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IZA DP No. 17501

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ABSTRACT

Born at the Right Time: Examining the Effect of Relative Age on Mental Health in Adulthood*

This paper examines the understudied effect of relative age on mental health in adulthood. Our empirical analysis utilizes nationwide Finnish register-based data on mental health, encompassing a spectrum of conditions from severe to less severe mental health problems. To identity causal effects, we employ a regression discontinuity design centered around the January 1 cutoff. We find that being born at the start of the year leads to better mental health outcomes. Notably, these effects, primarily influenced by relative school starting age, are driven by women in their late twenties.

JEL Classification: I10, I14, I31, J13

Keywords: relative age, mental health, education, school starting age, children

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1 Introduction

Extensive literature shows that students who start school older relative to their peers have better academic performance. This effect, known as the relative age effect (RAE), is also observed in other outcomes, including mental health. For example, the relatively young are more likely to be diagnosed with attention deficit hyperactivity disorder (ADHD) (Brault et al., 2022; Chen et al., 2021) and are also more frequently prescribed antidepressant medication.[1] While these differences in mental health outcomes are well established for children and adolescents, there is practically no evidence of the prevalence of these effects in adulthood.

Our paper addresses this gap in the literature by being the first to analyze the causal long-term effects of relative age on mental health in early adulthood. We utilize the existing exogenous variation in school starting age, resulting from the school entry cutoff date in the Finnish education system (January 1), and estimate a regression discontinuity design (RDD) using detailed population-wide Finnish administrative register data.

The potential impact of relative age on mental health in adulthood should not be overlooked. According to Patalay et al. (2015) childhood symptoms of anxiety and depression have plausibly long-lasting consequences, as they are often precursors of adult depression and psychopathology. Given that poor mental health in adulthood contributes to increased absenteeism, reduced work efficiency, hindered career advancement (Bubonya et al., 2017), and even leads to disability pension claims (Eläketurvakeskus, 2024), studying and understanding the underlying causes of these issues is crucial. From a societal perspective, addressing gaps in mental health research is also increasingly important, as mental health has a significant long-term impact on health care spending and overall well-being (Layard, 2013).

The Finnish register-based data provide a unique opportunity to study the effects of relative age on mental health in adulthood. The detailed data on mental health from the Social Insurance Institution of Finland (Kela) and the Finnish Institute for Health and Welfare (THL) include comprehensive records of all prescription drug purchases and inpatient hospital visits related to mental

[1] An overview of the literature is provided in Appendix Table A.1.3.

disorders. Prescription records include information on all dispensed mental health-related medications from Finnish pharmacies, along with the corresponding Anatomical Therapeutic Chemical (ATC) classification codes. Hospitalization data include all mental health-related inpatient visits covered by the national health insurance system-—practically all such visits-—and also include the International Classification of Diseases (ICD) codes. Therefore, these data allow us not only to examine overall mental health medication use and inpatient visits but also to analyze different types of medications and specific reasons for inpatient visits separately.

Another notable advantage that our data provide is that, for each cohort in our study, we have data through ages 18—34, thus allowing us to follow individuals well into early adulthood. Based on our data, 70% of mental health problems observed by the age of 43 are diagnosed by age 34 (see also Pedersen et al., 2014, for related Danish evidence), making our age group highly relevant in terms of mental well-being over the life cycle.

Our evidence shows that women born at the beginning of the year have more favorable mental health outcomes in early adulthood than those born prior to the new year. This overall effect is driven by a statistically significant reduction of 1.5 percentage points (4.9%) in the probability of using depression medication. We also observe that relatively older women are 0.5 percentage points (21.7%) less likely to be hospitalized because of depression, which indicates a clear reduction in more severe forms of depression. Our heterogeneity analyses reveal that these effects begin appearing after the age of 23 and are mainly driven by women whose parents have secondary education. Interestingly, we observe no effect on men's mental health outcomes.

To gain understanding of the underlying mechanisms driving the observed gender gap in mental health, we estimate the RAEs on a few variables that might act as intermediates to see whether they also differ based on gender. We find that relatively older women have 2.6% higher grade point averages (GPAs) at the end of primary schooling (age 16), whereas for men the corresponding effect is 1.4%. Relatively older women are also 3.7% more likely to complete a higher education degrees than relatively younger women, while no such effect is found for men. Overall, our findings suggest that the RAE is stronger for women than for men and that, although the exact source

of these gender differences eludes our analysis, it is likely that the observed educational attainment and achievement differences are also likely to contribute to the gender differences in mental health outcomes.

As our study provides new insights into the literature on the RAE and mental health, by being the first to examine the long-term effects of relative age in adulthood, comparing our estimates with those in previous literature is challenging. Nevertheless, the existing literature indicates that the relatively young are more likely to experience various mental health-related disorders during youth (e.g., Rose and Barlow, 2023). In particular, they face increased peer-related problems (Patalay et al., 2015; Broughton et al., 2022), and have poorer overall mental health (e.g., Fumarco et al., 2020; Duncan et al., 2022; Dee and Sievertsen, 2018), although the effect size tends to be generally small (Rose and Barlow, 2023). Thus, while direct comparison with the results of the earlier literature is challenging because of differing variables, methodologies and age, our results are consistent with those of earlier research in both direction and, in the case of medicine purchases, magnitude. Meanwhile, our estimated reduction in inpatient care is substantial compared to the effects in previous literature.

We also contribute to the literature on the long-term effects of relative age. The limited existing research on this question has primarily focused on career-related outcomes, with findings suggesting that the relatively old tend to achieve greater success in their working careers (Du et al., 2012) and are more likely to assume leadership positions (Dhuey and Lipscomb, 2008). Evidence of the long-term effects of school starting age on educational attainment and earnings is inconclusive (Black et al., 2011; Fredriksson and Öckert, 2014). Our results suggest that mental health outcomes also demonstrate RAEs in adulthood, which could be related to other long-term outcomes, such as labor market outcomes or educational attainment. Deducing the direction of causality is beyond the scope of this study, but it presents a promising avenue for future research.

The rest of this paper is structured as follows. Section 2 describes the institutional background and introduces the administrative data. Section 3 presents the descriptive statistics. Section 4 outlines our empirical approach based on the RDD, while Section 5 reports the estimation results.

Section 6 concludes the paper and provides a further discussion of the results.

2 Institutional background and data

2.1 Age-based entry in Finnish schools

In Finland, children begin mandatory education in August of the calendar year in which they turn seven.[2] As a result, children born in December start their mandatory (primary) education nearly one year younger than those born at the beginning of the next calendar year. Until recently, mandatory education lasted until individuals either completed their lower secondary education, typically lasting nine years, or until they reached the age of 16.[3] Thus, individuals born at the end of the calendar year graduate from mandatory education approximately one year younger than those born just a little bit later at the beginning of the following calendar year. The vast majority of students ($>90\%$) then proceed directly into either vocational (40%) or academic (50%) secondary education.

2.2 Data

We utilize several Finnish population-wide register datasets linked using encrypted social security numbers provided by Statistics Finland. The primary data source we employ is the Longitudinal Population Census Files from Statistics Finland. The data are available from 1956 onwards and include information on individuals' exact dates of birth and death, as well as their gender. Information on native tongue is obtained from the Population Structure Statistics. We also incorporate additional administrative data from Statistics Finland, which include demographic and educational information on completed degrees. Information on parents is based on parent–child links, allowing us to analyze the effects by parental education.

For mental health outcomes, we use register-based measures that capture a wide range of diag-

[2] For more details on the Finnish education system, see Ministry of Education and Culture (2022).
[3] In 2021, mandatory education was expanded to include secondary education and ages 7–18 years.

nosed conditions, from severe to mild, providing a comprehensive view of adult mental health. The data on mental health are sourced from two institutions: Kela and THL. The data from Kela consist of all dispensed mental health-related medications at Finnish pharmacies (1995–2020), coded under the World Health Organization's ATC system as N05, N06A, N06B, or N06C (see Appendix Table A.1.1). These data provide individual-level prescriptions reimbursed under national health insurance and cover all citizens of Finland. The reimbursement amount varies by medication but usually ranges from 40% to 100% of the price for mental health-related medications. These data provide information on whether an individual purchased specific medication and detail the cost of the medication and the quantity repurchased. Thus, these data enable us not only to analyze whether individuals purchased medications for mental health disorders but also to estimate associated medication costs.

From the THL, we use the Finnish Care Register for Health Care (1972–2018), which contains data on all mental health-related inpatient visits covered by the national health insurance system (Sund, 2012). The insurance system covers all citizens, with practically all hospitalizations in the public sector. In our analysis, the hospitalization variable measures whether an individual had at least one inpatient hospitalization spell resulting from mental health-related disorders based on the International Statistical Classification of Diseases and Related Health Problems (ICD-10: F, ICD-8 and ICD-9: 290–319) (see Appendix Table A.1.2). We examine the specific conditions related to depression as a separate category.

Together, these two datasets from Kela and the THL enable the examination of a wide range of mental health issues across different types and severity levels, providing a comprehensive overview of individuals' mental health in adulthood.

3 Estimation sample and descriptive statistics

As our aim is to study how birth dates affect individuals' mental health in adulthood, we focus only on individuals born between 1976 and 1986. Furthermore, as our empirical approach relies

Table 1: Descriptive statistics for cohorts born from 1976 to 1986.

	Women		Men	
Born in	January–June	July–December	January–June	July–December
	(1)	(2)	(3)	(4)
Finnish mother tongue	0.944	0.947	0.941	0.945
	(0.229)	(0.223)	(0.234)	(0.228)
Parents with basic education	0.340	0.355	0.340	0.353
	(0.474)	(0.479)	(0.474)	(0.478)
Parents with secondary education	0.372	0.362	0.370	0.363
	(0.483)	(0.481)	(0.483)	(0.481)
Parents with tertiary education	0.284	0.280	0.286	0.280
	(0.451)	(0.449)	(0.452)	(0.449)
Grade average in ninth grade	7.933	7.828	7.283	7.186
	(1.296)	(1.299)	(1.350)	(1.357)
Children by age 33	0.545	0.573	0.419	0.446
	(0.498)	(0.495)	(0.493)	(0.497)
Using mental health-related medicine (ages 18–34)	0.362	0.370	0.271	0.278
	(0.481)	(0.483)	(0.444)	(0.448)
Observations	163,514	156,237	172,017	162,891

Note: The cells present the mean and standard deviation (in parentheses) of the variable in each subgroup. The total number of observations is 654,659. The means of parental education do not add up to 100% because some parents have missing information.

on comparing those born just before January 1 to those born just after that, we exclude individuals born in the first half of 1976 or the second half of 1986. This ensures that there are individuals on both sides of the January 1 cutoff for any given year in our sample. We further restrict the sample to Finnish and Swedish speakers, as immigrants with missing identification details are often artificially assigned a birth date of January 1 in their birth years, which would compromise our identification strategy. These restrictions result in a sample of 654,659 individuals in whom we can observe mental health medication purchases between ages 18 and 34 and hospitalizations for ages 18–32. In our main estimations, we estimate the effects separately for men (N = 334,908) and women (N = 319,751) due to substantial gender differences in the prevalence of mental health problems, which are higher among women (Figure A.2.1a).

Table 1 presents the descriptive mean estimates for the samples, both at the beginning and at the end of the calendar year, starting from the means of relevant background variables and followed by a few outcome variables. The figures show that both of our estimation samples consist primarily of

native Finnish speakers, with the most common parental education level being secondary education, accounting for approximately 36%–37% of each sample, followed closely by basic education at around 34%–35%. Meanwhile, women appear to have over half a grade better overall grades than men at the end of ninth grade, and are also around 27%–30% more likely to have children by the age of 33. However, they also appear to be approximately 10 percentage points more likely to have purchased any mental health-related medicines than men, who have around 27% likelihood.

Meanwhile, for both genders, those born at the beginning of the year and those born at the end of the year are fairly similar in terms of their background characteristics, although those born later in the year tend to have slightly less educated parents than those born earlier. Those born later in the year also have slightly lower grade averages in the ninth grade. Moreover, they are slightly more likely to purchase mental health-related medication between the ages of 18 and 34.

4 Empirical approach and validity

4.1 The model

Our estimation strategy is based on the cutoff created by January 1. In practice, we compare individuals born just after January 1 to those born just before it. In other words, we employ an RDD, where the (centralized) running variable, r_{ik}, represents the closest distance of an individual's birthdate to January 1. July is used to separate different birth year cohorts from one another, ensuring that discontinuity occurs in the middle of the redefined cohort year.[4]

Using the centralized running variable, our estimation model has the following structure:

$$Y_{ik} = \delta_k + \alpha Z_{ik} + (1 - Z_{ik}) f_0(r_{ik}) + Z_{ik} f_1(r_{ik}) + \epsilon_{ik}, \tag{1}$$

where Y_{ik} represents the outcome variable for individual i in cohort year k. δ_k accounts for cohort-

[4] As a result, individuals born in March 1977, for example, are placed in the same cohort year (cohort year 1977) as those born in September 1976. This approach to cohort redefinition has been utilized previously by Fredriksson and Öckert (2014) and Black et al. (2011).

specific fixed effects, and Z_{ik} is an indicator that equals 1 if the individual is born after January 1 and 0 if born before it in the same cohort year. $f_0(r_{ik})$ and $f_1(r_{ik})$ identify the slopes of the running variable on either side of the calendar year, with the slopes specific to each cohort.[5] Finally, ϵ_{ik} denotes the heteroskedasticity-robust error terms. Equation 1 is estimated using nonparametric local linear regression with triangular kernel weights that are calculated using optimal bandwidths, obtained using a fixed bandwidth of 60 days.[6] Following the approach by Silliman and Virtanen (2022), the average outcome below the cutoff is estimated by substituting the outcome variable with $Y_{ik}(1 - Z_{ik})$ and the treatment indicator with $(1 - Z_{ik})$ in Equation 1.

Fredriksson and Öckert (2014) and Black et al. (2011) use the school entry cutoff as an instrument for school starting age based on a fuzzy RDD approach. In our analysis, we focus on the reduced-form estimates based on Equation 1 because we do not observe the school starting age in our data. As a result, we employ a sharp RDD. While we could theoretically use graduation age from primary school as a proxy for school starting age, this approach would be problematic because being born early versus late in the year could affect the likelihood of grade repetition, which would also violate the exclusion restriction.

4.2 Internal validity of the estimates

For our results to be interpreted causally, our RDD setup needs to be internally valid. We use several approaches to evaluate this. First, we visually inspect the distribution of observations around the cutoff point. The histograms presented in Appendix Figures A.2.3a and A.2.3b show that the distribution of observations appears to flow fairly smoothly around the January 1 cutoff, lending credibility to our causal inference. To further examine this, we estimate the distributional changes at the cutoff, with the results presented in the second to last rows of Table 2. According to these results, there are no major differences in the distribution of observations for both men and women, although there appears to be a small, significant increase for men. However, there is

[5] These slopes are interacted with cohort indicators.

[6] This corresponds to the average of the outcome-specific optimal bandwidths, calculated as proposed by Calonico et al. (2014).

no clear reason why this effect would appear for men but not for women. Regardless, to ensure the robustness of our results, we estimate a donut version of our RDD estimates by excluding observations within seven days on either side of the cutoff. These results are presented in Appendix Table A.1.6 and show that while estimates unsurprisingly turn out to be less precise, they remain relatively close to our main estimates, thereby enhancing the credibility of our findings.

Second, we check the balance of covariates around the cutoff point. The covariate balance is reported in Table 2. Encouragingly, we find only very little evidence of covariate imbalance at the cutoff, as the estimates are very small, and none indicate a discontinuity at the 5% significance level. This further supports the internal validity of our empirical approach. Third, we estimate the main results while adding these background characteristics into our empirical specification. These results are presented in Table A.1.5 and, as one would expect in the case of a valid model, they show that our results do not change much. As an additional robustness check, we also estimate the effects using half (30 days) and double (120 days) the optimal bandwidth of 60 days (Appendix Table A.1.7 and Figures A.2.2a and A.2.2b). As can be seen from these results, the estimates are

Table 2: Estimated discontinuities in background characteristics.

Covariate	Women	Men
Finnish mother tongue	0.001	0.003
	(0.002)	(0.004)
Parents with basic education	0.008	-0.001
	(0.008)	(0.010)
Parents with secondary education	-0.011*	0.000
	(0.006)	(0.009)
Parents with tertiary education	0.001	0.000
	(0.006)	(0.007)
Parental information missing	0.002*	0.000
	(0.001)	(0.001)
Density	0.0000	0.0002**
	(0.0001)	(0.0001)
Observations	99,366	103,783

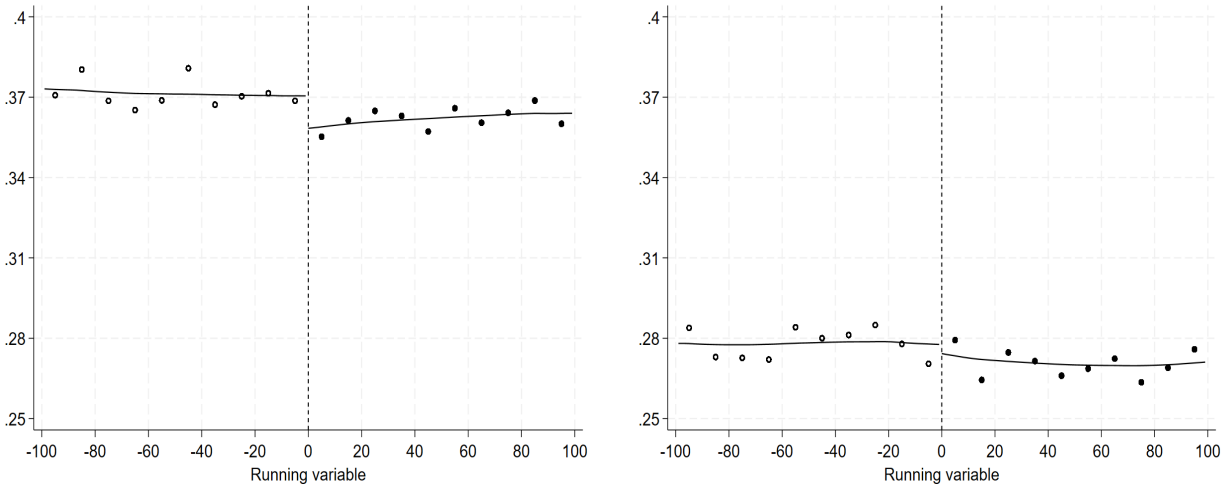
Note: Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. Density differences are estimated using the *rddensity* command in Stata and optimal bandwidths.

reasonably robust with respect to the choice of bandwidth, thereby further enhancing the credibility of our conclusions.

5 Results

5.1 Main estimates

We begin our analysis by plotting the cumulative probability of mental health-related drug purchases, measured between ages 18 and 34, against the distance in days from January 1 in Figure 1. The figure shows a visually clear reduction in the probability of drug purchases for women. For men, we find no clear effect.



(a) Women

(b) Men

Note: Graphs plot the probability within 100 days of the new-year cutoff. The dots depict the sample means for each bin, with a binwidth of 10. The lines represent local linear regressions, weighted using edge kernel and bandwidth 100.

Figure 1: Bingraphs for the probability of women and men having purchased mental health-related medicine between ages 18 and 34.

We then estimate the impact of relative age on cumulative mental health-related outcomes, measured between ages 18 and 34, separately for men and women. We use the specification in Equation 1. These results are presented in Table 3, where the first three columns report the results

for all mental health-related medicine purchases, their costs, and the likelihood of hospitalization, while the last two focus on depression-related purchases and hospitalizations.

Table 3: Birth cohorts 1977–1986. Cumulative medicine-related results for ages 18–34 and hospitalizations for ages 18–32.

	All mental health related			Depression related	
	Cum P(Drug purchase)	Cum cost	Cum P(Hospital-ization)	Cum P(Drug purchase)	Cum P(Hospital-ization)
	(1)	(2)	(3)	(4)	(5)
Women					
Born after January 1	-0.013	20.536	-0.002	-0.015**	-0.005***
	(0.008)	(28.814)	(0.003)	(0.007)	(0.001)
Mean below	0.370	400.332	0.049	0.305	0.023
Observations	99,366	99,366	99,366	99,366	99,366
Men					
Born after January 1	0.004	-52.801	-0.004	0.002	0.001
	(0.007)	(57.077)	(0.005)	(0.005)	(0.002)
Mean below	0.273	550.516	0.069	0.210	0.013
Observations	103,783	103,783	103,783	103,783	103,783

Note: Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Intriguingly, while we do not observe an effect on overall medicine purchases or hospitalization likelihood for either gender, the estimates provide evidence of a causal link between birth timing and reduced depression-related mental health or treatment needs for women, with no corresponding evidence for men. Notably, the cumulative results reveal that women born after the January 1 cutoff point have statistically significantly lower rates of both depression-related mental health drug purchases and the probability of hospitalization for depression-related reasons.[7]

The quantitative magnitude of the effects is substantial, particularly concerning hospitalizations. The results show that being born early in the calendar year reduces a woman's likelihood of purchasing depression-related mental health drugs by 4.9% and the probability of hospitalization for depression-related reasons between ages 18 and 34 by 21.7%.

[7]We have also estimated these effects separately for different types of medicine. These results are presented in Appendix Table A.1.4.

5.2 Heterogeneity analyses

To better understand the sources of these effects, we have estimated the main effects based on different parental education levels as well as annually for ages 18–34. The estimates for the former are shown in Table 4 and reveal that again, regardless of parental education level, no statistically significant effects are observed for men. We also find no effects for women whose parents have only primary education. Our main results for women appear to be driven by those whose parents have secondary education and, in the case of medicine purchases, by those whose parents have higher education. For the former group of women, the effect of being born early in the year decreases the likelihood of purchasing depression-related medicine by around 6.9% and the likelihood of depression-related hospitalizations by 36%. This finding contrasts with that of Fredriksson and Öckert (2014), who find that the effects of school starting age are greater for individuals with low-educated parents than for individuals with high-educated parents.

Meanwhile, Figures 2a–3b illustrate the annual estimates for purchases of mental health, and specifically depression medications. For women, these estimates are at first close to zero or even slightly positive but turn negative after age 23, indicating that women born at the beginning of the year are less likely to purchase any mental health-related, and specifically depression-related medications from their mid-twenties onward. For men, the estimates generally remain close to zero for most of the period; however, after age the of 30, they tend to be more clearly positive and achieve statistical significance in some instances. However, caution should be used when interpreting these results for men, as they appear to be quite sensitive to bandwidth selection (unlike those for women; see Appendix Figures A.2.2a and A.2.2b).

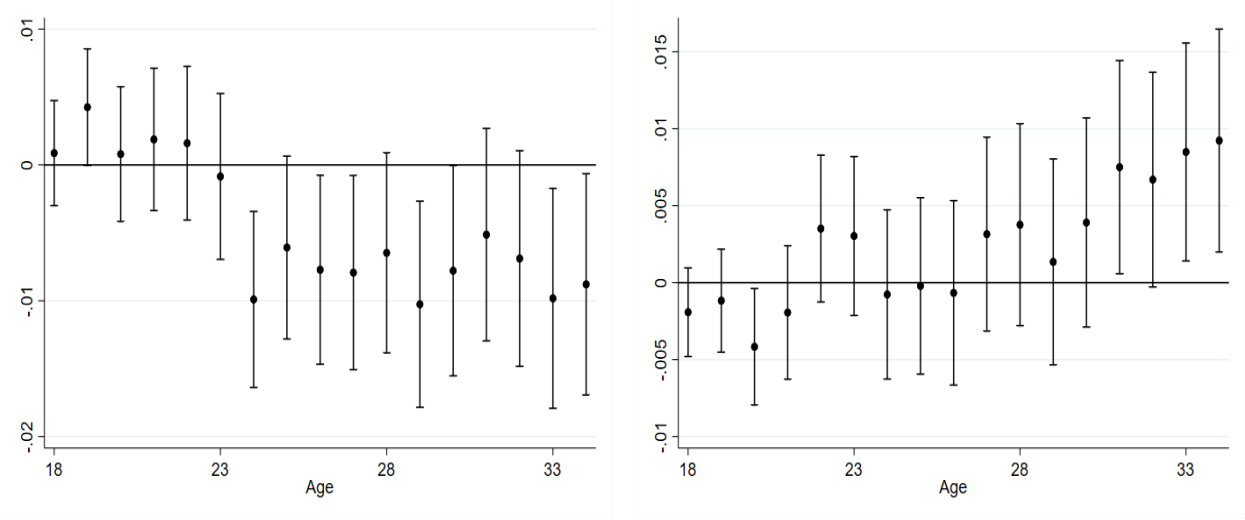
5.3 Potential mechanisms

Identifying our results' underlying mechanisms and causes is challenging, as intermediate outcomes may be interconnected with mental health and other unobservable factors. Thus, determining whether any observable effect differences between men and women in terms of intermediate outcomes are the true causal channel is difficult. Nevertheless, such an analysis provides insights

Table 4: Birth cohorts 1977–1986. Cumulative results for ages 18–34 (18–32 for hospitalizations) by parental education.

	All mental health related			Depression related	
	Cum P(Drug purchase)	Cum cost	Cum P(Hospitalization)	Cum P(Drug purchase)	Cum P(Hospitalization)
	(1)	(2)	(3)	(4)	(5)
Parents with primary education					
Women					
Born after January 1	-0.009	42.336	-0.006	-0.007	-0.002
	(0.013)	(50.150)	(0.005)	(0.013)	(0.002)
Mean below	0.380	404.395	0.058	0.316	0.023
Observations	34,943	34,943	34,943	34,943	34,943
Men					
Born after January 1	0.005	-75.545	-0.012	0.002	-0.004
	(0.011)	(65.318)	(0.008)	(0.009)	(0.003)
Mean below	0.289	628.672	0.088	0.230	0.018
Observations	36,159	36,159	36,159	36,159	36,159
Parents with secondary education					
Women					
Born after January 1	-0.011	-14.428	-0.001	-0.021**	-0.009***
	(0.009)	(38.551)	(0.003)	(0.008)	(0.003)
Mean below	0.369	419.992	0.049	0.306	0.025
Observations	36,232	36,232	36,232	36,232	36,232
Men					
Born after January 1	-0.001	-39.536	0.004	0.001	0.005
	(0.009)	(63.686)	(0.005)	(0.009)	(0.003)
Mean below	0.268	507.827	0.063	0.199	0.011
Observations	38,002	38,002	38,002	38,002	38,002
Parents with tertiary education					
Women					
Born after January 1	-0.019**	41.010	0.003	-0.017**	-0.002
	(0.010)	(62.639)	(0.005)	(0.007)	(0.004)
Mean below	0.359	374.030	0.037	0.291	0.018
Observations	27,882	27,882	27,882	27,882	27,882
Men					
Born after January 1	0.009	-40.825	-0.004	0.003	0.004
	(0.007)	(83.140)	(0.004)	(0.005)	(0.003)
Mean below	0.261	517.605	0.055	0.200	0.010
Observations	29,212	29,212	29,212	29,212	29,212

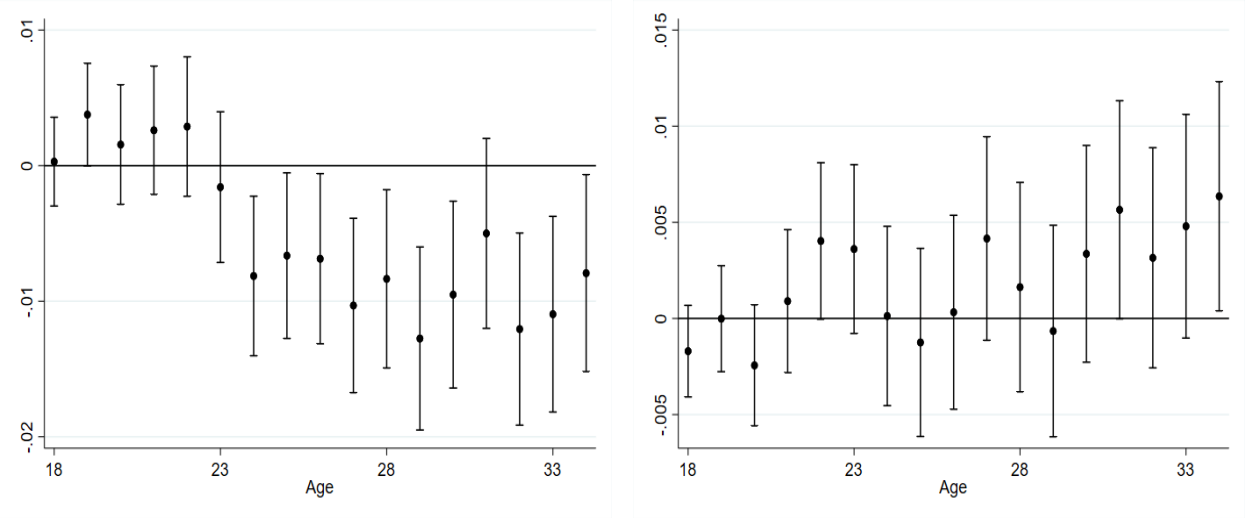
Note: Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. Parental education refers to the highest level of education attained by either parent.



(a) Women (b) Men

Note: The estimates are computed using Equation 1 and a fixed bandwidth of 60 days. Vertical lines present 90% confidence intervals of the estimates.

Figure 2: Probability of mental health-related medicine purchases. Annual results for birth cohorts 1977–1986.



(a) Women (b) Men

Note: The estimates are computed using Equation 1 and a fixed bandwidth of 60 days. Vertical lines present 90% confidence intervals of the estimates.

Figure 3: Probability of depression-related medicine purchases. Annual results for birth cohorts 1977–1986.

into the factors influencing our results, but caution is warranted in interpretation.

We have studied the impact of our cutoff on four different outcomes, thus enhancing our understanding of the potential mechanisms. The results are reported in Table 3 and begin with the estimates on individuals' ages at the end of their ninth grade (i.e., the end of compulsory school-

ing).[8] The results reported in the first column of Table 3 show that being born after January 1 increases compulsory school leaving age by three-quarters of a year for men and 0.85 years for women, from the average age of 15.3 years for men and 15.1 for women. Hence, on average, it appears that school starting age rules are not as clearly reflected in the graduation age for men as they are for women. This difference could arise from men repeating grades more often than women do or that men born late in the year have the start of their compulsory schooling more often postponed then their female counterparts. Unfortunately, we do not observe grade repetition or school starting age in our data so we cannot disentangle these effects.

Table 5: Potential mechanisms.

	Age in ninth grade	Grade average in ninth grade	Higher education degree	Children by age 33
	(1)	(2)	(3)	(4)
Women				
Born after January 1	0.848***	0.202***	0.019***	-0.015*
	(0.003)	(0.030)	(0.003)	(0.008)
Mean below	15.110	7.778	0.518	0.566
Observations	96,521	95,752	99,366	99,366
Men				
Born after January 1	0.741***	0.101***	-0.011	-0.015**
	(0.010)	(0.024)	(0.007)	(0.006)
Mean below	15.267	7.197	0.350	0.446
Observations	100,417	99,626	103,783	103,783

Note: The grade scale is from 4 to 10. Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Next, we estimate the effects on their grades. The second column shows that being born after January 1 increases women's GPA by 2.6% from 7.78 and men's GPA by 1.4% from 7.20. In other words, the effects on grades appear to be greater for women than for men. Intriguingly, the estimates in column (3) show that women also appear to be the only ones benefiting in terms of education level, as their likelihood of gaining tertiary education increases by 1.9 percent points from the 51.8% baseline. Meanwhile, the estimates for men are statistically insignificant and on the negative side.

[8] Note that the sample size is slightly smaller in columns (1) and (2) because some individuals are not observed at this grade level. For instance, because of grade retention, some reach age 16 before progressing to this grade and may opt out of school. Moreover, in some cases, the relevant grade data are unavailable.

Lastly, we estimated the effects on the likelihood of having children by the age of 33.[9] In case of both men and women, we find that being born at the beginning of the year decreases the likelihood of having a child by that age by around 1.5 percentage points. These findings suggest that being born early in the year may have a modest delaying effect on family formation for both genders, although in terms of relative effects, this impact appears to be larger for men than for women.

During the period covered by our data, there were no significant educational reforms that could have influenced our results. To further evaluate whether our findings are influenced by a particular cohort year, we have tested the sensitivity of our main estimates by excluding each cohort year separately from the analysis. The results are reported in Appendix Table A.1.8. As shown, these estimates, while shifting slightly, remain largely consistent with our baseline results and do not alter our main conclusions.

Overall, it appears that by being born at the beginning of the year, women gain more than men in terms of relative age and school grade at the end of ninth grade, as well as in terms of educational attainment. It is likely that educational attainment and achievement play a role in explaining discrepancy in the effects of relative age on mental health for men and women. However, with the data at our disposal, we cannot specify whether this difference is derived from earlier schooling years or from differences in higher educational attainment.

6 Conclusions

An individual's birth month may influence life outcomes by determining their relative age within peer groups, particularly in educational settings. Empirical research on the effects of relative age has predominantly focused on educational attainment and earnings, generally finding positive effects of being born at the beginning of the year on education outcomes. Meanwhile, evidence of the effects of relative age on mental health outcomes remains scarce and has primarily focused on

[9] Fertility outcomes are only available until 2019.

childhood and early adolescence, although these effects may very well extend into adulthood. Considering that mental health issues among adults are increasingly prevalent (WHO, 2022) and poor mental health is one of the two leading causes of disability pension in Finland (Eläketurvakeskus, 2024), identifying the underlying determinants of mental health, not only during childhood but also in adulthood is crucial.

To address this important but understudied topic, we analyzed the causal impacts of being born early in the year on mental health outcomes in adulthood by utilizing nationwide register-based data from Finland. Our identification strategy was based on an RDD centered around the January 1 cutoff. We focused on the cumulative impacts at ages 18–34 for cohorts born between 1977 and 1986.

We show that individuals born at the beginning of the year generally experience more favorable mental health outcomes in adulthood. These effects are particularly evident in the reduced use of depression medication and are most pronounced among women in their late twenties and especially among those whose parents have secondary education. The findings add a significant dimension to the understanding of the long-term effects of birth timing on mental health outcomes. Our results are helpful in informing future educational and health policies, particularly highlighting the importance of age- and gender-specific strategies. Our findings on potential channels and mediating factors suggest that educational achievement and attainment could be important determinants of an individual's mental health. Exploring the potential mediating role of mental health in educational attainment and labor market outcomes thus offers a promising future research avenue.

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A Additional tables and figures

A.1 Tables

Table A.1.1: Mental Health Medication Classification.

ATC Code	Description
N05 Psychosis Medication	
N05A Antipsychotics	Drugs with antipsychotic actions (i.e., neuroleptics)
N05B Anxiolytics	Preparations used in the treatment of neuroses and psychosomatic disorders associated with anxiety and tension (e.g., benzodiazepines)
N05C Hypnotics and sedatives	Preparations with mainly sedative or hypnotic actions. Melatonin receptor agonists are also classified in this group.
N06 Depression Medication and Central Nervous System Stimulants	
N06A Antidepressants	Preparations used in the treatment of endogenous and exogenous depression
N06B Psychostimulants	Psychostimulants, and agents used for ADHD and nootropics
N06C Psycholeptics and psychoanaleptics in combination	Combinations of, for example, antidepressants and anxiolytics are classified in this group, including Aldazine drug combinations.

Source: https://fimea.fi/en/databases_and_registers/atc-codes and https://atcddd.fhi.no/atc/application_for_atc_codes/

Table A.1.2: Reasons for mental health hospitalization and related ICD-10 codes.

Reason	Related ICD-10 codes
Dementia	F0
Schizophrenia	F20
Other non-affective psychosis	F22–F25, F28, F29
Bipolar disorder	F30, F31
Depression	F32, F33, F341
Anxiety and stress-related and neurotic disorders	F40–F42, F430, F431
Alcohol use-related mental health problem	F10
Substance use-related mental health problem	F1

Note: For hospitalizations prior to 1996, ICD-9 and ICD-8 codes are used. We also include hospitalizations resulting from self-harm attempts into our main hospitalization outcome, which are recorded as independent, external causes of hospitalization (ICD-10: X60–X84, ICD-8, and ICD-9: E950–E959).

Table A.1.3: Overview of the literature on the effects of relative age on mental health.

Author(s) and publication year	Sample	Data sources for outcome variables	Key findings
Rose and Barlow (2023)	59 studies, 76% based on samples from Western Europe and America	Systematic review	The relatively young are more likely to have more negative behavior, mental well-being, and social experiences. Effect sizes are consistently small for all outcomes.
Urruticoechea et al. (2021)	21 studies using data from 24 countries	Systematic review	The relatively young have lower mean scores in cognitive and motor tests and higher rates of repetition and dropout. They also have lower self-esteem and more maladaptive behaviors. RAEs tend to diminish with age.
Brault et al. (2022)	1,783 children from kindergarten to grade 6 in Canada	Questionnaire on parents' and teachers' behavior identification or suspicion of ADHD	The proportion of children with ADHD diagnosis is two times higher among relatively younger children. However, this is explained mostly by the medicalization of immature behaviors. There is no RAE for medication intake.
Broughton et al. (2022)	14,643 individuals between 4 and 25 years old in the UK	Parent-rated SDQ and self- and parent-rated SMFQ	Being relatively young is associated with poorer parent-rated general mental health, including emotional problems and peer problems, but not with symptoms of depression. The RAE is strongest at age 11 and attenuates to null at age 25.
Chen et al. (2021)	9,548,393 children and adolescents between 3 and 17 years old in Taiwan	Diagnoses of ADHD, DD, anxiety disorder, and depressive disorder and prescriptions of ADHD and antidepressant medication	Relatively young children are more likely to receive ADHD, DD, anxiety disorder, and depressive disorder diagnoses and are more likely to be exposed to ADHD medication and antidepressants. The RAE is also present in the long-term use of medication. Boys have a stronger RAE on diagnoses and long-term antidepressant use. The RAE peaks during preschool but diminishes with age.
Dee and Sievertsen (2018)	8,092 children at ages 7 and 11 in Denmark	Parent-rated SDQ	Delaying kindergarten entry leads to improvements in mental health and reduces the overall "difficulties" score through the inattention/hyperactivity construct of the SDQ.
Duncan et al. (2022)	49,921 students between 13 and 18 years old in Canada	Self-report surveys of depressive symptoms, anxiety symptoms, and psychosocial well-being	There are no significant differences in depression or anxiety scores. The youngest relative birth quarter had significantly lower scores in psychosocial well-being, but the difference is quantitatively very small. Null findings may be the result of a sample with a higher average age than in many other studies.
Fumarco et al. (2020)	379,524 students between 10 and 17 years old in 32 countries	International Health Behaviour in School-Aged Children survey	An increase in relative age improves life satisfaction and self-rated general health, and decreases psychosomatic complaints and chances of being overweight. Only the gaps in life satisfaction are reduced with an increased absolute age and only in countries, where students are first tracked at age 14 or later.
Patalay et al. (2015)	23,379 students between 11 and 13 years old in the UK	Self-rated SDQ	The relatively younger have more emotional symptoms and peer problems, but the effect sizes are small. They also have a higher risk of internalizing symptoms, including symptoms of anxiety and depression. The RAEs are stronger for younger cohorts.

Abbreviations: RAE, Relative age effect; DD, Disruptive behavior disorder; SDQ, Strengths and Difficulties Questionnaire; SMFQ, Short Mood and Feelings Questionnaire.

Table A.1.4: Birth cohorts 1977–1986. Cumulative results (ages 18–34) by medication class.

	N05A Antipsychotics	N05B Anxiolytics	N05C Hypnotics and sedatives	N06A Antidepressants	N06B Psychostimulants	N06C Drug combinations (Aldazine)
Women						
Born after January 1	-0.002	-0.006*	-0.002	-0.015**	-0.001	0.000
	(0.004)	(0.003)	(0.003)	(0.007)	(0.001)	(0.001)
Mean below	0.077	0.135	0.134	0.305	0.008	0.015
Observations	99,366	99,366	99,366	99,366	99,366	99,366
Men						
Born after January 1	0.005	0.003	0.004	0.002	-0.000	0.000
	(0.003)	(0.004)	(0.004)	(0.005)	(0.001)	(0.001)
Mean below	0.077	0.099	0.111	0.210	0.011	0.009
Observations	103,783	103,783	103,783	103,783	103,783	103,783

Note: See Table A.1.1) for description of the ATC Codes. Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table A.1.5: Birth cohorts 1977–1988. Cumulative results for ages 18–34. Added background characteristics.

	All mental health related			Depression related	
	Cum P(Drug purchase)	Cum cost	Cum P(Hosp.)	Cum P(Drug purchase)	Cum P(Hosp.)
Women					
Born after January 1	-0.013*	20.521	-0.002	-0.015**	-0.005**
	(0.007)	(32.170)	(0.003)	(0.006)	(0.002)
Mean below	0.370	400.384	0.049	0.305	0.023
Observations	99,366	99,366	99,366	99,366	99,366
Men					
Born after January 1	0.004	-53.449	-0.004	0.002	0.001
	(0.006)	(45.301)	(0.003)	(0.006)	(0.002)
Mean below	0.273	550.809	0.069	0.210	0.013
Observations	103,783	103,783	103,783	103,783	103,783

Note: Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table A.1.6: Birth cohorts 1977–1988. Cumulative results with donut RDD.

	All mental health related			Depression related	
	Cum P(Drug purchase)	Cum cost	Cum P(Hospitalization)	Cum P(Drug purchase)	Cum P(Hospitalization)
Women					
Born after January 1	-0.005	-4.276	-0.001	-0.012	-0.003
	(0.009)	(41.782)	(0.003)	(0.008)	(0.002)
Mean below	0.367	419.368	0.048	0.303	0.020
Observations	88,186	88,186	88,186	88,186	88,186
Men					
Born after January 1	-0.007	-72.147	-0.001	-0.006	0.002
	(0.007)	(59.685)	(0.003)	(0.006)	(0.001)
Mean below	0.275	534.819	0.066	0.212	0.013
Observations	91,999	91,999	91,999	91,999	91,999

Note: Seven days are excluded from the data prior and after the new year cutoff. Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table A.1.7: Birth cohorts 1977–1986. Cumulative results using bandwidths of 30 and 120.

	All mental health related			Depression related	
	Cum P(Drug purchase)	Cum cost	Cum P(Hospitalization)	Cum P(Drug purchase)	Cum P(Hospitalization)
Bandwidth 30					
Women					
Born after January 1	-0.016	35.270	-0.004	-0.016	-0.006***
	(0.014)	(38.154)	(0.004)	(0.013)	(0.002)
Mean below	0.370	394.840	0.050	0.305	0.024
Observations	48,517	48,517	48,517	48,517	48,517
Men					
Born after January 1	0.015	-51.259	-0.004	0.010	0.002
	(0.009)	(69.071	(0.006)	(0.007)	(0.002)
Mean below	0.266	568.156	0.070	0.205	0.014
Observations	50,732	50,732	50,732	50,732	50,732
Bandwidth 120					
Women					
Born after January 1	-0.012***	-21.316	-0.003*	-0.012***	-0.005***
	(0.004)	(19.717)	(0.002)	(0.004)	(0.001)
Mean below	0.370	432.757	0.051	0.304	0.023
Observations	208,087	208,087	208,087	208,087	208,087
Men					
Born after January 1	-0.005	-64.424*	-0.003	-0.005	0.001
	(0.006)	(35.372)	(0.003)	(0.003)	(0.001)
Mean below	0.278	544.518	0.068	0.214	0.013
Observations	217,493	217,493	217,493	217,493	217,493

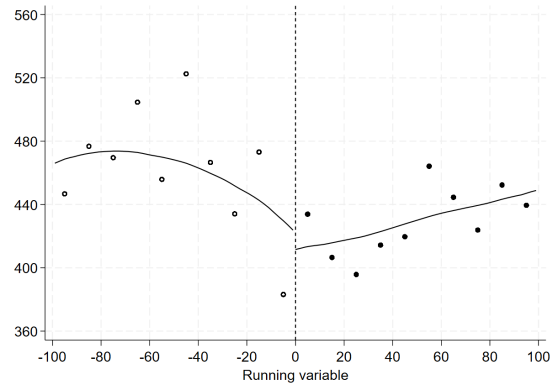
Note: Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

Table A.1.8: Cumulative results on medicine and hospitalization probabilities while dropping a cohort year.

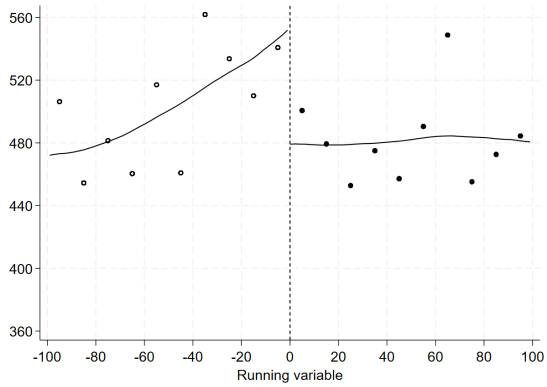
		Women				Men			
		All mental health related		Depression related		All mental health related		Depression related	
		Cum P(Drug purchase)	Cum P(Hosp.)	Cum P(Drug purchase)	Cum P(Hosp.)	Cum P(Drug purchase)	Cum P(Hosp.)	Cum P(Drug purchase)	Cum P(Hosp.)
Dropped cohort year:									
1977									
	Born after January 1	-0.017**	-0.003	-0.019***	-0.005***	0.004	-0.001	0.003	0.002
		(0.007)	(0.003)	(0.007)	(0.001)	(0.007)	(0.004)	(0.006)	(0.002)
1978									
	Born after January 1	-0.013	-0.001	-0.016**	-0.004***	0.001	-0.005	-0.000	0.001
		(0.009)	(0.003)	(0.008)	(0.001)	(0.006)	(0.005)	(0.005)	(0.002)
1979									
	Born after January 1	-0.013	-0.001	-0.017**	-0.005***	0.001	-0.007**	-0.001	0.000
		(0.009)	(0.003)	(0.008)	(0.001)	(0.007)	(0.003)	(0.005)	(0.001)
1980									
	Born after January 1	-0.008	0.001	-0.011*	-0.004***	0.002	-0.005	0.001	0.001
		(0.007)	(0.002)	(0.007)	(0.001)	(0.007)	(0.005)	(0.006)	(0.002)
1981									
	Born after January 1	-0.014*	-0.002	-0.015*	-0.005***	0.005	-0.003	0.002	0.001
		(0.009)	(0.003)	(0.008)	(0.001)	(0.007)	(0.005)	(0.006)	(0.002)
1982									
	Born after January 1	-0.011	-0.002	-0.013*	-0.005***	0.005	-0.004	0.004	0.001
		(0.009)	(0.003)	(0.008)	(0.001)	(0.007)	(0.005)	(0.006)	(0.002)
1983									
	Born after January 1	-0.008	-0.002	-0.012	-0.004***	0.008	-0.004	0.005	0.002
		(0.008)	(0.003)	(0.007)	(0.001)	(0.006)	(0.005)	(0.005)	(0.002)
1984									
	Born after January 1	-0.013	-0.003	-0.015*	-0.005***	0.007	-0.003	0.004	0.002
		(0.009)	(0.003)	(0.008)	(0.001)	(0.007)	(0.005)	(0.006)	(0.002)
1985									
	Born after January 1	-0.013	-0.001	-0.014*	-0.005***	0.003	-0.002	0.002	0.002
		(0.009)	(0.003)	(0.008)	(0.001)	(0.007)	(0.005)	(0.006)	(0.002)
1986									
	Born after January 1	-0.016*	-0.002	-0.018**	-0.004***	0.003	-0.003	0.002	0.002
		(0.008)	(0.003)	(0.007)	(0.001)	(0.007)	(0.005)	(0.006)	(0.002)

Note: Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

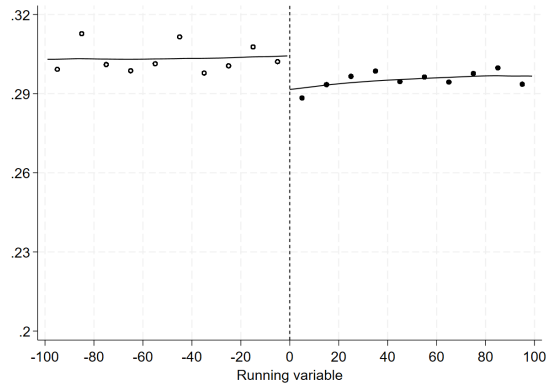
A.2 Figures



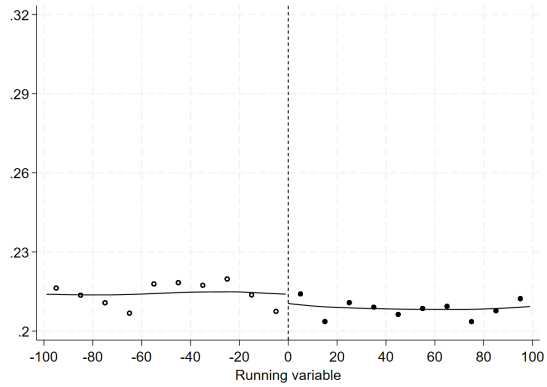
(a) Mental health medicine cost - Women



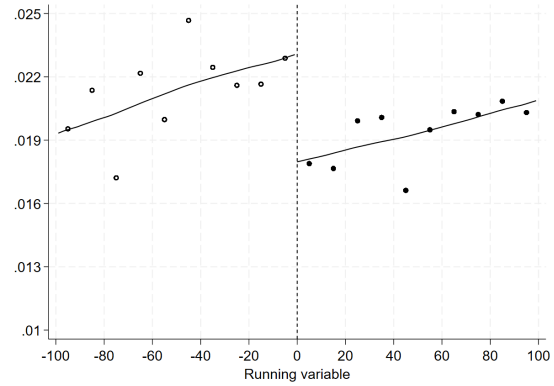
(b) Mental health medicine cost - Men



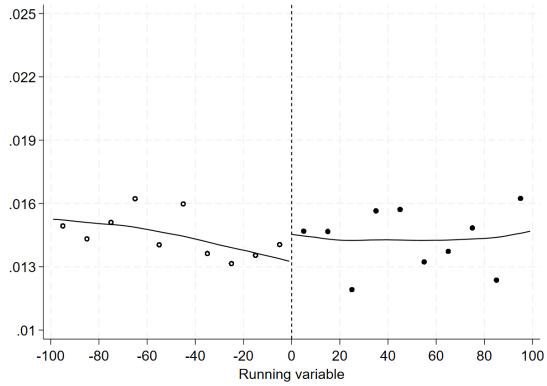
(c) Depression-related medicine - Women



(d) Depression-related medicine - Men

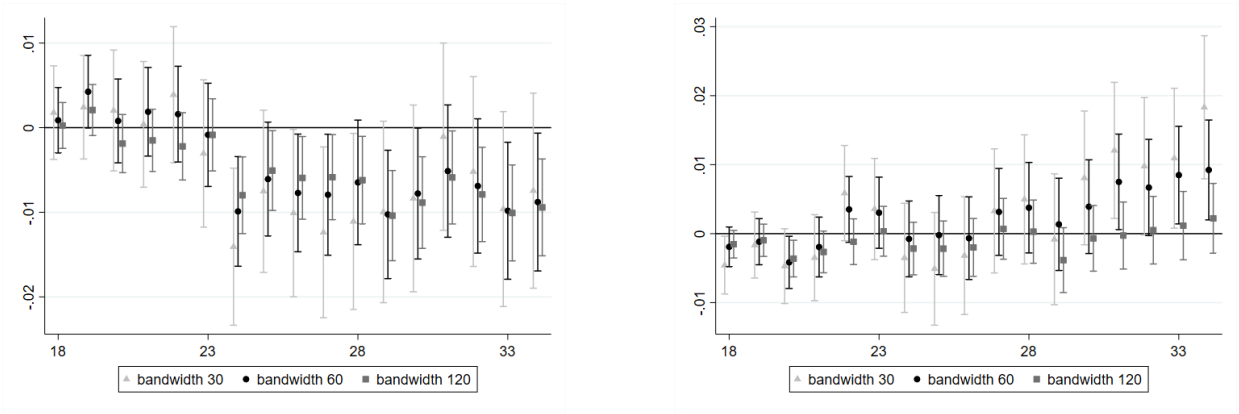


(e) Hospitalized for depression-related reasons - Women



(f) Hospitalized for depression-related reasons - Men

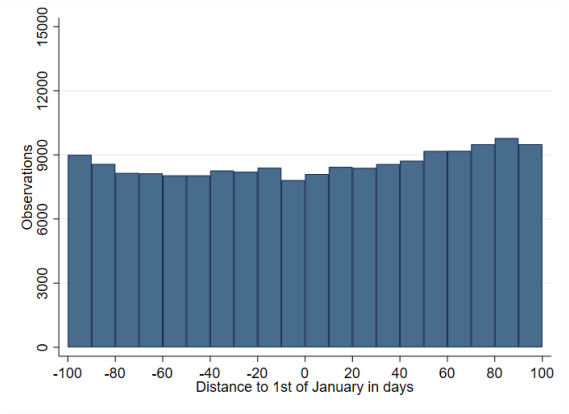
Figure A.2.1: Bingraphs within 100 days of the new year cutoff, The binwidth is set at 10 days.



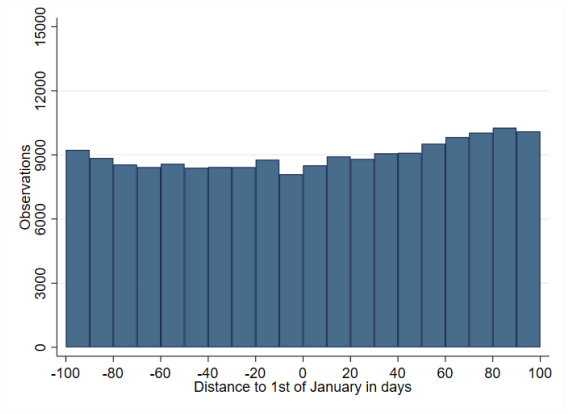
(a) Women

(b) Men

Figure A.2.2: Regression discontinuity estimates on annual mental health medicine purchases using different bandwidths, together with 90% confidence intervals for cohorts 1977–1986.



(a) Women



(b) Men

Figure A.2.3: Histogram for cohorts 1977–1986, separately for men and women and with a bandwidth of 10.