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ABSTRACT

As recreational marijuana laws (RML) expanded marijuana access over the last decade, very little is known about the impact of RML on two costly social behaviors that may arise as a consequence of marijuana consumption: unhealthy eating (i.e. munchies) and sedentary lifestyle (i.e. couch-lock). Using NielsenIQ Consumer Panel data, we find that the passage of RML led to an increase in the number of grocery store trips that involved "junk food", as well as the amount of spending. This effect is particularly driven by an increase in ice cream, chips, and candy. Using the Behavioral Risk Factor Surveillance System (BRFSS) and the American Time Use Survey (ATUS), we find that the passage of RML also led to a decrease in exercise, particularly driven by a reduction in cardio, and suggestive evidence of more time spent at home. These results suggest that RMLs have an adverse effect on health through unhealthy eating and reduced physical activity, posing a significant public health challenge to diet and lifestyle-related chronic conditions.

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1 Introduction

While still classified as a Schedule I controlled substance at the federal level, state-level policies have increasingly enabled the use of marijuana for medical and recreational purposes. Medical marijuana laws (MML), which first passed in California in 1996, were soon followed by recreational marijuana laws (RML) with Colorado and Washington as the first states to adopt in 2012. Since then, several states and the District of Columbia have adopted RMLs, which fully legalize all components of the marijuana market (production, sale, possession, and consumption) for individuals of age 21 and older, without requiring proof of medical need. Table 1 provides a detailed breakdown of each state's MML and RML dates, effective through 2023.[1] Recent RML expansion is accompanied by growing support for marijuana legalization, which has doubled from 34 percent support in 2001 to 68 percent by 2021 (Gallup 2022), and an increase in marijuana consumption over time (Herrington 2023; Substance Abuse and Mental Health Services Administration 2022; Steigerwald et al. 2020). As the legal landscape of recreational marijuana consumption has drastically changed since 2012 and access is rapidly expanding, it has become crucial for policy makers to gain a better understanding of potential consequences on health.

Though some studies have evaluated the impact of MML on health and health behaviors,

[1]The dates in Table 1 were constructed from three online sources, often requiring validation between sources: (1) websites produced by marijuana advocacy groups (www.norml.org) or information providers focused on marijuana policy (www.mpp.org); (2) national or local news sources identifying law passage or momentous events such as the start of recreational sales; and (3) direct legal documentation (https://www.legislature.mi.gov/documents/2019-2020/publicact/pdf/2020-PA-0192.pdf) or agency websites of those responsible for legalizing, licensing, or regulating marijuana (e.g., https://legislature.maine.gov/9419). We also cross-referenced these dates with other academic sources researching medical and recreational marijuana (e.g., Powell et al. 2018 and Anderson and Rees 2023); however, there are notable differences between our dates and these other academic sources. Two key sources of difference between previous research include the extension of time and labeling (e.g., we separately identify MML effective and sales start dates).

In addition to time and labeling, differences in dating may be attributed to the interpretation of legal gray areas. For example, we identify RML sales in Washington DC starting with effective RML. While the exchange of money for marijuana was prohibited and there existed no regulatory system for marijuana in DC, transfers of up to an ounce of marijuana were legal. These transfers included small "gifts" of marijuana that could be provided with the purchase of other items. When there were clear start dates for licensing and regulatory systems for providing marijuana, we opted for official sales start dates despite lags between effective and sales dates (e.g., California, Colorado, Hawaii, Michigan, Nevada, and Oregon).

RML provides a novel opportunity to create generalizable estimates, as it targets a healthy adult population. While increased appetite (i.e., "the munchies" − a popular, colloquial term describing a common side effect from marijuana consumption) is a desired outcome among cancer patients undergoing chemotherapy, among HIV patients facing wasting syndrome, and anorexia patients, this increase in appetite may lead towards unhealthy and frequent eating among recreational users, which has negative public health consequences.[2] Similarly, sleepiness (i.e., "couch-lock" − another popular colloquialism describing a side effect of marijuana consumption) may be a desired outcome among individuals who are diagnosed with insomnia, but it may lead to reduced movement, exercise, and increased social isolation among otherwise healthy individuals. Though MMLs already grant access to patients with medical need, there are debates about whether the benefits of extending marijuana access outside its medical purposes outweighs the associated costs. On the one hand, marijuana legalization mechanically reduces the number of prosecutions for possession, which is a crime often criticized for its economic and racial disparities (ACLU 2013; ACLU of Washington 2014). On the other hand, opponents express concerns about marijuana being a potentially addictive drug that is a gateway to other harmful substances (DeSimone 1998; van Ours 2003; Kelly and Rasul 2014; Volkow et al. 2014). Even though RML only increases access among those of age 21 and older, opponents also express concern about RML inadvertently becoming more available to underage youth, which can be consequential given the well-established correlation between early marijuana use and behavioral and cognitive impairments, poor academic performance, attention and memory deficits, as well as heightened risks of depression and anxiety (Wilson et al. 2000; Pacula and Ringel 2003; Van Ours and Williams 2009; George and Vaccarino 2015; Blanco et al. 2016; Ames et al. 2020). Despite the well-documented substantial increase in marijuana consumption in the US driven by RML laws (Dave et al. 2023), the unintended consequences on decision-making regarding healthy lifestyle choices

[2]In addition to stimulating appetite, marijuana is used to manage several other diseases and symptoms such as glaucoma, nausea, chronic pain, inflammation, multiple sclerosis, and epilepsy (Anderson and Rees 2014; Molina et al. 2011; Musty and Rossi 2001; Penner et al. 2013; Sabia et al. 2017; Ungerleider et al. 1982; Volkow et al. 2014)

(i.e., healthy eating and exercise) are poorly understood.

This study exploits temporal variation in RML implementation across states to evaluate the impact of marijuana availability on two health behaviors: consumption of unhealthy foods and exercise. We begin by examining purchases of unhealthy foods ("junk food") in grocery stores using the NielsenIQ Consumer Panel data. In particular, the granularity of our data allows us to use the Borusyak et al. (2024) (BJS) imputation estimator. Using the BJS approach and an expansive set of weekly fixed effects as well as state by month fixed effects, our results can be summarized as follows. First, we find that "junk food" spending increased by 1.8%. Second, we find that the likelihood of a weekly grocery trip that involved "junk food" increased by 0.5 percentage points (pp). Third, the number of weekly household trips involving "junk food" increased by 0.8%. Finally, these increases are particularly notable as the total number of grocery store trips remained unchanged. Therefore, taken together, these findings indicate an increase in "junk food" purchasing patterns at the extensive and intensive margin.

Our second behavior of interest is sedentary lifestyle, as measured by exercise, and engagement in activities outside the home using the Behavioral Risk Factor Surveillance System (BRFSS) and the American Time Use Survey (ATUS). Our findings indicate that RML decreased the likelihood of reporting exercise in the previous 30 days by 1.1 pp. This decrease can be attributed primarily to cardio intensive exercise declining by 2.0 pp. Time use data confirms these patterns; using ATUS, we find that respondents report 0.63 fewer daily minutes at the gym (18.2% effect). More broadly, however, the ATUS shows that respondents spend more time at home after the passage of RML: 8.37 daily additional minutes at home, 5.98 fewer daily minutes at work, 2.72 fewer daily minutes outdoors, and 1.99 fewer daily minutes in restaurants and bars. These effects are statistically significant at the conventional level.

In addition to the already documented decrease in overall grocery store visits, we use Advan mobile device tracking data to examine whether the reduction in time spent outside

of one's home also affects other "junk food" points of sale. We find no change in visits to fast-food restaurants, convenience food stores, and dollar stores. Though the Advan results are more limited, they provide additional evidence that the increase in unhealthy foods consumption does not extend to fast-foods.

Accordingly, this paper contributes to this emerging literature in three ways. First, we focus on the more recent time period of recreational marijuana legislation expansion, well after the implementation of MML. This allows us to focus on the effects of RML, while taking into account whether MML laws were also present. Our second contribution is the use of a number of novel datasets to evaluate the combined effect on unhealthy foods consumption, as well as physical activity. Such analysis allows us to not only see increased consumption of "junk foods", but it also indicates reduced opportunities to spend those calories. To our knowledge, this is the first paper that combines these two aspects of RMLs impact on health. Third, we improve on previous research by using methodological advances in staggered implementation literature to account for the gradual expansion of RML across states.

The remainder of the paper proceeds as follows. The next section summarizes the literature relating physical activity and food consumption with marijuana use. Sections 3 and 4 describe our data sources and empirical approaches, respectively. Section 5 discusses our main results and the consistency of our findings in a series of robustness checks. Finally, we provide a brief discussion of our findings and some concluding remarks in section 6.

2 Background

We contribute to the literature that focuses on the effect of marijuana on two health behaviors: unhealthy eating and physical activity. We discuss the existing knowledge in each of these areas.[3]

[3]It is worth noting that the health behaviors we examine could be associated with broader mental health changes related to RML passage and marijuana consumption. There is a growing literature examining the relationship between marijuana and mental health, documenting behavioral impairments, cognitive deficits, depression, and anxiety related to marijuana consumption (Blanco et al. 2016; George and Vaccarino 2015; Hasin et al. 2015; Kalbfuß et al. 2018; Keyes 2018; Nussbaum et al. 2011; Serafini et al. 2013; Van Ours

2.1 Consumption of Unhealthy Foods ("The Munchies")

Research into the relationship between marijuana and food consumption has coalesced into three main areas: clinical and survey studies examining physiological changes in appetite and food preference following cannabinoid ingestion, large scale studies of reported food purchasing and consumption behavior, and public health studies using cross-national data.

Early research focused on randomized control trials examining the food preferences of users after ingesting marijuana, noting an increase in appetite and calories consumed (Hollister 1971; Mendelson 1976; Greenberg et al. 1976; Mattes et al. 1994; Berry and Mechoulam 2002; Gorter 1999). The increase in appetite was characterized by increased preference for less nutritious foods such as unhealthy snacks (e.g., sugary, high-calorie treats) as well as larger amounts of food (Foltin et al. 1988; Kruger et al. 2019). Even when satiated, marijuana users experienced an increased preference for sweet foods (Iversen 2003). In survey data, Gelfand and Tangney (2021) used the National Health and Nutrition Examination Survey (NHANES) between 2005 to 2016 to compare the dietary intake of current marijuana users, past users, and non-users, and found that current cannabis users consumed fewer fruits and

and Williams 2011; Van Ours and Williams 2012; Wilson et al. 2000). Related, there is a set of literature linking marijuana use to mental health outcomes. These include eating disorders (Bennett et al. 2013), suicide (Anderson et al. 2014; Bartos et al. 2020; Grucza et al. 2015), drug overdose (Bachhuber et al. 2014; Chan et al. 2020; Conyers and Ayres 2020; Powell et al. 2018; Shover et al. 2019; Smith 2020), and addiction to other substances such as prescription drugs, alcohol, tobacco, and opioids (Guttmannova et al. (2016), Subbaraman (2016), Risso et al. (2020), and Anderson and Rees (2023)). The majority of these studies examine these relationships in the MML framework.

Two recent studies relate mental health outcomes to RML passage. Borbely et al. (2023) are unable to associate changes in mental health distress with marijuana use for broad populations, but do provide evidence of differing effects between two specific age groups. In particular, they find mental health benefits from MML for elderly individuals (i.e., age 60 or older with pre-existing conditions) while RML is associated with negative mental health effects for younger individuals (i.e., below 35 and relatively healthy). Furthermore, Ortega (2023) shows a decrease in the average number of mental health treatment admissions shortly after a state adopts an RML. Overall, there is not strong evidence to suggest how health or the health behaviors we examine are related to RML and marijuana consumption through these mental health related measures.

Along the same lines, changes to alcohol consumption related to marijuana use could have indirect effects on mental health (as well as couch-lock and the choice to consume unhealthy foods). Early literature on the relationship between alcohol and marijuana is mixed, but more recent literature suggests they are substitutes (see Guttmannova et al. (2016) and Subbaraman (2016) for an early review of the alcohol-marijuana literature, andAnderson and Rees (2023) for an updated review concerning all substance use related to marijuana). While a decrease in alcohol consumption related to marijuana use could improve mental health and influence the behaviors we examine, understanding the potential mediating role of alcohol and changes to mental health are beyond the scope of our analysis.

vegetables in comparison to previous and never users, resulting in a lower quality diet. However, this shift in taste does not preclude a broader increase in appetite. Roberts et al. (2019) report an increased appetite for all foods, contradicting the common assumption and general findings that marijuana users prefer sweet, calorie dense foods.

While the link between marijuana and food has been examined through controlled trials and survey data, these tend to include small samples and short-term shifts in preference, limiting broader conclusions. Roberts et al. (2019) suggested that sustained marijuana use over time may result in a less significant effect on appetite, implying that these effects may only be observed at a micro scale or in specific time-frames associated with marijuana ingestion. While larger scale research has focused away from unhealthy eating, a notable exception is Baggio and Chong (2020), which provides the first study using non-survey data to estimate the relationship between a state's RML status and food consumption. Their analysis, based on county-level data spanning 52 designated markets from 2006 to 2016 and employing a difference-in-difference border analysis between RML and non-RML western states, indicated a 3.2 percent increase in overall "junk" food sales.

Expanding the work of Baggio and Chong (2020), Lu (2021), used the Consumer Expenditure Interview Survey from 2005 to 2019 to show that RML legislation increased spending on food consumed away from home, while food consumed at home did not change. However, Lu does not indicate how this relates to health or changes in healthy behavior. Similarly, Hodge and Hazel (2022) showed an increase in taxable food sales in Washington after recreational marijuana was introduced, without associated decreases in other food categories (e.g., non-taxable and restaurant food). Taxable food are defined as prepared food (such as hot foods sold in grocery stores), often considered more calorie dense than unprepared food. Finally, Romano et al. (2023) examined the link between fast-food consumption and cannabis using the Global School-Based Student Health Survey of adolescents from 28 countries (2010-2016), observing statistically significant associations between the prevalence of cannabis use and fast food consumption.

These studies collectively contribute to our understanding of how marijuana use may influence nutritional intake, dietary behaviors, and health outcomes associated with food. Overall, the literature suggests an unhealthy link between marijuana use and food consumption, with increases in high-calorie and snack foods observed after the ingestion of marijuana or legalization of recreational marijuana.[4]

2.2 Physical Activity ("Couch-Lock")

There is a growing body of research examining the relationship between marijuana use and physical activity or "couch-lock". Overall, evidence has been mixed on this relationship. Marijuana use has been associated with enhancing exercise experience via reduced anxiety, increased enjoyment, and reduced pain, potentially leading to health improvements (Pillard et al. 2001; Huestis et al. 2011; Kozela et al. 2013; De Vita et al. 2018; Nicholas and Maclean 2019). Some studies have also linked it to decreasing motivation and impairing exercise performance (Bloomfield et al. 2014; Lutchmansingh et al. 2014). Our review of this literature focuses on association between marijuana use and access and physical activity in the general population.[5]

Exercise-related marijuana research has focused on adolescents and young adults. While the majority of these studies reveal a negative relationship with exercise or a positive relationship with sedentary behavior (Ashdown-Franks et al. 2019; Delisle et al. 2010; Pate et al. 1996; Vancampfort et al. 2019; Winnail et al. 1995), these findings are not universal. Dunn and Wang (2003) and Gillman et al. (2015) failed to find any statistically significant

[4]Although not an examination of the association between marijuana and food, medical research related to this topic has provided insight into the complex physiological relationship between marijuana use and food consumption. In particular, researchers are beginning to understand how cannabis affects appetite regulation, dietary choices, and nutritional outcomes (De Luca et al. 2012; Soria-Gomez et al. 2014; Koch et al. 2015). The findings suggest the properties of tetrahydrocannabinol (THC), the active compound in marijuana long associated with its psychoactive effects of making users feel "high", mimic the natural mechanism for controlling satiation from food, signaling satiety or hunger to the brain and influencing the palatability of food (Soria-Gomez et al. 2014; De Fonseca et al. 1992).

[5]There is a related set of research examining the training, performance, and motivation enhancements of athletes (Ewing 1998; Kennedy 2017; Huestis et al. 2011; Renaud and Cormier 1986; Saugy et al. 2006; Ware et al. 2018), showing increased activity or potential athletic performance enhancement associated with marijuana use.

relationship, while French et al. (2021) suggested a positive relationship, even among heavy marijuana users.

Henchoz et al. (2014) were the first to examine the association between marijuana use and physical activity among adults. Focusing on the relationship between established health behaviors and marijuana use among young men in Switzerland, their analysis showed a negative relationship between cannabis use and regular sports and exercise. However, conditional on sports and exercise, they found that physical activity increased with cannabis use. Vidot et al. (2017) used the NHANES data from 2007-2014 for US adults and showed that marijuana users were less likely to engage in moderate and vigorous physical activity compared to never users. Furthermore, time spent engaging in physical activity decreased as the frequency of marijuana use increased.

Following the work of Vidot et al. (2017), Smith et al. (2021) used the same data to document higher odds of being active among survey respondents who reported having "ever used" cannabis, and attributed differences between their findings and Vidot et al. (2017) to having two additional years in their dataset (2007-2016), as well as additional covariates. However, their results were also mixed. Sedentary behavior increased among marijuana users, males who "ever used" cannabis had a significant increase in their television viewing times, and females who "ever used" cannabis experienced increases in total sitting time. Finally, YorkWilliams et al. (2019) observed cannabis users who used marijuana concurrently with exercise engaged in more minutes of aerobic and anaerobic exercise per week.

Overall, the research examining the relationship between marijuana and physical activity is inconclusive. However, the different set of conclusions among them can be attributed to differences in the type, quality, and granularity of data, differences in the methodologies, as well as differences in the definitions of physical activity. We overcome many of these challenges by using RML to circumvent the endogeneity of marijuana consumption, two distinct datasets to evaluate not only exercise but also time use, and staggered difference-in-differences technique to account for differing adoption timelines.

3 Data

We use a number of nationally representative public and private datasets to examine health outcomes and behavioral changes in response to RML.

3.1 NielsenIQ Consumer Panel Survey

We use the NielsenIQ Consumer Panel Survey data, which reflects millions of grocery trips made by 40,000 to 60,000 households each year between 2011 to 2020 across the contiguous 48 states and the District of Columbia.[6] The NielsenIQ Consumer Panel is a nationally representative panel of consumers where individuals over the age of 18 are recruited into the ongoing panel. Once enrolled, a household is required to scan receipts from every purchase made in retail venues, including online purchases. Participating households remain in the survey for as long as they are deemed eligible, allowing for an extended longitudinal overview of timing and composition of purchases.

Each observation in the NielsenIQ Consumer Panel Survey is a purchase by a household. Data include information about the price, brand, and quantity of the products. We use product subcategories to identify purchases of snacks, chips, cookies, candy, and ice cream.

We aggregate the purchase data to household-week level. The outcomes of interest are defined by spending and trips: (i) total spending and trips; (ii) spending on "junk food" and by category of food; (iii) total number of trips that include purchase of any "junk food" item. We winsorize the top 1% and transform the amount spent and number of trips using a natural logarithm. These measures have limitations. First, spending may be subject to changing prices in anticipation or after the implementation of RML. Second, spending is a proxy for the quantity of "junk food" purchased - a proxy which may obscure compositional changes.[7] Third, trips with any "junk food" purchases may censor the effect of increased

[6]Researcher(s)' own analyses calculated (or derived) based in part on data from Nielsen Consumer LLC and marketing databases provided through the NielsenIQ Datasets at the Kilts Center for Marketing Data Center at The University of Chicago Booth School of Business. The conclusions drawn from the NielsenIQ data are those of the researcher(s) and do not reflect the views of NielsenIQ. NielsenIQ is not responsible for, had no role in, and was not involved in analyzing and preparing the results reported herein.

[7]An alternative to spending is quantity purchased. This measure, however, is more difficult to define

purchasing. In our data, 67% of households purchase "junk food" during a weekly grocery trip, and therefore we may not detect a change on the margin. An alternative definition of outcome of interest is trips with more than 50% of "junk food" purchased, however, as fewer than 5% of all trips fit into this category in our data, it is not a viable source of variation.

Once collapsed, we have 20.5 million household-week observations. We restrict analysis to 18 months prior and post RML enactment, creating a 36 month window balanced panel.

3.2 Behavioral Risk Factor Surveillance System (BRFSS)

The BRFSS is a publicly available individual-level cross-sectional national survey of approximately 400,000 respondents conducted annually by the Centers for Disease Control and Prevention (CDC). The focus of the survey is to provide a nationally representative dataset that monitors health behaviors. While the survey is cross-sectional, we observe the date of interview allowing us variation across months and years of interview. We focus on annual waves between 2011 and 2021, consisting of approximately 4.3 million respondents.

Each year, as part of the survey, respondents are asked whether they have participated in any physical activity or exercise such as running, calisthenics, golf, gardening, or walking in the previous 30 days. Though the question is very broad and asks to identify any type of exercise, approximately 75% of respondents report exercise. We also use the narrower question about cardio intensive exercise in the previous 7 days, which was asked every other year.

In addition to the exercise questions, we use respondent demographic variables, interview date, and respondent location to control for implicit characteristics and identify RML access. Specifically, all analyses control for age and sex, and we limit the sample to respondents 21 years and older, which corresponds to the legal usage age of RMLs.

because while the Consumer Panel Survey provides information of the number of products purchased, it provides much less information about the size and nutritional information of each product. Thus, if consumers switched from a small to a large size of a product this change is likely to be reflected in the amount paid, but not the quantity purchased. Similarly, if a consumer switched from a nutritionally healthier product towards a less healthy product, this would not be reflected in the reported quantity.

3.3 American Time Use Survey (ATUS)

The ATUS is an annual nationally representative survey conducted by the Bureau of Labor Statistics (BLS) identifying how, where, and with whom Americans spend their time. ATUS participants are randomly selected from households which completed the Current Population Survey (CPS). While the CPS over-samples households in small states, ATUS adjusts its household composition to construct a sample representative of the US. The sample is further stratified by race and household composition. One person from the household who is 15 years or older is then asked to complete the one-day time diary, detailing activities in 15-minute fragments over a designated 24 hour period of time. The respondent lists primary activities, describing them in their own words, including where each activity took place. The designated diary date is distributed across the week, with 10% allocated to each weekday, and 25% allocated each to Saturday and Sunday. In each survey year, ATUS includes about 14,000 respondents, or about 1,150 diaries per month.

We use the IPUMS ATUS Extract Builder to construct our sample, focusing on surveys between 2011 to 2021 and including 104,497 respondents (Hofferth et al. 2023). For our analysis, we use reported places of activity such as home, gym, outdoors, workplace, grocery store, and bars/restaurants. The outcome of interest is time spent in these locations throughout the day and the intent is to identify whether RML increases time spent at home and reduces time spent in out-of-home engagement. As with the BRFSS, we use the recorded interview date and respondents state of residence to situate the response relative to passage of RML. Analyses are restricted to individuals 21 years and older.

3.4 Weekly Patterns

Advan is a private company providing data derived from movement of cellular devices across time and space. We use the Weekly Patterns dataset which counts the number of cellular devices frequenting over 4.4 million points of interest (POIs) across the US each week. As an individual navigates through their daily routine of work, leisure, shopping, and

activities, the Weekly Patterns data records each of those stops, aggregating to count the number of visits to individual businesses, public and private venues, and health care facilities. A visit is recorded if the individual stays a minimum of four minutes at the POI.

The data also allows us to identify the census tract of visitors, providing an opportunity to convert the data to the number of visitors from a census tract who have visited specific types of retail outlets. Retail outlets are identified using the North American Industry Classification System (NAICS), which is a five to six digit number issued by the Office of Management and Budget (OMB) designating the nature of the business. The retail outlets of interest are those where, we believe, individuals may purchase low-nutrition foods such as fast food restaurants, convenience stores, and dollar stores.[8]

Our analysis allows us to evaluate changes in visits behavior at each type of venue due to RML. Our final sample includes over 654,000 county-week observations between January 2019 and December 2022. We winsorize the top 1% and transform the number of weekly visits using a natural logarithm.

Since these data do not include any information about visitor characteristics, we supplement our analysis with American Community Survey (ACS) county characteristics. In particular we include annual statistics on population counts, percent population between 18-24 years, percent population male, percent population with high school education or less, and percent population married.

4 Methods

Given the staggered implementation of RML laws, a two-way fixed-effects model - which does not account for such timing - may result in biased estimates (Goodman-Bacon 2021). To address this we implement the Borusyak et al. (2024) (henceforth BJS) imputation estimator as our preferred specification. BJS uses observations from the not-yet-treated period to infer the counterfactual never-treated potential outcome for each unit. We describe the

[8]NAICS codes: 722513 and 722511 (fast food restaurants), 44712 (convenience stores), and 452319 (dollar stores).

specification below.

Let the observed outcome be $Y_{ist} = Y_{ist}(0) + RML_{st}\beta_{st}$ where $Y_{ist}(0)$ is the untreated counterfactual outcome for household or individual i in state s and time period t. In this setting, RML_{st} is the treatment indicator, and β_{st} is the unit specific causal effect.

Assuming that the untreated outcome has the form:

$$Y_{ist}(0) = \delta_s + \mu_t + X_{ist}\gamma + \epsilon_{ist} \tag{1}$$

where X_{ist} is the vector of time varying covariates which include an indicator for presence of medical marijuana law in state s in period t (MML_{st}), and an intercept. The γ is a vector of coefficients which do not vary across units. δ_s and μ_t are state and time fixed effects. Standard errors, ϵ_{ist} are clustered at the state level. For this method to yield unbiased estimates, we assume that ϵ_{ist} has a mean zero conditional on the covariates in the model. These estimates are then aggregated across groups into an average treatment effect on treated and reported as a single coefficient. To check the robustness of our estimates, we implement a naive two-way fixed effects specification and a Gardner (2022) regression. We define the treatment date as the day when RML became effective in the state.

The outcomes of interest and unit of observation differ by dataset. The BRFSS is a cross-sectional dataset at the individual-level, which includes self-reported behavioral indicators for each respondent. We use any self-reported exercise in the 30 days prior to interview, and cardio intensive exercise in the previous 7 days. The ATUS, also cross-sectional data at the individual level, provides self-reported time spent in a specified location. The analysis focuses on time in minutes spent in specified places: home, gym, outdoors, workplace, grocery store, and bars/restaurants. For these outcomes, location and time fixed effects are at the state and year or month of the interview.

The NielsenIQ Consumer Panel Survey is a panel survey tracking households across time. We aggregate observations at the household-week level to the count of trips and total amount

purchased for all and "junk food" groceries. We also aggregate the amount purchased in the following categories of "junk foods": snacks, chips, cookies, candy, and ice cream. For these outcomes, location and time fixed effects are at the county and week levels.

The standard errors in all analyses are clustered at the state level.

5 Results

5.1 Summary Statistics

Table 2 presents the mean and standard deviation for each of the outcomes of interest for all states, for states that have ever passed an RML and those that never implemented RML within the analysis time period. The summary statistics presented in Panel A of Table 2, which correspond to the outcomes related to unhealthy eating: a household in our data spends approximately $8.27 on "junk food" weekly; 67% of households have a grocery trip which includes the purchase of "junk food", an average of 1.1 trips per week. In terms of spending composition, snacks and candy have slightly higher averages than spending on chips, cookies, or ice cream. These consumption patterns are similar across RML and non-RML states.

The summary statistics presented in Panel B of Table 2 correspond to the outcomes related to exercise and movement and 74.2% of respondents report any exercise in the previous month. Panel B2 reports average time spent in locations, while panel B3 reports average time spent conditional on a non-zero report. The averages show a preponderance of home (519 min) and work (490 min) time, but also substantial time spent at other's home (178 min), outdoors (85 min), in the gym (83 min), and at school (82 min). Though differences exist across RML and non-RML states, they are within order of magnitude of each other.

5.2 Main Results

5.2.1 Is It Unhealthy Foods?

We first turn to grocery purchase patterns from the NielsenIQ Consumer Panel Survey data, and evaluate whether the following household-level outcomes in a week-period changed in response to RML implementation: (i) total amount spent in "junk food," (ii) number of

total trips to grocery stores that involved the purchase of any "junk food" items (extensive margin), (iii) number of total trips to grocery stores that involves the purchase of any "junk food" item using only households that with non-zero such trips (intensive margin), (iv) number of trips to grocery stores, and (v) total amount spent in grocery stores.

We present the results of our estimates in Table 3. In column (1) and (2) estimates indicate that RML increases spending on "junk foods" by 1.8%, grocery trips with these foods increase by 0.8%, and there is 0.5 pp higher probability that any given grocery trip will include "junk food" purchases. We note that including state by month fixed effects does not change the estimates significantly, as week by year fixed effects absorb seasonal trends and account for the treatment effect.

We further examine the possibility that this increase in "junk food" consumption may be part of a trend in increasing grocery store spending post-RML, which could arise as a result of an income effect or preference shift towards at home food consumption. Our findings indicate that the total number of grocery store trips and total spending (Panels D and E in Table 3) did not change. The absence of an increase in total trips makes the increase in "junk food" trips more prominent.

We follow up these findings by delving further into specific categories of "junk food" spending in Table 4. We find increases in chips (1.2%), ice cream (1.8%), and candy (1.1%) sales. As the sign of the effect and the mean of the dependent variable is comparable across all food categories, we do not interpret these changes as substitution towards salty or sweet snack categories.

We examine the event study for the NielsenIQ data in Figure 1. In panels (a) and (b) we graph the unadjusted weekly average for all spending and spending on "junk foods" over 2011-2020, with an indication of the overall trend. We note that spending data has substantial seasonal variation and differences in levels year to year. We also note the substantive change in both the seasonal patterns as well as levels in 2020. During the COVID period, spending on "junk foods" increased substantially with deviation from seasonal norms. RML

was implemented in various years and various seasons by the states in our sample. Thus, the analysis window of 24 months will capture different segments of the spending cycle and different annual trends for each state.

In panels (c) and (d), we construct a stacked sample of 24 months before and after implementation of RML. We, then, estimate a event study specification with the location and time fixed effects from main analysis. The figures for spending (panel (c)) and trips (panel (d)) show no significant pre-trend in the analysis window, and a modest increase in levels post-implementation as the overall results show in Table 3.

Ideally, we would like to understand the extent to which the decrease in the number of trips to the grocery store after RML implementation arise as a result of these grocery store purchases being substitutes or complements to other "junk food" outlets such convenience stores or fast-food restaurants. In the absence of purchasing data other than grocery stores, we turn to the Weekly Patterns mobility data. It is important to recognize the limitations of this data. Due to its shorter time period, the analysis is restricted to only the most recent RML implementations and coincides with the COVID-19 pandemic.[9] Therefore, these additional analyses are suggestive and we do not rely on them in our main conclusions.

We estimate the BJS specification described in the Method section, where the outcome of interest is the number of visits at each of the following types of venue at a weekly frequency: fast food, convenience food, dollar stores, and grocery stores. The results presented in Table 5 indicates no significant change in visits to any of these venues. Though we estimate a marginally significant decrease of 0.3% to fast-food restaurants, the effect loses precision when covariates and state by month fixed effects are added.

Taken together, our results suggest an increase in "junk food" spending and purchases in any given grocery store visit. We find no change in visits to grocery stores, but also no change to other venues where unhealthy foods can be purchased. In the next subsection, we will extend the evidence of these visits to time spent outside of home, including restaurants

[9]These time period includes implementation by Arizona, Illinois, Maine, and Michigan.

and bars, in the ATUS.

5.2.2 Is it couch-lock?

We first evaluate self-reported exercise behavior from the BRFSS for the entire sample, and separate for male and female respondents (Table 6). Each panel reports a different outcome and its respective number of observations as some outcomes are surveyed every other year, reducing the sample size used. We report estimates of BJS baseline specification without covariates in columns (1), (3), and (5), and with covariates in columns (2), (4), and (6). While the BJS specification includes state and year by month fixed effects, in addition to these we include state, year, and month fixed effects.

In Table 6, Panel A indicates a 1.1 pp decrease in the likelihood of exercising last month, which corresponds to a modest 1.6% decline relative to the mean. This effect is reflected in the approximately 2.0 pp decline in the probability of engaging in cardio exercise at least once a week in the month to the interview, corresponding to a 8.7% effect on the mean (Panel B). When separating the estimates by gender, we find a comparable loss in probability of exercise in the previous month among both male and female respondents. However, we estimate larger losses in cardio exercise among women relative to men.

These results are supported by the event study presented in Figure 2 for any exercise in the last month (Panel A), and the likelihood to engage in cardio at least once weekly in the past month (Panel B). Relative to the last period prior to the enactment of RML, Panels A and B show a notable, though noisy, decrease in exercise and cardio strength training in the previous month. Figure 2 also shows flat trends prior to RML implementation.

As an additional check we stratify the analysis by age for the following groups: 21-24, 25-39, and 40 and older. In results presented in Table A1 we find that exercise declines in every age category, though only older respondents (40 plus) have precisely estimated results with 1.2 pp decline. The effects of engaging in cardio exercise at least once a week in the past month also decrease in probability across all age groups, though only the older (40+) age group has precisely estimated 2.1 pp decline in this category. Taken together, the BRFSS

estimates suggest a shift towards a more sedentary lifestyle.

Next, we investigate how individuals allocate their time after RML. BRFSS results may imply that individuals may substitute away exercise with other activities, such as spending time outdoors. We explore possible substitutions using the ATUS by focusing on the time spent at home, as well as various indoor and outdoor locations. The results for all respondents and stratified by gender are presented in Table 7. As in other results, we report the BJS model with additional month, year and state fixed effects, with and without controls.

We find significant changes to time use after RML, using specification with covariates. In particular, we find that respondent report 8.36 more minutes spent at home (1.7% effect), primarily due to men who spend 13.78 (3.0%) more minutes at home each day. This increase in time spent at home is reflected in 5.98 fewer minutes spent at work (3.3% effect) – again, due to 12.53 minute reduction of time spent by men. We also find that RML leads to 0.63 fewer minutes spent at the gym, comparable estimates for men (-0.53) and women (-0.62) in this category. While the Advan data shows no change in visits to fast food, convenience store, and dollar stores, the ATUS estimates show 1.99 fewer minutes spent in restaurants, with similar estimates for men (-2.34) and women (-1.77); and, more broadly, 2.72 fewer minutes spent outdoors – this effect comes primarily from declining outdoor time for women (-3.74). We also estimate a slight decline in time spent in grocery stores, though the effect is not precisely estimated. Finally, use of marijuana may affect respondent reporting accuracy – either intentionally or unintentionally (Andersson et al. 2023; McCabe and West 2016; Studer et al. 2013). Thus, in Panel G we report the coefficient on missing or unaccounted time. We find suggestive evidence that, overall, 3.5 additional minutes are unaccounted time by women, but this estimate is not statistically significant at the conventional level.

Figure 3 shows a gradual declines in time at work, outdoors, and restaurant or bar, and it shows a flat pre-trend satisfying the assumption requirement for causal interpretation.

As previously, we show estimates by age groups in Table A2. The age group stratification shows that these effects are heterogeneous. In particular, young adults (21-24 yo) experience

declines in gym (-7.5), grocery store (-4.2), and restaurant (-14.87). Adults (25-39 yo) experience the most significant loss in outdoor time (-7.96) which is most likely to be spent at home (19.04). Older adults (40 yo plus) spend less time at the gym (-0.75) and in restaurants (-2.12).

Overall, our findings indicate that RML decreases the amount of exercise and time spent at work and commercial establishments, which is in line with an increase in the time spent at home.

5.3 Robustness of Estimates

5.3.1 Alternative Estimator

Our main analyses show estimates of the BJS imputation method to account for the staggered implementation of the RML across states. We discuss the choice of staggered estimation methodology in the Appendix. Furthermore, we choose to test the sensitivity of our findings with a naive TWFE and Gardner (2022) estimator in Table A3 for NielsenIQ, Table A4 for BRFSS, and Table A5 for ATUS. Though in some cases the estimates lose statistical significance, the sign and magnitude of effects is similar to BJS, reinforcing our confidence in our main estimates.

5.3.2 Fixed Effects

Our estimates may be sensitive to inclusion of state specific time fixed effects as the enactment of RML differed by month and year across states. This factor is particularly important for the BRFSS and ATUS results, which are annual. In these surveys, the treatment is designated on the year basis, which allows for the possibility of differing intensity of treatment depending on the month of interview following the implementation of RML.

For the NielsenIQ Consumer Panel, results of this estimate presented in Table A6 show effects of similar magnitude to those in Table 3. For the BRFSS and ATUS in Tables A7 and A8, the results do not differ substantively from our main preferred specification.[10] Thus, we

[10]We cannot estimate state by year fixed effects with BRFSS and ATUS annual data as these would absorb the identifying variation of RML.

conclude that the choice of fixed effects does not determine our estimates.

5.3.3 Sample Definition

The NielsenIQ data overlaps with the COVID period, which saw significant changes in grocery shopping habits and composition of food consumption. We address whether our results are sensitive to COVID changes in Appendix Table A9 in two ways: in column (1) , the stay-at-home indicator is modified from one which turns on during months where policy was in effect to one which stays on for all months post March 2020 if a stay-at-home order was ever present; in column (2) the sample omits 2020. The inclusion of an indicator of stay-at-home status boosts the estimated effects for spending (2.0%), trips (0.9%). The omission of 2020 from estimated effects increases spending by 2.0%, and trips by 1.0%. Combined, these results suggest that RML occurring during the COVID-19 pandemic had a significantly smaller effect on consumption of "junk foods" than previously. This attenuation of the effect could be the result of significant changes in grocery purchasing patterns during this period. While the NielsenIQ data includes online purchasing which became more mainstream during COVID, declining number of grocery trips may have affected whether "junk food" was purchased concurrently with marijuana products. The changing composition of treated states may affect our estimates, as well. Two states passed RML in 2020 – Arizona and Illinois. Furthermore, Hansen et al. (2020) show the importance of cross-border spillovers in RML. As more states adopt RML, the later adopters are likely to be "treated" to some extent. We explore cross border effects below.

The NielsenIQ estimates are restricted to 18 months around the RML passage. This was motivated by data trend and quality constraints: households change over the entire time-period of the panel and limiting the sample reduces compositional changes among them; as the unit of observation is a household per week, we want to create a balanced panel of observations without long tails in the pre- and post-period. We explore the sensitivity of our estimates to the length of the time panel in Appendix Table A10, estimating our main results for a panel of 24 month and 30 month window. Increasing the panel window boosts

the magnitude and statistical significance for most estimates.

5.3.4 Alternative Definition of Time Spent in ATUS

In Table 7 Panel G, we show a slight increase in the number of minutes reported as missing from the ATUS. This increase in the gap of accounted minutes may mechanically affect the number of minutes reported in any given activity, including exercise. To test for this, we estimate the share of time spent on activity relative to total non-missing daily minutes in Table A11. Consistent with minute estimates, we show a 1.1 percentage point increase in minutes at home, and decreases in minutes spent at gym, work, outdoors, and restaurants. These results are consistent with our main reported effects.

5.3.5 Cross-border Spillovers

Hansen et al. (2020) show evidence of substantially large cross-border purchasing of marijuana products between RML and non-RML states. In particular, they focus on marijuana sales in Washington state which enacted RML in July 2014, when Oregon enacted its own RML in October 2015. In counties which bordered Oregon, the authors find a 36% decline in sales, generating $44 to $75 million in tax revenue for the state of Washington from these cross-border shoppers.

Cross-border analysis is relevant to our estimates in two ways. First, we consider the effect of control counties and states which may be subject to some level of treatment. Thus, the control group may be experiencing some change in pre-RML levels, contaminating the counterfactual we estimate. Second, residents of counties and states which border RML states may travel across the border to obtain and consume marijuana, resulting in some of the behavioral outcomes we observe in RML states. That is, RML states may in fact act as treatment on adjacent states as well. We examine the effect of RML on adjacent states in Tables A12, A13, and A14. In Table A12, we use the NielsenIQ data to estimate two effects: sensitivity of main estimates to inclusion of non-RML counties bordering RML states by excluding these from sample (column (1)); testing spillovers directly by restricting the sample to non-RML states, and designated RML-adjacent states as treated (column (2)).

We show that while exclusion of adjacent counties amplifies the magnitude of our estimates, the overall cross-border spillovers in the states adjacent to RML is small to negligible in terms of purchasing of "junk foods".

We conduct cross-border analysis for BRFSS and ATUS data in Tables A13, and A14. In these results, because the data is at the state level, we are able to perform only the cross-state comparison – that is designating non-RML states adjacent to RML states as treated. The estimates in Table A13 show modest decreases in exercise that are marginally significant. Table A14 show no significant changes in time spent at home, but a modest increase in gym time in adjacent states.

Overall, the cross-border comparison show very modest spillovers, with little or no effect in time spent. The analysis also allows us to rule out contamination of the control group in our main estimates.

6 Discussion

As of 2024, 24 states have legalized recreational marijuana, while 38 states have medical marijuana laws in place. This is part of a larger movement of legalization of psychoactive substances such as decriminalization of psilocybin in Oregon and other states and municipalities, 3,4-methylenedioxy-methamphetamine (MDMA), and peyote (Siegel et al. 2023). Dave et al. (2023) estimate that RMLs resulted in 2.5 pp increase in marijuana use in the year following legalization, 3.7 pp two years, and 4.5 pp three or more years after legalization. While cognitive impairment resulting from marijuana use may be anticipated and regulated, we offer evidence of unintended behavioral changes with respect to consumption of unhealthy foods and physical activity.

Using high-frequency data to examine weekly grocery store purchasing habits of households from NielsenIQ and detailed fixed effects we find that RML increased "junk food" spending by 1.8%, increased the likelihood that a grocery trips includes a "junk food" purchase by 0.5 pp, and increase the number of trips to the grocery store that involved "junk food" by 0.8%. These "junk food" purchases are broadly distributed among snacks, chips, ice

cream, and candy. Given that these purchasing patterns are not accompanied by an increase in overall grocery store trips, the increase in purchases of "junk food" is particularly salient. Using mobility data, we show that the increase in "junk food" purchases is not reflected in fast-food, convenience store, or dollar store visits.

In order to estimate the effect of RML on physical activity, we use the BRFSS and find that RML led to a 1.1 pp reduction in exercise in the previous month and, specifically, 2.7 pp decline in cardio exercise. These results are sensitive to gender and age, as women and individuals under 40 years of age experience the largest effect. At the same time, however, we estimate that this decline in exercise is more broad-based, as the ATUS results highlight significant reductions in time spent at work and outdoors, and increased time spent at home after the passage of RML. Together, these estimates suggest that after RML, people are more likely to adopt sedentary habits, or couch-lock.

The estimates reflect the average treatment effect (ATE) on a household or individual residing in a state which enacted RML, irrespective of whether the individual or a member of that household is a marijuana user prior- or post-RML. The estimated effect may be due to large effects experienced by a small share of marijuana users. To evince the possible effects on this population we estimate the average treatment effect on treated to contextualize our findings. To compute the average treatment effect on treated (ATT), we rely on estimates of proportion of population who already were users or became users of marijuana following the passage of RML. The effect we observe could be the result of new marijuana users changing their unhealthy foods consumption and exercise; alternatively, this effect could also be result of increased marijuana consumption by existing users, resulting in similar changes in healthy lifestyle. We explore both possibilities.

Dave et al. (2023) estimates that RMLs resulted in 4.5 pp increase in marijuana use in three or more years after legalization. If we assume that the effects on consumption of "junk food" and exercise is the result of changing behavior exclusively among new users of marijuana, then our estimates would indicate that these users experienced a 40% increase

in "junk food" spending, 24.4 pp decrease in exercise, and 185 additional minutes spent at home each day. These estimates are incredibly large motivating us to believe that the observed changes are not the result exclusively of new marijuana users. Turning to existing users, Steigerwald et al. (2020) estimate that 21.1% of residents in RML states use some form of marijuana. If this is the prevalence of the treated population in RML states, then these users would experience 8.5% increase in spending on unhealthy foods, 5.2 pp decrease in exercise, and 39.6 additional minutes spent at home daily. While even a 8.5% increase in "junk food" spending seems large, this translates into an increase of $0.70 relative to the mean household weekly expenses of $8.3.

Though the latter ATT effects are more plausible, we note that these behavioral effects have likely spillovers on non-users. An increase in household of purchasing of "junk foods" affects children in the household; reduced exercise, time outside the home, and social interactions by parents are likely to result in reduced activity among children. Thus, while the ATT ascribes the estimated effects to marijuana users, the true effect is likely to be somewhere between that and the ATE which includes the effects of these undesirable spillovers.

Combining multiple datasets, we are able to establish the effect of RML on health behaviors, specifically unhealthy food choices and physical activity. The US has been experiencing what has been termed as an epidemic of obesity and sedentary lifestyle, along with associated chronic conditions of diabetes and cardiovascular disease (Ferraro et al. 2012; Pratt and Brody 2014). Previous efforts at decriminalizing marijuana focused on its medical use. While appetite increase may be a desirable outcome for medical purposes, unhealthy eating is a costly outcome in terms of public health in otherwise healthy adults. Similarly, while the use of marijuana may provide pain management and increase mobility among patients with such constraints, it results in a sedentary lifestyle among adults without such conditions. Our findings highlight health behavior changes resulting from RML and motivate more careful evaluation of RML policies, alerting the need for parallel policy efforts to reduce their long-term impact on unhealthy eating and sedentary lifestyle. Such policies can take

the form of information campaigns to increase awareness, or direct interventions to reduce access to unhealthy foods or encourage exercise and physical activity to partially mitigate the unintended consequences of RML on unhealthy eating and activity behaviors.

References

ACLU (2013). *The war on marijuana in Black and White*. New York: American Civil Liberties Union. URL: https://www.aclu.org/publications/report-war-marijuana-black-and-white.

ACLU of Washington (2014). *Court filings for adult marijuana posession plummet*. Washington: ACLU of Washington. URL: https://www.aclu.org/press-releases/court-filings-adult-marijuana-possession-offenses-drop-dramatically-after-i-502s.

Ames, M.E. et al. (2020). "Patterns of Marijuana Use and Physical Health Indicators among Canadian Youth". *International Journal of Psychology* 55 (1), 1–12.

Anderson, D. Mark and Daniel I. Rees (2014). "The Legalization of Recreational Marijuana: How Likely Is the Worst Case Scenario?" *Journal of Policy Analysis and Management* 33 (1), 221–232. DOI: 10.1002/pam.21722. URL: https://onlinelibrary.wiley.com/doi/10.1002/pam.21722.

– (2023). "The Public Health Effects of Legalizing Marijuana". *Journal of Economic Literature* 61 (1), 86–143.

Anderson, D. Mark, Daniel I. Rees and Joseph J. Sabia (2014). "Medical Marijuana Laws and Suicies by Gnder and Age". *American Journal of Public Health* 104 (12), 2369–2376.

Andersson, Filip et al. (2023). "Prevalence of cannabis use among young adults in Sweden comparing randomized response technique with a traditional survey". *Addiction* 118 (9), 1801–1810. ISSN: 0965-2140. DOI: https://doi.org/10.1111/add.16219.

Ashdown-Franks, Garcia et al. (2019). "Cannabis use and physical activity among 89,777 adolescents aged 12-15 years from 21 low- and middle-income countries". *Drug Alcohol Depend.* 205.

Bachhuber, Marcus A. et al. (2014). "Medical Cannabis Laws and Opioid Analgesic Overdose Mortality in the United States, 1999-2010". *JAMA Internal Medicine* 174 (10), 1668–1673.

Baggio, Michele and Alberto Chong (2020). "Recreational Marijuana Laws and Junk Food Consumption". *Economics and Human Biology* 39 (2020), 100922.

Bartos, Bradle J. et al. (2020). "Medical Marijuana Laws and Suicide". *Archives of Suicide Research* 24 (2), 204–217.

Bennett, Jessica, Geoffrey Greene and Donna Schwartz-Barcott (2013). "Perceptions of emotional eating behavior. A qualitative study of college students." *Appetite* 60, 187–192.

Berry, Elliot M and Raphael Mechoulam (2002). "Tetrahydrocannabinol and endocannabinoids in feeding and appetite". *Pharmacology & therapeutics* 95 (2), 185–190.

Blanco, Carlos et al. (2016). "Cannabis Use and Risk of Psychiatric Disorders: Prospective Evidence from a US National Longitudinal Study". *JAMA Psychiatry* 73 (4), 388–395.

Bloomfield, Michael A P et al. (2014). "Dopaminergic function in cannabis users and its relationship to cannabis-induced psychotic symptoms". *Biol Psychiatry* 75 (6), 470–478.

Borbely, Daniel et al. (Mar. 2023). *Marijuana Legalization and Mental Health*. Working Papers 2302. University of Strathclyde Business School, Department of Economics. URL: https://ideas.repec.org/p/str/wpaper/2302.html.

Borusyak, Kirill, Xavier Jaravel and Jann Spiess (Feb. 2024). "Revisiting Event-Study Designs: Robust and Efficient Estimation". *The Review of Economic Studies*, rdae007. ISSN: 0034-6527. DOI: 10.1093/restud/rdae007. eprint: https://academic.oup.com/restud/advance-article-pdf/doi/10.1093/restud/rdae007/56643619/rdae007.pdf. URL: https://doi.org/10.1093/restud/rdae007.

Callaway, Brantly and Pedro H.C. Sant'Anna (2021). "Difference-in-Differences with multiple time periods". *Journal of Econometrics* 225 (2). Themed Issue: Treatment Effect 1, 200–230. ISSN: 0304-4076. DOI: https://doi.org/10.1016/j.jeconom.2020.12.001. URL: https://www.sciencedirect.com/science/article/pii/S0304407620303948.

Chan, Nathan W., Jesse Burkhardt and Matthew Flyr (2020). "The Effects of Recreational Marijuana Legalization and Dispensing on Opioid Mortality". *Economic Inquiry* 58 (2), 589–606.

Conyers, Gregory and Ian Ayres (2020). "A Lottery Test of the Effect of Dispensaries on Emergency Room Visits in Arizona". *Health Economics* 29 (8), 854–864.

Dave, Dhaval et al. (2023). "Have recreational marijuana laws undermined public health progress on adult tobacco use?" *Journal of Health Economics* 90, 102756. ISSN: 0167-6296. DOI: https://doi.org/10.1016/j.jhealeco.2023.102756. URL: https://www.sciencedirect.com/science/article/pii/S0167629623000334.

De Fonseca, F. Rodriguez et al. (1992). "Acute Effects of Delta-9-Tetrahydrocannabinol on Dopaminergic Activity in Several Rat-Brain Areas". *Pharmacology Biochemistry and Behavior* 42 (2), 269–275.

De Luca, M.A. et al. (2012). "Cannabinoid facilitation of behavioral and biochemical hedonic taste responses". *Neuropharmacology* 63 (1), 161–168.

De Vita, Martin J et al. (2018). "Association of Cannabinoid Administration With Experimental Pain in Healthy Adults: A Systematic Review and Meta-analysis". *JAMA Psychiatry* 75 (11), 1118–1127.

Delisle, Tony T. et al. (2010). "Relationship between frequency and intensity of physical activity and health behaviors of adolescents". *J Sch Health* 80 (3), 134–140.

DeSimone, Jeffrey (1998). "Is marijuana a gateway drug?" *Eastern Economic Journal* 24 (2), 149–164.

Dunn, Michael S. and Min Qi Wang (2003). "Effects of physical activity on substance use among college students". *American Journal of Health Studies* 18 (2/3), 126–132.

Ewing, B.T. (1998). "High school athletes and marijuana use". *J Drug Educ.* 28 (2), 147–157.

Ferraro, Z. M. et al. (2012). "Excessive gestational weight gain predicts large for gestational age neonates independent of maternal body mass index". *The Journal of Maternal-Fetal & Neonatal Medicine* 25 (5). PMID: 22081936, 538–542. DOI: 10.3109/14767058.2011.638953. eprint: https://doi.org/10.3109/14767058.2011.638953. URL: https://doi.org/10.3109/14767058.2011.638953.

Foltin, Richard W, Marian W Fischman and Maryanne F Byrne (1988). "Effects of smoked marijuana on food intake and body weight of humans living in a residential laboratory". *Appetite* 11 (1), 1–14.

French, Michael T., Karoline Mortensen and Manuel Alcala Kovalski (2021). "The relationships between marijuana use and exercise among young and middle-aged adults". *Preventive Medicine* 147, 106518.

Gallup (2022). *Marijuana Views Linked to Ideology, Religiosity, Age*. Gallup. URL: https://news.gallup.com/poll/405086/marijuana-views-linked-ideology-religiosity-age.aspx.

Gardner, John (2022). "Two-stage differences in differences". *arXiv preprint arXiv:2207.05943*.

Gelfand, Amy R and Christy C Tangney (2021). "Dietary quality differs among cannabis use groups: data from the National Health and Nutrition Examination Survey 2005-16". *Public Health Nutr.* 24 (11), 3419–3427.

George, T and F Vaccarino (2015). "Substance abuse in Canada: The effects of cannabis use during adolescence". *Ottawa, ON: Canadian Centre on Substance Abuse*.

Gillman, Arielle S, Kent E Hutchison and Angela D Bryan (2015). "Cannabis and Exercise Science: A Commentary on Existing Studies and Suggestions for Future Directions". *Sports Med.* 45 (10), 1357–1363.

Goodman-Bacon, Andrew (2021). "Difference-in-differences with variation in treatment timing". *Journal of Econometrics* 225 (2). Themed Issue: Treatment Effect 1, 254–277. ISSN: 0304-4076. DOI: https://doi.org/10.1016/j.jeconom.2021.03.014. URL: https://www.sciencedirect.com/science/article/pii/S0304407621001445.

Gorter, RW (1999). "Cancer cachexia and cannabinoids". *Complementary Medicine Research* 6 (Suppl. 3), 21–22.

Greenberg, Isaac et al. (1976). "Effects of marihuana use on body weight and caloric intake in humans". *Psychopharmacology* 49, 79–84.

Grucza, Richard A. et al. (2015). "A Reexamination of Medical Marijuana Policies in Relation to Suicide Risk". *Drug and Alcohol Dependence* 152 (1), 68–72.

Guttmannova, Katarina et al. (2016). "Impacts of Changing Marijuana Policies on Alcohol Use in the United States". *Alcohol Clin Exp Res* 40 (1).

Hansen, Benjamin, Keaton Miller and Caroline Weber (2020). "Federalism, partial prohibition, and cross-border sales: Evidence from recreational marijuana". *Journal of Public Economics* 187, 104159. ISSN: 0047-2727. DOI: https://doi.org/10.1016/j.jpubeco.2020.104159.

Hasin, Deborah S. et al. (2015). "Medical Marijuana Laws and Adolesent Marijuana Use in the USA from 1991 to 2014: Results from Annual, Repeated Cross-Sectional Surveys". *Lancet Psychiatry* 2 (7), 601–608.

Henchoz, Yvesand et al. (2014). "Associations of Physical Activity and Sport and Exercise with At-risk Substance use in Young Men". *Prev Med.* Apr 2.

Herrington, A. J. (2023). *Gallup Poll Shows Half of Americans Have Tried Marijuana*. Forbes. URL: https://www.forbes.com/sites/ajherrington/2023/08/14/gallup-poll-shows-half-of-americans-have-tried-marijuana/?sh=5ddab5d6b8db.

Hodge, Timothy R. and Cooper Hazel (2022). "The Munchies: Marijuana Legalization and Food Sales in Washington". *Southern Economic Journal* 89 (1), 112–137.

Hofferth, Sandra L et al. (2023). *American time use survey data extract builder: Version 2.8 College Park, MD: University of Maryland and Minneapolis, MN: IPUMS.* Dataset. DOI: https://doi.org/10.18128/D060.V3.2.

Hollister, LE (1971). "Hunger and appetite after single doses of marihuana, alcohol, and dextroamphetamine". *Clin Pharmacol Ther* 12 (1), 44–49.

Huestis, Marilyn A., Irene Mazzoni and Olivier Rabin (2011). "Cannabis in sport: anti-doping perspective". *Sports Med.* 41 (11), 949–966.

Iversen, Leslie (2003). "Cannabis and the brain". *Brain* 126 (6), 1252–1270.

Kalbfuß, Jorg, Reto Odermatt and Alois Stutzer (2018). "Medical Marijuana Laws and Mental Health in the United States". *CEP Discussion Papers 1546.*

Kelly, Elaine and Imran Rasul (2014). "Policing cannabis and drug related hospital admissions: Evidence from administrative records". *Journal of Public Economics* 112, 89–114. ISSN: 0047-2727. DOI: https://doi.org/10.1016/j.jpubeco.2014.01.008. URL: https://www.sciencedirect.com/science/article/pii/S0047272714000097.

Kennedy, Michael C. (2017). "Cannabis: Exercise performance and sport. A systematic review". *Journal of Science and Medicine in Sport* 20 (9), 825–829.

Keyes, Katherine M (2018). "Commentary on Kerr et al. (2018): Marijuana, Drug use, and mental health in the United States - a tale of two generations". *Addiction* 113 (3), 482–483.

Koch, Marco et al. (2015). "Hypothalamic POMC neurons promote cannabinoid-induced feeding". *Nature* 519 (7451), 45–50.

Kozela, Ewa et al. (2013). "Cannabinoids decrease the th17 inflammatory autoimmune phenotype". *J Neuroimmune Pharmacol.* 8 (5), 1265–1276.

Kruger, Jessica S et al. (2019). "Manipulation checking the munchies: Validating self-reported dietary behaviors during cannabis intoxication". *Human Ethology* 34, 10–16.

Lu, Thanh (2021). "Marijuana legalization and household spending on food and alcohol". *Health Economics* 30 (7), 1684–1696.

Lutchmansingh, Denyse, Leena Pawar and Dana Savici (2014). "Legalizing Cannabis: A physician's primer on the pulmonary effects of marijuana". *Curr Respir Care Rep.* 3 (4), 200–205.

Mattes, Richard D et al. (1994). "Cannabinoids and appetite stimulation". *Pharmacology Biochemistry and Behavior* 49 (1), 187–195.

McCabe, S. E. and B. T. West (2016). "Selective nonresponse bias in population-based survey estimates of drug use behaviors in the United States". *Soc Psychiatry Psychiatr Epidemiol* 51 (1). 1433-9285 McCabe, Sean Esteban West, Brady T R01 DA031160/DA/NIDA NIH HHS/United States R01 DA036541/DA/NIDA NIH HHS/United States Journal Article Research Support, N.I.H., Extramural Germany 2015/09/17 Soc Psychiatry Psychiatr Epidemiol. 2016 Jan;51(1):141-53. doi: 10.1007/s00127-015-1122-2. Epub 2015 Sep 16., 141–53. ISSN: 0933-7954 (Print) 0933-7954. DOI: 10.1007/s00127-015-1122-2.

Mendelson, Jack H. (1976). "Marihuana Use: Biologic and Behavioral Aspects". *Postgrad. Med.* 60 (5), 111–115.

Molina, Patricia E. et al. (2011). "Cannabinoid Administration Attenuates the Progression of Simian Immunodeficiency Virus". *AIDS Research and Human Retroviruses* 27 (6), 585–592. DOI: 10.1089/aid.2010.0218. URL: https://doi.org/10.1089/aid.2010.0218.

Musty, Richard E. and Rita Rossi (2001). "Effects of Smoked Cannabis and Oral Delta9-Tetrahydrocannabinol on Nausea and Emesis After Cancer Chemotherapy". *Journal of Cannabis Therapeutics* 1 (1), 29–56. DOI: 10.1300/J175v01n01_03. eprint: https://doi.org/10.1300/J175v01n01_03. URL: https://doi.org/10.1300/J175v01n01_03.

Nicholas, Lauren Hirsch and Johanna Catherine Maclean (2019). "The Effect of Medical Marijuana Laws on the Health and Labor Supply of Older Adults: Evidence from the Health and Retirement Study". *J Policy Anal Manage.* 38 (2), 455–480.

Nussbaum, Abraham, Christian Thurstone and Ingrid Binswanger (2011). "Medical Marijuana Use and Suicide Attempt in a Patient with Major Depressive Disorder". *The American Journal of Psychiatry* 168 (8), 778–781.

Ortega, Alberto (2023). "The highs and the lows: Recreational marijuana laws and mental health treatment". *Health Economics* 32 (10), 2173–2191.

Pacula, Rosalie Liccardo and Jeanne Ringel (2003). *Does marijuana use impair human capital formation?*

Pate, R.R. et al. (1996). "Associations between physical activity and other health behaviors in a representative sample of US adolescents." *Am J Public Health* 86 (11), 1577–1581.

Penner, Elizabeth A., Harold Buettner and Murray A. Mittleman (2013). "The Impact of Marijuana Use on Glucose, Insulin, and Insulin Resistance among US Adults". *The American Journal of Medicine* 126 (7), 583–589. DOI: 10.1016/j.amjmed.2013.03.002. URL: https://www.amjmed.com/article/S0002-9343(13)00200-3/fulltext.

Pillard, F et al. (2001). "Sport practice and cannabis consumption in a representative sample of French high school adolescents". *Annales de medecine interne* 152, 28–36.

Powell, David, Rosalie Liccardo Pacula and Mireille Jacobson (2018). "Do Medical Marijuana Laws Reduce Addictions and Deaths Related to Pain Killers?" *Journal of Health Economics* 58 (March), 29–42.

Pratt, Laura A and Debra J Brody (2014). *Depression and obesity in the U.S. adult household population, 2005–2010*. NCHS data brief 167. Hyattsville, MD: National Center for Health Statistics.

Renaud, A.M. and Y. Cormier (1986). "Acute effects of marihuana smoking on maximal exercise performance". *Med Sci Sports Exerc.* 18 (6), 685–689.

Risso, Constanza et al. (2020). "Does cannabis complement or subsitute alcohol consumption? A systematic review of human and animal studies". *Journal of Psycopharmacology* 34 (9), 938–954.

Roberts, Carl A et al. (2019). "Exploring the munchies: An online survey of users' experiences of cannabis effects on appetite and the development of a Cannabinoid Eating Experience Questionnaire". *Journal of Psychopharmacology* 33 (9), 1149–1159.

Romano, Eugenia et al. (2023). "The association of cannabis use with fast-food consumption, overweight, and obesity among adolescents aged 12-15 years from 28 countries". *Journal of Substance Use* 28 (6), 952–961.

Sabia, Joseph J., Joseph Swigert and David Young (2017). "The Effect of Medical Marijuana Laws on Body Weight". *Health Economics* 26 (1), 6–34. DOI: 10.1002/hec.3451. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/hec.3451.

Saugy, M. et al. (2006). "Cannabis and sport". *Br J Sports Med.* 40 (1), i13–i15.

Serafini, Gianluca et al. (2013). "The association between cannabis use, mental illness, and suicidal behavior: what is the role of hoplessness?" *Front Psychiatry*, 1–5.

Shover, Chelsea L. et al. (2019). "Association between Medical Cannabis Laws and Opioid Overdose Mortality Has Reversed Over Time". *Proceedings of the National Academy of Sciences* 116 (26), 12624–12626.

Siegel, Joshua S. et al. (2023). "Psychedelic Drug Legislative Reform and Legalization in the US". *JAMA Psychiatry* 80 (1), 77–83. ISSN: 2168-622X. DOI: 10.1001/jamapsychiatry.2022.4101.

Smith, L. et al. (2021). "Physical activity, sedentary behaviour and cannabis use in 15,822 US adults: cross-sectional analyses from NHANES". *Public Health* 193, 76–82.

Smith, Rhet A. (2020). "The Effects of Medical Marijuana Dispensaries on Adverse Opioid Outcomes". *Economic Inquiry* 58 (2), 569–588.

Soria-Gomez, Edgar et al. (2014). "The endocannabinoid system controls food intake via olfctory processes". *Nature Neuroscience* 17 (3), 407–415.

Steigerwald, S. et al. (2020). "Differences in Opinions About Marijuana Use and Prevalence of Use by State Legalization Status". *J Addict Med* 14 (4), 337–344. ISSN: 1932-0620 (Print) 1932-0620. DOI: 10.1097/adm.0000000000000593.

Studer, J. et al. (2013). "Examining non-response bias in substance use research–are late respondents proxies for non-respondents?" *Drug Alcohol Depend* 132 (1-2). 1879-0046 Studer, Joseph Baggio, Stéphanie Mohler-Kuo, Meichun Dermota, Petra Gaume, Jacques Bertholet, Nicolas Daeppen, Jean-Bernard Gmel, Gerhard Journal Article Research Support, Non-U.S. Gov't Ireland 2013/03/29 Drug Alcohol Depend. 2013 Sep 1;132(1-2):316-23. doi: 10.1016/j.drugalcdep.2013.02.029. Epub 2013 Mar 25., 316–23. ISSN: 0376-8716. DOI: 10.1016/j.drugalcdep.2013.02.029.

Subbaraman, Meenakshi Sabina (2016). "Substitution and complementarity of alcohol and cannabis: a review of the literature". *Subst Use Misuse* 51 (11), 1399–1414.

Substance Abuse and Mental Health Services Administration (2022). *Key Substance Use and Mental Health Indicators in the United States: Results from the 2021 National Survey on Drug Use and Health*. Tech. rep. HHS Publication No. PEP22-07-01-005, NSDUH Series H-57. Center for Behavioral Health Statistics, Quality, Substance Abuse and Mental Health Services Administration. URL: https://www.samhsa.gov/data/report/2021-nsduh-annual-national-report.

Ungerleider, J THOMAS et al. (1982). "Cannabis and cancer chemotherapy: a comparison of oral delta-9-THC and prochlorperazine." *Cancer* 50 (4), 636–645.

van Ours, Jan C (2003). "Is cannabis a stepping-stone for cocaine?" *Journal of Health Economics* 22 (4), 539–554. ISSN: 0167-6296. DOI: https://doi.org/10.1016/S0167-6296(03)00005-5. URL: https://www.sciencedirect.com/science/article/pii/S0167629603000055.

Van Ours, Jan C and Jenny Williams (2009). "Why parents worry: initiation into cannabis use by youth and their educational attainment". *Journal of health economics* 28 (1), 132–142.

– (2011). "Cannabis use and mental health problems". *Journal of Applied Econometrics* 26 (7), 1137–1156.

– (2012). "The effects of cannabis use on physical and mental health". *Journal of health economics* 31 (4), 564–577.

Vancampfort, Davy et al. (2019). "Cannabis use and leisure-time sedentary behavior among 94,035 adolescents aged 12-15years from 24 low- and middle-income countries". *Addict Behav.*

Vidot, Denise C. et al. (2017). "Moderate and vigorous physical activity patterns among marijuana users: Results from the 2007–2014 National Health and Nutrition Examination Surveys". *Drug and Alcohol Dependence* 178, 43–48.

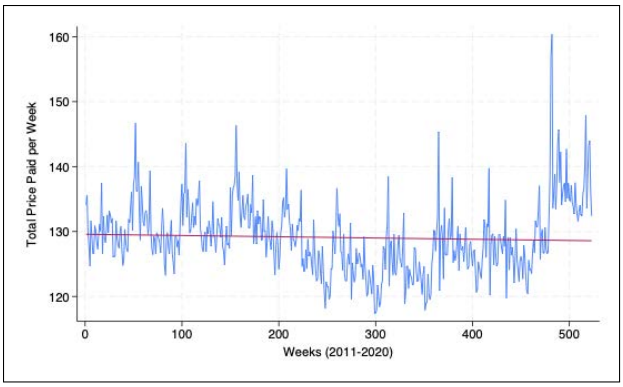
Volkow, Nora D et al. (2014). "Adverse health effects of marijuana use". *New England Journal of Medicine* 370 (23), 2219–2227.

Ware, Mark A. et al. (2018). "Cannabis and the Health and Performance of the Elite Athlete". *Clin J Sport Med.* 28 (5), 480–484.

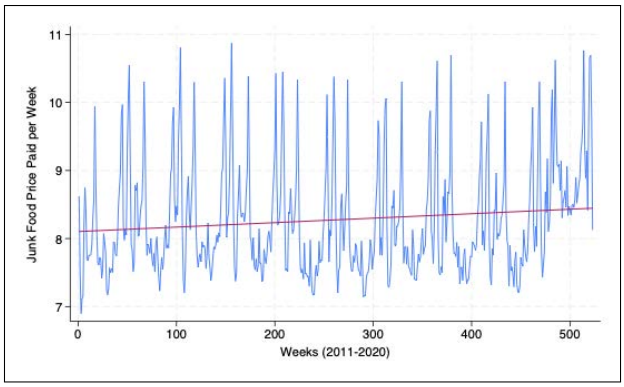
Wilson, William et al. (2000). "Brain morphological changes and early marijuana use: a magnetic resonance and positron emission tomography study". *Journal of addictive diseases* 19 (1), 1–22.

Winnail, S.D. et al. (1995). "Relationship between physical activity level and cigarette, smokeless tobacco, and marijuana use among public high school adolescents". *J Sch Health* 65 (10), 438–442.

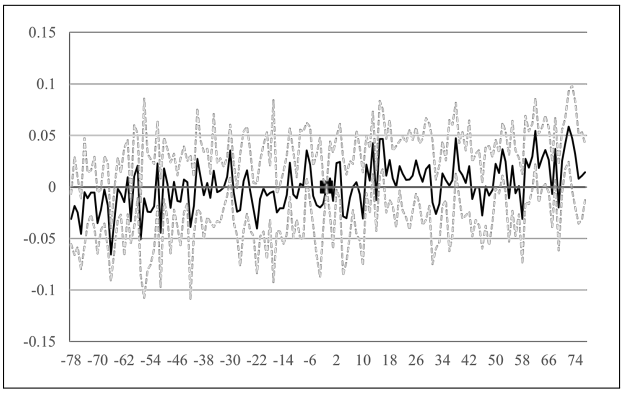
YorkWilliams, Sophie L. et al. (2019). "The New Runner's High? Examining Relationships Between Cannabis Use and Exercise Behavior in States With Legalized Cannabis". *Front Public Health* 7 (99).



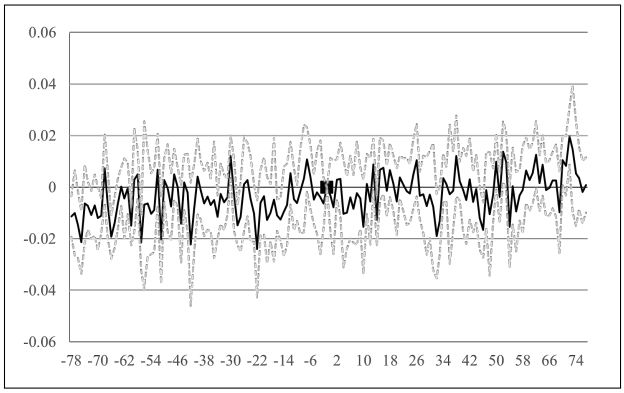
(a) All spending



(b) Spending on "junk foods"



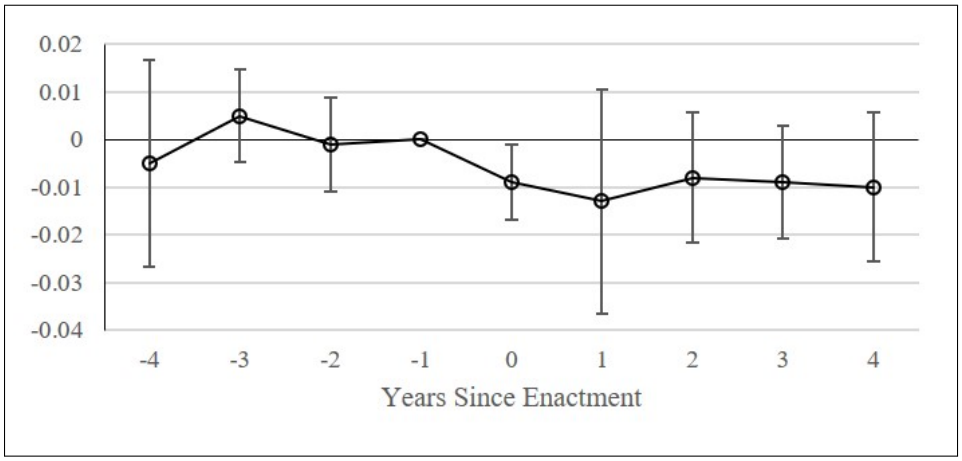
(c) Event Study: Spending on "junk foods"



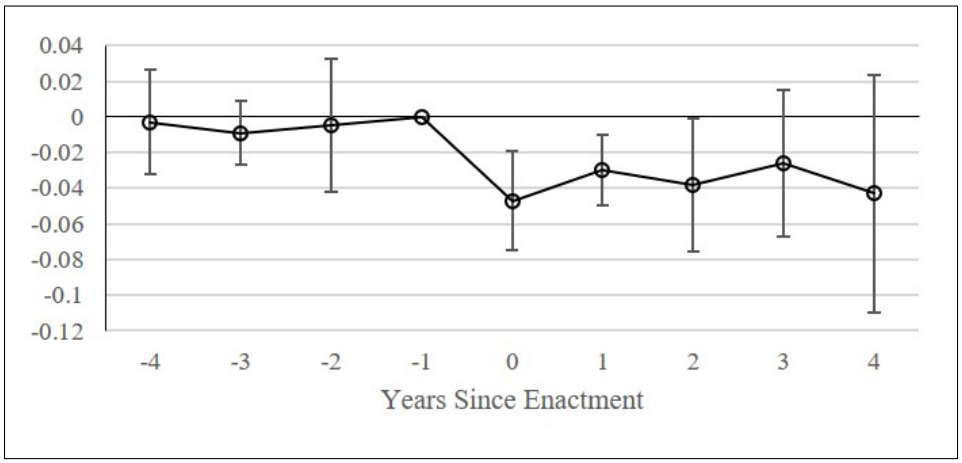
(d) Event Study: Trips with "junk foods"

Figure 1: Unadjusted and Event Study: NielsenIQ

Note: Panel (a) represents average weekly spending on all purchases, and panel (b) "junk food" purchases along with fitted trend line relative to all data. Panels (c) and (d) represent the stacked event study comparison between RML and non-RML states in an 18 month window around implementation for spending and trips. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start; covariates including percent population aged 20-24, percent with at least high school education, percent of married households at the county level, and week-year and county fixed effects. All estimates are weighted using an annual projection factor for the household. Period restricted to 18 months window around RML enactment. Standard errors are clustered at the state level and reflected with grey dashed lines around estimates. Source: NielsenIQ 2011-2020.



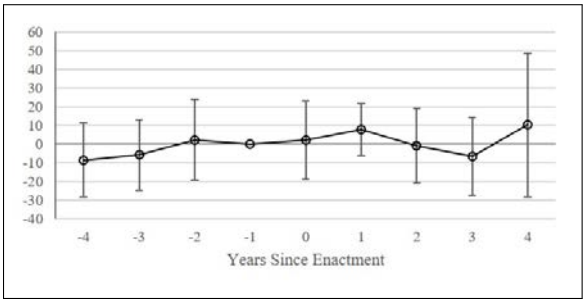
(a) Exercise last month



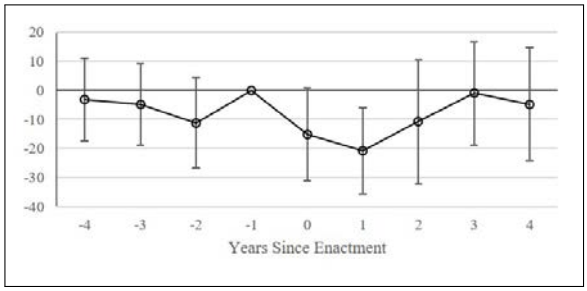
(b) Cardio at least once in prior week

Figure 2: BRFSS Event Study.

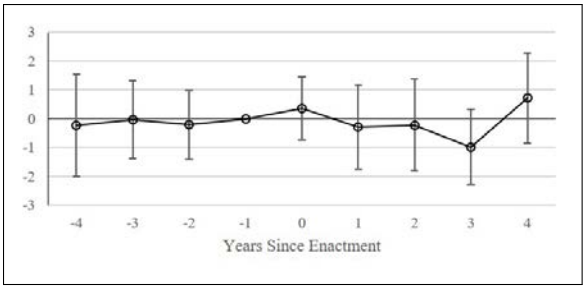
Note: Each point in the figure represents the difference between states with RML relative to those without relative to period prior to enactment. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, marital status, and fixed effects for month, year, and state of residence. Standard errors are clustered at the state level and adjusted with survey weights. 95% confidence intervals reported as band around point estimates. Source: BRFSS 2011-2021.



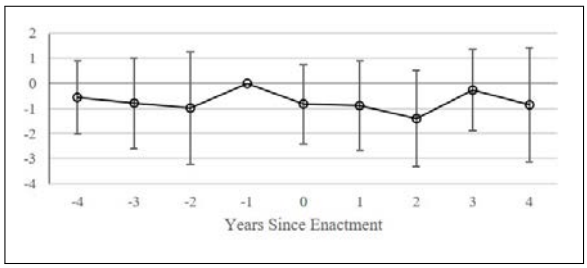
(a) Time at home



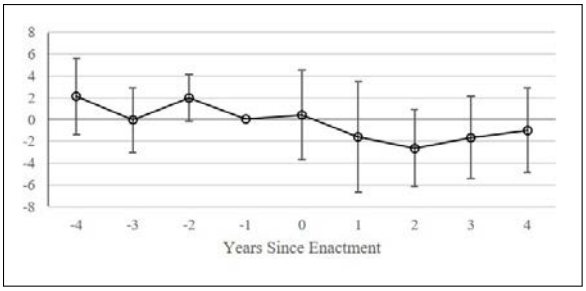
(b) Time at work



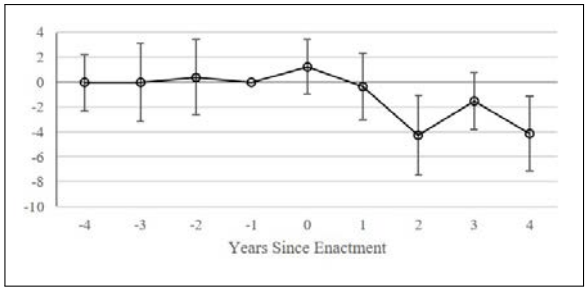
(c) Time at grocery store



(d) Time at gym



(e) Time spent outdoors



(f) Time at a restaurant or bar

Figure 3: ATUS Event Study.

Note: Each point in the figure represents the difference between states with RML relative to those without relative to period prior to enactment. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, marital status, and fixed effects for month, year, and state of residence. Standard errors are clustered at the state level. 95% confidence intervals reported as band around point estimates. Source: ATUS 2011-2021.

Table 1: MML and RML Effective and Sale Dates

State	MML Effective	MML Sales	RML Approved	RML Effective	RML Sales
Alabama	**5/17/2021**	-	-	-	-
Alaska	3/4/1999	-	**11/4/2014**	2/24/2015	10/29/2016
Arizona	4/14/2011	**12/6/2012**	**11/3/2020**	11/30/2020	**1/22/2021**
Arkansas	11/9/2016	**5/11/2019**	-	-	-
California	11/6/1996	**1/1/2018**	**11/9/2016**	11/9/2016	1/1/2018
Colorado	6/1/2001	**10/26/2011**	**11/6/2012**	12/10/2012	1/1/2014
Connecticut	**10/1/2012**	**8/20/2014**	**6/22/2021**	7/1/2021	**1/10/2023**
Delaware	**7/1/2011**	**6/26/2015**	**3/28/2023**	**4/23/2023**	**Late 2024**
District of Columbia	**1/1/2011**	**7/30/2013**	**11/4/2014**	2/26/2015	2/26/2015
Florida	**3/25/2016**	**7/26/2016**	-	-	-
Georgia	-	-	-	-	-
Hawaii	12/28/2000	**8/8/2017**	-	-	-
Idaho	-	-	-	-	-
Illinois	**1/1/2014**	**11/9/2015**	**6/25/2019**	1/1/2020	1/1/2020
Indiana	-	-	-	-	-
Iowa	-	-	-	-	-
Kansas	-	-	-	-	-
Kentucky	**1/1/2025**	-	-	-	-
Louisiana	**5/19/2016**	**8/6/2019**	-	-	-
Maine	12/22/1999	**3/2011**	**11/8/2016**	**1/30/2017**	**10/9/2020**
Maryland	**6/1/2014**	**12/1/2017**	**11/8/2022**	**7/1/2023**	**7/1/2023**
Massachusetts	1/1/2013	**6/24/2015**	**11/8/2016**	12/15/2016	11/20/2018
Michigan	12/4/2008	**08/2018**	**11/6/2018**	12/6/2018	12/1/2019
Minnesota	**5/29/2014**	**7/1/2015**	**5/30/2023**	**8/1/2023**	-
Mississippi	**2/2/2022**	**1/25/2023**	-	-	-
Missouri	**12/6/2018**	**10/17/2020**	**11/8/2022**	**12/8/2022**	**2/3/2023**
Montana	11/2/2004	**4/2018**	**11/3/2020**	1/1/2021	**1/1/2022**
Nebraska	-	-	-	-	-
Nevada	10/1/2001	**7/31/2015**	**11/8/2016**	1/1/2017	7/1/2017
New Hampshire	**7/23/2013**	**5/1/2016**	-	-	-
New Jersey	**1/18/10**	**12/6/2012**	**11/3/2020**	2/22/2021	**4/20/2022**
New Mexico	7/1/2007	**1/1/2010**	**4/12/2021**	6/29/2021	**4/1/2022**
New York	**7/5/2014**	**1/7/2016**	**3/31/2021**	3/31/2021	**12/29/2022**
North Carolina	-	-	-	-	-
North Dakota	**4/18/2017**	**3/1/2019**	-	-	-
Ohio	**9/8/2016**	**1/16/2019**	-	-	-
Oklahoma	**6/26/2018**	**10/26/2018**	-	-	-
Oregon	12/3/1998	**3/21/2014**	**11/4/2014**	7/1/2015	10/1/2015
Pennsylvania	**5/17/2016**	**2/15/2018**	-	-	-
Rhode Island	1/3/2006	**4/19/2013**	**5/25/2022**	**5/25/2022**	**12/1/2022**
South Carolina	-	-	-	-	-
South Dakota	**7/1/2021**	**7/27/2022**	-	-	-
Tennessee	-	-	-	-	-
Texas	-	-	-	-	-
Utah	**12/1/2018**	**3/2/2020**	-	-	-
Vermont	7/1/2004	**6/25/2013**	**1/22/2018**	7/1/2018	**10/1/2022**
Virginia	**7/1/2020**	**10/17/2020**	**4/7/2021**	7/1/2021	-
Washington	11/3/1998	**7/8/2014**	**11/6/2012**	12/6/2012	7/8/2014
West Virginia	**7/1/2019**	**11/12/2021**	-	-	-
Wisconsin	-	-	-	-	-
Wyoming	-	-	-	-	-

Notes: While there is some overlap between this table and the information provided in Anderson and Rees (2023), there are a number of notable differences; we separately identify MML effective dates and MML sales start dates, we include RML approval dates, and we update information that was unavailable at the time of their study. Differences are identified in bold.

Table 2: Summary Statistics

	(1) Total		(2) Ever RML		(3) Never RML	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A: Unhealthy Foods						
Junk Food Spending	8.274	12.31	8.278	12.62	8.272	12.20
Junk Food Trips (extensive)	0.676	0.468	0.661	0.473	0.682	0.466
Junk Food Trips (intensive)	1.108	1.117	1.073	1.103	1.120	1.121
Junk Food Type Spent						
Snacks	7.381	8.344	7.845	8.935	7.229	8.136
Chips	4.838	4.083	4.959	4.101	4.798	4.077
Cookies	5.032	4.961	5.240	5.145	4.967	4.901
Candy	7.408	9.833	7.728	10.42	7.302	9.630
Ice Cream	5.963	4.583	5.979	4.581	5.957	4.583
Panel B: Movement and Exercise						
1. Exercise last month						
Any exercise	0.742	0.437	0.767	0.423	0.725	0.447
Cardio At Least Once/Week	0.284	0.451	0.302	0.459	0.273	0.445
2. Time Spent at Location						
Home	504.7	276.5	505.7	275.2	503.9	277.5
Gym	3.001	18.50	3.439	20.00	2.663	17.25
Grocery Store	7.484	22.20	7.953	23.01	7.121	21.54
Restaurant-Bars	17.57	46.98	18.00	47.97	17.24	46.21
Work	134.9	237.8	132.4	235.0	136.9	239.8
Other's Home	40.75	115.8	40.46	115.6	40.97	115.9
Outdoors	12.95	52.30	14.79	54.42	11.53	50.56
3.Time Spent (Conditional on Activity)						
Home	519.0	266.8	519.7	265.6	518.4	267.7
Gym	83.52	52.91	84.78	54.42	82.31	51.39
Grocery Store	46.76	35.25	46.54	36.11	46.95	34.49
Restaurant-Bars	68.68	71.54	71.66	72.89	66.45	70.42
Work	490.9	175.9	488.9	172.2	492.3	178.7
Other's Home	178.1	184.7	182.1	185.4	175.3	184.1
Outdoors	85.37	108.8	84.95	105.1	85.78	112.5

Source: NielsenIQ (2011-2020), BRFSS (2011-2021), ATUS (2011-2021).
Notes: Column (1) includes observations from all states, column (2) includes states which have passed an RML in the period of analysis, and column (3) includes states which did not pass RML during the period of analysis. In Panel B3, time spent in location conditional on having spent any time on activity.

Table 3: NielsenIQ, Grocery Store Total Spent and Number of Trips

	(1)		(2)
	Coeff./SE		*Coeff./SE*
Panel A: Junk Food Spending			
Recreational Start	0.019*		0.018*
	(0.008)		(0.008)
Observations		20,511,172	
Dependent Mean		1.495	
Panel B: Junk Food Trips (Extensive)			
Recreational Start	0.006+		0.005+
	(0.003)		(0.003)
Observations		20,714,648	
Dependent Mean		0.679	
Panel C: Junk Food Trips (Intensive)			
Recreational Start	0.009***		0.008**
	(0.003)		(0.003)
Observations		20,608,759	
Dependent Mean		0.615	
Panel D: Trips			
Recreational Start	-0.003		-0.002
	(0.004)		(0.004)
Observations		20,546,010	
Dependent Mean		1.365	
Panel E: Total Paid			
Recreational Start	0.009		0.009
	(0.006)		(0.006)
Observations		20,510,072	
Dependent Mean		4.457	
Covariates	N		Y
Fixed Effects:			
State	N		Y
State by Month	N		Y

Source: NielsenIQ (2011-2020). Notes: The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. Column (2) adds state by month fixed effects and covariates including percent population aged 20-24, percent with at least high school education, percent of married households at the county level, and week-year and county fixed effects. All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. All estimates are weighted using an annual projection factor for the household. Period restricted to 18 months window around RML enactment. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table 4: NielsenIQ, Spending on Specific Categories of Food

	(1) *Coeff./SE*		(2) *Coeff./SE*
Panel A: Snacks			
Recreational Start	0.005		0.006
	(0.005)		(0.005)
Observations		7,370,396	
Dependent Mean		1.826	
Panel B: Chips			
Recreational Start	0.012*		0.012*
	(0.005)		(0.005)
Observations		5,792,909	
Dependent Mean		1.581	
Panel C: Cookies			
Recreational Start	0.007		0.007
	(0.005)		(0.005)
Observations		4,468,706	
Dependent Mean		1.583	
Panel D: Ice Cream			
Recreational Start	0.016*		0.018**
	(0.008)		(0.007)
Observations		2,670,658	
Dependent Mean		1.789	
Panel E: Candy			
Recreational Start	0.011		0.011+
	(0.007)		(0.007)
Observations		6,741,729	
Dependent Mean		1.757	
Covariates	N		Y
Fixed Effects:			
State	N		Y
State by Month	N		Y

Source: NielsenIQ (2011-2020). Notes: The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. Column (2) adds state by month fixed effects and covariates including percent population aged 20-24, percent with at least high school education, percent of married households at the county level, and week by year and county fixed effects. All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. All estimates are weighted using an annual projection factor for the household. Period restricted to 18 months window around RML enactment. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table 5: Advan Weekly Patterns, Visits to Specific Food Vendors (2019-2022)

	(1) *Coeff./SE*		(2) *Coeff./SE*
Panel A: Fast Food			
Recreational Start	-0.031+		-0.026
	(0.019)		(0.020)
Observations		566,472	
Dependent Mean		4.069	
Panel B: Convenience Food			
Recreational Start	-0.013		-0.004
	(0.020)		(0.023)
Observations		566,256	
Dependent Mean		2.821	
Panel C: Dollar Store			
Recreational Start	0.025		0.032
	(0.028)		(0.030)
Observations		566,105	
Dependent Mean		3.262	
Panel D: Grocery Store			
Recreational Start	0.032		0.039
	(0.029)		(0.031)
Observations		567,457	
Dependent Mean		3.172	
Covariates	N		Y
Fixed Effects:			
State	N		Y
State by Month	N		Y

Source: Advan (2019-2022). Notes: The outcome variables are the log of weekly visits to the specified business type. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. Column (2) adds state by month fixed effects and covariates including percent population aged 20-24, percent with at least high school education, percent of married households at the county level, and week-year and county fixed effects. All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. All estimates are weighted using the number of devices in the state. Period restricted to 18 months window around RML enactment. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table 6: BRFSS, Overall and by Gender (21+, 2011-2021)

	All		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)
	Coeff./SE	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*
Panel A: Exercise						
Recreational Start	-0.012***	-0.011***	-0.012***	-0.011***	-0.012***	-0.012***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Observations	4,636,990	4,256,949	1,812,955		2,443,994	
Dep. Mean	0.742	0.744	0.767		0.726	
Panel B: Cardio Week						
Recreational Start	-0.012+	-0.020**	-0.013*	-0.015**	-0.024**	-0.024**
	(0.006)	(0.006)	(0.006)	(0.005)	(0.008)	(0.008)
Observations	2,207,545	1,823,749	755,643		1,068,106	
Dep. Mean	0.284	0.286	0.277		0.293	
Covariates	N	Y	N	Y	N	Y
Fixed Effects:						
State	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Month	N	Y	N	Y	N	Y

Source: BRFSS (2011-2021). Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, demographic controls for age, sex, education, and marital status are identified by the last row. Standard errors are clustered at the state level and adjusted with survey weights (when available). Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table 7: ATUS, Overall and by Gender (21+, 2011-2021)

	All		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)
	Coeff./SE	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*
Panel A: Home						
Recreational Start	13.478***	8.368*	17.726***	13.779**	11.417***	3.402
	(2.820)	(3.541)	(4.247)	(5.158)	(3.161)	(3.658)
Observations	109,896		48,722		61,174	
Dep. Mean	504.7		485.7		519.8	
Panel B: Gym						
Recreational Start	-0.681***	-0.631**	-0.602*	-0.531*	-0.705**	-0.629*
	(0.147)	(0.208)	(0.294)	(0.259)	(0.229)	(0.262)
Observations	109,896		48,722		61,174	
Dep. Mean	3.001		3.635		2.497	
Panel C: Grocery Store						
Recreational Start	-0.078	-0.111	-0.123	-0.043	0.080	-0.127
	(0.213)	(0.276)	(0.232)	(0.280)	(0.268)	(0.403)
Observations	109,896		48,722		61,174	
Dep. Mean	7.484		5.945		8.709	
Panel D: Restaurant/Bar						
Recreational Start	-2.539***	-1.996***	-2.467***	-2.343***	-2.643***	-1.772***
	(0.493)	(0.454)	(0.672)	(0.702)	(0.586)	(0.533)
Observations	109,896		48,722		61,174	
Dep. Mean	17.57		18.98		16.45	
Panel E: Work						
Recreational Start	-9.387***	-5.981*	-16.134***	-12.533***	-5.786+	0.306
	(2.229)	(2.441)	(3.693)	(3.585)	(3.330)	(3.720)
Observations	109,896		48,722		61,174	
Dep. Mean	134.9		167.5		108.9	
Panel F: Outdoors						
Recreational Start	-2.501***	-2.724***	-1.863+	-1.839	-3.123***	-3.472***
	(0.543)	(0.598)	(1.052)	(1.162)	(0.498)	(0.574)
Observations	109,896		48,722		61,174	
Dep. Mean	12.95		15.24		11.13	
Panel G: Missing						
Recreational Start	1.893	1.724	0.043	-0.012	4.299**	3.534+
	(1.156)	(1.262)	(2.181)	(2.231)	(1.592)	(2.083)
Observations	109,896		48,722		61,174	
Dep. Mean	577.1		562.0		589.1	
Covariates	N	Y	N	Y	N	Y
Fixed Effects:						
State	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Month	N	Y	N	Y	N	Y

Source: ATUS (2011-2021). Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, demographic controls for age, sex, education, and marital status are identified by the last row. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

A Appendix

A.1 Stratification by Age

Table A1: BRFSS, by Age (2011-2021)

	(1) Age 21-24 *Coeff./SE*	(2) Age 25-39 *Coeff./SE*	(3) Age 40+ *Coeff./SE*
Panel A: Exercise			
Recreational Start	-0.013+	-0.009+	-0.012***
	(0.007)	(0.005)	(0.003)
Observations	141,861	692,735	3,422,353
Dependent Mean	0.834	0.809	0.727
Panel B: Cardio Week			
Recreational Start	-0.019	-0.017	-0.021**
	(0.012)	(0.007)	(0.006)
Observations	57,076	293,547	1,471,126
Dependent Mean	0.359	0.326	0.275
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y

Source: BRFSS (2011-2021).
Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level and adjusted with survey weights (when available). Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A2: ATUS, by Age (2011-2021)

	(1) Age 21-24 *Coeff./SE*	(2) Age 25-39 *Coeff./SE*	(3) Age 40+ *Coeff./SE*
Panel A: Home			
Recreational Start	6.556	19.039*	0.715
	(16.18)	(8.895)	(4.003)
Observations	3,794	28,595	77,507
Dep. Mean	387.1	436.7	535.6
Panel B: Gym			
Recreational Start	-7.560***	0.944+	-0.758***
	(1.711)	(0.515)	(0.213)
Observations	3,794	28,595	77,507
Dep. Mean	4.993	3.720	2.639
Panel C: Grocery Store			
Recreational Start	-4.214*	0.019	0.399
	(2.108)	(0.347)	(0.349)
Observations	3,794	28,595	77,507
Dep. Mean	5.540	7.415	7.604
Panel D: Restaurant/Bar			
Recreational Start	-14.875***	1.111	-2.124***
	(2.936)	(0.882)	(0.489)
Observations	3,794	28,595	77,507
Dep. Mean	22.66	19.86	16.48
Pacel E: Work			
Recreational Start	-15.72	-5.107	-2.463
	(14.40)	(7.787)	(2.182)
Observations	3,794	28,595	77,507
Dep. Mean	169.5	184.7	114.8
Panel F: Outdoors			
Recreational Start	-1.66	-7.965***	-0.590
	(2.936)	(1.387)	(0.648)
Observations	3,794	28,595	77,507
Dep. Mean	12.56	14.34	12.46
Panel G: Missing			
Recreational Start	13.57	-2.307	2.236
	(13.16)	(2.663)	(1.737)
Observations	3,794	28,595	77,507
Dep. Mean	610.0	577.0	5675.5
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y

Source: ATUS (2011-2021).
Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period

A.2 Staggered DID Implementation

Gardner (2022) employs a stacked regression structure, where each treated unit is compared to a not-yet-treated controls with fixed effects for each treated-control pair. Under the assumption of parallel trends and no anticipation, Gardner shows that this estimate is a convex weighted average of the group specific average treatment effects on treated.

We do not use the Callaway and Sant'Anna (2021) estimator, as we believe it does not reflect the structure of the data used in this analysis. Callaway and Sant'Anna uses only a single pre-period in estimation of treatment effect, and relies on parallel trends existing between the single pre-period and treatment period. Our analysis relies on multiple pre-periods which, in some datasets, are panel series with high time granularity. Therefore, the use of single period is detrimental to accurate measurement of ATE.

Table A3: NielsenIQ, TWFE and Gardner Results

	(1) TWFE *Coeff./SE*		(2) Gardner *Coeff./SE*
Panel A: Junk Food Spending			
Recreational Start	0.019*		0.020*
	(0.008)		(0.009)
Observations		20,511,303	
Dependent Mean		1.455	
Panel B: Junk Food Trips (Extensive)			
Recreational Start	0.006+		0.006+
	(0.003)		(0.003)
Observations		20,714,780	
Dependent Mean		0.665	
Panel C: Junk Food Trips (Intensive)			
Recreational Start	0.008*		0.008*
	(0.003)		(0.003)
Observations		20,608,891	
Dependent Mean		0.599	
Panel D: Trips			
Recreational Start	-0.003		-0.002
	(0.005)		(0.005)
Observations		20,546,142	
Dependent Mean		1.343	
Panel E: Total Paid			
Recreational Start	0.008		0.009
	(0.007)		(0.007)
Observations		20,510,204	
Dependent Mean		4.413	
Covariates	Y		Y
Fixed Effects:			
State	Y		Y
State by Month	N		N

Source: NielsenIQ (2011-2020).
Notes: The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). Column (1) uses a naive two-way fixed-effects (TWFE); column (2) uses staggered timing Gardner (2022) specification with week by year and county fixed effects. Each model controls for state shelter-in-place orders during pandemic onset, the period between MML and RML sales start, percent population aged 20-24, percent with at least high school education, and percent of married households at the county level. Period restricted to 18 months window around RML enactment. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A4: BRFSS, TWFE and Gardner Results

	All		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)
	TWFE	Gardner	TWFE	Gardner	TWFE	Gardner
	Coeff./SE	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*
Panel A: Exercise						
Recreational Start	-0.010+	-0.011*	-0.011	-0.011	-0.008	-0.011*
	(0.005)	(0.005)	(0.007)	(0.007)	(0.005)	(0.005)
Observations	4,256,949		1,812,955		2,443,994	
Dep. Mean	0.742		0.767		0.726	
Panel B: Cardio Week						
Recreational Start	-0.025*	-0.021	-0.023+	-0.018	-0.026**	-0.023+
	(0.011)	(0.014)	(0.014)	(0.017)	(0.009)	(0.013)
Observations	1,823,749		755,643		1,068,106	
Dep. Mean	0.284		0.277		0.293	
Covariates	Y	Y	Y	Y	Y	Y
Fixed Effects:						
State	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Month	N	Y	N	Y	N	Y

Source: BRFSS (2011-2021).
Notes: Columns (1), (3), and (5) use a naive two-way fixed-effects (TWFE) with month by year and state fixed effects; columns (2), (4), and (6) use staggered timing Gardner (2022) specification with month by year and state fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level and adjusted with survey weights (when available). Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A5: ATUS, TWFE and Gardner Results

	All		Male		Female	
	(1)	(2)	(3)	(4)	(5)	(6)
	TWFE	Gardner	TWFE	Gardner	TWFE	Gardner
	Coeff./SE	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*	*Coeff./SE*
Panel A: Home						
Recreational Start	5.734	7.681	5.537	13.491	5.551	2.265
	(5.186)	(7.204)	(8.660)	(8.326)	(5.625)	(10.37)
Observations	109,896		48,722		61,174	
Dep. Mean	480.2		457.2		501.4	
Panel B: Gym						
Recreational Start	-0.082	-0.577+	0.313	-0.437	-0.426	-0.611
	(0.245)	(0.302)	(0.441)	(0.413)	(0.377)	(0.377)
Observations	109,896		48,722		61,174	
Dep. Mean	3.468		4.025		2.953	
Panel C: Grocery Store						
Recreational Start	-0.144	-0.080	-0.119	0.056	-0.175	-0.164
	(0.363)	(0.648)	(0.456)	(0.597)	(0.526)	(0.926)
Observations	109,896		48,722		61,174	
Dep. Mean	6.701		5.066		8.212	
Panel D: Restaurant/Bar						
Recreational Start	-0.571	-2.002*	-0.103	-2.379	-1.151	-1.732
	(0.911)	(0.867)	(1.623)	(1.448)	(1.162)	(1.115)
Observations	109,896		48,722		61,174	
Dep. Mean	16.56		17.42		15.77	
Panel E: Work						
Recreational Start	-9.119+	-5.741	-13.882+	-12.575+	-3.918	0.850
	(4.962)	(5.024)	(7.988)	(7.530)	(4.569)	(4.619)
Observations	109,896		48,722		61,174	
Dep. Mean	180.6		218.3		145.8	
Panel F: Outdoors						
Recreational Start	-2.653**	-2.779***	-2.188	-1.876	-3.115***	-3.556**
	(0.883)	(0.773)	(1.423)	(1.589)	(0.888)	(1.227)
Observations	109,896		48,722		61,174	
Dep. Mean	12.16		13.98		10.47	
Covariates	Y	Y	Y	Y	Y	Y
Fixed Effects:						
State	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
Month	Y	Y	Y	Y	Y	Y

Source: ATUS (2011-2021).
Notes: Columns (1), (3), and (5) use a naive two-way fixed-effects (TWFE) with month by year and state fixed effects; columns (2), (4), and (6) use staggered timing Gardner (2022) specification with month by year and state fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

A.3 Varying Fixed Effects

Table A6: NielsenIQ, State by Month and State by Year Fixed Effects

	(1) *Coeff./SE*	(2) *Coeff./SE*
Panel A: Junk Food Spending		
Recreational Start	0.018*	0.021***
	(0.008)	(0.005)
Observations	20,511,172	19,691,432
Dependent Mean	1.495	1.498
Panel B: Junk Food Trips (Extensive)		
Recreational Start	0.005+	0.007***
	(0.003)	(0.002)
Observations	20,714,648	19,885,586
Dependent Mean	0.679	0.680
Panel C: Junk Food Trips (Intensive)		
Recreational Start	0.008**	0.007***
	(0.003)	(0.002)
Observations	20,608,759	19,782,364
Dependent Mean	0.615	0.6170
Panel D: Trips		
Recreational Start	-0.002	0.001
	(0.004)	(0.001)
Observations	20,546,010	19,722,574
Dependent Mean	1.365	1.366
Panel E: Total Paid		
Recreational Start	0.009	0.003
	(0.006)	(0.002)
Observations	20,510,072	19,688,776
Dependent Mean	4.457	4.457
Covariates	Y	Y
Fixed Effects:		
State	Y	Y
State by Month	Y	N
State by Year	N	Y

Source: NielsenIQ (2011-2020).
Notes: The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset, the period between MML and RML sales start, percent population aged 20-24, percent with at least high school education, and percent of married households at the county level. Pre-period trends are limited to 18 months of the state's RML sales date. All models are weighted by a projection factor of household representation annually. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A7: BRFSS, State by Month Fixed Effects

	(1) All *Coeff./SE*	(2) Male *Coeff./SE*	(3) Female *Coeff./SE*
Panel A: Exercise			
Recreational Start	-0.012***	-0.011***	-0.013***
	(0.003)	(0.003)	(0.003)
Observations	4,256,949	1,812,955	2,443,994
Dependent Mean	0.744	0.767	0.726
Panel B: Cardio Week			
Recreational Start	-0.014*	-0.010+	-0.018**
	(0.005)	(0.005)	(0.006)
Observations	1,823,749	755,643	1,068,106
Dependent Mean	0.286	0.277	0.293
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y
State by Month	Y	Y	Y

Source: BRFSS (2011-2021).
Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, marital status, and fixed effects for month, year, and state of residence. Standard errors are clustered at the state level and adjusted with survey weights (when available). Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A8: ATUS, State by Month Fixed Effects

	(1) All *Coeff./SE*	(2) Male *Coeff./SE*	(3) Female *Coeff./SE*
Panel A: Home			
Recreational Start	5.888	12.48*	0.954
	(3.811)	(5.769)	(3.932)
Observations	109,896	48,719	61,174
Dep. Mean	480.2	457.2	501.4
Panel B: Gym			
Recreational Start	-0.657**	-0.918**	-0.559*
	(0.215)	(0.284)	(0.271)
Observations	109,896	48,719	61,174
Dep. Mean	3.468	4.026	2.953
Panel C: Grocery Store			
Recreational Start	-0.083	-0.128	-0.072
	(0.257)	(0.274)	(0.352)
Observations	109,896	48,719	61,174
Dep. Mean	6.701	5.066	8.212
Panel D: Restaurant/Bar			
Recreational Start	-1.879***	-2.544***	-1.582**
	(0.449)	(0.726)	(0.545)
Observations	109,896	48,719	61,174
Dep. Mean	16.56	17.42	15.77
Pacel E: Work			
Recreational Start	-4.642+	-8.446***	1.248
	(2.556)	(3.827)	(4.132)
Observations	109,896	48,719	61,174
Dep. Mean	180.6	218.3	145.8
Panel F: Outdoors			
Recreational Start	-2.549***	-1.688	-3.201***
	(0.607)	(1.180)	(0.575)
Observations	109,896	48,719	61,174
Dep. Mean	12.16	13.98	10.47
Panel G: Missing			
Recreational Start	2.022	-0.537	4.081+
	(1.267)	(2.220)	(2.104)
Observations	109,896	48,719	61,174
Dep. Mean	569.2	555.0	582.2
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y
State by Month	Y	Y	Y

Source: ATUS (2011-2021).
Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

A.4 Additional Robustness Checks

Table A9: NielsenIQ, Non-COVID Years

	(1) Stay-at-Home *Coeff./SE*	(2) Excl. 2020 *Coeff./SE*
Panel A: Junk Food Spending		
Recreational Start	0.020*	0.020**
	(0.008)	(0.007)
Observations	20,511,172	18,633,381
Dependent Mean	1.495	1.492
Panel B: Junk Food Trips (Extensive)		
Recreational Start	0.006+	0.005
	(0.003)	(0.003)
Observations	20,714,648	18,439,806
Dependent Mean	0.679	0.680
Panel C: Junk Food Trips (Intensive)		
Recreational Start	0.009***	0.010***
	(0.003)	(0.003)
Observations	20,608,759	18,341,859
Dependent Mean	0.615	0.617
Panel D: Trips		
Recreational Start	-0.003	0.001
	(0.004)	(0.004)
Observations	20,546,010	18,287,278
Dependent Mean	1.365	1.368
Panel E: Total Paid		
Recreational Start	0.010+	0.012*
	(0.006)	(0.006)
Observations	20,510,072	18,258,662
Dependent Mean	4.457	4.448
Covariates	Y	Y
Fixed Effects:		
State	Y	Y
State by Month	N	N

Source: NielsenIQ (2011-2020).
Notes: Column (1) has an indicator stay-at-home states anytime in 2020; column (2) restricts the sample to exclude 2020. The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. Each model controls for the period between MML and RML sales start, percent population aged 20-24, percent with at least high school education, and percent of married households at the county level. Period restricted to 18 months window around RML enactment. All models are weighted by a projection factor of household representation annually. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A10: NielsenIQ, Varying Months

	(1)	(2)
	24 Months	30 Months
	Coeff./SE	*Coeff./SE*
Panel A: Junk Food Spending		
Recreational Start	0.021**	0.022***
	(0.008)	(0.007)
Observations	21,058,121	22,098,341
Dependent Mean	0.073	0.070
Panel B: Junk Food Trips (Extensive)		
Recreational Start	0.006+	0.006*
	(0.003)	(0.003)
Observations	21,267,380	22,319,135
Dependent Mean	0.022	0.021
Panel C: Junk Food Trips (Intensive)		
Recreational Start	0.008**	0.008**
	(0.003)	(0.003)
Observations	21,159,528	22,207,171
Dependent Mean	0.037	0.036
Panel D: Trips		
Recreational Start	-0.003	-0.005
	(0.004)	(0.004)
Observations	21,094,879	22,139,639
Dependent Mean	0.093	0.090
Panel E: Total Paid		
Recreational Start	0.012*	0.014*
	(0.006)	(0.006)
Observations	21,057,741	22,098,783
Dependent Mean	0.140	0.135
Covariates	Y	Y
Fixed Effects:		
State	Y	Y
State by Month	N	N

Source: NielsenIQ (2011-2020).
Notes: The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset, the period between MML and RML sales start, percent population aged 20-24, percent with at least high school education, and percent of married households at the county level. Period restricted 24 or 30 months around RML enactment as indicated. All models are weighted by a projection factor of household representation annually. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A11: ATUS, Percentage of Non-Missing Time

	(1) All *Coeff./SE*	(2) Male *Coeff./SE*	(3) Female *Coeff./SE*
Panel A: Home			
Recreational Start	1.079*	1.443**	0.781
	(0.435)	(0.530)	(0.483)
Observations	109,896	48,722	61,174
Dep. Mean	56.01	52.66	59.11
Panel B: Gym			
Recreational Start	-0.052*	-0.027	-0.065*
	(0.023)	(0.031)	(0.029)
Observations	109,896	48,722	61,174
Dep. Mean	0.398	0.463	0.339
Panel C: Grocery Store			
Recreational Start	-0.021	-0.001	-0.033
	(0.035)	(0.033)	(0.053)
Observations	109,896	48,722	61,174
Dep. Mean	0.793	0.593	0.978
Panel D: Restaurant/Bar			
Recreational Start	-0.214***	-0.221**	-0.217***
	(0.051)	(0.078)	(0.062)
Observations	109,896	48,722	61,174
Dep. Mean	1.916	1.979	1.858
Panel E: Work			
Recreational Start	-0.589*	-1.231**	0.022
	(0.269)	(0.410)	(0.424)
Observations	109,896	48,722	61,174
Dep. Mean	19.74	23.56	16.21
Panel F: Outdoors			
Recreational Start	-0.311***	-0.195	-0.409***
	(0.067)	(0.128)	(0.065)
Observations	109,896	48,722	61,174
Dep. Mean	1.403	1.589	1.232
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y

Source: ATUS (2011-2021).
Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A12: NielsenIQ, Border Analysis

	(1) Excl. Border Counties *Coeff./SE*		(2) Non-RML States *Coeff./SE*
Panel A: Junk Food Spending			
Recreational Start	0.018*		0.017*
	(0.008)		(0.008)
Observations		19,262,479	
Dependent Mean		1.494	
Panel B: Junk Food Trips (Extensive)			
Recreational Start	0.005		0.005
	(0.003)		(0.003)
Observations		19,453,249	
Dependent Mean		0.678	
Panel C: Junk Food Trips (Intensive)			
Recreational Start	0.008**		0.007*
	(0.003)		(0.001)
Observations		19,354,563	
Dependent Mean		0.614	
Panel D: Trips			
Recreational Start	-0.003		-0.002
	(0.004)		(0.004)
Observations		19,295,339	
Dependent Mean		1.365	
Panel E: Total Paid			
Recreational Start	0.008		0.008
	(0.007)		(0.06)
Observations		19,261,138	
Dependent Mean		4.457	
Covariates	N		Y
Fixed Effects:			
State	Y		Y
State by Month	N		N

Source: NielsenIQ (2011-2020). Notes: The outcome variables are the log of total weekly household spending on junk food (panel a), probability of taking a trip that includes junk food (b), log of weekly household trips involving junk food purchases (c), log of all weekly household trips (d), and the log of weekly total household purchase price spent (e). All models use Borusyak et al. (2024) estimation method which integrates county and week by year fixed effects. Covariates include state shelter-in-place orders during pandemic onset, the period between MML and RML sales start, percent population aged 20-24, percent with at least high school education, and percent of married households at the county level. All estimates are weighted using an annual projection factor for the household before applying the specified differencing estimation. Period restricted to 18 months window around RML enactment. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A13: BRFSS, Border Analysis

	(1) All *Coeff./SE*	(2) Male *Coeff./SE*	(3) Female *Coeff./SE*
Panel A: Exercise			
Recreational Start	-0.001	0.006+	-0.007*
	(0.003)	(0.003)	(0.003)
Observations	2,212,828	927,425	1,285,403
Dependent Mean	0.727	0.749	0.707
Panel B: Cardio Week			
Recreational Start	-0.016*	-0.012	-0.019**
	(0.007)	(0.008)	(0.007)
Observations	975,573	397,982	577,591
Dependent Mean	0.261	0.258	0.264
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y

Source: BRFSS (2011-2021). Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level and adjusted with survey weights (when available). Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.

Table A14: ATUS, Border Analysis

	(1) All *Coeff./SE*	(2) Male *Coeff./SE*	(3) Female *Coeff./SE*
Panel A: Home			
Recreational Start	-3.040	-5.548	-0.509
	(2.678)	(9.014)	(4.138)
Observations	50,305	21,805	28,439
Dep. Mean	483.5	459.5	505.2
Panel B: Gym			
Recreational Start	0.755**	0.929**	0.609
	(0.268)	(0.332)	(0.415)
Observations	50,305	21,805	28,439
Dep. Mean	2.999	3.165	2.841
Panel C: Grocery Store			
Recreational Start	-0.110	-0.091	-0.164
	(0.322)	(0.341)	(0.415)
Observations	50,305	21,805	28,439
Dep. Mean	6.514	4.632	8.214
Panel D: Restaurant/Bar			
Recreational Start	0.611	0.596	0.378
	(1.098)	(2.029)	(1.315)
Observations	50,305	21,805	28,439
Dep. Mean	16.28	16.85	15.77
Panel E: Work			
Recreational Start	-3.232	-9.926**	4.675
	(2.333)	(5.056)	(3.537)
Observations	50,305	21,805	28,439
Dep. Mean	179.7	220.3	142.8
Panel F: Outdoors			
Recreational Start	-0.442	-3.267	1.392
	(1.280)	(2.544)	(0.762)
Observations	50,305	21,805	28,439
Dep. Mean	10.84	12.84	8.978
Covariates	Y	Y	Y
Fixed Effects:			
State	Y	Y	Y
Year	Y	Y	Y
Month	Y	Y	Y

Source: ATUS (2011-2021). Notes: All models use Borusyak et al. (2024) estimation method which integrates state and month by year fixed effects. Each model controls for state shelter-in-place orders during pandemic onset and the period between MML and RML sales start. In addition, each specification includes demographic controls for age, sex, education, and marital status. Standard errors are clustered at the state level. Symbols denote significance at the 0.5% (***), 1% (**), 5% (*), and 10% (+) levels.