson estimates from equation (1) in Columns 1, 2, 5, and 6; from equation (2) in Columns 3, 4, 7, and 8. Controls are the 2014-2018 opioid overdose rates, quintile dummies related to the opioid overdose rate, share Black, share White, share Hispanic, share ages 25-44, and urbanicity. Panel B shows p-values from statistical tests for the null hypothesis that the two listed estimates are equal.

Table 4: Results by Product Type (Quantity)

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Main Estimates	**Narcan**		**Nasal Naloxone Kits**		**Injectable Naloxone Kits**	
Any Ad		0.764		0.284		0.273
		(0.550)		(0.283)		(0.379)
$20 Price		0.537		0.758***		-0.098
		(0.327)		(0.239)		(0.345)
Base Ad, $20	1.543***		1.204***		0.107	
	(0.592)		(0.351)		(0.417)	
Base Ad, $110	0.827		0.052		0.454	
	(0.613)		(0.358)		(0.401)	
Info/stigma, $20	0.981*		0.847***		0.239	
	(0.578)		(0.311)		(0.547)	
Info/stigma, $110	0.698		0.470		0.053	
	(0.576)		(0.306)		(0.488)	
Panel B: P-Values						
Base ad, $20=Base ad, $110	0.135		0.002		0.352	
Base ad, $20 = Info $20	0.196		0.286		0.802	
Base ad, $20 = Info, $110	0.050		0.026		0.909	
Base ad, $110 = Info, $20	0.739		0.020		0.676	
Base ad, $110 = Info, $110	0.779		0.216		0.375	
Info, $20 = Info, $110	0.492		0.189		0.751	
Mean of Untreated	0.018	0.018	0.061	0.061	0.045	0.045

Notes: *10%, **5%, ***1% statistical significance. $N = 2{,}204$. Heteroscedastic-robust standard errors presented in parentheses. Panel A provides Poisson estimates from equation (1) in Columns 1, 3, and 5; from equation (2) in Columns 2, 4, and 6. No controls are included. Panel B shows p-values from statistical tests for the null hypothesis that the two listed estimates are equal.

Table 5: Results by Intent of Purchase

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Quantity (Self)				**Quantity (Other)**		
Panel A: Main Estimates								
Any Ad			0.149	0.025			0.649*	0.570*
			(0.295)	(0.308)			(0.337)	(0.343)
$20 price			0.673***	0.715***			0.227	0.258
			(0.259)	(0.242)			(0.258)	(0.252)
Base Ad, $20	1.045***	0.942***			0.851**	0.764*		
	(0.360)	(0.352)			(0.392)	(0.391)		
Base Ad, $110	0.189	0.102			0.568	0.519		
	(0.332)	(0.337)			(0.399)	(0.402)		
Info/stigma, $20	0.532	0.456			0.900**	0.893**		
	(0.342)	(0.346)			(0.400)	(0.435)		
Info/stigma, $110	0.107	-0.056			0.724**	0.615*		
	(0.354)	(0.360)			(0.362)	(0.362)		
Panel B: P-Values								
Base ad, $20=Base ad, $110	0.016	0.006			0.459	0.485		
Base ad, $20 = Info $20	0.160	0.130			0.898	0.716		
Base ad, $20 = Info, $110	0.013	0.003			0.710	0.638		
Base ad, $110 = Info, $20	0.309	0.255			0.394	0.326		
Base ad, $110 = Info, $110	0.815	0.625			0.657	0.771		
Info, $20 = Info, $110	0.236	0.143			0.615	0.430		
Mean of Untreated	0.083	0.083	0.083	0.083	0.043	0.043	0.043	0.043
Controls?	No	Yes	No	Yes	No	Yes	No	Yes
N	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204

Notes: *10%, **5%, ***1% statistical significance. Heteroscedastic-robust standard errors presented in parentheses. Panel A provides Poisson estimates from equation (1) in Columns 1, 2, 5, and 6; from equation (2) in Columns 3, 4, 7, and 8. Controls are the 2014-2018 opioid overdose rates, quintile dummies related to the opioid overdose rate, share Black, share White, share Hispanic, share ages 25-44, and urbanicity. Panel B shows p-values from statistical tests for the null hypothesis that the two listed estimates are equal.

Online Appendix

Price Sensitivity and Information Barriers to the Take-up of Naloxone
Mireille Jacobson and David Powell

Figures

Figure A1: Script Health Homepage

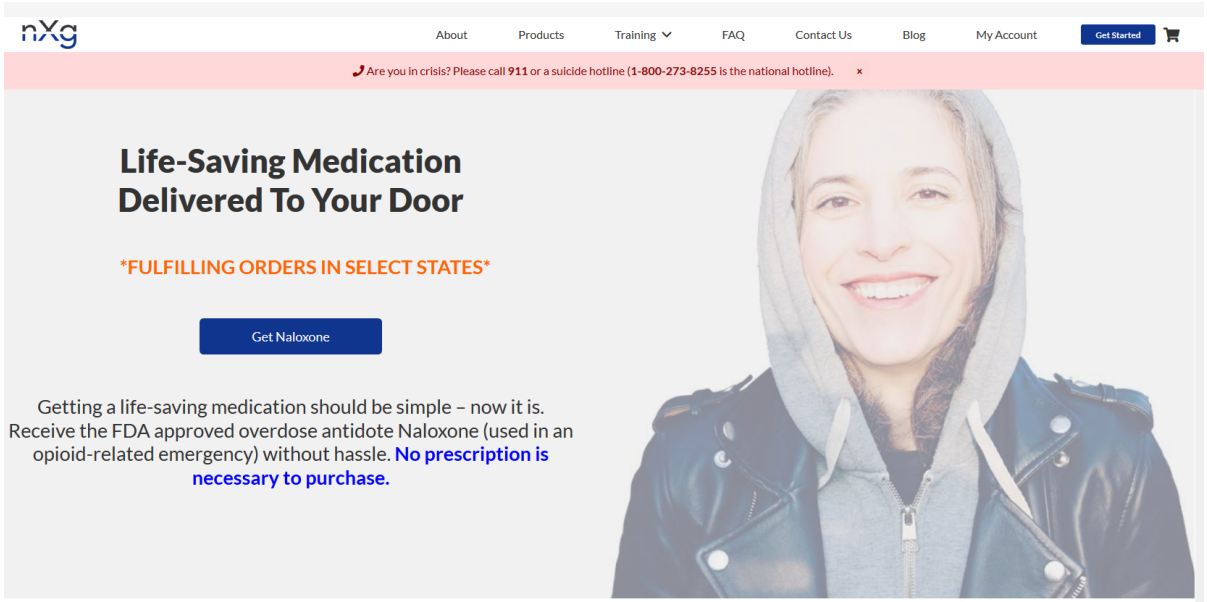
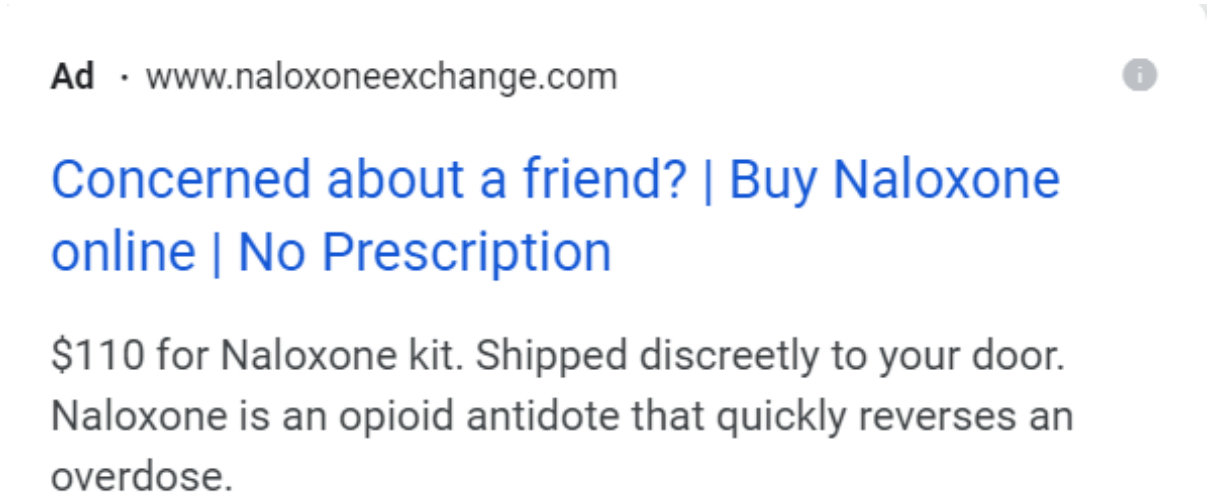


Figure A2: Sample Google Advertisement



Notes: This ad was part of the "information/stigma, $110" treatment arm.

Tables

Table A1: Variation in Wording for Baseline Advertisement

	Version 1	Version 2
Headline 1	Buy Naloxone online	Buy Naloxone online
Headline 2	No Prescription	No Prescription
Headline 3		Shipped to your door.
Description 1	Fast. $X for Naloxone Kit.	$X for Naloxone kit.
Description 2	Naloxone is an opioid antidote that quickly reverses an overdose.	Naloxone is an opioid antidote that quickly reverses an overdose.
Path (optional)		
Display URL	https://www.naloxoneexchange.com	https://www.naloxoneexchange.com
Final URL	https://www.naloxoneexchange.com/buy/	https://www.naloxoneexchange.com/buy/

	Version 3	Version 4
Headline 1	Naloxone Shipped to Your Door	Naloxone Shipped to Your Door
Headline 2	Buy Naloxone online	Buy Naloxone online
Headline 3	No Prescription	No Prescription
Description 1	Fast. $X for Naloxone Kit.	$X for Naloxone kit.
Description 2	Naloxone is an opioid antidote that quickly reverses an overdose.	Naloxone is an opioid antidote that quickly reverses an overdose.
Path (optional)		
Display URL	https://www.naloxoneexchange.com	https://www.naloxoneexchange.com
Final URL	https://www.naloxoneexchange.com/buy/	https://www.naloxoneexchange.com/buy/

Notes: Our "baseline" advertisement used one of the four versions above. Instead of the price amount, we include $X above, where X was either 20 or 110 (and randomized across arms). Google Ads optimizes the use of the four versions by favoring the versions generating more clicks. We permitted this within-arm optimization given the similarity of the messaging among the four versions.

Table A2: Variation in Wording for Information/Stigma Advertisement

	Version 1
Headline 1	Worried about a Loved One?
Headline 2	Buy Naloxone online
Headline 3	No Prescription
Description 1	Fast & Discreet. $X for Naloxone Kit.
Description 2	Naloxone is an opioid antidote that quickly reverses an overdose.
Path (optional)	
Display URL	https://www.naloxoneexchange.com
Final URL	https://www.naloxoneexchange.com/buy/

	Version 2
Headline 1	Worried about a Loved One?
Headline 2	Buy Naloxone online
Headline 3	No Prescription
Description 1	$X for Naloxone kit. Shipped discreetly to your door.
Description 2	Naloxone is an opioid antidote that quickly reverses an overdose.
Path (optional)	
Display URL	https://www.naloxoneexchange.com
Final URL	https://www.naloxoneexchange.com/buy/

	Version 3
Headline 1	Concerned about a friend?
Headline 2	Buy Naloxone online
Headline 3	No Prescription
Description 1	Fast & Discreet. $X for Naloxone Kit.
Description 2	Naloxone is an opioid antidote that quickly reverses an overdose.
Path (optional)	
Display URL	https://www.naloxoneexchange.com
Final URL	https://www.naloxoneexchange.com/buy/

	Version 4
Headline 1	Concerned about a friend?
Headline 2	Buy Naloxone online
Headline 3	No Prescription
Description 1	$X for Naloxone kit. Shipped discreetly to your door.
Description 2	Naloxone is an opioid antidote that quickly reverses an overdose.
Path (optional)	
Display URL	https://www.naloxoneexchange.com
Final URL	https://www.naloxoneexchange.com/buy/

Notes: Our "information/stigma" advertisement used one of the four versions above. Instead of the price amount, we include $X above, where X was either 20 or 110 (and randomized across arms). Google Ads optimizes the use of the four versions by favoring the versions generating more clicks. We permitted this within-arm optimization given the similarity of the messaging among the four versions.

Table A3: Raw Data by Treatment Arm

Campaign / Campaign ID	Users	Buyers	Units Sold	Coupons Used	Coupons Per User	Coupons Per Buyer
Baseline, $20 / 9772477619	5464	139	148	100	0.018	0.719
Information, $20 / 9778104942	3147	94	108	62	0.020	0.660
Baseline, $110 / 9772546310	3482	62	77	22	0.006	0.355
Information, $110 / 9778256808	3756	67	80	22	0.006	0.328
Control	1869	50	56	22	0.012	0.440

Notes: This table lists totals across all counties in each arm.

Table A4: Number of Coupons

	(1)	(2)	(3)	(4)
Panel A: Main Estimates		**Number of Coupons**		
Any Ad			-0.195	-0.324
			(0.318)	(0.322)
$20 Price			1.307***	1.337***
			(0.270)	(0.262)
Baseline, $20	1.321***	1.185***		
	(0.370)	(0.355)		
Baseline, $110	-0.189	-0.31		
	(0.404)	(0.405)		
Information, $20	0.847***	0.778**		
	(0.315)	(0.306)		
Information, $110	-0.200	-0.341		
	(0.343)	(0.348)		
Panel B: P-Values				
Base ad, $20=Base ad, $110	0.000	0.000		
Base ad, $20 = Info $20	0.156	0.150		
Base ad, $20 = Info, $110	0.000	0.000		
Base ad, $110 = Info, $20	0.005	0.002		
Base ad, $110 = Info, $110	0.977	0.937		
Info, $20 = Info, $110	0.001	0.000		
Mean of Untreated	0.061	0.061	0.061	0.061
Controls?	No	Yes	No	Yes
N	2,204	2,204	2,204	2,204

Notes: *10%, **5%, ***1% statistical significance. Heteroscedastic-robust standard errors presented in parentheses. Panel A provides Poisson estimates from equation (1) in Columns 1 and 2; from equation (2) in Columns 3 and 4. Controls are the 2014-2018 opioid overdose rates, quintile dummies related to the opioid overdose rate, share Black, share White, share Hispanic, share ages 25-44, and urbanicity. Panel B shows p-values from statistical tests for the null hypothesis that the two listed estimates are equal.

Table A5: Main Results with State Fixed Effects

	(1)	(2)	(3)	(4)
Panel A: Main Estimates	**Site Users**		**Quantity Purchased**	
Any Ad		0.457***		0.176
		(0.170)		(0.244)
$20 price		0.167		0.439**
		(0.170)		(0.192)
Base Ad, $20	0.817***		0.729***	
	(0.216)		(0.277)	
Base Ad, $110	0.399**		0.136	
	(0.181)		(0.268)	
Info/stigma, $20	0.328		0.462	
	(0.240)		(0.294)	
Info/stigma, $110	0.504**		0.209	
	(0.214)		(0.280)	
Panel B: P-Values				
Base ad, $20=Base ad, $110	0.055		0.027	
Base ad, $20 = Info $20	0.055		0.314	
Base ad, $20 = Info, $110	0.158		0.035	
Base ad, $110 = Info, $20	0.766		0.223	
Base ad, $110 = Info, $110	0.620		0.773	
Info, $20 = Info, $110	0.502		0.348	
Mean of Untreated	4.130	4.130	0.126	0.126
Controls?	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes
N	2,204	2,204	2,204	2,204

Notes: *10%, **5%, ***1% statistical significance. Heteroscedastic-robust standard errors presented in parentheses. "Site Users" are number of unique Google cookies that visit the company's website. Panel A provides Poisson estimates from equation (1) in Columns 1 and 3; from equation (2) in Columns 2 and 4. Controls are the 2014-2018 opioid overdose rates, quintile dummies related to the opioid overdose rate, share Black, share White, share Hispanic, share ages 25-44, and urbanicity. State fixed effects also included. Panel B shows p-values from statistical tests for the null hypothesis that the two listed estimates are equal.

Table A6: Other Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: Main Estimates		**Sessions**				**New Sessions**				**Number of Buyers**		
Any Ad			0.690***	0.541**			0.561***	0.415**			0.265	0.140
			(0.201)	(0.213)			(0.189)	(0.181)			(0.247)	(0.251)
$20 Price			0.203	0.260			0.025	0.079			0.595***	0.628***
			(0.235)	(0.197)			(0.193)	(0.158)			(0.223)	(0.201)
Baseline, $20	1.115***	0.968***			0.782***	0.643***			1.034***	0.912***		
	(0.301)	(0.289)			(0.253)	(0.232)			(0.323)	(0.312)		
Baseline, $110	0.651***	0.533**			0.558**	0.437**			0.231	0.131		
	(0.234)	(0.227)			(0.223)	(0.200)			(0.293)	(0.286)		
Information, $20	0.606**	0.558**			0.341	0.291			0.647**	0.580**		
	(0.279)	(0.268)			(0.242)	(0.225)			(0.280)	(0.278)		
Information, $110	0.726***	0.547**			0.564**	0.394*			0.297	0.145		
	(0.255)	(0.257)			(0.228)	(0.214)			(0.279)	(0.277)		
Panel B: P-Values												
Base ad, $20=Base ad, $110	0.150	0.087			0.406	0.326			0.016	0.006		
Base ad, $20 = Info $20	0.153	0.157			0.122	0.137			0.227	0.226		
Base ad, $20 = Info, $110	0.250	0.142			0.425	0.268			0.021	0.006		
Base ad, $110 = Info, $20	0.881	0.918			0.403	0.483			0.150	0.077		
Base ad, $110 = Info, $110	0.788	0.950			0.982	0.828			0.819	0.956		
Info, $20 = Info, $110	0.705	0.969			0.397	0.650			0.203	0.081		
Mean of Untreated	5.124	5.124	5.124	5.124	3.342	3.342	3.342	3.342	0.112	0.112	0.112	0.112
Controls?	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204	2,204

Notes: *10%, **5%, ***1% statistical significance. Heteroscedastic-robust standard errors presented in parentheses. Panel A provides Poisson estimates from equation (1) in Columns 1, 2, 5, 6, 9, and 10; from equation (2) in Columns 3, 4, 7, 8, 11, and 12. Controls are the 2014-2018 opioid overdose rates, quintile dummies related to the opioid overdose rate, share Black, share White, share Hispanic, share ages 25-44, and urbanicity. Panel B shows p-values from statistical tests for the null hypothesis that the two listed estimates are equal.